2013 Update of the Hawaii Water Reuse Survey and Report

Prepared For
Department of Land and Natural Resources
Commission on Water Resource Management

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THE LIMTIACO CONSULTING GROUP
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Exhibit 15

2013 UPDATE OF THE HAWAII WATER REUSE SURVEY AND REPORT

State of Hawaii

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LIST OF ABBREVIATIONS

Abbreviation	Definition
%	Percent
ADC	Agribusiness Development Corporation
BG	Billion Gallons
BOD	Biochemical Oxygen Demand
CDBG	Community Development Block Grant
CSC	Coastal Services Center
CWG	Community Working Group
CWRM	State of Hawaii, Department of Land and Natural Resources, Commission on Water Resources Management
DES	City and County of Honolulu, Department of Enterprise Services
DHHL	State of Hawaii, Department of Hawaiian Home Lands
DOE	State of Hawaii, Department of Education
DOH	State of Hawaii, Department of Health
DOT	State of Hawaii, Department of Transportation
DPR	City and County of Honolulu, Department of Parks and Recreation
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
ft	Foot/Feet
FY	Fiscal Year
GBI	Goodfellow Brothers Incorporated
gpd	Gallons per Day
HAR	Hawaii Administrative Rules
HARC	Hawaii Agriculture Research Center
HBWS	City and County of Honolulu, Board of Water Supply
HC&S	Hawaii Commercial & Sugar Company
HECO	Hawaiian Electric Company
HDPE	High Density Polyethylene
HWD	County of Hawaii, Wastewater Division
IRWD	Irvine Ranch Water District
KDWM	County of Kauai, Division of Wastewater Management
KLC	Kikiaola Land Company
MBR	Membrane Bioreactor
MBBR	Moving Bed Bioreactor
MCBH	Marine Corps Base Hawaii
MG	Million Gallons
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
mL	Milliliters
MLP	Maui Land & Pineapple Company
MWWRD	County of Maui, Wastewater Reclamation Division
NOAA	National Oceanic and Atmospheric Administration

LIST OF ABBREVIATIONS (Continued)

Abbreviation	Definition
OCWD	Orange County Water District
PVC	Polyvinyl Chloride
PWED	Public Works and Economic Development Program
R-O	Reverse Osmosis
R&T	Research & Technology
SRF	State Revolving Fund
State	State of Hawaii
Title XVI	Title XVI, The Reclamation Wastewater and Groundwater Study and Facilities Act of 1992
TSS	Total Suspended Solids
USACE	Army Corps of Engineers
USDA	U.S. Department of Agriculture
UV	Ultra-violet
WF-21	Water Factory 21
WRF	Water Reclamation Facility
WWB	State of Hawaii, Department of Health, Wastewater Branch
WWRF	Wastewater Reclamation Facility
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

Water reuse is well established in Hawaii and it continues to play an important role in sustaining our State's water resources. There are numerous benefits associated with water reuse including preservation of water supplies and the reduction of wastewater effluent disposal practices that may be detrimental to the environment. Despite these benefits, the annual volume of recycled water beneficially reused in Hawaii has not substantially increased since 2004, when the original Water Reuse Survey and Report was developed. Nearly nine years later, this report provides an update by describing current recycled water usage, opportunities, and challenges in Hawaii.

Various qualities of recycled water identified by the Department of Health are produced at municipal and private wastewater reclamation facilities for reuse throughout Hawaii's counties. The County of Maui's Wastewater Reclamation Division and the City and County of Honolulu, Board of Water Supply are the most progressive municipal agencies with regards to water reuse and have invested heavily in their programs. Both agencies have near and long-term plans to expand their programs. The County of Kauai also has made significant strides in recent years by upgrading two of its wastewater reclamation facilities to tertiary treatment capability and by implementing a plan to develop a recycled water distribution system. Water reuse on the island of Hawaii occurs primarily at private resort areas.

Table 1: Recycled Water Use by County

	County of Maui	City and County of Honolulu	County of Kauai	County of Hawaii
R-1 (mgd)	3.03	6.54	1.72	0.71
R-2 (mgd)	0.05	1.48	1.29	0.60
R-3 (mgd)	< 0.01	0	0	0
R-O (mgd)	0	1.74	0	0
TOTAL	**3.08**	**9.76**	**3.01**	**1.31**

Traditionally, golf course irrigation has been the most common application for recycled water; however, the realm of applications has diversified over the years and continues to have more potential for growth. The number of landscape irrigation projects in urban areas has greatly increased since 2004 with the availability of higher quality recycled water. Use of recycled water in industry has also grown. Agricultural irrigation with recycled water is ongoing but limited; however, this application has great potential for expansion, since large volumes of water are needed to irrigate crops. In order to boost Hawaii's self-sufficiency by locally growing more produce, the State legislature has committed funding for U.S. Department of Agriculture projects. Recycled water has received attention in the State of Hawaii's 2013 Legislative session where House Resolution No. 187 and House Concurrent Resolution No. 232 (Appendix B) were introduced, which would establish a task

force to study and make recommendations on the reuse of R-1 water for agricultural purposes in Central Oahu.

Table 2: Statewide Recycled Water Use by Application

Use	Quantity (mgd)
Golf Course	12.35
Industrial	1.74
Agricultural	1.56
Landscaping	1.06
Other (e.g., construction, composting, etc.)	0.35

Obstacles exist that can delay or prevent water reuse projects from being implemented, but they are not insurmountable. Public acceptance is a critical component for the success of all water reuse projects and it is highly recommended that a proactive and concerted effort be placed on educating the community, politicians, administration officials, and local farmers about the safety of recycled water and the reasons why water reuse projects need to be developed.

The price of recycled water should be set to encourage its use; it should not be more expensive than other water sources. The cost to construct water reuse projects is significant, but there are several funding sources that can be tapped. Priority is now being placed on reserving low interest State Revolving Fund monies for water reuse projects. The Reclamation Wastewater and Groundwater Study and Facilities Act of 1992 Program can contribute significantly to funding water reuse projects. Also, the Bureau of Reclamation's Title XVI Program can provide financial and technical assistance to eligible reuse projects in Hawaii. Since water reuse addresses effluent supply and disposal issues, a broad customer base could be tapped to pay for operation, maintenance and debt service associated with water reuse projects. These customers could include sewer users, potable water users, property tax payers, the visitor industry, and new developments. Some new developments are already being required to contribute to water reuse project improvements. The designation of a water reuse program coordinator can focus efforts toward identifying and implementing new water reuse initiatives.

Discussions at the November 2012 Hawaii Water Reuse Conference strongly suggest the outlook of Hawaii's recycled water industry (producers, users and regulators) is as positive as ever. In addition to documenting current usage, this updated report identifies challenges and provides recommendations to advance recycled water usage in Hawaii.

1. INTRODUCTION

1.1. Commission on Water Resource Management Policy on Water Reuse

The Commission on Water Resource Management's (CWRM) policy is that water should be put to its best and highest use and the quality of the water supply should be matched to the quality of water needed. Operationally, this means that potable water should be used for drinking water purposes and other domestic needs, and non-potable water should be used for agriculture, landscape and golf course irrigation, and other non-potable needs. But, the Water Code does not preclude potable water from being used for non-potable purposes, if the proposed use meets the regulatory requirements and there are no practical non-potable alternatives.

It is also the policy of the CWRM to promote the viable and appropriate reuse of recycled water insofar as it does not compromise beneficial uses of existing water resources. CWRM does not have the authority to mandate recycled water use. In Water Management Areas, CWRM may require the installation of dual-line plumbing systems, and furthermore, it may deny an application for use of public trust resources if an alternate source, such as recycled water, is available.

The Hawaii State Department of Health (DOH) has jurisdiction and authority over wastewater reclamation and reuse in Hawaii. In matters of water quality and public health and safety, CWRM defers to the authority and expertise of the DOH, which administers State water quality and protection programs.

1.2. The Expanded Role of Water Reuse in Hawaii

Hawaii's population continues to grow as urban development is spreading throughout the main islands of the Hawaiian archipelago. Concerns over where future water supplies may be obtained from as well as the environmental impacts of treated wastewater once it is disposed of are prompting City, County, and State agencies throughout Hawaii to take a closer look at water reuse opportunities. Throughout this report, the terms "water reclamation", "recycled water", and "water reuse" will be frequently used. The standard definitions of these terms are as follows: "water reclamation" is the treatment of wastewater to make it usable, "recycled water" is the end product of water reclamation, and "water reuse" is the beneficial use of recycled water.

Water reuse addresses both water supply and wastewater disposal concerns; because of these benefits, it is now being viewed as a key opportunity for future developments. Many of the water use plans being prepared by both municipal and private water purveyors throughout the State indicate that, in some areas of the State, inexpensive water sources have already been developed and that future water resources will be more difficult and expensive to obtain. These plans indicate that aggressive water conservation programs, combined with the increased use of

recycled water, can significantly contribute towards sustainable water resource management in many of Hawaii's communities. For example, the draft Central Maui Water Use and Development plan prepared in 2009 states that in conjunction with standard water conservation programs, the expansion of the County of Maui's R-1 recycled water distribution system from the Kihei Wastewater Reclamation Facility (WWRF) to the Wailea area of south Maui could displace enough potable water to defer the need to develop other water supply resources in the region until the year 2018 or 2019 (Freedman, 2009).

Tightening discharge requirements for treated wastewater also play an important role in driving water reuse programs in Hawaii. The United States Environmental Protection Agency (EPA) is requiring the City and County of Honolulu to upgrade many of its wastewater facilities to meet secondary treatment standards. These facilities have been granted a waiver from the requirements of the Clean Water Act (commonly referred to as the 301(h) waiver) for many years. The EPA is also requiring Maui County to upgrade the quality of effluent it discharges to injection wells located at the Lahaina WWRF to meet the DOH R-1 water disinfection requirements for fecal coliform (EPA, 2011). These requirements stem from concerns that effluent disposed in nearshore injection wells may leach into the ocean and affect public health. It is possible that other wastewater facilities in the State that rely on injection wells for effluent disposal will be required to meet this stringent discharge requirement in the future. A result of regulatory mandates requiring higher quality effluent standards is that more recycled water will be made available for water reuse. Opportunities to utilize this high quality recycled water need to be explored and, if technically and economically feasible, included in regional water supply strategies.

Since the Department of Health, Wastewater Branch (WWB) established its *Guidelines for the Treatment and Use of Recycled Water* in 1993, water reuse activities within the State have gradually increased. Promoting the safe use of recycled water is one of the DOH's highest priorities. Water reuse can greatly assist in meeting water requirements of the State, enhance the environment, and benefit public health by preserving resources upon which public health protection is based (WWB, 2002, p. 1). County governments are also requiring developers to either contribute funds toward improving recycled water production and distribution capabilities at existing centralized wastewater reclamation facilities, or to construct their own wastewater reclamation facilities. By building and operating their own wastewater facilities, these developments will be more sustainable since they will be able to reclaim and reuse their own wastewater within their properties for landscape irrigation or other purposes. Potential negative impacts of the effluent disposed of by these developments will also be reduced by implementing water reuse projects.

1.3. Project Objective

The primary objective of this report is to provide the CWRM with the most current information regarding the use of recycled water in Hawaii. This report shall provide an update of an earlier report – the *2004 Hawaii Water Reuse Survey and Report* – that was prepared for the CWRM. A major goal of this report is to identify the location and availability of recycled water sources and potential water reuse sites so that the CWRM can make informed decisions that will assist in the appropriate utilization of recycled water in the State. This report will also help identify trends that have occurred over the last 9 years, in hopes of forecasting future trends.

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2. OVERVIEW OF WASTEWATER RECLAMATION AND WATER REUSE IN HAWAII

This chapter will provide a brief overview of water reuse activity within the State of Hawaii (State). Included in this discussion will be:

- The most common uses of recycled water in the State,
- The current state of reuse within each county,
- A step-by-step description of the various treatment processes needed to produce R-3, R-2, and R-1 quality water, and
- Information pertaining to the State's water reuse guidelines and existing county rules for recycled water service.

2.1. Current View and Recent Growth of Water Reuse Activities in Hawaii

Water reuse has been well established in Hawaii for many years; the pioneering use of recycled water was irrigation of sugar cane fields in Waialua, Oahu, in 1928. There have since been successful projects on all of the populated islands throughout the State (Parabicoli, 1997). Traditionally, recycled water has been used in Hawaii for irrigation of golf courses and agriculture. While golf course irrigation continues to be a major use for recycled water, the decline of large scale sugar cane and pineapple cultivation has led to a decline in the use of recycled water for agricultural irrigation. As upgrades at Hawaii's wastewater reclamation facilities have improved the quality of recycled water, progressively more recycled water is being used to irrigate urban areas, such as schools, parks, shopping centers, and residences. Industrial use of recycled water has also increased.

The City and County of Honolulu, Board of Water Supply (HBWS) and the County of Maui, Wastewater Reclamation Division (MWWRD) have built water reuse programs that employ program coordinators to implement public outreach. Rules and rate structures for recycled water service have also been established by the County of Maui. Both agencies continue to gradually add new customers as recycled water production and distribution systems are expanded.

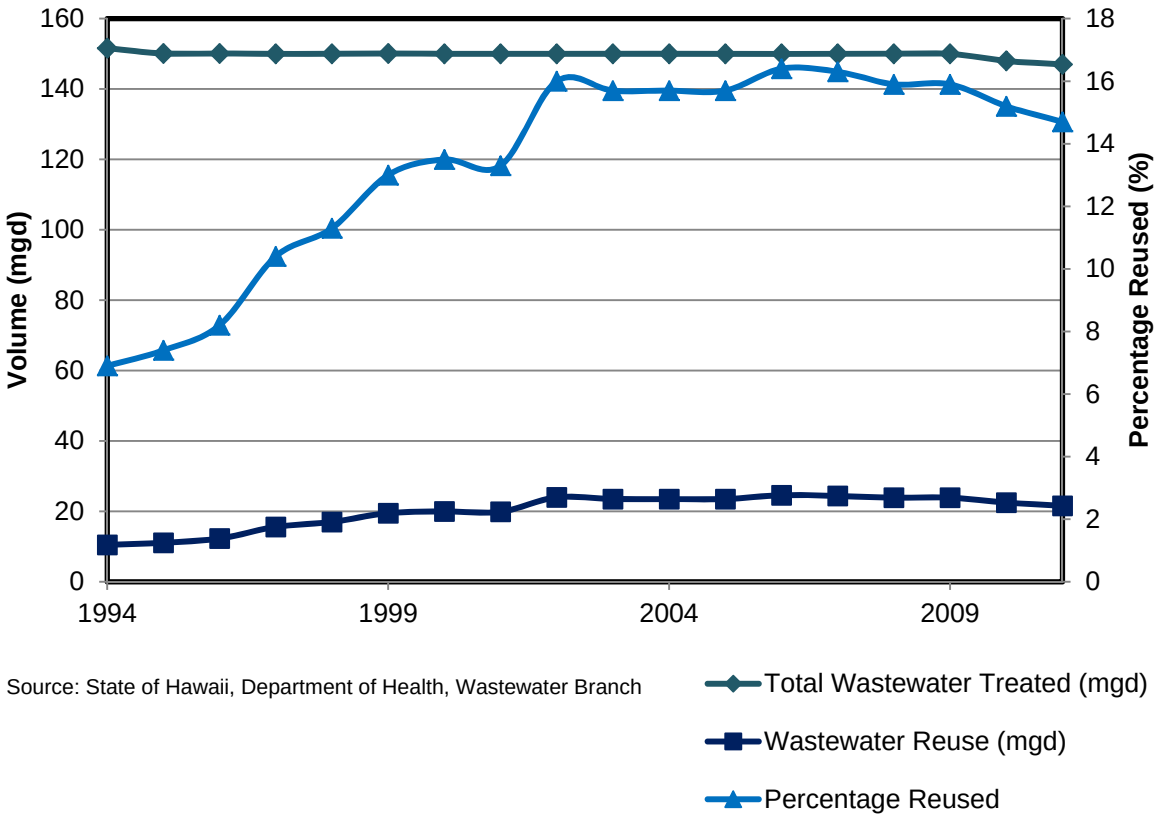
The County of Kauai, Division of Wastewater Management (KDWM) is in the process of developing a structured water reuse program. However, the proximity of wastewater reclamation facilities to agricultural operations and golf courses has stimulated use of a high percentage of Kauai's recycled water. Additionally, upgrades to both municipal and private treatment facilities in recent years have boosted the production of higher quality recycled water, making it more acceptable for use at neighboring commercial properties.

The County of Hawaii, Wastewater Division (HWD) currently handles the county's water reuse matters; however, a full-fledged reuse program has not been developed.

Most of the water reuse activity on the island of Hawaii occurs at private resort developments where recycled water is primarily used for golf course irrigation.

The WWB estimates the volume of wastewater treated and reused per day in Hawaii. **Figure 2-1** depicts the volume of wastewater treated and reused in Hawaii since 1994.

Figure 2-1: Total Statewide Wastewater Treatment and Reuse FY1994 - FY2011



Source: State of Hawaii, Department of Health, Wastewater Branch

The data in **Figure 2-1** was obtained from the WWB, and is based on recycled water use applications rather than actual water use data. The flows are often overestimated, and do not always accurately represent the actual amount of water reused by each project. However, **Figure 2-1** indicates a general pattern of increasing recycled water use from 1994 through 2002, followed by a plateau in usage. An important objective of this report is to determine with greater accuracy the volume of wastewater treated and reused on an average daily basis. True water reuse opportunities can be identified only after the current and future plans for each treatment plant are understood.

Recycled water is now used in Hawaii for many applications. The WWB has identified a few basic project types: irrigation (landscape and agriculture), industrial uses, dust control, and other emerging uses such as toilet flushing. **Table 2-1** shows the volume of recycled water per day utilized for the basic project types for the year 2011, as was reported to the WWB.

Table 2-1: Hawaii Water Reuse Projects, Year 2011

Project Type	2011 Volume (mgd)
Irrigation	29.18
Industrial Uses	1.34
Dust Control	0.13
Other Uses	0.05

Source: State of Hawaii, Department of Health, Wastewater Branch

The level of treatment drives the way recycled water may be used; higher quality recycled water may be used in more ways. The following sections of this chapter describe the wastewater reclamation process, recycled water classifications, and allowable uses.

2.2. The Wastewater Reclamation Process

As defined in Chapter 1, wastewater reclamation is the treatment of wastewater to make it reusable. Recycled water (also referred to as reclaimed water) is the end product of wastewater reclamation. Water reuse is when recycled water is used for beneficial purposes.

Wastewater reclamation is a multi-step process in which a variety of treatment methods are employed in series to improve wastewater quality, resulting in recycled water. Each WWRF is designed for the individual needs of the area it serves. The process described in this section may not represent every WWRF, but it does describe the typical wastewater reclamation process. The treatment process described in this section is visualized in **Figure 2-2**.

Preliminary Treatment

The treatment process typically starts with the removal of large debris and grit bar racks, bar screens, comminutors, or grit chambers. This step is commonly referred to as preliminary treatment.

Primary Treatment

Next, primary treatment continues in the removal of solids and organic material through settling in a primary clarifier tank. National levels of primary treatment are set at a 30 percent (%) reduction of Total Suspended Solids (TSS) and Biochemical Oxygen Demand (BOD). However, after primary treatment, the quality of the treated wastewater is not yet at a level where it is allowed for reuse according to the *Guidelines for the Treatment and Use of Reclaimed Water* (DOH, 2002).

Secondary Treatment

The next step is secondary treatment, which must achieve an 85% reduction and concentrations of less than 30 milligrams per liter (mg/L) for both BOD and TSS. This reduction is achieved through oxidation (also known as biological treatment), additional settling, or sometimes filtration. Secondary treatment (particularly the oxidation process) becomes more involved and requires operators to manage populations of helpful "bugs", a diverse mix of microorganisms like bacteria, protozoa, ciliates, and worms that essentially eat the organic material in wastewater. Bacteria are the most important microbial group and are responsible for most of the BOD and TSS removal associated with secondary treatment. Some nitrogen removal often occurs during secondary treatment when ammonia in wastewater undergoes nitrification then denitrification. The end product of secondary treatment is R-3 quality recycled water.

A variety of secondary treatment methods have been developed, and will be discussed throughout this report. Descriptions of common methods currently utilized in Hawaii are provided in Appendix D.

This aeration basin uses activated sludge – one type of secondary treatment method – to treat wastewater.

Tertiary Treatment

Advanced treatment after secondary treatment creates higher quality recycled water suitable for a wider variety of applications. Advanced treatment (called tertiary treatment) can include additional filtration and disinfection to reduce pathogen levels. Sand filters are often used for filtration, while disinfection can be achieved by using ultra-violet (UV) light, ozone, or chlorine. Additional nutrient removal is sometimes pursued during tertiary treatment through the use of chemical precipitation, denitrifying filters or through uptake by flora in treatment lagoons or constructed wetlands. However, there is a benefit to retaining the nitrogen and phosphorous in recycled water as these compounds act as fertilizers if the recycled water is used for irrigation.

Membrane Bioreactor (MBR) technology is a secondary treatment method for domestic and industrial wastewater that utilizes a combination of concentrated activated sludge and membranes to produce very high quality effluent. Commonly referred to as “permeate”, MBR effluent is extremely low in suspended solids, turbidity and BOD and is efficiently disinfected to R-1 recycled water quality. Advantages of MBRs are that they produce exceptional quality effluent, they are compact and can fit into small areas (secondary clarifiers and effluent filtration are not required), and they can be retrofit into wastewater reclamation facilities with conventional secondary treatment systems. A disadvantage of MBRs is that they use more electrical power than most of the other secondary treatment methods. The two most common types of membranes are flat plates and hollow fibers.

The end product of tertiary treatment is R-2 or R-1 recycled water, depending on the extent of disinfection. The specific DOH requirements of R-1, R-2, and R-3 water are discussed in **Section 2.3.1** and are shown in **Figure 2-2**.

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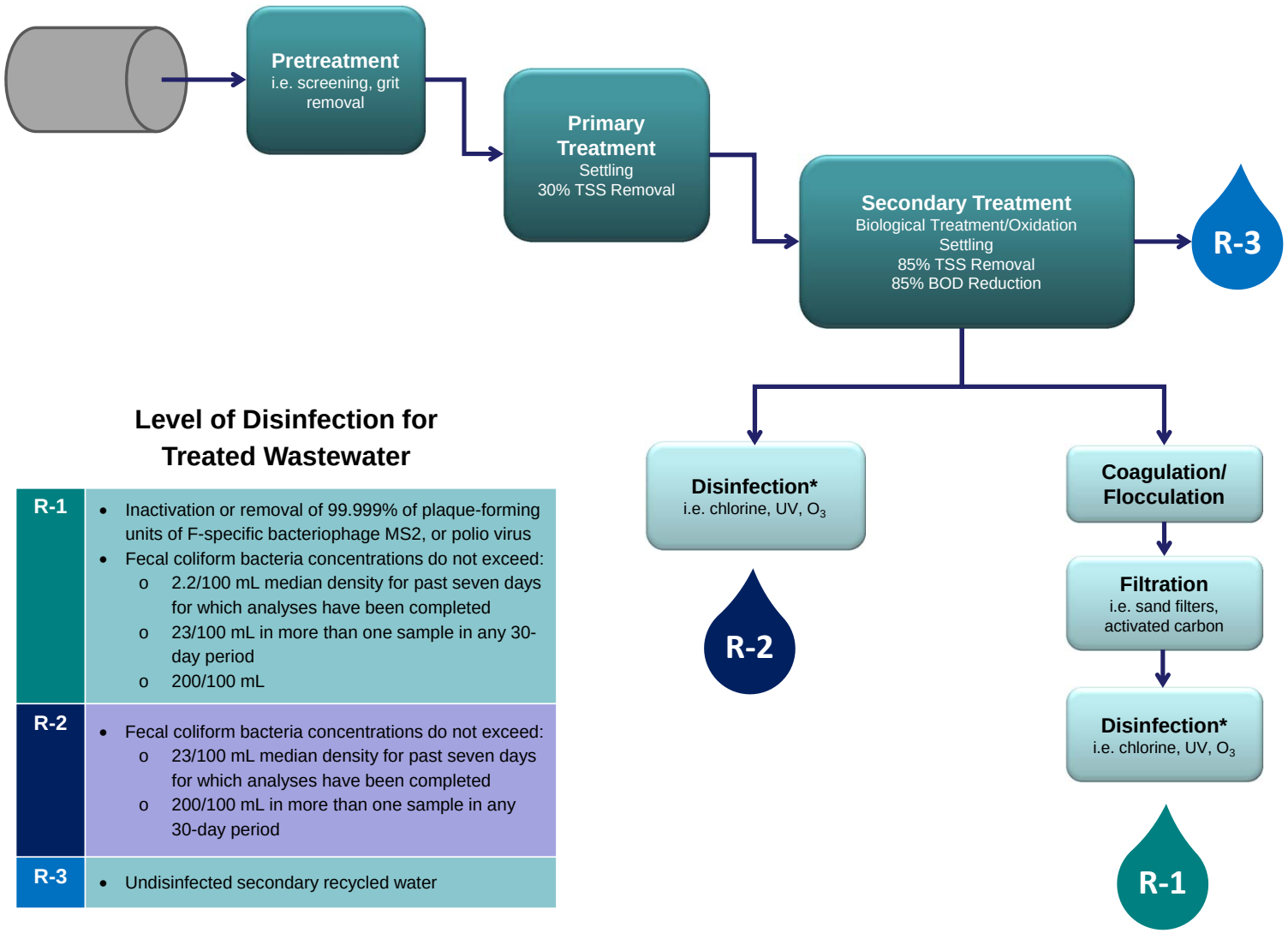

Level of Disinfection for Treated Wastewater

R-1	• Inactivation or removal of 99.999% of plaque-forming units of F-specific bacteriophage MS2, or polio virus • Fecal coliform bacteria concentrations do not exceed: o 2.2/100 mL median density for past seven days for which analyses have been completed o 23/100 mL in more than one sample in any 30-day period o 200/100 mL
R-2	• Fecal coliform bacteria concentrations do not exceed: o 23/100 mL median density for past seven days for which analyses have been completed o 200/100 mL in more than one sample in any 30-day period
R-3	• Undisinfected secondary recycled water

STATE OF HAWAII
Commission on Water Resource Management
Department of Land & Natural Resources

2013 STATEWIDE WATER REUSE SURVEY AND REPORT

FIGURE 2–2

Wastewater Treatment Process

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2.3. The State of Hawaii's Guidelines for the Treatment and Use of Recycled Water

The DOH issued the *Guidelines for the Treatment and Use of Reclaimed Water* in November, 1993 and updated the Guidelines in May, 2002. The Guidelines are now referred to as the *Guidelines for the Treatment and Use of Recycled Water* (herein, simply referred to as the "DOH Guidelines"), and they identify the requirements for both the purveyors and the users of recycled water. The DOH Guidelines have now been incorporated into Chapter 11-62 of the Hawaii Administrative Rules (HAR). The DOH plans to solicit input from stakeholders in 2013 and once again update the DOH Guidelines.

2.3.1. Recycled Water Classifications, Definitions and Allowable Uses

The DOH Guidelines define three classes of recycled water: R-1, R-2, and R-3. A complete list of the allowable uses of recycled water is summarized in Chapter III of the DOH Guidelines – Uses and Specific Requirements for Recycled Water. **Table 2-2** summarizes the allowable uses and treatment/quality requirements of all recycled water categories.

R-1

R-1 water is tertiary-treated recycled water that has undergone a significant reduction in viral and bacterial pathogens. As defined by the DOH Guidelines, R-1 water is recycled water that is at all times oxidized, then filtered, and then exposed, after the filtration process, to:

A. A disinfection process that, when combined with the filtration process, has been demonstrated to inactivate and/or remove 99.999% of the plaque-forming units of F-specific bacteriophage MS2, or polio virus in the wastewater. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of demonstration; and
B. A disinfection process that limits the concentration of fecal coliform bacteria to the following criteria:
    1. The median density measure in the disinfected effluent does not exceed 2.2 per 100 milliliters (mL) utilizing the bacteriological results of the last seven days for which analyses have been completed, and
    2. The density does not exceed 23 per 100 mL in more than one sample in any 30-day period, and
    3. No sample shall exceed 200 per 100 mL.

R-1 water can be utilized for spray irrigation without restrictions on use. It is approved for a number of applications including spray irrigation of golf courses, parks, athletic fields, school yards, residential properties where

managed by an irrigation supervisor, road sides/medians, and for vegetables and fruits that are eaten raw. The number of projects in Hawaii utilizing R-1 water has increased significantly in recent years. The *2004 Hawaii Water Reuse Survey and Report* indicated 36 R-1 water reuse projects in the State, while 63 R-1 water use projects were surveyed for this report.

R-2

R-2 water is disinfected secondary treated recycled water. As defined by the DOH Guidelines, R-2 water means recycled water that has been oxidized and disinfected to meet the following criteria:

A. Fecal coliform bacteria densities as follows:
    1. The median density measured in the disinfected effluent does not exceed 23 per 100 mL utilizing the bacteriological results of the last seven days for which analyses have been completed, and
    2. The density does not exceed 200 per 100 mL in more than one sample in any 30-day period.

When using R-2 water, spray irrigation is limited to evening hours and a 500-foot (ft) buffer zone between the approved use area and adjacent properties is required. Several golf courses in Hawaii are irrigated with R-2 water, although some are exempt from the 500-ft buffer zone requirement because they existed before the DOH Guidelines were established. This exemption is referred to as “The Grandfather Clause”. Irrigation of food crops with R-2 water must be via a subsurface irrigation system, or if spray irrigation is used, the crops must undergo extensive commercial, physical, or chemical processing determined by the DOH to be sufficient to render it free of viable pathogenic agents prior to human consumption.

R-3

R-3 water is secondary treated recycled water that is not disinfected. There are severe limitations on its use.

Reverse Osmosis (R-O)

R-O water is wastewater that has undergone secondary treatment and then is purified through reverse osmosis. Since R-O water is not disinfected, it is technically classified as R-3 water by the DOH, despite the fact that it is essentially pathogen free water.

Alternative Storage or Disposal

In order for recycled water to be certified by the DOH, reuse systems must include backup storage or alternate disposal to prevent overflows or discharges when irrigation systems are not in operation (such as during wet

weather) or when effluent quantities exceed irrigation requirements. Alternate disposal systems such as injection wells or outfalls, are also required to dispose of effluent that is "off-spec"; meaning that the quality does not meet the recycled water standards established by DOH.

Wastewater Reclamation Facility Compliance (Grandfather Clause)

All WWRFs that purvey recycled water must meet the recycled water quality standards established by the 1993 DOH Guidelines. However, WWRFs constructed prior to the passage of the 1993 Guidelines may have certain components of their treatment system "grandfathered," making them exempt from the 1993 Guidelines. For example, the County of Maui's Lahaina WWRF's UV disinfection system was designed and constructed prior to the 1993 Guidelines. The UV system does not have the backup capacity required by the Guidelines so it was "grandfathered" by DOH since it was approved prior to 1993.

The DOH reports that throughout the State, there are now fifteen R-1 water facilities producing 13.4 million gallons per day (mgd), fourteen R-2 water facilities producing 6.14 mgd and three R-3 facilities producing 0.6 mgd.

Figure 2-3: Total Statewide Recycled Water Production

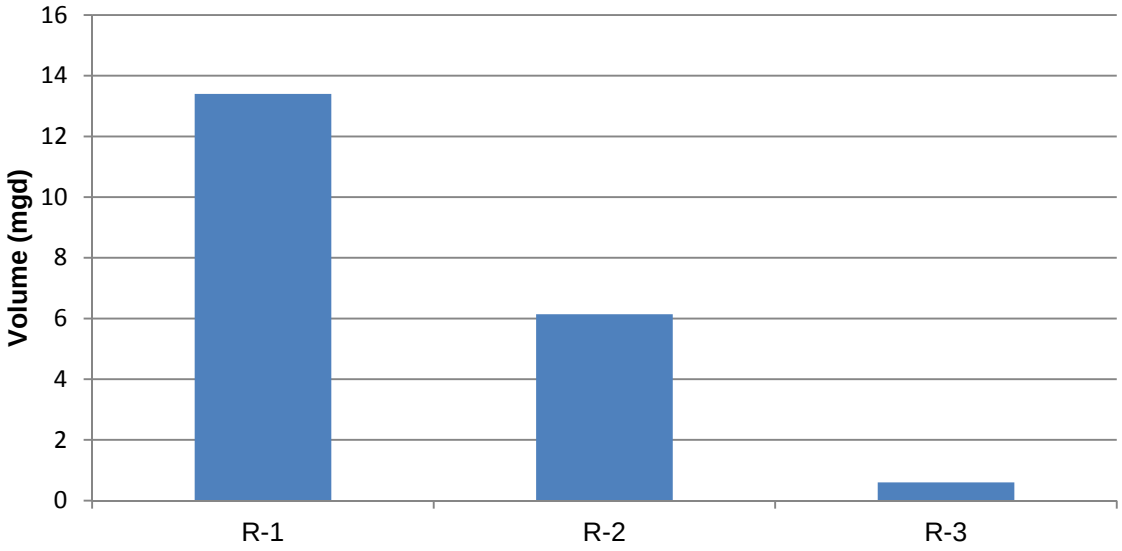

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Table 2-2: Summary of DOH Guidelines for the Treatment and Use of Recycled Water

Recycled Water Category and Treatment/Quality Requirements	Suitable Uses
R-3 water is secondary-treated wastewater that is not disinfected and meets the following: 1. 85% TSS Removal 2. 85% BOD removal	1. Surface, drip, subsurface irrigation of: a. Feed, fodder and fiber crops, and pasture for animals not producing milk for human consumption. b. Non-food bearing tree provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting or allowing access by the general public. c. Seed crops that are not eaten by humans. d. Orchards and vineyards where the recycled water does not come into contact with the edible portion of the crop. e. A food crop, which must undergo extensive commercial, physical or chemical processing, determined by the DOH to be sufficient to destroy pathogens prior to human consumption. This is allowed no later than 30 days before harvest. 2. Surface or drip irrigation of ornamental nursery stock and sod farms provided no irrigation with recycled water occurs for a period of 14 days prior to harvesting, retail sale, or allowing access by the general public. 3. Application within a reclamation facility for the following a. Non-spray irrigation of landscape not contacted by the general public; b. Polymer dilution water; c. Mechanical seal water for gas compressors; d. Cooling water for gas compressors and internal combustion engines; e. Dilution water for chlorination; f. Mechanical seal water and cooling water for sludge pumps; g. Heat exchangers: air, water and oil cooling; h. Odor and gas absorption; i. Centrifuge flushing; and j. Flushing grit and sludge pipes. 4. Other uses as approved by the DOH.
R-2 water is secondary-treated wastewater that is oxidized and disinfected to meet the following fecal coliform bacteria densities:	1. Purposes cited under R-3 water. 2. Subsurface irrigation: a. Landscape and turf on parks and elementary school yards. b. Residential property where managed by an irrigation supervisor.

1. The median density measured in the disinfected effluent does not exceed 23 per 100 mL utilizing the bacteriological results of the last seven days for which analyses have been completed. 2. The density does not exceed 200 per 100 mL in more than one sample in any 30-day period.	c. Golf Courses d. Vineyards and orchards (e.g., banana, papaya). e. Food crops that are above ground and not contacted by recycled water. f. Pastures for milking and other animals. 3. Any form of irrigation for: a. Fodder crops (e.g., alfalfa) and fiber crops. b. Sod not installed by the general public. c. Trees grown for timber or firewood, and Christmas trees, whether or not the general public harvests them. d. Trees and vines that do not have food crops on them when irrigated. e. Seed crops that are not eaten by humans. f. Food crops which must undergo extensive commercial, physical or chemical processing determined by the DOH to be sufficient to render it free of viable pathogenic agents prior to human consumption. g. Landscape on cemeteries, and around freeways. h. Other landscape vegetation and non-edible plants, allowed only where: ▪ The public would have access and exposure to irrigation water similar to that, which would occur along a freeway or on a cemetery. ▪ Access is controlled so that irrigated area cannot be used as if it were part of a park, school yard or athletic field. i. Landscaping of developments under construction, with no access by the public during establishment period, no overspray, and where workers use appropriate protective equipment and clothing. 4. Surface, drip or subsurface irrigation of ornamental plants for commercial use. This is allowed only if the plants are harvested above any portion contacted by recycled water. Subsurface irrigation shall be supplied for the growth of all material used in the production of leis or other flowers used in human apparel. 5. Use in an industrial process that does not generate mist, does not involve facial contact, and does not involve incorporation into food or drink for humans or contact with anything that will contact food or drink for humans. 6. Water jetting for consolidation of backfill material around underground pipelines except potable water pipelines. 7. Dampening soil for compaction at construction sites, landfills, and elsewhere.

	8. Washing aggregate and making concrete. 9. Dampening brushes and street surfaces during street sweeping. 10. A source of supply for a landscape impoundment without a decorative fountain. 11. Flushing sanitary sewers. 12. Such other uses as approved by the DOH.
R-1 water is secondary-treated wastewater that is oxidized, filtered, then disinfected to meet the following criteria: 1. A disinfection process, when combined with filtration, inactivates and/or removes 99.999% of plaque-forming units of F-specific bacteriophage MS2 or polio virus. A virus that is at least as resistant to disinfection as polio virus may be used for purposes of demonstration. 2. A disinfection process that limits the concentration of fecal coliform bacteria to the following criteria: a. The median density measure in the disinfected effluent does not exceed 2.2 per 100 mL utilizing the bacteriological results of the last seven days for which analyses have been completed.	1. Purposes cited under R-2 and R-3 water. 2. Any form of irrigation for food crops, including all edible root crops, where the recycled water comes into contact with the edible portion of the crop. 3. Any form of irrigation served by fixed irrigation system supplied by buried piping for turf and landscape irrigation of: a. Golf Courses; b. Parks, playgrounds, school yards, athletic fields; c. Residential property where managed by an irrigation supervisor; and d. Road sides and medians 4. Any form of irrigation for pasture where milking animals, and other animals graze. 5. Any form of firefighting from outdoor hydrants, fire trucks, or aircraft. 6. Cooling saws while cutting pavement. 7. Spray washing of electric insulators on utility poles. 8. High pressure water blasting to clean surfaces. 9. Drinking water for animals may be accepted if it will not be given to dairy animals, and the applicant demonstrates to the satisfaction of the DOH there will be no unreasonable risk of occurrence of adverse effects on the animal related to chemical constituents or radioactivity. 10. Supply for commercial and public laundries for clothing and other lines. 11. Industrial cooling in a system that does not have a cooling tower, evaporative condenser, or other feature that emits vapor or droplets to the open atmosphere or to air to be passed into a building or other enclosure occupied by a person. 12. Supply for addition to a cooling system or air conditioning system with a cooling tower, evaporative condenser, or other feature that emits vapor or droplets to the open atmosphere or to air to be passed into a building or other enclosure occupied by a person, when all the following shall occur: a. A high efficiency draft reducer is used and the system is maintained to avoid greater rate of generation of drift than that with which a high efficiency drift reducer is associated; b. A continuous biocide residual, sufficient to prevent bacterial population from exceeding 10,000 per mL, is maintained in circulating water; and

b. The density does not exceed 23 per 100 mL in more than one sample in any 30-day period. c. No sample shall exceed 200 per 100 mL.	c. The system is inspected by an operator, capable of determining compliance with this subdivision, at least once per day. 13. In the absence of one or more of the three conditions in Item 12 above, it is suitable for addition to such a cooling or air conditioning system when the purveyor of R-2 water uses has demonstrated to the satisfaction of the DOH that the probability of intestinal infection with virus will not exceed 1 in 10,000 under the specific conditions of use and that growth of Legionella will be controlled to avoid a concentration that could pose a significant hazard to health. 14. Industrial process that does not generate mist or facial contact with recycled water unless personal protective equipment is worn. 15. Water jetting for consolidation of backfill material around potable pipelines and for compaction of soil backfill above such pipelines. 16. Flushing toilets and urinals in types of buildings and institutions approved by the DOH and where counties have adopted a provision in their plumbing code pertaining to the use of a dual water supply within a building. 17. A source of supply for a decorative fountain if the recirculating water does not support growth of microorganisms from the surrounding environment that could infect either the respiratory or digestive systems of mammals. 18. A source of supply for: a. A restricted recreation impoundment; and b. Basins at fish hatcheries. 19. Washing of hard surfaces (e.g. parking lots and sidewalks). 20. Such other uses as approved by the DOH.

2.3.2. Requirements for Recycled Water Purveyors and Users

All projects that use recycled water must first receive DOH approval. The DOH approval process for most new projects requires that each project submit a Basis of Design Report, an Engineering Report, and construction plans of the recycled water transmission and irrigation systems. The full Basis of Design and Engineering Reports may be waived by the DOH for smaller reuse projects such as dust control and landscape irrigation areas less than five acres. Simplified application forms may be submitted to the DOH in lieu of an Engineering Report for smaller projects. A final inspection of each project by the DOH is also required prior to the commencement of recycled water use. Specific information pertaining to the submittal and approval process for typical water reuse projects is detailed below.

1. Submittals of Engineering Reports and Construction Plans to the DOH
    a. Basis of Design Report
        i. Water reclamation facility information
        ii. Approved use area information
        iii. Transmission and distribution system details
        iv. Design application rate
        v. Evaporation losses and precipitation gains
        vi. Maximum daily design percolation rate
        vii. Supplemental water supplies
    b. Engineering Report
        i. Irrigation plan
        ii. Management reuse plan
        iii. Public education plan
        iv. Employee training plan
        v. Vector control plan
        vi. Monitoring system construction report (if project over potable water aquifer)
    c. Construction Plans
        i. Compliance with design standards of the respective County Department of Public Works and Water System Standards
        ii. Identification and description of irrigation system components
        iii. Color coding of pipe and appurtenances

2. Construction Phase Approval
    a. Approval to Construct
        i. Issued by the DOH after review of Basis of Design Report, Engineering Report and Construction Plans for conformance w/ HAR 11-62 and the Reuse Guidelines

   b. Construction Inspections
      i. Transmission system inspection
      ii. Reuse system inspection
      iii. Layout inspection
      iv. Operation inspection

3. Operation Phase Approval
   a. Approval to Operate
      i. The DOH issues letter after satisfactory completion of construction inspections stating conformance with HAR 11-62 and the Reuse Guidelines
   b. Performance and Compliance Inspections
      i. The DOH conducts periodic O&M inspections on storage impoundments, distribution system and approve reuse areas
      ii. Review of records

Purveyors of recycled water are also required to keep operational records pertaining to the daily volumes and quality produced by the respective water reclamation facility (WRF). These records are subject to review by the DOH during annual operation and maintenance inspections of the respective water reclamation facilities.

2.3.3. County Rules Pertaining to Recycled Water Use

The County of Maui was the first county in Hawaii to establish its own rules for recycled water use. The *County of Maui Rules for Reclaimed Water Service* (referenced in this section as "Rules") were adopted in June 1997 and document requirements for the use of recycled water within Maui County. The DOH Guidelines, the State of Hawaii's Water System Standards and Chapter 11-62, HAR are incorporated into the Rules. The Rules include sections on establishing recycled water service, design standards for onsite and offsite recycled water facilities, operational guidelines, monitoring/enforcement provisions and fees/charges.

The MWWRD provides a copy of the Rules to each property manager or the designated consulting engineering firm of each property that will utilize recycled water. Payment of a connection fee is required upon submittal of the County of Maui's application for recycled water service. A permit for recycled water service is issued after a final inspection of the project is completed.

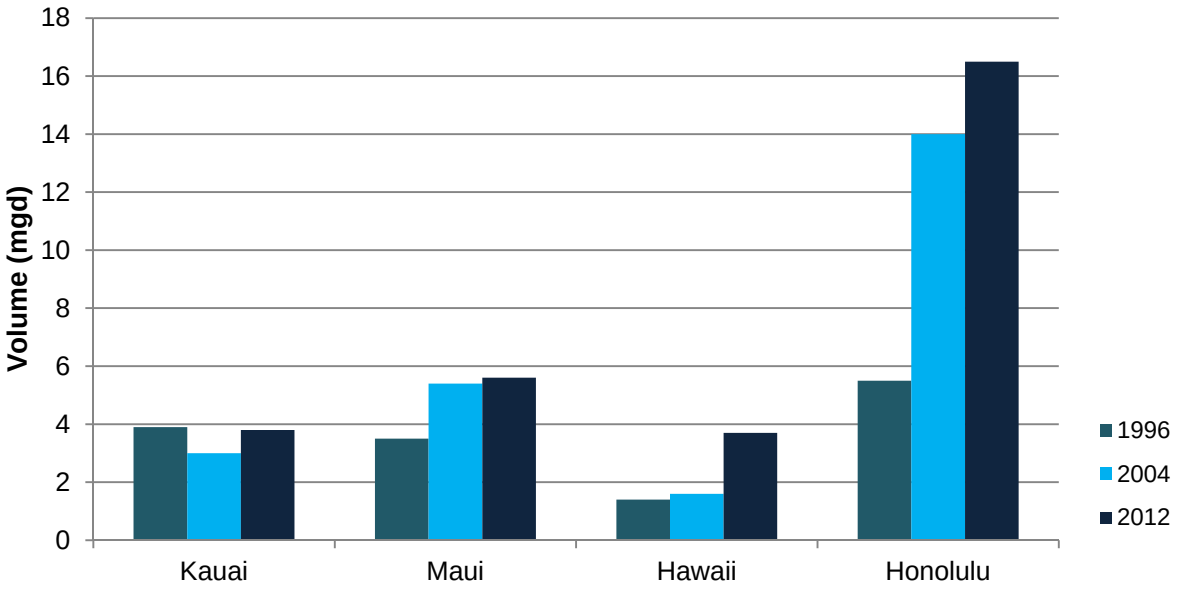
The County of Hawaii, County of Kauai, and City and County of Honolulu do not have separate rules for recycled water use, and defer to the DOH Guidelines.

3. COUNTY REUSE ACTIVITY AND PROJECT DESCRIPTIONS

3.1. County Reuse Activity

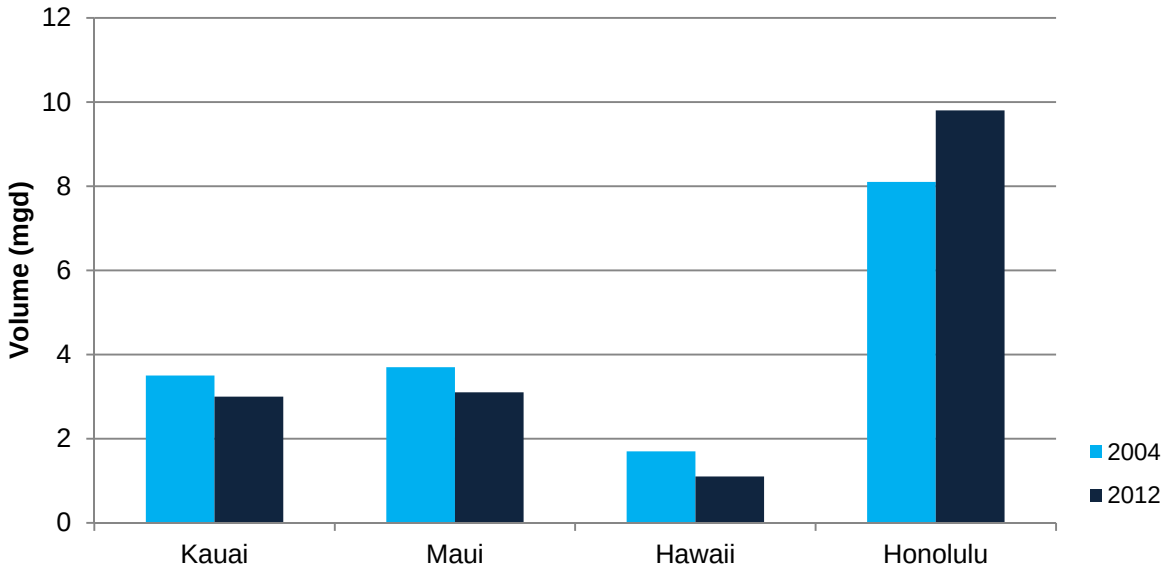
The State consists of four counties: the City and County of Honolulu (Oahu), the County of Maui (Maui, Lanai and Molokai), the County of Kauai, and the County of Hawaii (the Big Island). The approximate recycled water use volumes for each of the four counties in the years 1996, 2004, and 2012 are compared in **Figure 3-1**.

Figure 3-1: Reuse Activity Estimate Based on WWB Data - Years 1996, 2004 & 2012



The data in **Figure 3-1** is obtained from recycled water user applications submitted to the WWB. This WWB data generally shows a slow, steady growth of water reuse throughout the State. However, because the data is based on reuse applications, it was found that these reuse volumes were typically over-estimated when compared to reuse volumes obtained from our user surveys. Additionally, the WWB data includes some water reuse projects not currently in service (e.g., closed facilities, facilities not yet constructed, etc.). As a result, reuse volumes obtained during this survey – presented in **Figure 3-2** – are significantly less than reuse volumes indicated by the WWB.

Figure 3-2: Survey Based Reuse Activity Estimate - Years 2004 & 2012



Recycled water use volumes obtained for this survey were based on the best available data, which may differ by County and project. For example, data from County of Maui reuse projects was obtained directly from the MWWRD; thus, it is empirical data based on actual reuse volumes. However, data for the City and County of Honolulu was obtained from recycled water customers: this may take the form of empirical data from water bills or from knowledge of reuse project managers. WWB reuse application data was used when reuse volumes were unavailable or project managers were not willing to publicly share their reuse data.

While the number of reuse projects in both the County of Kauai and County of Maui has increased since 2004, the reported reuse volumes at many of the projects have decreased. **Figure 3-2** exhibits the overall decrease in reuse volumes; however, the decrease from 2004 is primarily due to overestimation by DOH, which also included volumes from temporary dust control projects on Maui that were no longer in operation. The slight drop in reuse in the County of Hawaii was expected: the Swing Zone Golf Facility in Kona discontinued using R-2 water from the County of Hawaii's Kealakehe WWRF because brackish groundwater could be obtained at a lower cost, and the Parker Ranch has indicated that it no longer uses recycled water from its private treatment plant.

3.2. County Government Water Reuse Program Descriptions

This section will provide detailed descriptions of the County-run water reuse programs (see **Section 3.3** for discussions about privately-run programs and projects). The County of Maui and the City and County of Honolulu have invested heavily towards the development of their water reuse programs, and both programs have been in place for several years. The County of Kauai does not have as structured a water reuse program as these two counties. However, in recent years, the KDWM has upgraded two of its facilities to R-1 water capability and is planning to develop an R-1 water distribution system in southwest Kauai. The County of Hawaii does not have a structured water reuse program; the HWD is currently responsible for matters involving water reuse.

3.2.1. The County of Maui's Water Reuse Program

The MWWRD is considered to be a water reuse leader in Hawaii. In 1990, Maui County developed a proactive plan to reuse millions of gallons of high-quality recycled water produced at its wastewater reclamation facilities. The vast majority of this water resource had been disposed into injection wells. To lay the foundation for the County's program, the following key components were initiated: water reuse feasibility studies, a community-based rate study, creation of a Water Recycling Program Coordinator position, upgrades to the County's Kihei (South Maui) and Lahaina (West Maui) wastewater reclamation facilities to R-1 tertiary treatment capability, passage of an ordinance which mandated the use of recycled water at commercial properties, adoption of rules for recycled water service, and the creation of a recycled water rate structure which recovers monies spent on distribution system development from both recycled water and sewer users.

Program Development

The initial reason for the development of Maui County's water reuse program was related to effluent disposal. The EPA and local environmental groups expressed concern that injection wells may contribute nutrients that cause algae blooms in coastal waters. In 1995, the EPA placed a limitation on the amount of effluent that could be disposed into injection wells at the County's Lahaina WWRF. This played a major role in the passage of a bill that led to the mandatory recycled water use ordinance on Maui: Chapter 20.30 *Use of Reclaimed Water* of the Maui County Code was established in 1995, and it requires improved commercial properties within 100 ft of the County's recycled water distribution system to connect to the system and utilize recycled water for irrigation purposes (Maui County, 1996, 1997 & 1998). The effluent disposal concern resulted in designation of the MWWRD as the County's only agency to fund, develop, and operate the County of Maui's water reuse program. As a result, sewer user fees are the major source of funds used to pay for expenses associated with the production and delivery of

recycled water. These expenses include debt service, operations, and maintenance-related costs. This strategy, while effective in the early stages of the water reuse program, has recently resulted in the County delaying the implementation of planned water reuse projects due to higher-priority sewer improvement projects. Since no other County of Maui agency has dedicated funds to support new water reuse project infrastructure, the development of necessary infrastructure to increase water reuse from County facilities has slowed considerably.

Effluent disposal continues to be the primary factor behind the County of Maui's water reuse program since most of its wastewater reclamation facilities rely on injection wells. Concerns have been expressed by the community about the potential detrimental environmental and health effects associated with the use of injection wells. Studies have been conducted by the United States Geological Survey (Hunt, 2006) and researchers from the University of Hawaii (Dailer, 2010) to determine the location, transport time, and any impacts on the coastal marine environment from potential pollutants in wastewater effluent injected at County wastewater reclamation facilities. A major concern is that un-disinfected injected effluent may be causing bacterial infections in ocean users. Concerns also have been expressed that the effluent could play a role in coral reef decline as well as feed invasive algal blooms.

In 2011, tracer studies were conducted on the Lahaina WWRF injection wells. Dye was used to detect a seep that was discharging effluent from the facility in the near shore waters off of the nearby Kahekili Park. As discussed in Chapter 1, the EPA (prompted by the west Maui community's concerns about injection wells contributing to bacterial infections in ocean users) entered into a consent agreement with the County requiring the quality of effluent disposed of into the Lahaina WWRF's injection wells be improved. The consent agreement stipulates that by December 31, 2013, all effluent flow (up to 9.0 mgd) must meet the DOH R-1 water disinfection requirements for fecal coliform. This will require the construction of additional UV treatment capacity. The EPA also proposed significant reductions in nitrogen loading to the facility's injection wells. By enacting these requirements, the EPA is strongly encouraging the County to reduce the use of injection wells for effluent disposal and increase the use of the recycled water from the Lahaina WWRF. The County has also been sued by local environmental and cultural organizations over the continued reliance on injection wells and has expended considerable resources dealing with these lawsuits.

A major driving factor behind the development of the County of Maui's water reuse program is that injection wells at Maui's wastewater reclamation facilities may be contributing to invasive algal growth and coral reef decline.

Potable Water Supply Benefits

Water supply is also an important factor driving the County of Maui's water reuse program as the island has limited supplies of available fresh water. The island's main water source, the Iao Aquifer, supplies most of Central and arid South Maui with potable water. Much of this water is used for landscape irrigation at parks, schools, condominiums, hotels, and single-family residences. Due to increasing development in these areas, the Iao aquifer is showing signs of over-pumping. Monitoring of the aquifer's wells indicated that chloride levels are increasing and fresh water levels are decreasing. In 2003, the CWRM designated the Iao Aquifer as a water management area. Designation requires that all withdrawals of water from the aquifer be permitted and closely monitored. Future withdrawals from the Iao Aquifer will be limited.

The MWWRD's water reuse program has resulted in a reduction in withdrawals from the Iao Aquifer. In fiscal year (FY) 2012, (July 2011 – June 2012), MWWRD's data indicates that its water reuse program resulted in over 1.2 billion gallons (BG) of recycled water use by projects which would otherwise be served by potable or brackish water sources. The program is undeniably supplementing Maui's limited potable water supplies.

The County of Maui's water reuse program is currently saving over 1.2 BG of potable and brackish water per year.

Recycled Water Infrastructure

The MWWRD reuses recycled water from all five of its facilities. Distribution systems have been developed in the South Maui and West Maui areas (as indicated in **Figure 3-3** and **Figure 3-4**). The South Maui area has more reuse projects due to its well-developed R-1 water production and distribution system, and the South Maui system now provides recycled water to 32 separate properties. An expansion of the South Maui system to Kihei Road is scheduled for 2013. This will result in more commercial properties converting to recycled water in the near future. Uses of recycled water include landscape irrigation, agricultural irrigation, fire control, industrial cooling, composting, construction activities, toilet/urinal flushing, and a source of drinking water for cattle.

The West Maui distribution system is limited due to a lack of sufficient recycled water storage, but it does service Maui County's largest water reuse project: the Kaanapali Resort. Up to 1.2 mgd of R-1 water is utilized by the resort for golf course and landscape irrigation. This system also provides R-1 water for landscape irrigation for two other commercial properties. All agricultural uses of R-1 water from the Lahaina WWRF ceased in 2006, when Maui Pineapple Company phased-out pineapple production in West Maui. A system expansion, to be completed by 2015, will increase the Lahaina

WWRF's R-1 water production and distribution capability and enable the facility to provide recycled water to condominiums and resorts in the Kaanapali area. R-1 water will also be made available to the State of Hawaii, Department of Hawaiian Home Lands' (DHHL) future commercial and industrial developments in the West Maui area for landscape irrigation purposes.

In central Maui, R-2 water is used primarily at the facility for irrigation of plant grounds and industrial purposes. R-2 water is also occasionally provided to contractors for dust control and other construction uses.

On Lanai, wastewater is processed to R-3 quality utilizing stabilization ponds. From there, the entire plant flow is sent to a privately-owned auxiliary WWRF where it is upgraded to R-1 quality and used for irrigation of The Experience at Koele golf course.

On the island of Molokai, the State of Hawaii, Department of Transportation (DOT) utilizes R-2 water from the County's Kaunakakai WWRF for landscape irrigation along the Mauna Loa Highway. R-2 water is also used at the facility for landscape irrigation and to fill sludge stabilization ponds. These ponds have become nesting spots for endangered Hawaiian birds, such as the Hawaiian Coot and Hawaiian Stilt.

Program Economics

Since effluent disposal was an important factor driving Maui County's water reuse program when developed in the early 1990's, the price of recycled water was set to encourage users to connect to the distribution system. The projected revenue from recycled water sales was not enough to recover all costs associated with the production and delivery of recycled water, so sewer user fees were slightly increased. Sewer users currently pay for approximately 75% of the program's costs. Enabling legislation was also required, thus Chapter 20.30 *Use of Reclaimed Water* of the Maui County Code was established. Chapter 20.30 defines the various recycled water user classes, and recycled water rates and fees are set in the annual County budget. **Table 3-1** depicts these user classes with the original recycled water rates set in 1996 compared to alternative water sources' subsequent rates at that time. Also shown are the 2012 recycled water rates for the various user classes.

Table 3-1: Alternative Source and Recycled Water Rates

Consumer Class	Alternative Source and 1996 Rates (per 1,000 gallons)[1]	1996 Recycled Water Rates (per 1,000 gallons)	2012 Recycled Water Rates (per 1,000 gallons)
Major Agriculture	Surface ditch water: $0.12	$0.10	$0.15
Agriculture (including golf courses)	Brackish groundwater: $0.24	$0.20	$0.33
All Others	Agricultural potable water: $0.62	$0.55	$1.28

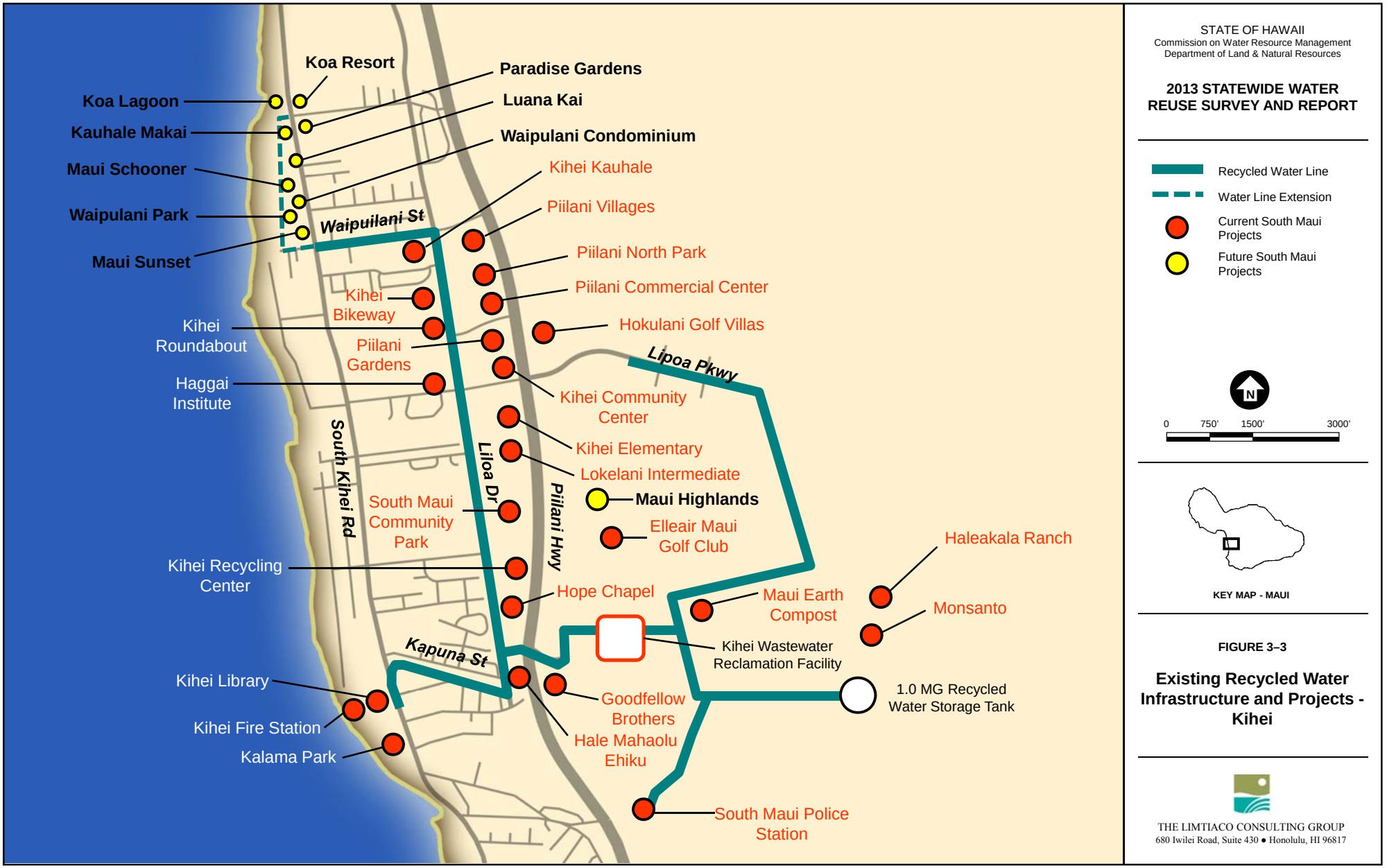
1- Alternative source and 1996 rates are obtained from the report *County of Maui – Rate and Fee Alternatives for Reclaimed Water Service* (Brown and Caldwell, 1995)

An "Avoided Cost" customer classification was later added which allows the County to match the rate a consumer previously spent on their non-potable water source. Connection fees for South and West Maui were also established at this time. To "kick start" the program, connection fees were waived for the first two years of the program.

Public Education and Outreach

Proactive public education has played an important role in the success of the County of Maui's water reuse program. The MWWRD's Water Recycling Program Coordinator conducts presentations on water conservation, wastewater reclamation, and water reuse to schools, community groups, and the general public. Tours of the County's wastewater reclamation facilities are also provided. In addition, the MWWRD issues press releases announcing new projects that are to commence using recycled water and expansions to County recycled water distribution systems. Promotional items such as bumper stickers, magnets, rulers, and pamphlets are also utilized.

The public has generally supported the concept of reusing wastewater within the community. As a result of its proactive approach to public education, the MWWRD has encountered little opposition to its water reuse program. In fact, the County of Maui has been criticized by members of the community and local environmental groups for delaying plans to implement more water reuse projects.


Koa Resort
Koa Lagoon
Paradise Gardens
Luana Kai
Kauhale Makai
Waipulani Condominium
Maui Schooner
Kihei Kauhale
Waipulani Park
Waipuilani St
Piilani Villages
Maui Sunset
Piilani North Park
Kihei Bikeway
Piilani Commercial Center
Kihei Roundabout
Hokulani Golf Villas
Piilani Gardens
Lipoa Pkwy
Haggai Institute
Kihei Community Center
South Kihei Rd
Liloa Dr
Kihei Elementary
Piilani Hwy
Lokelani Intermediate
Maui Highlands
South Maui Community Park
Elleair Maui Golf Club
Haleakala Ranch
Kihei Recycling Center
Hope Chapel
Maui Earth Compost
Monsanto
Kihei Wastewater Reclamation Facility
Kapuna St
Kihei Library
1.0 MG Recycled Water Storage Tank
Goodfellow Brothers
Kihei Fire Station
Hale Mahaolu Ehiku
Kalama Park
South Maui Police Station
STATE OF HAWAII
Commission on Water Resource Management
Department of Land & Natural Resources
2013 STATEWIDE WATER REUSE SURVEY AND REPORT
Recycled Water Line
Water Line Extension
Current South Maui Projects
Future South Maui Projects
N
0
750'
1500'
3000'
KEY MAP - MAUI
FIGURE 3–3
Existing Recycled Water Infrastructure and Projects - Kihei
THE LIMTIACO CONSULTING GROUP
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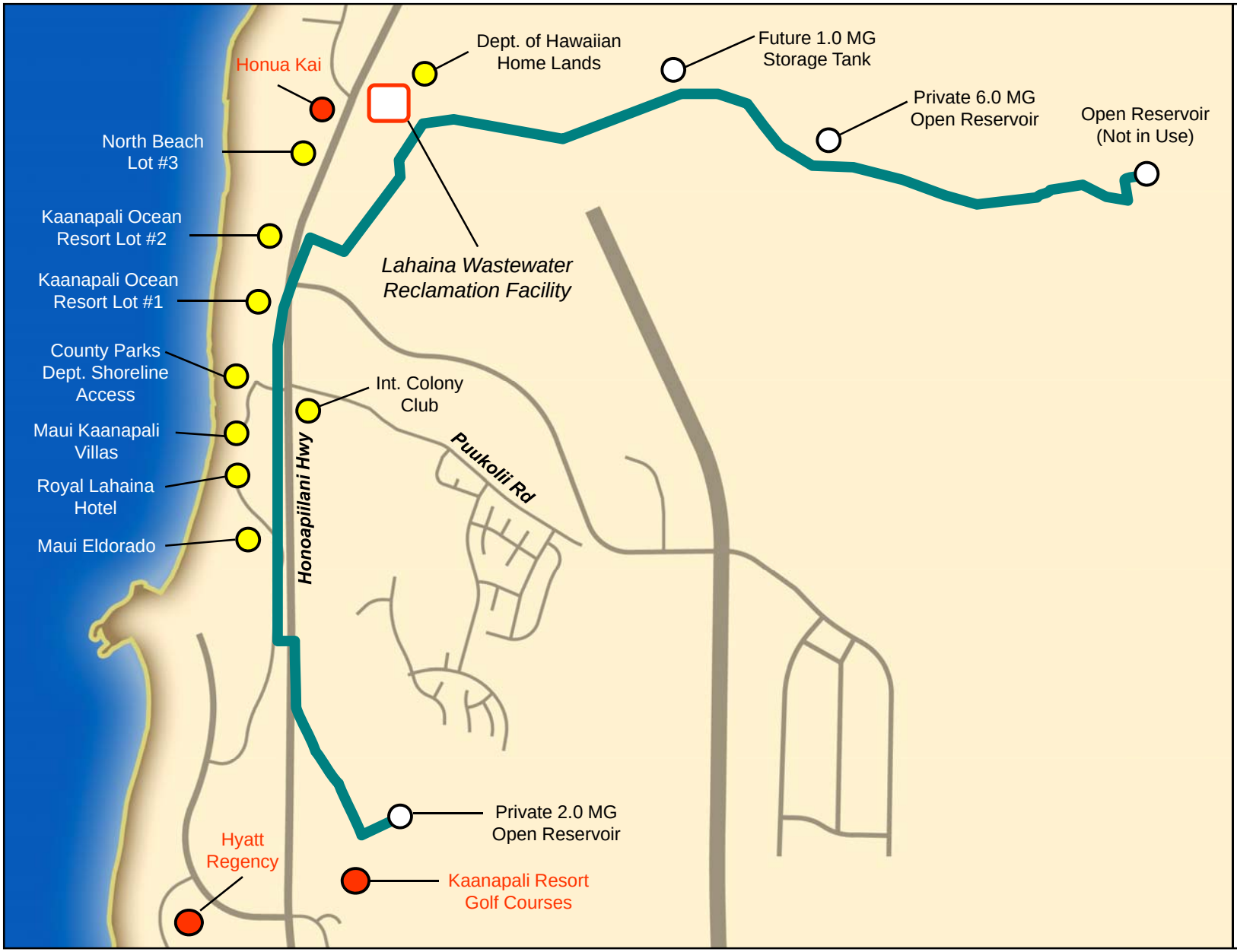

STATE OF HAWAII
Commission on Water Resource Management
Department of Land & Natural Resources

2013 STATEWIDE WATER REUSE SURVEY AND REPORT

Recycled Water Line

Current West Maui Projects

Future South Maui Projects

N

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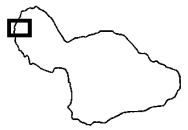

KEY MAP - MAUI

FIGURE 3–4

Existing Recycled Water Infrastructure and Projects - Lahaina

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3.2.2. The City and County of Honolulu's Water Reuse Program

In contrast to the County of Maui where water reuse has been championed by the municipal wastewater agency, the County's municipal water agency – the HBWS – has emerged as the lead agency for water reuse in the City and County of Honolulu. The use of recycled water has increased significantly on Oahu since the HBWS developed a comprehensive water reuse program in the late 1990s. The HBWS recognized that recycled water is a valuable resource that will help extend Oahu's potable water supplies.

Program Development

Similar to the County of Maui, the impetus for development of the HBWS water reuse program was government mandate. The City and County of Honolulu was required to build the secondary treatment facilities at the Honouliuli Wastewater Treatment Plant (WWTP) to comply with a 1993 consent order by the DOH. The main objective of the consent order was to establish secondary treatment at the plant and to reuse portions of the treated effluent. Improvements to the facility were completed in 1996 with approximately 2.0 mgd of recycled water being used for in-plant demands.

In 1995, the EPA, the DOH, and the City and County of Honolulu entered into a consent decree that required the County to develop a water reuse system that would recycle 10 mgd of water by July 2001. The Honouliuli WWTP was selected for implementation of the water reuse requirements due to restrictions on withdrawals from the Pearl Harbor aquifer and anticipated growth in the Ewa region.

To accomplish these goals, the HBWS entered a public-private partnership with USFilter. The agreement called for USFilter to finance, design, build, and operate the soon-to-be-constructed Honouliuli WRF for a period of 20 years before turning the facility over to the City and County of Honolulu (Tswei, n.d.). Through this arrangement, the Honouliuli WRF accepts secondary treated effluent from the Honouliuli WWTP and further treats it to produce R-1 and R-O quality recycled water.

Knowing that R-1 water would ultimately be available in the area, the CWRM issued temporary groundwater use permits for planned golf courses (requiring conversion to R-1 water once it became available). Also, in order to convince users to switch to recycled water, the HBWS entered into individual agreements with each user offering favorable pricing compared to their existing water supply.

The HBWS purchased the Honouliuli WRF in 2000 from USFilter with the intent of integrating water reuse into a plan to protect water resources through

conservation and development of new water supplies. The facility is now operated by Veolia Water North America.

Water Conservation Benefits

The Honouliuli WRF accounts for most of the County's water reuse. The Honouliuli WRF is located in the arid Ewa district of southwest Oahu, where significant development has occurred in recent years. Much of the water supply for the Ewa area is drawn from Oahu's Pearl Harbor groundwater aquifer (CWRM, n.d.). The Pearl Harbor aquifer stretches from the Koolau Mountain Range and Central Oahu to the Ewa district and Oahu's Leeward coast. Like Maui's Iao Aquifer, Oahu's Pearl Harbor aquifer has been designated a Water Management Area by the CWRM. This means that the CWRM has determined that the Pearl Harbor aquifer may be threatened by existing or proposed withdrawals, which are regulated by the CWRM.

Recycled Water Infrastructure and Projects

The City and County of Honolulu utilizes recycled water from two treatment facilities: the Honouliuli WRF and the Laie WWRF. As discussed above, the HBWS is the distributor for recycled water from the Honouliuli WRF (see **Figure 3-5**). The distribution system for recycled water from the Honouliuli WRF continues to expand to meet the increased demand from various reuse projects in the Ewa region, particularly the City of Kapolei. When considering both existing and planned uses, nearly all the recycled water from the Honouliuli WRF is accounted for during peak demand in the summer months. There are no current plans for expansion of the Honouliuli WRF to increase production of recycled water.

In contrast to the Honouliuli WRF, the City and County of Honolulu is not responsible for the purveying recycled water from the Laie WWRF. Although the City and County of Honolulu owns and operates the WWRF, the distribution and disposal systems for the plant are privately-owned and -operated by Hawaii Reserves, Inc.

Program Economics

The HBWS has entered into individual agreements with users of recycled water from the Honouliuli WRF. Unlike the County of Maui, the City and County of Honolulu does not have a mandatory reuse ordinance. The HBWS promotes the use of recycled water through competitive pricing. The downside of this approach is that initial rates are significantly below costs to produce and deliver the recycled water. Initial capital expenditures were made to extend the distribution system and attract new users. Many of these capital costs were subsidized by HBWS income from potable water users (whereas the Maui County model is subsidized by sewer users). As agreements with existing recycled water users expire, the HBWS could increase recycled

water rates to recover the true costs; however, increased rates may encourage existing users to revert back to less expensive groundwater sources. This could jeopardize the HBWS recycled water program.

Public Education and Outreach

The HBWS has a structured organization in place to manage its water reuse program. The program is staffed with a recycled water program manager and three recycled water program coordinators. As in the case with the County of Maui, proactive public education has been an important component of the HBWS water reuse program. The HBWS has hired a professional public relations firm to develop a strategy to gain public acceptance of its program through the use of promotional/educational items. The recycled water coordinators play a key role in HBWS outreach efforts: the coordinators participate in outreach efforts, conduct numerous tours of the Honouliuli WRF, and provide presentations to the community on a regular basis.

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STATE OF HAWAII
Commission on Water Resource Management
Department of Land & Natural Resources

2013 STATEWIDE WATER REUSE SURVEY AND REPORT

R-1 Distribution Lines

R-0 Distribution Lines

Current Leeward Oahu Projects

Future Leeward Oahu Projects

N

0 1600' 3200' 6400'

KEY MAP - OAHU

FIGURE 3–5

Existing Recycled Water Infrastructure and Projects - Leeward Oahu

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3.2.3. The County of Kauai's Approach to Water Reuse

The County of Kauai does not have as structured a water reuse program. Nevertheless, progress has been made in recent years in the KDWM's recycled water production capability through upgrades to two of its wastewater reclamation facilities to R-1 water capability. Plans have also been developed to construct an R-1 distribution system in southwest Kauai.

The KDWM operates four wastewater reclamation facilities on the island. For many years, a high percentage of the recycled water produced at three of its facilities has been reused at nearby commercial properties. The County has long-term agreements in place with the Kauai Lagoons Resort and Kikiaola Land Company (KLC) to accept all the Lihue WWRF's and Waimea WWRF's recycled water, respectively. The Wailua WWRF provides recycled water to the neighboring Wailua Golf Course and Lydgate Park for irrigation, as well as utilizing an ocean outfall for effluent disposal. The Eleele WWRF disposes all of its effluent into injection wells.

These properties are convenient disposal locations for the KDWM. As a result, recycled water has, until recently, been provided at no cost to the respective properties. The County's facilities treat relatively small volumes of wastewater; thus, the nearby commercial properties are often able to utilize the entire daily volumes of recycled water produced.

R-1 Water Upgrades

Lihue WWRF: Due to the proximity of fairway homes to spray-irrigated areas of its golf course, Kauai Lagoons desired to have the recycled water it received from the KDWM's Lihue WWRF upgraded from R-2 to R-1 water quality. Kauai Lagoons originally planned to construct its own polishing plant – additional facilities like effluent filters and UV disinfection that improve the quality of the recycled water – but the KDWM convinced Kauai Lagoons to help fund the addition of the R-1 facilities to the existing Lihue WWRF. In 2008, Kauai Lagoons contributed $3 million to add the necessary equipment and processes to classify the Lihue WWRF as an R-1 facility. Coagulation, continuous turbidity monitoring, effluent filtration, and UV disinfection were included in the R-1 upgrade that was completed in 2010. In exchange for their contribution, Kauai Lagoons received a $3 million credit towards future wastewater system assessment fees and will continue to receive free recycled water until the year 2015. Per a long-term agreement, the cost of the R-1 water used after 2015 will be negotiated and will not exceed the alternative cost that Kauai Lagoons incurs when it pumps brackish water from wells. The brackish water is used as a supplemental irrigation source.

Waimea WWRF: R-2 recycled water from the Waimea WWRF has historically been pumped to a reservoir owned by KLC and then blended with surface water from the Kekaha Ditch. The diluted R-2 water has been used for agricultural irrigation since the early 1970's. Sugar cane and, more recently, seed corn crops have been irrigated with this diluted R-2 water over the years. These agricultural operations have provided a convenient disposal option for the Waimea WWRF. As a result, the KDWM has provided R-2 water at no cost to KLC.

Various factors have contributed to the County's decision to upgrade the Waimea WWRF to have R-1 water capability. Potable water is used to irrigate landscapes at county parks, schools, and other commercial properties in southwest Kauai at a considerable expense. R-1 water would be an attractive non-potable option in this arid area. Prior to the 2012 facility upgrade, safety concerns were expressed by agricultural workers in the region who were exposed to R-2 water. Improvements included upgrading the preliminary and biological treatment facilities as well as adding the required R-1 system components and processes. Coagulation, turbidity monitoring, effluent filtration, and UV disinfection have been installed at the plant to classify it as an R-1 water facility. The County also received earmarked federal funding through the Consolidated Appropriations Act of 2010 grant to design a dedicated R-1 water distribution system for the Waimea area. This system could be used to displace the potable water utilized to irrigate a County park, schools, and commercial properties. Additional funding will be required to construct the system.

Recycled Water Rates

As previously mentioned, the KDWM has historically provided recycled water to its users at no cost. However, in 2011, the County of Kauai passed an R-2 recycled water ordinance establishing a rate of $0.20 per 1,000 gallons. This rate was set to allow the KDWM to recover pumping costs incurred when R-2 water is delivered to users. The KDWM also planned to charge for R-1 water and utilized a version of Maui County's "Avoided Cost" strategy to set the R-1 rate. This rate will be negotiated into long-term agreements with KDWM's two R-1 water users – Kauai Lagoons and KLC – and is not to exceed the costs associated with the alternative sources of water typically used for irrigation. These sources currently include brackish water and ditch water, but they could also include potable water when R-1 water service is expanded to properties that utilize potable water for irrigation.

3.2.4. The County of Hawaii's Approach to Water Reuse

The County of Hawaii has not developed a water reuse program and does not provide recycled water to any facilities. Although the County has not developed a formal reuse program, responsibility for construction and maintenance of recycled water infrastructure falls under the HWD.

Previously, recycled water from the County's Kealakehe WWRF was utilized at the privately-owned Swing Zone Golf Facility. However, use of recycled water at this facility has discontinued, and the facility has since closed. The County has not adopted the distribution infrastructure that supported the Swing Zone Golf Facility as it was constructed by the facility's owner and is considered by the County to be substandard.

County WWTP

Kealakehe WWRF: There are plans to upgrade the Kealakehe WWTP to produce R-1 quality effluent in FY 2013-2014. The HWD has contemplated developing a distribution system that would be capable of providing recycled water from Kealakehe WWRF to a number of irrigation projects including parks and future golf courses. Current plans call for a portion of the distribution main – from Kealakehe Parkway to Hulikoa Drive along Kaahumanu Highway – to be constructed in conjunction with the DOT's Queen Kaahumanu Highway Widening Project – Phase 2. However, a distribution main from the Kealakehe WWTP to Kealakehe Parkway would have to be constructed before the distribution system could be utilized. A State Revolving Fund (SRF) loan has been acquired to upgrade the facility to R-1 water capability and construct the distribution system; however, delays have been encountered due to the presence of archeological sites along the proposed R-1 water line route. No timeline has been established to resume the development of this project.

Other County WWTP: The County is responsible for a number of other WWTPs of notable capacity, including facilities at Hilo, Kulaimano, and Paipaikou. However, these facilities are located on the windward side of the island where high rainfall quantities suppress the demand for recycled water. As such, the County is not considering recycled water upgrades at any of these facilities.

Recycled Water Rates

Although the County of Hawaii does not currently provide recycled water to any facilities, Chapter 21 of the Hawaii County Rules sets the cost of recycled water from the county at $1.20 per 1,000 gallons.

3.3. Hawaii Water Reuse Project Descriptions

This section provides detailed descriptions of both County-run and privately-run water reuse programs and projects in each of the State's four counties. Prior to surveying Hawaii's water reuse projects, current contact information and basic data for each project was obtained from the WWB. Telephone calls were made to project managers to gather detailed information and schedule site visitations. The information collected from each project included:

- Project location;
- WWRF information;
- Recycled water quality, volume, and blending information;
- Year reuse was Initiated;
- Project type (golf course, agriculture, etc.);
- Driving factor for water reuse: water supply and/or wastewater disposal;
- Price of recycled water; and
- Benefits and challenges associated with recycled water use

3.3.1. Water Reuse in Maui County (Maui, Lanai & Molokai)

The majority of water reuse projects in Maui County are provided with recycled water by the MWWRD. There are also private systems, including resort and residential developments, that use recycled water produced at their respective wastewater reclamation facilities for golf course irrigation. The Pukalani Country Club and Makena Golf Club on Maui and the Challenge at Manele on Lanai all blend recycled water with other non-potable water sources to meet their golf course irrigation requirements.

3.3.1.1. Water Reuse in South Maui

All but one of south Maui's water reuse projects are supplied with R-1 water from the MWWRD's Kihei WWRF. The facility is designed to produce up to 8.0 mgd of R-1 water. An average daily flow of 3.5 mgd is currently treated and 50%, or 1.7 mgd, of the R-1 water is currently reused on an average daily basis. Most of the R-1 water is delivered to commercial properties that utilize this resource for landscape or agricultural irrigation. Figure 3.1 shows the MWWRD's south Maui recycled water distribution system and the current and near-future R-1 projects. Recycled water that is not reused is discharged into three injection wells, and approximately 0.25 mgd is used at the WWRF for landscape irrigation and industrial uses.

The Kihei WWRF utilizes activated sludge with biological nutrient removal, up-flow sand filtration, and UV disinfection to produce R-1 water. The facility has coagulation capability, but it is rarely used as secondary effluent turbidity is typically very low. An issue for all of the south Maui

reuse system's projects is that the R-1 water contains bits of plastic debris. The up-flow sand filters allow this debris to migrate up and through the sand media during the media backwashing process, and it then enters the recycled water distribution system. The debris consists of fruit stickers, cellophane wrap, and bits of plastic bags. The MWWRD has added additional screening to the facility's sand filters and increased the frequency of meter strainer cleaning and distribution system flushing to address this situation. Additionally, the MWWRD will be retrofitting the Kihei WWRF's up-flow sand filters with disk filters in 2013.

The primary factor for virtually all of the water reuse projects in south Maui is water supply. The vast majority of the potable water used in this region is imported from central Maui. Potable water is provided by the County of Maui's DWS and is more expensive than recycled water. Sewer fees are assessed when potable water is used, as the County of Maui's sewer fee is partially based on water consumption. The MWWRD's water reuse program resulted in over 340 million gallons (MG) of potable water savings in the south Maui area in 2012. Brackish water in the area, while less expensive than potable water, is generally high in salts; thus, it is an undesirable irrigation source in many cases.

3.3.1.1.1. South Maui Water Reuse Project Descriptions

Elleair Maui Golf Club

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.57 average 0.73 peak	$0.33	• Inexpensive • Effective • Nutrients	• Lower nutrient content due to additional treatment

The Elleair Maui Golf Club, formerly known as the Silversword Golf Club, is adjacent to the County of Maui's Kihei WWRF and has used recycled water since the course was constructed in 1986. This golf course was constructed with the intent of using recycled water as its sole source of irrigation water and it is the County of Maui's largest volumetric user of recycled water in south Maui. The golf course utilizes pressure from the County's R-1 distribution system (including an elevated reservoir) to operate its spray irrigation system. Several years ago, the golf course upsized the R-1 water transmission main to boost water pressure and increase irrigation performance. Elleair Maui Golf Club pays for R-1 water at the rate golf courses are assigned by

the County of Maui's recycled water rate structure: $0.33 per 1,000 gallons.

Nutrient content in R-1 water reduced since the Kihei WWRF added biological nutrient removal into its treatment process, and, as a result, the golf course has to apply fertilizer more frequently. The lower nutrient content has resulted in less algal in water hazards that contain R-1 water.

Monsanto

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issue**
R-1	Kihei WWRF	0.17 average 0.73 peak	$0.33 $1.28	• Inexpensive • Consistency	• Salinity

Monsanto uses genetic modification to grow disease, insect, and pesticide resistant strains of animal feed corn at several locations on Maui and Molokai. The 200-acre Piilani Farm was developed above the Kihei WWRF in 1998 after the recycled water distribution system was constructed. An average of 0.17 mgd of R-1 water is used primarily for seed corn cultivation, but approximately 0.02 mgd is used in the office buildings, bagging facility, workshops and employee lunch room. At these locations, R-1 water is used for landscape irrigation, toilet flushing, and fire protection. Monsanto is charged a higher rate of $1.28 per 1,000 gallons for R-1 water used for these applications since they fall into the "All Other" classification in Maui County's recycled water rate structure.

During construction of the WWRD's recycled water distribution system, Monsanto constructed a 12-inch ductile iron lateral to their office and bagging facility. The lateral was dedicated to the County in 2012 and was extended to the site of the new south Maui police station, where R-1 water will be used for landscape irrigation and fire protection.

Monsanto would not have developed the Piilani Farm if not for the consistent availability of inexpensive recycled water. This project is a good example of high-quality recycled water stimulating economic development. The company employs over 100 people at the Piilani Farm and has hired consultants and contractors to design and construct improvements.

The County repaired salt water intrusion points in the south Maui wastewater collection system to reduce chloride concentration; however, R-1 water from the Kihei WWRF contains approximately 200 mg/L of total chlorides. Although this concentration is suitable for most landscape plants, corn is more sensitive. Monsanto minimizes salt accumulation in the soil by periodically adding gypsum to improve drainage, tilling the fields, and relying on occasional storms to drive salt below the root zones.

Piilani is one of Monsanto's most productive farms in the United States.

Goodfellow Brothers Incorporated

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	Variable	$1.28	• Convenience • Inexpensive	• None reported

Goodfellow Brothers (GBI) is one of several construction companies on Maui that utilizes R-1 water from the Kihei WWRF for dust control and other construction activities. GBI also uses recycled water for landscape irrigation and fire control.

GBI's south Maui base yard is adjacent to the Kihei WWRF. In 1995, GBI built a recycled water fill station and connected it to the Kihei WWRF's recycled water utility system, which is pressurized from the WWRD's elevated storage tank. GBI has used over 100 MG of recycled water since 1995.

Sunshine Vetiver

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.0005	$0.33	• Faster growth rate	• None reported

Sunshine Vetiver took over the site (below the GBI base yard) where Pohaku Masonry used to be located. Approximately 500 gallons per day (gpd) of R-1 water from the Kihei WWRF is used via surface drip irrigation to grow vetiver grass, a non-invasive plant that is used

primarily to control soil erosion. Since this pilot project is agricultural in nature, Sunshine Vetiver pays $0.33 per 1,000 gallons for the R-1 water.

The company also grows vetiver grass in west Maui with stream water. It has been observed that the vetiver growth rate is significantly faster with R-1 water than with stream water.

Vetiver grass is also used hydroponically to treat human and animal wastewater, typically in lagoon-type treatment systems. It has been demonstrated that vetiver can remove nutrients such as nitrogen and phosphorous in the wastewater. The WWRD is currently experimenting at its Lahaina WWRF to determine if vetiver grass can be used to help reduce nutrients in the effluent discharged to the facility's injection wells.

Hokulani Golf Villas

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.1 average	$1.28	• Supply • Nutrients	• None reported

The Hokulani Golf Villas is a single-family home complex located within the confines of the Elleair Maui Golf Club. The first phase of the project was completed in 2008, and two more phases of construction are planned.

As a development/condition, the County of Maui's Planning Commission required the developer to provide its own potable water source and extend the County's R-1 water distribution system to source its landscape irrigation. As a result, brackish water is desalinated for potable water use, and an R-1 water pipeline was built and dedicated to the County of Maui's WWRD. The extension of the County's distribution system was designed with the intent of ultimately providing R-1 water to the nearby Maui Research & Technology (R&T) Park. A series of standpipes were also constructed for fire control and system flushing purposes.

Hokulani Golf Villas meets the DOH's requirement for use of R-1 water for landscape irrigation at single-family homes: the landscaping and irrigation systems are maintained by landscaping contractors through an entity such as a homeowner's association. So irrigation of the front

and back yards of each single-family home was approved by the DOH. The R-1 water is applied both through spray and surface drip irrigation systems, and the landscaping at Hokulani Golf Villas is thriving from the nutrients present in the recycled water. While this development is currently the County of Maui's third largest volumetric user of recycled water in the south Maui area, the volume of recycled water it uses will increase when future phases of the development are constructed.

Maui Research & Technology Park

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.09 average	$1.28	• Supply • Nutrients • Improved landscape health/growth • Less water use	• Increased landscape maintenance

The Maui R&T Park is located in central Kihei in the vicinity of the Elleair Maui Golf Club and Hokulani Golf Villas. The Maui R&T Park has five buildings and is home to over 20 high technology and professional service companies.

Until 2010, landscaping around its buildings and at its common areas was irrigated with brackish water obtained from an on-site well. Due to over-pumping of this well, salinity levels increased and landscaping suffered. In early 2010, the irrigation well collapsed and the Maui R&T Park manager requested an emergency connection to the R-1 water system that had recently been installed by the Maui Highland Partners. The County's WWRD allowed this connection and, within two weeks, R-1 water service was initiated at the Park.

Since converting its irrigation source from brackish water to recycled water, the health of the Park's landscaping has improved dramatically. Turf grasses are greener and require much less water, flowering plants are now flowering, and trees within the Park are much healthier. In fact, landscape maintenance personnel had to increase the mowing frequency of the Park's lawns since the growth rate of the grass has increased.

The use of R-1 water will increase in the future as the R&T Park is expanded. Park management has submitted a request to the Maui

Planning Commission to allow the Park to be rezoned so mixed residential and commercial lots can be developed.

The Piilani Reuse System

The County of Maui installed an R-1 water distribution system from the Kihei WWRF *makai* of the Piilani Highway in 1998. Three extensions were constructed, and the line now extends to Kihei Road via Waipulani Street. The County plans to extend the R-1 water distribution system in 2013 to provide service to condominiums and a County park.

The system currently delivers recycled water to several commercial properties for landscape irrigation. New projects that have also connected to the system in recent years include Hope Chapel, the Hale Mahaolu Ehiku elderly housing complex, the Kihei Recycling Center, green space at the Kihei Kauhale subdivision, the South Maui Community Park, and the Kihei bikeway and roundabout. In addition, several MG of R-1 water were drawn from the system's fire hydrants and clean outs for dust control use during the construction phases of these projects. Other R-1 water landscape irrigation users include County parks, a shopping center, a condominium complex, common areas within a single-family residential subdivision, a church, and public schools.

All projects, except the Haggai Institute, pay $1.28 per 1,000 gallons. The County exercised the avoided cost clause for the Haggai Institute and matched the rate it paid to operate and maintain its brackish water pumping system. The rate can be increased to accommodate for inflation and is currently set at $0.56 per 1,000 gallons.

Many commercial properties along the Piilani Reuse System may not have been developed had it not been for the availability of R-1 water. Potable water resources are limited in south Maui, and the region's brackish water has high salinity levels making it problematic for landscape applications.

Below are descriptions of a few of the Piilani Reuse System's projects.

Piilani Reuse System: South Maui Community Park

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.06* 0.002 + surface washing*	$1.28	• Supply • Nutrients • Fire protection • Dust control, construction supply	• None reported
* Note: These usage quantities do not include the large amounts of recycled water utilized for dust control and/or other construction activities during the construction phase of the projects.					

The South Maui Community Park is a County park that opened in 2011. The first phase of development included a softball field, a soccer field, a playground, and walking path. Since the park is adjacent to the WWRD's 12-inch R-1 water line, over 26 MG of recycled water were utilized for dust control and other construction activities when the first phase of the park was developed. The current irrigation demand is approximately 0.06 mgd; however, R-1 water use will increase in the future as the next two phases of the park are developed. The irrigation of additional softball, baseball, and soccer fields will ultimately increase the park's total irrigation requirement to 0.2 mgd and, once developed, a booster pump will be required to increase pressure so that the playing fields receive adequate watering. The County's Parks Department is uncertain at this time when these future phases of the park will be developed.

The park is also equipped with R-1 water fire hydrants. To gain approval for this use, the WWRD needed to demonstrate that the Kihei WWRF's R-1 system had adequate storage to meet minimum fire flow as required by the County of Maui's Fire Department.

The South Maui Community Park is also the current home of the Kihei Recycling Center and the future Kihei Multi-Purpose Center. An R-1 lateral was extended to these projects in 2008, and each project has its own R-1 water meter. The Kihei Recycling Center uses approximately 2,000 gpd for irrigation and also uses recycled water for washing down the asphalt surface at the beverage redemption center. A 2-inch recycled water standpipe was installed to provide fire protection for this area. As in the case of most of the other Piilani Reuse System's projects, R-1 water was used extensively during the construction phase of these projects.

Piilani Reuse System: The Kihei Roundabout and the Kihei Bikeway

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.03	$1.28	• Supply • Nutrients • Dust control, construction supply	• Contact with pedestrians and vehicles must be prevented

The Kihei Roundabout and the first two phases of the Kihei Bikeway were completed in 2012 by the County of Maui Department of Public Works. These projects work in conjunction to greatly enhance the safety of and provide a park-like environment to the area. Being adjacent to the WWRD's 12-inch R-1 water line made these projects feasible as other water sources are scarce in the south Maui area: R-1 water was used during the construction phase of this project and is now its sole irrigation source. The Public Works Highway Division pays the WWRD for the recycled water used at these projects.

Overspray conditions must be avoided to prevent contact with passing pedestrians and vehicles. To avoid these conditions, periodic testing of the irrigation must be conducted to make adjustments to sprinkler heads.

The Kihei Bikeway is located adjacent to the County of Maui's R-1 water distribution system, making recycled water a practical and economically feasible source of non-potable water.

Piilani Reuse System: Hope Chapel

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.04	$1.28	• Supply • Inexpensive	• Runoff

Hope Chapel opened its Kihei location in 2005. The property has approximately six acres of turf grass and other landscape plants that are irrigated with an average of 0.04 mgd of R-1 water. The Hope Chapel facility has another six acres of undeveloped land on its property. At some point in the future, this land will be developed and additional R-1 water will be required for landscape irrigation. To accommodate this irrigation requirement, another tap and meter off of the WWRD's 12-inch R-1 water transmission line will need to be installed.

The R-1 water Hope Chapel obtains from the WWRD is reasonably priced as the use of potable water is close to three times the cost of recycled water. Occasionally the recycled water runs off of the facility's lawns and down the main entryway onto the main access road. Runoff of recycled water is a condition that must be avoided per both the DOH Guidelines and the County's Rules for Recycled Water Service. To address this, irrigation rates are decreased to avoid over saturation of the facility's lawns.

Piilani Reuse System: Piilani Gardens

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.05	$1.28	• Supply • Inexpensive • Nutrients	• Debris clogs irrigation system

Piilani Gardens is a multi-family residential complex that commenced using R-1 water for landscape irrigation in 2002. The R-1 water is applied via both spray and surface drip irrigation.

The owner of Piilani Gardens has reported that the R-1 water quality is poor due to the presence of plastic debris that has resulted in clogged sprinkler heads and drip tubing. To address this complaint, the WWRD exercised the "Cost to Retrofit" clause in Chapter 20.30 *Use of Reclaimed Water* to reimburse Piilani Gardens for an additional filter that was installed to remove the plastic debris from the recycled water. As previously mentioned, the WWRD has initiated plans to improve the Kihei WWRF's effluent filtration capability. The WWRD has also increased maintenance activities, such as distribution system flushing and meter strainer cleaning, to address this issue.

Despite this, the use of R-1 water has been successful at Piilani Gardens. The landscaping appears healthy and lush, and a significant monetary savings has also been realized. Based on the volume of R-1 water used since the project's inception, it is estimated that the owner has saved approximately $450,000 by avoiding potable water use for landscape irrigation.

Piilani Reuse System: Hale Mahaolu Ehiku

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.05	$1.28	• Supply • Inexpensive • Nutrients • Fire protection	• Debris clogs irrigation system and reduces pressure

Hale Mahaolu Ehiku is a senior citizen housing complex in south Maui that is adjacent to the Hope Chapel property. R-1 water has been used for landscape irrigation at the facility since it was constructed in 2007. The facility is subject to windy conditions; therefore, to avoid overspray of recycled water onto buildings and vehicles, stream irrigation heads were installed in areas exposed to the wind instead of conventional spray heads. Surface drip irrigation is also utilized for ground cover.

Hale Mahaolu Ehiku has also had issues with plastic debris that is present in the recycled water clogging its drip lines and irrigation heads. R-1 water pressure to the property's irrigation system was reduced due to the plastic debris. To address this, Hale Mahaolu Ehiku cleans the meter strainer on a weekly basis and has reported improved operation of its irrigation system. Full pressure to the system has also been restored since it implemented this maintenance activity.

The landscape of Hale Mahaolu Ehiku appears to be thriving and rarely requires supplemental fertilization. During the construction of the second phase of this project, a fire was intentionally set by an arsonist at the facility's community center. The fire was extinguished with R-1 water from the WWRD's nearby fire hydrant system and damage to the facility was minimized.

The Kalama Park System

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kihei WWRF	0.07	$1.28	• Supply • Consistent • Inexpensive • Nutrients	• Supply pipeline leaks

R-1 water from the Kihei WWRF is also conveyed to three properties in south Maui through a 6-inch polyvinyl chloride (PVC) pipeline. Kalama Park, the Kihei Fire Station, and the Kihei Public Library all use R-1 water from this pipeline to spray-irrigate turf grass and landscaping. Collectively, these projects use 0.07 mgd, with Kalama Park being the largest user.

This system is independent of the County's core recycled water distribution system and has been in place since 1975. The recycled water supply comes from a storage reservoir at the Kihei WWRF and is provided to the Kalama Park area at relatively low pressure (45 pounds per square inch). This pressure is adequate for the Kihei Fire Station and Kihei Public Library; however, it is too low to cover the larger irrigated areas of Kalama Park. The Parks Department installed a booster pump station to increase pressure in their irrigation system.

The appearance of the turf grass and landscaping at all three properties has improved due to the availability of a consistent supply of low cost water. The $1.28 per 1,000 gallons rate paid for the recycled water is much less than the rate paid for potable water. Conversely, in recent years, the system's PVC line has had a number of leaks occur from pipe couplings. The WWRD Central Maintenance crew works cooperatively with the south Maui Parks maintenance staff to expedite repairs to the pipe line so that R-1 water service can be restored as quickly as possible.

Makena North Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Makena WWRF and Brackish water	0.08	$0.00	• Disposal • Supply • Nutrients, lower salinity	• WWRF well under design capacity

The Makena Golf and Beach Resort has operated two golf courses over the years. While the Makena South Golf Course was shut down in 2005, now only the Makena North Golf Course is in operation. This golf course is the only water reuse project in south Maui that utilizes recycled water from a privately-owned WWRF: the Makena WWRF, operated by private contractor Aqua Engineers. The golf course has used R-1 water from the facility since it was constructed in 2002.

Currently, 0.08 mgd of R-1 water is produced at the WWRF through extended aeration activated sludge, traveling bridge dual media sand filtration, and UV disinfection. The R-1 water is blended with approximately 0.4 mgd of high-salinity brackish water in a reservoir on the golf course. The brackish water, which has a chloride concentration of 1500 mg/L, is slightly diluted by the recycled water. There is no charge for the R-1 water use at the golf course.

The Makena North Golf Course will be temporarily shut down in 2013 when fairway homes are constructed. The golf course will be redesigned during this period.

In the future, when development results in more wastewater generation, the Makena WWRF's recycled water will reduce the use of brackish water for irrigation. The higher-quality R-1 water will also help golf course maintenance personnel to minimize gypsum applications currently required to combat sodium build-up in the soils.

Currently, the Makena WWRF is well under its design capacity of 0.75 mgd, and the incoming wastewater is collected and stored before treated in a batch process mode. Because of the wastewater's long detention times in the system, the facility has had problems with high effluent turbidity due to excessive algae growth. Various remedies have been implemented, which have considerably reduced algae levels at the facility: expensive coagulants are relied upon to reduce turbidity levels to meet R-1 standards; during the summer months, a shade cloth is installed over the secondary clarifier to reduce sunlight levels; and the traveling bridge sand filters are also periodically treated with high doses of sodium hypochlorite to kill algae.

As development of the Makena area progresses, it is expected that the facility will operate more efficiently with increased wastewater flow. There are also plans for wastewater from the future Honuaula residential project to be sent to the Makena WWRF. This development has been approved by the Maui County Council and will proceed once the local economy improves. Up to 0.5 mgd of wastewater is expected to be produced once that project is fully completed. An equal volume of R-1 water will be pumped back to the Honuaula development, blended with brackish water, and used to irrigate a golf course and common areas.

3.3.1.2. Water Reuse in West Maui

Currently, all of the water reuse projects in west Maui are provided with recycled water from the County of Maui's Lahaina WWRF. A recycled water distribution system was developed when the first phase of the facility was constructed in the mid-1970's. R-2 water was provided to Pioneer Mill for sugar cane irrigation up to the mid-1980's. The recycled water was pumped from the Lahaina WWRF through a 20-inch ductile iron pipe line to a reservoir at the 700-ft elevation and blended with stream water. Pioneer Mill stopped growing sugar cane in this area, and the use of this pipe line was discontinued for several years. Virtually all of the effluent produced at the facility, except for what was used for in-plant uses, was subsequently disposed of into injection wells after sugar cane irrigation ceased.

Concerns that injection wells were causing algal blooms in the coastal waters near the Lahaina WWRF prompted the MWWRD to prioritize effluent reuse in the region in the mid-1990's. During this time period, the EPA placed a limitation on the daily volume of effluent that could be disposed of into the facility's injection wells. This limitation played a direct role in the passage of the ordinance that mandated the use of recycled water at commercial properties that were in close proximity to the County's recycled water transmission lines. To reduce the use of injection wells at the Lahaina WWRF, the MWWRD upgraded the facility to partial R-1 water capability. UV disinfection capability with a design output of 3.0 mgd was constructed as well as a recycled water distribution system to deliver R-1 water to the Kaanapali Resort's golf course irrigation pond.

The MWWRD resumed using the 20-inch recycled water line to provide R-1 water to Maui Pineapple Company from 2003 to 2010. New pumps were installed to deliver the R-1 water to a reservoir at the 300-ft elevation. The R-1 water was blended with stream water to a 50% recycled water concentration in the reservoir. This project was discontinued in 2010 when Maui Pineapple Company went out of business. While the use of the 20-inch pipe line was once again discontinued, the MWWRD will be utilizing it to deliver R-1 water to an elevated 1.0 MG storage tank that will be constructed in 2014. This tank will be an important component of the MWWRD's plan to fully-pressurize the entire west Maui R-1 water distribution system and will improve the MWWRD's ability to distribute R-1 water to more commercial properties. **Figure 3-2** shows the current layout of the MWWRD's west Maui R- 1 water distribution system as well as the current and near future commercial properties that are and will soon be provided R-1 water.

The Lahaina WWRF utilizes activated sludge with biological nutrient removal, coagulation capability, up-flow sand filtration, and UV disinfection to produce up to 2.0 mgd R-1 water. The original UV disinfection that was installed in the 1990's is still being utilized at the facility. While it was designed to produce 3.0 mgd of R-1 water, the daily output has been reduced to 2.0 mgd by the MWWRD's maintenance staff in order to reduce wear on equipment and extend the life of the system. The MWWRD will be upgrading the original system in 2013 to produce 3.0 mgd. To comply with an EPA consent agreement that stipulates that all of the effluent disposed of into the injection wells at the Lahaina WWRF be of R-1 water quality, two additional 3.0 mgd channels will be constructed bringing the total R-1 capability of the facility up to 9.0 mgd. The increase in UV disinfection capability will result in more R-1 water being available for future water reuse projects. The up-flow sand filters at the Lahaina WWRF will also be replaced in 2013 with disk filters.

An issue the MWWRD has faced in west Maui is saltwater intrusion into its wastewater collection system. Attempts have been made to reduce the amount of saltwater leaking into the wastewater collection system in the Lahaina area. The saltwater intrusion has led to moderately high levels of salinity in the R-1 water. The chloride concentration in the recycled water ranges from 500 to 600 mg/L. While most turf grasses are not affected by this salinity level, some landscape plants can be negatively impacted. Periodic repairs to the collection system have somewhat reduced the saltwater intrusion into the system. Nevertheless, the MWWRD is advising commercial properties that will be using the R-1 water in the future to use salt-tolerant plants in their landscapes and utilize other methods to reduce the effects of salinity.

Section 3.3.1.2.1: West Maui Water Reuse Projects

The Kaanapali Resort and Golf Courses

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Lahaina WWRF	0.9 average	$0.20	• Supply • Disposal • Nutrients, lower salinity	• None reported

The Kaanapali Resort and Golf Courses have used R-1 water from the Lahaina WWRF since 1997, and is the WWRD's largest user of recycled water. An average of 0.9 mgd of recycled water is used to

irrigate the lower portions of two golf courses as well as shoulders along the Honoapiilani Highway and median strips within the resort. The Kaanapali Resort and Golf Courses qualify as an “avoided cost” customer in the County of Maui’s recycled water structure since a non-potable water source is used for irrigation: currently, $0.20 per 1,000 gallons is charged for recycled water service.

Personnel at the Kaanapali Resort and Golf Courses are pleased with the R-1 water as it has less salinity than the brackish water previously used. The golf courses’ turf grass and other areas of the resort where recycled water is used appear healthy and green. Wastewater disposal concerns have also been eased somewhat as a significant volume of the Lahaina WWRF’s effluent is now being reused and not disposed of into injection wells.

The Kaanapali Golf Courses has allowed the Hyatt Regency Maui Resort to tap off its golf irrigation main line and utilize R-1 water for landscape irrigation.

The Kaanapali Resort is the County of Maui’s largest user of recycled water. Up to 1.2 mgd is utilized to irrigate portions of two golf courses, roadway medians, and highway shoulders.

The Hyatt Regency Maui Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Lahaina WWRF	0.032 average	$1.28	• Supply • Disposal • Nutrients • Inexpensive	• None reported

In 2010 when the Hyatt Regency Maui Resort submitted plans for a new time-share residential development, it was required by the County of Maui's Planning Commission to make a fair share contribution to the WWRD's recycled water system development and utilize R-1 water for irrigation. The Hyatt installed a tap and sub-meter off of the Kaanapali Golf Courses' irrigation main line in 2011, and it can only use the R-1 water during the day when the golf course is not being irrigated.

The Hyatt uses an average of 0.032 mgd of recycled water to irrigate landscaping, a nursery, and a sod farm. Previously, potable water from a private water purveyor was being used to irrigate these areas of the resort. Use of recycled water has resulted in a significant savings in irrigation and fertilizer costs.

The Honua Kai Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Lahaina WWRF	0.185	$1.28	• Supply • Disposal • Improvements to WWRF	• Salinity

The Honua Kai Resort is located directly across the Honoapiilani Highway from the Lahaina WWRF. It is adjacent to the main pipe line that supplies the Kaanapali Resort and Golf Courses with R-1 water.

Due to a shortage of water in the area, in 2006 the resort developer (IntraWest) requested construction of a separate R-1 water distribution system from the Lahaina WWRF to their resort, where it would be used for landscape irrigation. The WWRD convinced IntraWest to contribute to a solution that would benefit the Honua Kai Resort and other commercial properties in the area, as well as the WWRD in its quest to

increase recycled water use and reduce reliance on injection wells for effluent disposal. In exchange for 185,000 gpd of R-1 water capacity, the Honua Kai Resort agreed to contribute funding to the design and construction of more UV disinfection capacity at the Lahaina WWRF as well as the design of a planned elevated 1.0 MG storage tank. The elevated tank will result in a fully-pressurized R-1 water distribution system and make recycled water available to commercial properties in west Maui that are near the WWRD's existing distribution piping.

The resort commenced using R-1 water in 2009; however, it only has adequate pressure from the main pipe line when the Lahaina WWRF is pumping R-1 water to the Kaanapali Resort and Golf Courses. Once the system is fully-pressurized, the Honua Kai Resort will be able to access the R-1 water at any time for irrigation of its landscaping.

The salinity of the R-1 water has presented some challenges for the resort. Salinity reduces osmotic uptake of water and may cause stunted plant growth, wilting and other damage (Tanji, 2006). To address this issue, a "fertigation" system that injects gypsum as well as organic-based fertilizers into the R-1 water was installed. Gypsum supplies calcium ions to replace excess sodium in the soil and results in increased water intake rates and improved soil aeration. Occasional flushing of sensitive landscape areas with potable water has also helped.

3.3.1.3. Water Reuse in Central Maui

The County of Maui has not developed a recycled water distribution system in central Maui. Many of the potential projects that could use recycled water (such as parks, a golf course, and sugar cane fields) in the area are using high-quality, inexpensive non-potable water for irrigation. Kanaha Cultural Park previously utilized R-2 recycled water from the County's Wailuku-Kahului WWRF to help establish native plants and coconut trees; however, R-2 water use was discontinued in 2008 after it was discovered that the drip irrigation lines were being vandalized. A consultant for the County is currently preparing a feasibility study that will examine future water reuse opportunities in central Maui. Since the Wailuku-Kahului WWRF is located along the northern coast of Maui, the County is also once again exploring construction of a new wastewater treatment facility further inland to address the constant threats of tsunamis and salt air corrosion that are present at the current location.

The current water reuse projects in operation in central Maui are the Pukalani Country Club and the Haleakala National Park Visitor Center.

The Pukalani Country Club

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Pukalani WWRF and Well water	0.185	$0.55	• Supply • Disposal • Inexpensive • Consistent • Nutrients	• Irrigation mist may migrate • Pukalani WRF's recycled water is not certified as R-1 • Leaking ponds

The Pukalani Country Club, located in upcountry Maui at an elevation of 1,000 ft, has been using R-2 water to irrigate its golf course since 1978. Due to the proximity of fairway homes and the poor mechanical condition of the original Pukalani WWRF, a new wastewater facility was constructed in 2010 by the new owner, Hawaii Water Services Company. Wastewater collected from surrounding neighborhoods, the Pukalani Terrace Center, and the Kamehameha School campus is now treated at the Pukalani WRF to R-1 quality using a MBR and UV disinfection. The quality of the recycled water has improved considerably with the new facility.

The facility's entire daily flow of 0.185 mgd is blended at the facility with up to 0.5 mgd of well water. The well water used to supplement the recycled water is pumped from a 1,200-ft deep well. The well is expensive to operate and maintain, and it recently required a major mechanical overhaul. R-1 water was the only irrigation source for the golf course for a period of three months when the well pump failed. Due to the shortage of water, only the tees and greens were irrigated with the recycled water. The R-1 water is much less expensive than the well water, and its use helps lower the overall cost to irrigate the golf course.

The golf course superintendent has observed that the sprinkler heads on the golf course require less maintenance since the Pukalani WRF has been upgraded. Very little fertilizer is required due to the nutrient content of the recycled water and the fact that the predominant turf grass on the course - Kikuyu grass - requires little fertilization.

The area is typically very windy, and the R-1 water mist may migrate onto adjacent fairway homes and roadways during nighttime irrigation events. Irrigation of the course is avoided when high wind conditions are present.

An issue at the Pukalani WRF is that the facility has not officially been certified as an R-1 facility since its turbidity monitoring system is not continuously operated. The control system will be upgraded in 2013 to remedy this deficiency. Ponds located at the Pukalani WRF and on the golf course are also leaking. Both ponds are scheduled to be relined in 2013, which will result in the availability of more recycled water.

The Pukalani WRF is designed for 0.285 mgd and will eventually require an expansion when future development occurs in the area. As MBR systems are much more compact in size than conventional WWTPs, there is adequate room at the site to accommodate a facility expansion.

Haleakala National Park Crater Visitor Center

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Haleakala closed-loop system and Rain water	0.185	$0.55	• Supply • Cost savings	• System is not DOH-approved due to high turbidity issues • The Visitor Center's recycled water is not certified as R-1

The Haleakala National Park Visitor Center is located at the summit of Mount Haleakala at an elevation of 10,000 ft. A closed-loop water recycling system was constructed in 2004 to reuse R-1 water blended with captured rain water for toilet flushing in the park's restrooms. The intent of the system is to produce R-1 water using a standard septic system followed by a recirculation sand filter and disinfection with chlorine tabs. Due to the system's inability to meet the R-1 water turbidity standard, the DOH has not approved use of the recycled water for toilet flushing. To address this issue, an additional basket filter was installed in late 2012. Upon demonstrating to the DOH that the turbidity standard can be met and once a certified WWTP operator is hired, the Park will seek DOH-approval for the system.

Once fully-operational and approved by the DOH, the Park's closed-loop wastewater recycling system will provide a practical and economically-attractive alternative to hauling water as there is an insufficient supply of surface water available for sanitary purposes. Hauling potable water to the

summit with tanker trucks is extremely costly for the National Park Service.

3.3.1.4. Water Reuse on Lanai

The island of Lanai's economy is now based on tourism. Formerly known as the Pineapple Island, the island was the site of the world's largest pineapple plantation. Today, Lanai no longer has large-scale agriculture on the island. Two resorts, the Lodge at Koele and the Manele Bay Hotel, are located on the island, and both use recycled water for irrigation of their respective golf courses. Recycled water has proven to be a valuable water resource on Lanai because the island typically receives below-average rainfall. The County of Maui also prohibits the use of potable water for golf course irrigation.

The Experience at Koele

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Lanai City Auxiliary WWRF and rain water	0.15*	$3.18	• Supply • Disposal	• Loss of recycled water through evaporation and leaking ponds* • Demand not met*
* Note: The golf course demands up to 0.6 mgd of recycled water; however, only 0.15 mgd is used due to evaporation and leakage of recycled water from various ponds. Thus, rain water is used to supplement the demand; however, rainfall events have been infrequent.					

The Experience at Koele is a golf course located in Central Lanai that opened for public play in 1991. Potable water was initially utilized for irrigation; however, a County ordinance required the course to switch to non-potable water within five years of operation. To meet this requirement, the Lanai Company entered into a long-term agreement with the County of Maui: the R-3 water from the County's Lanai WWRF wastewater stabilization pond system would be accepted and upgraded at the new Lanai City Auxiliary WWRF. Constructed in 1994, the auxiliary facility produces R-1 water through the use of water hyacinths, chemical coagulant addition, up-flow sand filtration, and UV disinfection.

While the County's Lanai WWRF receives 0.3 mgd, a significant volume of this water evaporates from the facility's stabilization ponds. In addition, one of the ponds utilized at the facility is unlined which allows some

leakage of wastewater through the soil. As a result, the Lanai City Auxiliary WWRF currently receives only 0.21 mgd from the County's wastewater facility. The R-1 water produced at the Lanai City Auxiliary WWRF is then sent to a 10 MG pond before it is pumped to the golf course. Further evaporation occurs from both the water hyacinth ponds and the 10-MG pond resulting in the golf course receiving only 0.15 mgd of R-1 water.

On a typical day, this golf course requires approximately 0.6 mgd of irrigation water to satisfy its irrigation requirements. The R-1 water is blended with captured rain water; however, there has been a lack of rainfall in recent years due to a prolonged drought. Thus, the 0.15 mgd of R-1 water that is available is only used to irrigate tees, greens, and some fairways of the golf course. R-1 water is also used in some of the course's water features.

The lack of available water is especially challenging for the golf course. The County is contemplating taking the unlined pond out of service at their Lanai WWRF to address the leakage problem. Back-up ponds that are completely lined can be put into service. Additionally, due to algal growth in the 10 MG pond, the R-1 water becomes too alkaline with the pH value reaching 9. The golf course superintendent is requesting approval to purchase an electrostatic perimeter device to help lower the pH level. This device, commonly used at many golf courses to address this issue, is inserted into irrigation ponds and emits negative ions that counteract the positive ions created by the excessive algae present.

The golf course pays for the entire cost to operate and maintain the Lanai City Auxiliary WWRF. This cost works out to be approximately $3.18 per 1,000 gallons.

The Challenge at Manele

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Manele WWRF and Brackish water	0.06	$0.25	• Disposal • Nutrients	• Clogs in irrigation system from algae

The Challenge at Manele is a golf course located in southern Lanai and has utilized recycled water blended with brackish water for irrigation since

1995. This blend is also used to irrigate common areas around the Manele Resort area. The Manele WWRF produces up to 0.06 mgd of R-1 water using activated sludge in the sequencing batch reactor mode, chemical coagulant addition, up-flow sand filtration, and sodium hypochlorite disinfection. The R-1 water is blended with brackish water to approximately a 20% recycled water concentration. The golf course pays $0.25 per 1,000 gallons to help with the operation and maintenance costs of the Manele WWRF.

The primary factor behind water reuse at the golf course is wastewater disposal. While the brackish water used is quite saline, most of the turf at the Challenge at Manele has been converted to seashore paspalum– an extremely salt-tolerant grass. Some of the drip emitters used occasionally get plugged and must be cleaned or replaced.

3.3.1.5. Water Reuse on Molokai

The island of Molokai is lightly populated and one of the least-visited islands in the Hawaiian chain. The County of Maui's Kaunakakai WWRF processes the majority of wastewater generated on the island and disposes the bulk of the effluent into injection wells. A small volume is used for landscape irrigation along the Mauna Loa Highway. Two other water reuse projects, the Kaluakoi Resort and the Puu O Hoku Ranch, were also in operation in 2012.

Mauna Loa Highway Beautification

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Kaunakakai WWRF	0.001 average	$1.28	• Supply • Consistent	• None reported

Kaunakakai is located in south-central Molokai, a very arid region receiving less than 15 inches of rainfall per year. The Mauna Loa Highway Beautification Project was established in 1995 and required a source of irrigation water for native Hawaiian plants to be planted along the highway at Kaunakakai's entrance. Recycled water from the nearby Kaunakakai WWRF was the best option since potable water was not available. The County of Maui's WWRD constructed a delivery system that now provides recycled water for landscape irrigation at its Kaunakakai WWRF and the DOT's Mauna Loa Highway Beautification Project.

The Kaunakakai WWRF produces R-2 water using rotating biological contactors, secondary clarification, and liquid sodium hypochlorite disinfection. The R-2 water is pumped to the subsurface drip system of the Mauna Loa Highway Beautification Project where an average of 1,000 gpd is utilized. While technically under the management of the DOT, the project is maintained by the employees of the Kaunakakai WWRF as it fronts the entrance of the County's wastewater facility. The irrigation controller is located at the Kaunakakai WWRF and operates both the facility and the DOT's irrigation systems. The DOT pays $1.28 per 1,000 gallons for the recycled water service, and a regular flow of R-2 water is maintained and the system is flushed on a regular basis.

The Kaluakoi Resort and Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Kaluakoi WWRF	0.001 average	$1.28	• Disposal • Supply • Consistent	• None reported

The Kaluakoi Resort and Golf Course is owned by Molokai Ranch Company and is located in west Molokai. The golf course has intermittently used R-2 water for irrigation since 1985. The golf course is no longer being used for play, but it still provides a convenient disposal location for the recycled water produced at its WWRF.

The Kaluakoi WWRF processes 0.04 mgd of R-2 water using activated sludge, gravity sand filters, and sodium hypochlorite tabs for disinfection. The effluent is pumped to a pond. When the pond is nearly full, the R-2 water is spread onto two of the golf course's fairways.

The Kaluakoi WWRF is an older facility that has had operational issues. Molokai Ranch's utility staff has implemented strategies to improve effluent quality over the years. A crude sand filter has been successfully utilized to remove solids from the effluent, and an unused clarifier has been used to improve the facility's disinfection capacity. During the research investigation conducted for the *2004 Hawaii Water Reuse Survey and Report*, it was learned that Molokai Ranch (as part of its 50-year plan) intended to upgrade its wastewater reclamation system to R-1 capability using constructed wetlands. However, Molokai Ranch officials did not reveal their plans, if any, for a wastewater system improvement at the time of writing this report.

Puu O Hoku Ranch

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-3	Puu O Hoku Ranch constructed wetlands system	0.0037	$0.00	• Disposal • Supply • Inexpensive • Drought-proof	• Low wastewater generation requires non-potable water to operate system and prevent clogs

Puu O Hoku Ranch, located in east Molokai, treats wastewater from its leased cottages with a subsurface constructed wetlands system built in 2004. A "subsurface" constructed wetland utilizes gravel or sand as a medium where plants are rooted. Wastewater flows below the ground surface either horizontally or vertically through the wetland. The system treats approximately 3,700 gpd of wastewater to R-3 standards using septic tanks, effluent screens, and the constructed wetland. The recycled water is used to irrigate trees and shrubs via a sub-surface drip irrigation system. During periods of low occupancy at the Ranch, non-potable water must be introduced to the system to keep it operating and to prevent the drip lines from clogging.

The system has improved the Ranch's wastewater treatment capability and simultaneously created a drought-proof, inexpensive supply of irrigation.

3.3.2. Water Reuse in the City and County of Honolulu (Oahu)

Water reuse has been successfully practiced on Oahu for decades. The oldest reuse project in Hawaii was established by the Waialua Sugar Company where recycled water was blended with stream water and used for irrigation of sugar cane and diversified agriculture since 1928 – a practice continued today by the Dole Food Company. Other projects with successful track records include the Marine Corps Base Hawaii (MCBH) Kaneohe Klipper Golf Course, where R-2 water has been since 1966, and Hawaii Reserves, where R-1 water is used to irrigate agricultural crops and landscaped areas at the Brigham Young University Hawaii Campus and Polynesian Cultural Center since 1995. Most new projects have occurred in the Ewa district of southwest Oahu due to the development of a water recycling program by the HBWS.

3.3.2.1. Water Reuse in Southwest Oahu (Ewa)

Water reuse in southwest Oahu is extensive and diversified, ranging from golf course irrigation to steam powered turbines. All of the recycled water used in southwest Oahu comes from the Honouiluli WRF, owned by the HBWS and operated in conjunction with the Honouliuli WWTP. Honouliuli WWTP treats approximately 26 mgd of wastewater received from Halawa to Ko Olina, and as far north as Mililani. The Honouliuli WRF takes up to 12 mgd of Honouliuli WWTP's secondary treated wastewater and produces up to 2 mgd of R-O water and 10 mgd R-1 water. R-1 water is created by using flocculation, sand filters, and UV treatment. R-O water is created by using microfiltration and R-O. The R-1 recycled water produced at Honouliuli WRF is pumped to users throughout southwest Oahu, while the R-O is pumped to Campbell Industrial Park.

The drivers behind water reuse at the Honouliuli WRF include preserving potable water supplies in a growing community and recharging the caprock aquifer as inputs from agricultural activities decreased. It was also driven heavily by consent decrees between the City and the State and federal governments that required secondary treatment and water reuse. The Honouliuli WRF allows hundreds of millions of gallons of recycled water to be used while preserving valuable potable and groundwater sources.

Unlike the County of Maui, which depends upon elevated storage to produce consistent pressure distribution system, the HBWS pressurizes R-1 and R-O systems by running pumps. The systems are designed in a loop fashion to help stabilize system pressure and operators must manage water pressure. The HBWS is planning to construct a reservoir dedicated for recycled water; however, it is not known when the construction will occur.

3.3.2.1.1. Southwest Oahu Water Reuse Projects

Industrial Uses

R-O water from the Honouliuli WRF was made available for industrial use in 2000. Currently, seven facilities utilize the R-O water: six in the Campbell Industrial Park and one facility on the *leeward* coast. All seven facilities use recycled water as a direct replacement to their alternative water supply: HBWS potable water.

Current R-O water usage at these facilities is approximately 1.74 mgd (see **Table 3-2** below). The primary use for R-O water at these facilities is boiler feed for the production of steam and electricity. A

small amount is also used at the Chevron refinery for emission control and lab use.

Table 3-2: Daily Industrial R-O Water Use

Company	Average Daily R-O Use (mgd)
AES Hawaii	0.13
Chevron	0.64[1]
Hawaii Gas	0.05
HECO Campbell Industrial Park Plant	0.02
HECO Kahe Plant	0.15
Kalaeloa Partners	0.50
Tesoro Hawaii Corporation	0.25[1]
TOTAL	**1.74**

1- Empirical water use date from the facility was not available or facility operators were not otherwise able to provide water usage quantities. Average daily flows are based on information obtained from the State of Hawaii, Department of Health.

AES Hawaii

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.13	$5.00	• Reduced operating costs	• None reported

The privately-owned, 180-MW AES Hawaii power plant is the only coal-fired power plant in the State. The plant typically runs close to capacity due to the low cost of electricity produced at the plant.

In 2012, AES Hawaii used 48 MG of R-O water. The R-O water is converted into steam to power a steam turbine generator, which generates electricity sold to Hawaiian Electric Company (HECO). Some of the steam is extracted from the generator system and sold to the Chevron refinery.

The HBWS charges approximately $5.00 per 1,000 gallons of R-O water. Although much more expensive than potable water, overall operating costs are reduced and cost savings is realized because the demineralization requirements for R-O water are drastically less than potable water.

Chevron

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.64	Not Available	• Reduced operating costs	• None reported

The Chevron refinery located in Kapolei is one of two refineries in the State. The Chevron refinery currently produces 54,000 barrels of gasoline per day.

The refinery houses a cogeneration turbine that produces electricity and steam. R-O water from the Honouliuli WRF is used as boiler feed to power the turbine. In addition to use as boiler feed, approximately 10 gallons per minute of the R-O water from the Honouliuli WRF is used for emission control and laboratory use.

HawaiiGAS

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.05	$5.00	• Reduced operating costs	• None reported

The Gas Company, recently rebranded as HawaiiGAS, is Hawaii's only government franchised full-service gas company. The company manufactures primarily synthetic natural gas and renewable natural gas. R-O water from Honouliuli WRF is used as boiler feed water to generate the steam needed for gas production.

In 2012, the monthly usage of R-O water at The Gas Company ranged from approximately 1.2 to 1.5 MG. Although the facility is able to accept HBWS potable water, regeneration of the water demineralization system must be performed once a day as compared to regeneration every seven to nine days when using R-O water. As such, use of the R-O water results in fewer chemicals needed to treat the water and overall cost savings.

HECO Campbell Industrial Park Plant

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.02	Not Available	• Reduced operating costs	• None reported

The HECO Campbell Industrial Park plant in Kapolei is the smallest of four plants operated by HECO. In operation since October 2009, the plant has been used during periods of peak demand or as a backup generator during the maintenance of other plants.

In 2011, the HECO Campbell Industrial Park plant used 4.2 MG of R-O water: monthly water usage ranged from 0.165 MG in December to 0.615 MG in August. The R-O water is obtained through the distribution line servicing the Chevron refinery and stored in onsite reservoirs. The reservoirs have a total storage capacity of 700,000 gallons and are typically kept at capacity. R-O water from Honouliuli WRF is further treated at the plant through R-O and demineralization. Once treated, the R-O water is mixed with fuels to a 1:1 ratio for emission control.

The HECO Campbell Industrial Park plant is also capable of using well water or HBWS potable water in place of R-O water; however, R-O water is preferred due to savings on demineralization costs.

HECO Kahe Power Plant

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.15	Not Available	• Reduced operating costs	• High connection costs

The HECO Kahe power plant is Hawaii's largest power plant with a generating capacity of 658 MW. The plant operates six boilers that burn low sulfur fuel oil.

The plant originally operated on HBWS potable water and transitioned to R-O water in August 2009. In 2011, the plant used approximately 45

MG of R-O water with monthly usage ranging from 3.1 to 4.6 MG. R-O water is stored in onsite reservoirs and demineralized prior to use. With R-O water, regeneration of the water demineralization system must be performed once every six weeks as compared to once a day when using HBWS potable water. As such, cost savings are realized due to less chemical usage with the use of R-O water.

Due to the extended distance between the Honouliuli WRF and Kahe power plant, upfront construction costs paid by HECO to install the distribution main were high; however, the cost savings from reduced chemical usage is expected to offset the capital improvement costs.

Kalaeloa Partners

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.50	Not Available	• Environmental factors • Reduced operating costs	• None reported

The Kalaeloa Partners cogeneration plant located in Campbell Industrial Park is owned by Kalaeloa Partners, LLC. The 208-MW combined-cycle cogeneration plant generates electricity and steam. Electricity generated at the plant is sold to HECO, while steam is sold to the Tesoro refinery.

The Kalaeloa plant uses approximately 14 to 15 MG of R-O water per month as boiler feed to operate its steam and combustion turbines. Prior to use, R-O water is treated through a water demineralization system. While there is some cost savings from reduced water treatment compared to potable water, water conservation – not cost savings – was the primary reason behind the decision to use R-O water.

Tesoro Hawaii

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-O	Honouliuli WRF	0.25	Not Available	• None reported	• None reported

In June 2013, the Tesoro Corporation announced that it plans to sell its Campbell Industrial Park refinery – the larger of two refineries in the State – to Par Petroleum. Tesoro anticipates that the sale will be completed in the third quarter of 2013 (Scheuring & Daysog, 2013).

Facility representatives could not be reached for the preparation of this report, and it is unknown if or how the sale will impact refinery operations. Records from the WWB indicate that 252,000 gpd of R-O water are currently used at the Tesoro refinery.

Ewa Area Golf Courses

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Honouliuli WRF	Varies (see Table 3-3 below)	Varies (per individual rate agreements)	• Supply • Disposal • Environmental factors • Potable water preservation • Nutrients	• High nutrient content clogs the irrigation system

Golf course irrigation is the largest use of R-1 water from the Honouliuli WRF. The high number of golf courses in the Ewa area combined with the area's dry climate creates a large demand for irrigation water.

There are currently eight golf courses in the Ewa area that use this R-1 water for irrigation. Six of the eight golf courses are discussed in this section and use approximately 4.01 MGD. Due to their unique situation, the remaining two golf courses will be discussed in with the City and County of Honolulu, Department of Enterprise Services (DES) reuse projects below.

R-1 water produced at the Honouliuli WRF is transported by the HBWS distribution system to the golf courses. Many of the courses store the

recycled water in their ponds and spray-irrigate the greens and fairways; however, the Barber's Point Golf Course uses an enclosed 50,000-gallon reservoir in lieu of a pond. The approximate quantity used by each golf course is summarized in **Table 3-3** below.

Table 3-3 Daily R-1 Water Use at Ewa Area Golf Courses

Company	Average Daily R-1 Use (MGD)
Barber's Point Golf Course	0.50
Coral Creek Golf Course	1.00
Ewa Beach Golf Club	0.45
Hawaii Prince Golf Club	1.00
Hoakalei Country Club	0.06[1]
Kapolei Golf Course	1.00[1]
TOTAL	4.01

1-Empirical water use data from the facility was not available or facility operators were not otherwise able to provide water usage quantities. Average daily flows are based on information obtained from the State of Hawaii, Department of Health.

Access to quality and low-priced water sources directly competes with recycled water for golf course irrigation. As discussed in **Section 2.2**, the HBWS holds individual rate agreements with each facility so the price of R-1 water is competitive to the price of traditional water sources, often brackish wells owned by the golf course. Because rates are set on a case-by-case basis, facility operators typically prefer not to share recycled water rates. However, some facility operators indicated they pay a rate of $0.55 per 1,000 gallons. Although the HBWS would eventually like to have a uniform rate structure amongst its recycled water users, this goal will have to be balanced against the need to competitively price recycled water versus alternative water supplies. Increases to recycled water rates may force a business to decide to use the less expensive groundwater as its primary irrigation source, and this action could jeopardize the HBWS recycled water program. Although HBWS R-1 water is more expensive than pumping brackish water, the HBWS has been able to keep its R-1 water price competitive by subsidizing its recycled water costs with income from potable water users.

The Barber's Point Golf Course is the only facility that will not consider price in the decision to use recycled water; the United States Navy cites environmental stewardship as the primary factor in its decision to use recycled water and to preserve drinking water sources.

Some facilities reported nutrient benefits to using recycled water; however, associated typical problems include the need to clean sprinkler heads more often due to increased presence of biological

matter in the irrigation system. The Barber's Point Golf Course, which has an enclosed reservoir, does not experience the same sprinkler clogging problem. While algae blooms in holding ponds have also been attributed to the recycled water, personnel at the Coral Creek Golf Course have noted algae problems in ponds that do not hold recycled water and do not attribute such problems specifically to the use of this water.

Many golf courses use water features – like this pond at the Hawaii Prince Golf Course – to store recycled water prior to use.

City and County of Honolulu, Department of Enterprise Services

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Honouliuli WRF	0.25–1.0 and 0.5–0.9	$1.5898	• Consent Decree • Disposal • Potable water preservation • Nutrients	• High nutrient content clogs the irrigation system

The DES is a major user of Honouliuli WRF's R-1 water. The recycled water is distributed from the WRF to ponds located at DES's Ewa Villages Golf Course or West Loch Golf Course.

The recycled water distributed to the golf course ponds also supplies water to a number of nearby housing developments and parks for

landscape irrigation. The distribution system includes two separate HBWS meters at each golf course. All R-1 users pull water from the ponds; however, the users are not metered separately, so there is no way to determine how much water is used at each facility.

The Ewa Villages Golf Course receives 0.25 – 1 mgd of R-1 water and supplies recycled water to the Ewa Villages Development and Ewa Mahiko District Park. The West Loch Villages Golf Course receives 0.5 – 0.9 mgd and supplies the West Loch Villages Elderly Housing, West Loch Fairways & Townhouses, West Loch Estates, West Loch Estates Laulaunui, and Asing Community Park. From July 2012 to November 2012, 102 MG of recycled water were delivered to the Ewa Villages Golf Course pond and 112 MG were delivered to the West Loch Golf Course pond.

The DES pays $1.5898 per 1,000 gallons for R-1 water. The DES currently pays for all R-1 water delivered to both golf course ponds even though some of the R-1 users that pull water from the ponds are facilities not operated by the DES. For example, the Asing and Ewa Mahiko parks are facilities operated by the City and County of Honolulu, Department of Parks and Recreation (DPR). The DES is trying to resolve this issue with the HBWS.

The main challenge experienced at both the Ewa Villages and West Loch Golf Courses is the clogging of sprinkler heads with algae, snails, and bryozoans (an aquatic filter feeder that forms blob-like colonies, also known as moss animals). The algae, snails, and bryozoans are believed to originate in both distribution ponds. An upcoming filtration system project is expected to address sprinkler head clogging problems.

Effluent disposal, protecting water supplies, and the Consent Decree between the City and County of Honolulu, the DOH, and the EPA are factors driving the use of recycled water. Nutrients in the R-1 water also help reduce the need for fertilizers.

Landscape Irrigation

In addition to the facilities supplied by the DES system, Honouliuli WRF's R-1 water is used for landscape irrigation at other Ewa facilities. The DOT uses R-1 water for irrigation of medians along Fort Weaver Road, and the DPR uses R-1 water for irrigation of the West Loch Shoreline, Asing, and Ewa Mahiko parks.

The State of Hawaii, Department of Education (DOE) uses R-1 water for spray irrigation of landscaped areas at the Ewa Makai Middle School. The school is the first DOE facility on Oahu to use R-1 water. Faculty and students at the school are educated on the proper use of recycled water at the school, and the school has had no incidents to date.

The Kulana Malama Nursing Facility uses R-1 water for spray irrigation of landscaped areas. Kulana Malama is a 7-acre nursing facility, serving typically thirty residents, and is located approximately 1.5 miles northeast of the Honouliuli WRF. The nursing facility is the only healthcare facility on Oahu using recycled water. The main concern for Kulana Malama is that spray irrigation could be linked to respiratory problems. To address this issue, Kulana Malama has installed UV lights in their air conditioning system to kill microorganisms

3.3.2.2. Water Reuse in North and Central Oahu

Water reuse is practiced by a number of users on the north shore and in central Oahu including Dole Food Company, Kunia Plantation Villages (operated by the Hawaii Agriculture Research Center), Turtle Bay Resort Palmer Golf Course, and the Waiawa Correctional Facility. Unlike the Ewa area where golf course irrigation is common, the primary use for recycled water in North and Central Oahu is for agricultural purposes.

3.3.2.2.1. North and Central Oahu Water Reuse Projects

Dole Food Company

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2[1]	Wahiawa WWTP, Stream water, and Schofield WRF	1.6 and 2.3	$0.00[2]	• Supply • Disposal	• Restrictions on agricultural users

1-Although the Schofield WRF effluent meets R-1 water quality standards, it cannot be certified as such due to lack of an alternate disposal.
2-The Schofield WRF pays Dole for the right to discharge effluent into its irrigation ditch.

Since 1928, effluent from the City and County of Honolulu's Wahiawa WWTP has been discharged to the Wahiawa Reservoir (commonly known as Lake Wilson). This reservoir serves agricultural lands in north Oahu through a network of irrigation ditches. The reservoir is

also fed by mountain stream water. In 1975, the Army's Schofield Barracks WRF commenced discharging its effluent into a conveyance ditch – owned and operated by Dole Food Company – downstream of the Wahiawa Reservoir.

Approximately 1.6 mgd of R-2 water is currently produced at the Wahiawa WWTP, which is below its design capacity of 2.5 mgd. The plant currently produces tertiary-treated effluent using clarifiers, activated sludge, and UV treatment.

A number of upgrades will be completed at the Wahiawa WWTP, resulting in R-1 quality effluent. MBR construction – the City and County of Honolulu's first such improvement – is currently underway, as well as a new biofilter, an upgrade of the UV system, an R-1 pump station, and modification of existing secondary clarifiers to flow equalization basins. The upgrades are expected to be completed by late-summer of 2013.

The Schofield WRF is located at the Wheeler Army Airfield and currently treats 2.3 mgd of wastewater from U.S. Army facilities at Schofield Barracks and Wheeler Army Airfield. This WRF – which is operated by Aqua Engineers – produces R-1 quality water through MBR treatment with UV disinfection. Although the Schofield WRF produces R-1 quality recycled water, the DOH classifies the water as R-2 because the facility lacks a secondary disposal method which is required for R-1 classification. Dole charges the Army for the right to discharge effluent into its irrigation ditch.

Flow from the Wahiawa Reservoir is conveyed via the Dole Food Company irrigation ditch system to various agricultural users in north Oahu: users include food crops, ornamental plants, seed production, and a research station operated by the University of Hawaii. Dole irrigation ditch water is considered R-2 water by the DOH. One concern regarding the use of the recycled water for those farmers growing food crops is the restrictions placed on the type of edible crops that can be grown. Because of these restrictions, some farmers using the water have limited their crop selection to orchard type crops such as papaya, banana, mango, citrus crops and avocado. Additionally there is a restriction on the irrigation method, which is primarily limited to drip irrigation, which also affects crop selection. For example, corn crops benefit from spray irrigation because it regulates the temperature of the crop, and some herbicides used for weed control are water-activated and are not as effective when using drip irrigation.

The Dole irrigation ditch conveys water that includes effluent from the Wahiawa WWTP and Schofield WRF.

Hawaii Agriculture Research Center

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Kunia Villages WWTP	0.03	$0.00	• Disposal	• None reported

The Hawaii Agriculture Research Center (HARC) is a non-profit research organization whose work encompasses forestry, coffee, forage vegetable crops, tropical fruits, sugarcane, and other diversified crops (HARC, 2013).

In 2010, the HARC acquired Kunia Plantation Village from James Campbell Company. HARC envisions that the 119-acre facility – which is located off of Kunia Road in central Oahu – will be an agricultural complex with a mix of affordable housing and agricultural processing. (Chang, 2010). The complex currently consists of approximately 100 residential homes and 8 commercial buildings.

The Kunia Villages WWTP has a design capacity of 70,000 gpd, and it currently treats 30,000 gpd of wastewater from the Kunia Plantation Villages. The WWTP produces R-2 water, and the HARC uses all 30,000 gpd of recycled water for agricultural irrigation. HARC currently

uses the R-2 water for irrigation of guinea grass and plans to eventually use recycled water for irrigation of research sugar cane.

Turtle Bay Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Kuilima WWTP and Well water	0.002	$0.00	• Nutrients	• High nutrient content • Odors

The Turtle Bay Resort is located on the north shore of Oahu and has utilized recycled water for golf course irrigation since 1970. Currently, 2,000 gpd of R-2 water from the Kuilima WWTP is used for irrigation at the Palmer Course.

The Kuilima WWTP, currently operated by Aqua Engineers, is a privately-owned WWTP that serves the Turtle Bay Resort. The plant uses stabilization ponds, sand filtration, and chlorine disinfection to produce R-2 water. The water is stored in a golf course pond where it is blended with well water. The WWTP uses only one of its four stabilization ponds and is capable for future expansion.

The golf course benefits from the nutrients present in the recycled water; however, fine debris in the water have been noted to be an issue. Fetid odors are also noticed when the water in the irrigation system becomes stagnant.

Waiawa Correctional Facility

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Wahiawa Correctional Facility WWTP	0.066	$0.00	• Disposal	• None reported

The Waiawa Correctional Facility is located in central Oahu and utilizes approximately 66,000 gpd of R-2 water from its Waiawa Correctional Facility WWTP. Wastewater is treated to R-2 water at the WWTP using a pre-aeration basin, water hyacinths, chlorine disinfection, and a

polishing pond. The recycled water is applied via a drip irrigation system for agricultural and landscape irrigation.

3.3.2.3. Water Reuse in Windward Oahu

There are two current reuse projects in windward Oahu. Hawaii Reserves distributes R-1 water for a variety of uses in Laie, including landscape irrigation and agriculture. The MCBH in Kaneohe uses R-2 water for irrigation of the Kaneohe Klipper Golf Course.

3.3.2.3.1. Windward Oahu Water Reuse Projects

Hawaii Reserves

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Laie WWRF	0.4	$0.00	• Disposal	• None reported

Hawaii Reserves is located in Laie in northeast Oahu and is the purveyor of R-1 water from the Laie WWRF (owned and operated by the City and County of Honolulu). The facility produces R-1 water through tertiary treatment with final UV disinfection. The plant has a design capacity of 0.9 mgd and typically treats approximately 0.4 mgd.

The recycled water is used for turf irrigation at the Brigham Young University-Hawaii campus and landscaping at the Polynesian Cultural Center. It is also sold to nearby farmers who use the water for crop irrigation. Hawaii Reserves does not have on-site storage capacity and disposes of any unused R-1 water through leach fields. There is the potential for additional demand of recycled water as the Brigham Young University-Hawaii campus is planning for new facilities that may increase this need.

Marine Corps Base Hawaii Kaneohe Klipper Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	MCBH WWRF	0.6	$0.00	• Potable water preservation • Lower costs • Nutrients	• Inconsistency • High nutrient content clogs the irrigation system

The Kaneohe Klipper Golf Course is located along the windward shore of Oahu on MCBH in Kaneohe. It was the first golf course in Hawaii to use recycled water for irrigation having commenced the use of R-2 water in 1966.

The course receives its recycled water from MCBH's WWRF. The wastewater at MCBH undergoes treatment at its WWRF through a primary clarifier, trickling filter, secondary clarifier, and chlorine disinfection. The facility currently treats approximately 1 mgd, but it has a design flow of 2 mgd. Of the 1 mgd, MCBH reuses approximately 0.6 mgd for night-time irrigation of the Klipper Golf Course and discharges the remainder through an ocean outfall shared with the City and County of Honolulu's Kailua Regional WWTP. MCBH also has the ability to store up to 800,000 gallons in a polishing pond.

MCBH has had inconsistent disinfection and some sprinkler clogging through utilizing the recycled water. The inconsistency in disinfection was noticed while using chlorine tablets, and the facility has since switched to liquid chlorine. As a result of the inconsistent disinfection, the Klipper Golf Course has had to be irrigated with potable water for about a year. Golf course personnel intend to resume the use of recycled water for irrigation as soon as the disinfection issues are resolved.

3.3.3. Water Reuse in Kauai County

The island of Kauai has abundant surface water resources: there are a number of rivers and streams located throughout the island. Water from these tributaries has been diverted through ditch conveyance systems to provide non-potable irrigation water for many of the island's golf courses and agricultural projects. Quality brackish water obtained from wells is also abundant and used for irrigation.

As a result, the key factor for recycled water use at most of Kauai County's water reuse projects is primarily wastewater disposal. Additionally, water supply is also an important factor as using recycled water is often less expensive than pumping brackish water or using potable water for irrigation purposes. Recycled water is reused from both municipal and private facilities on Kauai. Most of the water reuse projects utilize recycled water blended with surface or brackish waters for golf course irrigation. Agricultural irrigation with recycled water continues to take place in southwest Kauai where recycled water is blended with ditch water and used for seed corn irrigation. Additionally, two commercial properties now use recycled water for landscape irrigation.

3.3.3.1. Kauai County Water Reuse Project Descriptions

Kikiaola Land Company

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Waimea WWRF and Waimea River water	0.3 average	$0.00	• Supply • Disposal	• Discharge to State Waters

KLC leases 450 acres of agricultural land in the Waimea area of southwest Kauai and has accepted recycled water from the County of Kauai's Waimea WWRF since 1973. The recycled water produced at the facility is pumped to a storage reservoir where it is blended with water from the Waimea River (which is conveyed to the reservoir through the Kekaha Ditch).

From 1973 to 1994, KLC utilized the facility's R-2 water to grow sugar cane. The company's lease expired in 1994, and KLC now leases 200 of its acres to a seed corn company. Over the years, KLC representatives claimed health related concerns raised by agricultural workers who are exposed to the R-2 water. This resulted in lower rental values for the land KLC leases.

To address this, an R-1 water upgrade of the Waimea WWRF was constructed in 2012. Influent screening, incorporation of a Moving Bed Bioreactor (MBBR) activated sludge system, and R-1 water components are now in place. R-1 water is produced through the addition of coagulation, effluent filtration, and UV disinfection. The facility produces an average 0.3 mgd of R-1 water, and all effluent is pumped to the storage

reservoir and blended with river water to approximately a 30% recycled water concentration (percentage may increase significantly during times of decreased rainfall). Currently, the County of Kauai has a long-term agreement with KLC and does not charge for the recycled water.

KLC's agricultural operations are the primary effluent disposal mechanism. There is concern that recycled water may enter the ocean during rainstorm events. Title 11-54, HAR does not permit discharges of recycled water to State Waters. Injection wells have been added as an alternate disposal option at the Waimea WWRF and can be utilized if the R-1 water is not in compliance with DOH standards for turbidity and fecal coliform.

The company's non-potable water supply (ditch water) decreases during dry seasons; thus, KLC considers the supplemental recycled water to be a valuable water resource for its agricultural operations. As mentioned in Section 3.2.3, the KDWM is planning to construct an R-1 water distribution system in the Waimea area so that R-1 water can be used instead of the potable water currently used for landscape irrigation at several commercial properties. KLC would serve as a secondary reuse customer once this plan is implemented, taking only the balance of the daily available R-1 water.

Kauai Lagoons Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Lihue WWRF and Brackish water	1.2	$0.00	• Disposal • Inexpensive • Consistency	• Supply vs. demand varies throughout year

The Kauai Lagoons Resort, located in southeast Kauai, has irrigated its Kiele golf courses with recycled water from the County of Kauai's Lihue WWRF since 1986. Prior to the resort, sugar cane utilized the facility's R-2 water for irrigation. The Kauai Lagoons Resort then utilized the R-2 water for golf course irrigation after the land was converted. Lihue WWRF: the facility utilizes primary clarifiers, bio towers followed by contact stabilization activated sludge, coagulation, disk filtration, and UV disinfection to process R-1 water. All daily flow is pumped to two irrigation ponds located at the resort.

During the summer months, the Lihue WWRF's daily flow of 1.2 mgd is not sufficient to satisfy the irrigation requirements of the two golf courses. Brackish water is blended with the recycled water in the irrigation ponds to meet the resort's irrigation demands when these warmer and drier conditions are prevalent.

The County of Kauai and the resort had an agreement that required the resort to accept all of the Lihue WWRF's effluent. While not a problem during the summer months when all of the recycled water was utilized for irrigation, the resort had to dispose of excess recycled water into an injection well at times during the wet season. As a result, the County constructed seven injection wells at the Lihue WWRF in the summer of 2004. The wells provide alternate effluent disposal, which is a DOH requirement for all water reuse projects. There are times when the Lihue WWRF's recycled water does not meet R-1 water quality standards and brackish water is needed to irrigate the golf course. The cost to produce brackish water is significant, so the Kauai Lagoons Resort prefers the use of recycled water.

The Kauai Lagoons Resort in southeastern Kauai contributed Funding to the County off Kauai to upgrade the recycled water produced at the Lihue WWRF to R-1 water quality.

Wailua Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Wailua WWRF and Brackish water	0.5	$0.20	• Supply • Disposal • Nutrients	• High nutrient content

One of the most challenging municipal courses in the nation, the Wailua Golf Course is a heavily used municipal golf course located on the eastern shore of Kauai. It is adjacent to the County's Wailua WWRF, and R-2 water from the facility has been used for golf course irrigation since 1969.

The Wailua WWRF utilizes conventional activated sludge, disk filtration, and chlorine disinfection to produce 0.5 mgd of R-2 water. The recycled water is pumped to the golf course on a regular basis, except for one 24-hour period per week when all daily flow is diverted to the facility's ocean outfall to keep it clear of sand. The outfall is also used during extended rainy periods when irrigation of the golf course is not required. Brackish water, used as a supplemental irrigation source, is typically blended with the R-2 water. The recycled water normally satisfies 60 – 80% of the golf course's annual irrigation requirement.

The golf course receives approximately two pounds of nitrogen per acre per year through the R-2 water; thus, supplemental fertilizer requirements are minimized. While this high nutrient content has previously resulted in excessive amounts of green algae in the course's storage reservoir, the reservoir water is now "turned over" frequently to lessen the algae.

The use of recycled water is preferred at the Wailua Golf Course; the course has a healthier appearance than when brackish water is primarily used. Additionally, the golf course is the main disposal option for the Wailua WWRF and is preferred to the use of the ocean outfall.

Lydgate Park Soccer Fields

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Wailua WWRF and Potable water	0.01*	$0.20	• Supply • Inexpensive	• High nutrient content clogs the irrigation system* • Potable water needed to meet demand*
* Note: The park demands up to 0.07mgd of recycled water; however, only 0.01 mgd is used due to the R-2 water's high nutrient content. Thus, potable water is used to supplement the demand.					

Lydgate Park consists of approximately 6 acres of soccer fields adjacent to the Wailua Golf Course. Constructed in 2008, it is owned by the County of Kauai. Since the golf course and park are both operated and maintained by the County's Parks Department, the golf course irrigation system was extended to the new soccer fields.

R-2 water from the Wailua WWRF is applied with a subsurface drip irrigation system. Spray irrigation was not considered due to the close proximity of a condominium complex: a 500-ft buffer between reuse projects and nearby properties is a DOH requirement when R-2 is applied via spray irrigation. The golf course is charged the R-2 water rate, as the KDWM considers the recycled water use at the soccer fields part of the golf course's irrigation demand.

While the soccer fields demand up to 0.07 mgd of R-2 water per day, only 0.01 mgd is currently utilized due to algae clogging the irrigation's subsurface drip system. As a result, Parks Department personnel use approximately 0.06 mgd of potable water to spray-irrigate the fields. A 30 mg/L chlorine solution is being periodically injected into the irrigation system to address this.

Puakea Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost**	**Benefits**	**Issues**
R-1	Lihue-Puhi WWTP and Stream water	0.4	$90,000/year	• Disposal • Supply • Nutrients	• Expensive

The Puakea Golf Course is located in southeast Kauai and is part of the Puakao Development of Grove Farms Properties, Incorporated. Puakea Golf Course has been irrigated with a blend of the Lihue-Puhi WWTP's R-1 water and stream water since 1993. R-1 water was required at this golf course because of its close proximity to residential housing.

Wastewater is processed to R-1 at the Lihue-Puhi WWTP using extended aeration activated sludge, chemical coagulant addition, up-flow sand filtration, and chlorine disinfection. All of the plant's 0.4 mgd flow is pumped to a large lake on the golf course where it is blended with stream water. This R-1 water concentration is typically 20% of the irrigation requirement for the front nine holes of the golf course; the back nine holes are irrigated with 100% stream water. The presence of nitrogen in the R-1 water decreases the need for fertilizers at the golf course.

The golf course contributes $90,000 per year to Grove Farms Properties to offset R-1 water production and delivery costs. This annual payment has resulted in a reduction in the number of maintenance employees that the Puakea Golf Course can employ.

The island of Kauai has abundant surface water sources. The Puakea Golf Course uses a blend of R-1 water and stream water as its irrigation source.

Princeville Makai Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Princeville WWRF and Rainwater	0.6	$0.163	• Inexpensive • Reliable	• Excessive supply during heavy rainfalls

The Princeville Makai Golf Course is located in northern Kauai and is part of the Princeville Resort. A blend of R-2 water and captured rainwater has been utilized for irrigation since 1971.

Wastewater is treated to R-2 quality at the Princeville WWRF using activated sludge and hypochlorite disinfection. The entire 0.6 mgd flow is pumped to a series of irrigation reservoirs where it is blended with rainwater collected by the storm drain system. The percentage of recycled water in this blend varies based on the amount of rainfall the region receives. The golf course pays Princeville Utilities Corporation $3,300 per month (approximately $0.163 per 1,000 gallons) for the recycled water. There are no injection wells located at the Princeville WWRF; all of the daily flow must be pumped to the irrigation reservoirs.

The use of recycled water has been very successful at the Makai Golf Course with no significant problems reported. While the golf course provides a convenient effluent disposal option, during heavy rainfall, the daily flow of R-2 water creates high levels in the irrigation ponds and the course must be over-irrigated to prevent the ponds from overflowing. Princeville Utilities Corporation plans to address this challenge by constructing injection wells for alternate disposal at the Princeville WWRF.

The Princeville Makai Golf Course in northern Kauai blends captured rain water with R-2 recycled water in ponds located on the golf course.

Poipu Bay Resort Golf Course

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Grand Hyatt WWRF and Waita Reservoir stream water	0.1	No set price	• Supply • Disposal • Nutrients	• Slight odor

The Poipu Bay Resort is located in southern Kauai. The resort's golf course, the Poipu Bay Resort Golf Course, has been irrigated with a blend of R-2 water and stream water since 1991.

Wastewater from the resort is treated at the Grand Hyatt WWRF to R-2 quality using the MBBR process and hypochlorite disinfection. The facility was upgraded from activated sludge to the MBBR process in 2006 to improve effluent quality. Flow to the WWRF facility has decreased in recent years due in part to the installation of water conservation plumbing fixtures at the Grand Hyatt Resort. Currently, the facility has an effluent

flow of 0.1 mgd. The entire effluent flow is blended with stream water from the Waita Reservoir into the golf course lake to a recycled water concentration of 20-40%. A higher percentage of recycled water (up to 60%) is used to irrigate the first three holes of the golf course, where maintenance personnel observed the benefit of added nutrients. The recycled water has a slight odor when spray-irrigated, and this odor is more noticeable at the first three holes where the higher concentration of recycled water is utilized.

The percentage of recycled water varies throughout the year depending upon rainfall volumes. An injection well operated by golf course maintenance personnel is available for disposal of excess recycled water during extended rainy conditions when irrigation is not required. While the recycled water is not necessarily needed due to the abundance of surface water available from the Waita Reservoir, it is considered a reliable source of water. The Poipu Bay Resort owns the entire system; therefore, recycled water is not assigned a set price.

Kiahuna Golf Club

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Poipu WRF and Waikomo Stream water	0.36	$0.00	• Supply • Disposal • Nutrients	• High nutrient content (and associated mitigation costs)

The Kiahuna Golf Club is located in the Poipu area of southern Kauai. R-2 water from the Poipu WRF blended with water from the Waikomo Stream has been used for irrigation since 1984. The recycled water concentration ranges from 40-60% depending on the time of year.

Single-family homes line the fairways of the golf course. Although the DOH Guidelines require a 500-ft buffer between the point of application and nearby properties, the DOH allowed application of the R-2 water via spray irrigation since this use was approved and initiated prior to the passage of the DOH Guidelines.

HOH Utilities, LLC, the owner of the Poipu WRF, upgraded the facility's biological process to the MBBR process in 2005. The integrated fixed film activated sludge process was later installed to improve the performance of the MBBR. To facilitate the use of recycled water at the golf course, an R-1 water upgrade of the Poipu WRF was constructed in 2006: the facility

utilizes coagulation, disk filtration, and UV disinfection to currently treat approximately 0.36 mgd. Injection wells were added to provide alternate disposal when effluent does not meet R-1 water standards or if the golf course does not require irrigation due to heavy rain events.

Kiahuna Golf Club allows HOH Utilities, LLC to utilize the golf course irrigation system for distribution of its R-1 water to nearby commercial properties. Currently, Koloa Landing is provided R-1 water through this arrangement. To compensate Kiahuna Golf Club for this agreement service, recycled water is provided to the golf course at no cost by HOH Utilities, LLC.

The Kiahuna Golf Club is a convenient effluent disposal option for the Poipu WRF and can typically utilize the entire daily flow from the facility. In fact, recycled water is a necessary resource that allows the Kiahuna Golf Club to meet irrigation demands. For example, during drought conditions, the Waikomo Stream provides only 0.3 mgd of water to the golf course: this is less than half of the course's peak summer requirement of 0.7 mgd.

While nutrients in the recycled water help reduce the fertilizer requirements of the course, they have also resulted in algae growth in the irrigation ponds. Aerators have been installed in the ponds to mitigate this condition. There is added power cost required to run these pond aerators.

Koloa Landing

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Poipu WRF	0.07	$1.30	• Reliable	• None reported

Koloa Landing is an exclusive ocean-side resort complex developed within the Poipu Beach Wyndham Grand Resort Hotel in 2010. The resort encompasses 25 acres of residential dwellings, lush landscaping, and pools. Up to 0.07 mgd of R-1 water is utilized for landscape irrigation and is delivered via the Kiahuna Golf Club's irrigation system. Koloa Landing pays HOH Utilities, Inc. (the owner of the Poipu WRF) for its R-1 water service.

Recycled water provides a reliable water supply at this location: the only other irrigation source considered at the time of development was potable water, but its cost was considered prohibitive.

3.3.4. Water Reuse in the County of Hawaii

Water reuse in the County of Hawaii takes place primarily at private resort developments along the Kona coast. These resort developments often occur far from municipal utilities and are served by private WWTPs. They also have a high demand for irrigation water because of their many golf courses and the arid conditions in the Kona region. As such, the resorts are often able to accept all of the effluent from their wastewater treatment facility.

3.3.4.1. Hawaii County Water Reuse Project Descriptions

Kona Country Club

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Heeia WRF and Brackish water	0.35–0.5	Reimburse for electrical costs of pumping	• Supply	• None reported

The Kona Country Club is located in the Keauhou area of west Hawaii and consists of two 18-hole courses: the “Mountain Course” is located *mauka* of Alii Drive and the ”Ocean Course” is located *makai* of Alii Drive. R-2 water has been used for irrigation and in water features at the golf courses since 1981. The recycled water is obtained from the Heeia WRF.

The Kona Country Club accepts all the effluent from the Heeia WRF; currently, 0.35–0.5 mgd of R-2 water is used for irrigation of the front nine holes of the Ocean Course. The irrigation method is currently manual; however, there are plans to install a spray irrigation system throughout the course. The Mountain Course and the back nine holes of the Ocean Course are irrigated with brackish water stored in reservoirs located above the Mountain Course. However, there is some flexibility in the country club’s water system; either brackish or recycled water can be used throughout the courses as needed or the R-2 water can be pumped to the brackish reservoir and blended.

The Heeia WRF is owned by the Kamehameha Investment Corporation and is operated by Aqua Engineers. It treats 0.35–0.40 mgd of wastewater from hotels and residential areas in the Keauhou resort community, as well as wastewater from the Kona Country Club; the service area stretches from Kahaluu Beach Park to the Sheraton Keauhou Hotel. The facility uses activated sludge in a sequence batch reactor and chlorine gas disinfection to produce the R-2 water. In 2006, there were plans to upgrade the WRF to R-1 capability; however, those plans never

materialized. While there are no current plans to upgrade the facility to R-1 capability, there have been preliminary discussions regarding plant expansion.

Recycled water use is a valuable option for the Kona Country Club as potable water is expensive and brackish water from the area has a high salinity. Currently, the Kona Country Club reimburses the Heeia WRF for the electrical costs associated with pumping the R-2 water to the golf course. However, there are currently talks between the golf course and the WRF to purchase the recycled water.

Kona International Airport

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Kona International Airport WWRF and Potable water	0.03	0.00	• Supply	• None reported

The Kona International Airport is located in west Hawaii and has its own wastewater treatment facility. The airport uses the R-1 water from its treatment plant for landscape irrigation. The treatment process includes an activated sludge oxidation ditch system, mixed media filtration, and UV disinfection. The daily flow of 0.03 mgd is blended at the treatment plant with an equal volume of potable water in a mixing basin prior to distribution.

Mauna Kea Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	South Kohala WWRF	0.18	0.00	• Disposal	• None reported

The Mauna Kea Resort is located on the Kohala coast of northwest Hawaii. The Mauna Kea Resort began using R-2 water at its golf course in 1996, and upgraded to R-1 capability in 2008. Recycled water is used at the resort's golf course for fairway irrigation.

The Mauna Kea Golf Course receives the entire daily flow from the South Kohala Wastewater Corporation WWRF, which uses dual clarifiers, activated sludge, and UV disinfection to produce R-1 quality effluent. The WWRF treats an average flow of 0.18 mgd. However, the design capacity of the facility is 0.60 mgd.

Mauna Lani Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-2	Kalahuipuaa Lagoons Treatment Facility	0.30	$0.00	• Supply	• High nutrient content

The Mauna Lani Bay Resort is located along the Kona coast of northwest Hawaii. Mauna Lani initiated water reuse in 1984 by blending R-2 water with brackish water to irrigate its golf courses; however, use of R-2 water at the golf courses was discontinued in 1997 due to the associated cost of chlorine disinfection. At that point, the R-2 water was used for irrigation of the resort's plant nursery, sod farm, and green waste composting. The resort no longer uses recycled water at its nursery and currently uses approximately 0.30 mgd of R-2 water for irrigation of its sod farm and composting.

The Mauna Lani Resort receives recycled water from the Kalahuipuaa Lagoons Treatment Facility, which is operated by Hawaii American Water. The facility is operating under its design capacity of 0.75 gpd: it currently treats approximately 0.30 mgd of wastewater from the resort to R-2 quality via two, large aerated lagoons (in series) and chlorine disinfection. Two injections wells serve as the alternate disposal; however, they are rarely used as all the recycled water is being used. The 16 million gallon capacity of the two aerated lagoons is enough to store peak flows, and ultrasonic emitters have been installed in the lagoons to reduce algae problems.

Waikaloa Beach Resort

Usage Summary					
Water	**Source**	**Recycled Water Usage (mgd)**	**Unit cost (per Kgal)**	**Benefits**	**Issues**
R-1	Waikoloa Resort WRF and Brackish water	0.50	$0.26	• Supply	• None reported

The Waikoloa Beach Resort is located immediately south of the Mauna Lani Resort in west Hawaii. It consists of homes, condominiums, hotels, the King's and Beach golf courses, and the Waikoloa village. Wastewater from all the resort facilities is treated at the Waikoloa Resort WRF, which is privately-owned by the Hawaii Water Service Company. All of the effluent from the Waikoloa Resort WRF (approximately 0.50 mgd) is accepted by Waikoloa Beach Resort's two golf courses.

The Waikoloa Resort WRF recently completed an R-2 to R-1 upgrade using MBBR treatment. R-1 water is stored in ponds and is blended with brackish water from five on-site wells; blending R-1 water actually reduces the salinity content of the irrigation water (brackish water has a higher salinity than R-1 water). The Beach Course uses approximately 0.80 mgd of blended water for irrigation, and the King's Course uses approximately 1.20 mgd of blended water. The golf course purchases the R-1 water.

4. PLANNED AND POTENTIAL EXPANSION OF WATER REUSE PROJECTS IN HAWAII

This chapter discusses municipal and private water reuse opportunities for each county. Chapter 4 will conclude with descriptions of recycled water projects not common to Hawaii.

4.1. Potential Expansions and New Developments within Maui County

Future water reuse opportunities are abundant within Maui County. Expansions of the MWWRD's recycled water distribution systems are already taking place. The MWWRD has conducted verification studies in recent years that identified potential water reuse projects in south, west, and central Maui (MWWRD, 2009, 2010 and 2012). Planned projects and potential projects (to be funded in the near future) are briefly discussed in this chapter. Water reuse opportunities could also occur at future private developments that are not in close proximity to the County's wastewater systems. Many of these proposed developments will need to construct smaller, decentralized wastewater reclamation facilities and reuse the recycled water locally.

4.1.1. Potential Expansions of the County of Maui's Systems

The County of Maui is expanding its recycled water production and distribution systems in south and west Maui as discussed in Chapter 3. In central Maui the Wailuku-Kahului WWRF produces R-2 water; however, there is no recycled water distribution capability at this time. Both an R-1 water quality upgrade at the facility and the construction of a distribution system are required before the use of recycled water can significantly increase in central Maui.

4.1.1.1. Planned and Potential South Maui System Expansions

<u>Planned System Expansion: Kihei Road</u>

The MWWRD will be expanding its R-1 water distribution system to Kihei Road to provide water to the County of Maui's Waipulani Park and several condominium complexes. The majority of the properties that will be served with R-1 water currently utilize potable water for landscape irrigation. This planned expansion is expected to be completed by 2014, and will increase the reuse of recycled water from the Kihei WWRF by approximately 0.25 mgd.

<u>Potential Expansion: Kihei High School</u>

A potential system expansion to the future Kihei High School site is being planned by the MWWRD. This location would be a prime water reuse site as it has a projected irrigation demand of approximately 0.23 mgd and is relatively close to the MWWRD's existing distribution system. The DOE

has elected to drill brackish water wells to provide irrigation water for its campus; however, Chapter 20.30 of the Maui County Code could require the DOE to utilize R-1 water for irrigation if the MWWRD extends its recycled water distribution system to the boundary of the Kihei High School Additionally, R-1 water is of lower salinity than bracking well water in south Maui, making it a better long-term option for meeting the high irrigation requirements associated with south Maui. The MWWRD plans to complete pipe line design in 2015, with construction completed in 2017 pending funding approval.

Potential Expansion: Additional R-1 Water Storage

The MWWRD is planning to construct a second 1.0 mgd R-1 water storage tank adjacent to its existing tank in south Maui. The second tank is necessary to help meet increased irrigation demands and enable the system to meet minimum fire flow requirements. Pending funding approval, the second tank will be designed in 2015 and constructed in 2017.

Future Increased Recycled Water Use by Existing Projects

The MWWRD is committed to recycled water availability for future projects in south Maui. Project schedules are not currently available, but the MWWRD will need to monitor its R-1 water supply carefully to insure that it does exceed its peak capacity to provide R-1 water to existing and future customers.

Projects that will use recycled water are described below. The South Maui Community Park has two additional phases of development and once completed, R-1 water usage will increase by approximately 0.12 mgd. The Hokulani Golf Villas also has two additional phases of development planned that could increase irrigation demand by approximately 0.2 mgd. Finally, the R&T Park has long-range growth plans. A water booster pump station is needed to deliver R-1 water to the park due to higher site elevation.

The County of Maui's South Maui Community Park utilizes R-1 water for landscape irrigation and fire protection.

4.1.1.2. Planned and Potential West Maui System Expansions

Planned Expansion: Increase UV Capacity and Construct Distribution System Improvements

The MWWRD is increasing the R-1 water production and distribution capability at the Lahaina WWRF. Once completed in 2014, the Lahaina WWRF will have an ample supply of R-1 water, and the distribution system will be fully pressurized. Commercial properties located near the existing R-1 water distribution system (see **Figure 3-2**) will have the potential to reuse approximately 0.38 mgd of R-1 water for landscape irrigation. Funding for this phase of improvements is being provided by developments in west Maui including the Honua Kai Resort, Starwood Resorts, and the Hyatt Regency Resort. An SRF loan is also helping to fund the improvements.

Seawater intrusion into the wastewater collection system causes elevated salinity content in west Maui's recycled water; to combat this, the MWWRD completed a gravity sewer rehabilitation project in 2009 that reduced the seawater intrusion. While the salinity level in the recycled water decreased after project completion, it still is higher than desired and may pose irrigation challenges to west Maui resorts. End users may elect to deal with the excess salinity by adding gypsum to their landscapes to

improve drainage of excess salts from the soil or replace landscape plants with more salt-tolerant plants.

Potential Expansion: Department of Hawaiian Home Lands

The MWWRD has an agreement in place with the DHHL that will allow the MWWRD to locate a planned 1.0 MG elevated storage tank on two acres of DHHL land. The site is adjacent to the MWWRD's existing 20-inch R-1 water line at approximately 220 ft in elevation. This pipe is currently not utilized but previously provided recycled water to Pioneer Mill and Maui Pineapple Company. The two acres of land is of sufficient size to add a second 1.0 MG tank if R-1 water demand increases. In exchange for the use of the land, the MWWRD is reserving 0.135 mgd of R-1 water for landscape irrigation at the DHHL's future commercial and industrial developments. These developments will be in close proximity to the Lahaina WWRF and its 20-inch R-1 water line. The DHHL estimates that construction of the commercial and industrial developments will be initiated within five years.

Potential Expansion: Kaanapali Resort

The MWWRD is proposing to extend an existing 16-inch R-1 water line installed along Honoapiilani Highway to the Kaanapali Resort for landscape irrigation. All area resorts collectively use approximately 0.36 mgd of potable water for landscape irrigation. This project, pending funding approval, would be designed in 2014 and constructed in 2016. Should this expansion project be implemented, the MWWRD plans to apply for Bureau of Reclamation, Title XVI Program funding that could cover up to 25% of the construction costs. The remainder of funding will be obtained from an SRF loan or general obligation bond.

Potential Expansion: Honokowai Condominiums

Another potential expansion proposed is to extend an existing 16-inch pipe line located along Honoapiilani Highway to the Honokowai area. The project would allow Honokowai Condominiums to reuse approximately 0.094 mgd of R-1 recycled water for landscape irrigation. The expansion will be relatively inexpensive since Honokowai is fairly close to the Lahaina WWRF. This project, pending funding approval, would be designed in 2016 and constructed in 2018.

Potential Expansion: Use of Existing Distribution System to Deliver R-1 Water for Bioenergy Crop Production

An existing R-1 water pipe line that was previously used to deliver water to Maui Pineapple Company's 300-ft elevation reservoir may be reused to provide irrigation water to a potential large scale agricultural operation. Anaergia Services, formerly known as UTS Bioenergy, initiated

discussions with County of Maui officials in 2011 and expressed interest in using R-1 water to irrigate biofuel crops. Methane would be produced through anaerobic digestion and used for the production of alternative energy. This power could be sold to Maui Electric Company for resale to the public or for direct use by the MWWRD's Lahaina WWRF. Approximately 800 acres of land owned by the DHHL and formerly used for pineapple cultivation would be used for this agricultural operation. Anaergia Services estimates it could utilize up to 3 mgd of R-1 water. This is a significant volume as the facility's average flow in 2012 was 3.8 mgd. Should this project be implemented, the MWWRD will need to first meet its commitments to current and near-future recycled water customers, then provide the balance of available R-1 water from the Lahaina WWRF to Anaergia Services.

The salinity of R-1 water from the Lahaina WWRF is too high for growing corn. To address this challenge, Anaergia Services plans to utilize a R-O process to remove excess salts. In addition to corn crops, other feed stocks include food wastes, fats, oils and grease, and biosolids from the Lahaina WWRF. Anaergia Services would be provided with a lateral from the future 1.0 MG R-1 storage tank and would pump water to a higher reservoir and fields at its own expense.

If implemented, this project would sustain west Maui in many ways: alternative energy would be produced with locally grown crops and local waste streams; jobs could be created; and a substantial volume of R-1 water would be used, thereby greatly reducing the need for injection well effluent disposal. This project may also result in postponing west Maui expansion projects that are more expensive to construct and would utilize lower volumes of R-1 water.

4.1.1.3. Potential Central Maui System Expansion

Up to this point, the MWWRD has not developed a recycled water distribution system in central Maui mainly because of available and affordable brackish groundwater and stream water. In addition, the Wailuku-Kahului WWRF is an R-2 facility and would need to be upgraded to R-1. However, the MWWRD is now planning for an R-1 and distribution system upgrade. The project will be designed in 2016 and constructed in 2018. Funding approval of these capital improvement projects must be obtained from the County administration and County Council.

As mentioned earlier in this chapter, the MWWRD prepared a study to evaluate the feasibility of an R-1 upgrade. Potential end users include the Dunes at Maui Lani Golf Course, County of Maui parks, the University of

Hawaii Maui College, hotels, the Kahului Airport, local schools, and seed cane fields. The MWWRD hired a consultant to evaluate water reuse opportunities from the Wailuku-Kahului WWRF and future decentralized wastewater systems. This evaluation is expected to be completed in late 2013.

The Wailuku-Kahului WWRF is located on the northern coast of Maui and is subject to salt air corrosion and tsunamis. The MWWRD has invested heavily to address these issues. These challenges have prompted discussions with private companies that yielded the proposal to construction of a new WWRF further inland. These companies have proposed that the MWWRD enter into a long-term agreement that will require the MWWRD to pay for the new facility and all related wastewater collection and distribution improvements over 20 to 30 years with sewer user fees. The proposed location of the facility would be close to agricultural areas currently farmed by Hawaii Commercial & Sugar Company (HC&S) to reduce the distribution system requirements. To date, the County of Maui has not made a decision on this proposal.

Should the County of Maui decide to keep the facility in its current location, there is one potential expansion opportunity that could result in a significant benefit to central Maui's fresh water aquifers. This opportunity is described in the following section.

Potential Expansion: Utilize Existing Non-Potable Water Distribution System to Provide R-1 Water to HC&S and Other Commercial Properties

Maui Land & Pineapple Company (MLP) constructed two 10-inch high density polyethylene (HDPE) pipe lines to provide reclaimed wastewater from its Kahului cannery to HC&S where it was used for seed cane irrigation. The cannery is no longer in operation since MLP ceased cultivating pineapple; thus, the distribution system is not being utilized at this time. These pipe lines are 20,000 ft in length and connect to a reservoir that currently stores stream water. HC&S uses approximately 1.8 mgd of stream water to irrigate seed cane in this region.

The MWWRD could upgrade the Wailuku-Kahului WWRF to R-1 and construct a pipe line to the cannery site. The pipe line could then be connected to the existing MLP lines. The main benefit is that recycled water could be used to irrigate HC&S's seed cane rather than stream water. While the use of R-2 water for sugar cane irrigation is allowed by DOH regulations, HC&S has indicated a preference for R-1 water to address potential safety concerns of workers who would come in direct contact with the recycled water. The 1.8 mgd of stream water could be left in the central Maui streams and potentially help recharge the Iao and

Waihee aquifers. Nearby properties could utilize an additional 0.2 mgd of R-1 water. Additional end users include Kahului Elementary School, Maui High School, the Kahului Community Center and Park, and the Hale Mahaolu senior housing project. All properties currently utilize potable water for landscape irrigation; they also use spray irrigation systems, which are required by DOH regulations to use R-1 quality water.

Mutual cooperation is needed between multiple parties to insure success, and HC&S must support the use of recycled water. MLP must agree to sell the existing HDPE pipe lines to the County of Maui at a reasonable price. The County of Maui must upgrade the Wailuku-Kahului WWRF. Finally, the County of Maui must also act in accordance with the "Avoided Cost" clause in Chapter 20.30 of the Maui County Code, thus allowing HC&S to obtain R-1 water at a cost that does not exceed the price it currently pays for stream water.

4.1.2. Potential Water Reuse Opportunities at Private Maui County Developments

There are a number of planned developments that are not near existing County of Maui wastewater infrastructure. These developments will need to construct their own wastewater reclamation facilities or invest in wastewater collection and R-1 distribution system improvements. Below are descriptions of a few future planned developments on Maui.

The Villages of Leialii

The Villages of Leialii is a planned affordable housing project in west Maui under the authority of the Hawaii Housing Finance and Development Corporation. It encompasses 1,000 acres of State land. The Environmental Impact Statement for the project was accepted by Governor Neil Abercrombie in December 2012 and the first phase of the project is scheduled to commence in 2016. Single-family and multi-family residential housing, neighborhood parks, a mixed-use town center and two elementary schools are proposed for the project.

Two options are being evaluated for the treatment and reuse of the development's wastewater. One option calls for the construction of sewer infrastructure to send the wastewater to the Lahaina WWRF. Recycled water distribution infrastructure would also need to be built to convey R-1 water back to the development where it could be used to irrigate common areas and open spaces. Another option is to construct a small decentralized WWRF for landscape irrigation within the project's boundaries. Up to 1.25 mgd of recycled water could be available for reuse at this planned development (Belt Collins Hawaii LLC, 2012).

Olawalu Town

The proposed Olawalu Town project encompasses 620 acres of west Maui. Of this acreage, 330 acres will be reserved for parks, open space, and community space, while 290 acres will be for residential use. Housing will be provided in many forms including affordable senior apartments, single-family, multi-family, and live/work opportunities.

Irrigation water will be provided by a combination of recycled wastewater, stream water, and captured storm water. Use of native plants will reduce overall irrigation water demands.

This project is currently in the process of being permitted and entitled. Design and infrastructure construction is expected to occur between 2013 and 2018. First phase construction is expected to begin in 2019 (Olawalu Town LLC, 2013).

Honuaula

Honuaula, formerly known as Wailea 670, is a south Maui project that has received zoning and entitlement approval. Proposed development is in 2016 or when real estate markets improve. The proposed residential mix calls for a maximum of 1,400 residences of which 40% are single-family and 60% are multi-family. An 18-hole golf course is planned along with parks and common areas. The developers determined it will be less expensive to send the estimated 0.4 mgd of wastewater to the privately-owned Makena WWRF for treatment and then pump the R-1 water back to Honuaula for beneficial reuse. The R-1 water will be blended with brackish water that is obtained from on-site wells and used to irrigate the golf course, parks, and common areas. This concept will require the construction of a wastewater transmission line to the Makena WWRF and a recycled water transmission line back Honuaula.

Haliimailie

A & B Properties, Inc. is planning a new residential development located makai of the existing Haliimailie town in Upcountry Maui. This project will feature 170 single-family units on 635 acres with 10 acres devoted for a park. An R-1 WWRF with the capacity to treat 0.059 mgd is planned. The R-1 water will be used to irrigate open spaces within the community and adjacent buffer zones and parks.

Since this proposed development is located above the Underground Injection Control line, a groundwater monitoring program must be established to comply with the DOH Guidelines. Development is expected to begin in 2014.

Lanai

The island of Lanai was purchased in June 2012 by Larry Ellison, founder of the Oracle Corporation, from David Murdock, CEO of Castle & Cooke, for the purchase price of $500 million. The new owner intends to turn the island into a “laboratory of sustainability” (Shimogawa, 2012). Along with strategies like solar photovoltaic and solar thermal energy production, water efficiency will be stressed in preliminary plans, as potable water resources are very limited on Lanai. Desalination of the island’s basal lens through the use of R-O is planned to supplement its fresh water resources. Aggressive water conservation practices will be exercised and a priority has been placed on reducing unaccounted water losses through leak detection. The extensive use of recycled water from existing facilities as well as future decentralized water reuse will be implemented. Plans call for upgrading the Manele WWRF to a MBR process and possibly relocating the auxiliary Koele WWRF to a new location where a more conventional wastewater reclamation process will be utilized. The new owner intends for residents on Lanai to start organic farms that will utilize drip irrigation to grow produce that can be exported to Japan and other markets.

4.2. Potential Expansion of Oahu Systems

4.2.1. Planned and Potential Southwest Oahu Expansions

As described in Chapter 3, the Honouliuli WRF produces 12 mgd of R-1 and R-O water reused in the Ewa Plain and Campbell Industrial Park areas.

Although there are no current plans to add R-O users, there is approximately 0.23 mgd of available R-O capacity at the Honouliuli WRF.

The R-1 system currently has a number of planned landscape irrigation projects for commercial buildings, parks, and other common spaces. These projects, shown on **Figure 3-3**, include Costco Wholesale, Kapolei Commons, Kapolei Judiciary Complex, Kapolei Hale, Kapolei Regional Park, Kapolei State Building, and the Villages of Kapolei development. With the continued expansion of the City of Kapolei, there will undoubtedly be more opportunities for the use of recycled water for landscape irrigation. However, the HBWS has noted that the R-1 system is close to capacity during the drier summer months.

Beyond the distribution system expansions described above, there are no plans for major upgrades (such as storage reservoirs or WRF expansion projects) to the City and County of Honolulu’s recycled water infrastructure in the Ewa region; however, according the to 2010 Global Consent Decree, the City will be required to upgrade the Honouliuli WWTP to full secondary

treatment. The WWTP upgrade will produce higher quality effluent, potentially increases the opportunity for more water reuse.

4.2.2. Planned and Potential North and Central Oahu Expansions

Potential Expansion: Agriculture

Although agriculture is the largest user of recycled water in north and central Oahu, there are significant additional agricultural opportunities moving forward.

With the Army's Schofield WRF currently producing R-1 quality water, and the City and County of Honolulu's Wahiawa WWTP on-going MBR upgrade, there is the potential for further reuse in the central Oahu region.

The Central Oahu Regional Park is a 269-acre public park operated by the City and County of Honolulu. The park is a significant opportunity for recycled water used for irrigation. A transmission main would need to be construction from the Wahiawa WWTP to the park, and if constructed the main would provide various other recycled water opportunities for parks and golf courses located between Wahiawa and the Central Oahu Regional Park.

Planned agricultural developments could benefit from the availability of recycled water. For example, the State recently purchased 1,723 acres in Wahiawa from the Galbraith Estate, which will be managed by the Agribusiness Development Corporation (ADC). The ADC has expressed interest in utilizing the recycled water from Wahiawa WWTP for irrigation at the farms that will be established on the former Galbraith lands. The Galbraith Estate acquisition is part of a larger plan to revitalize agriculture in Wahiawa. The ADC is working towards acquiring land in the Whitmore Village area that would support agriculture processing and distribution. Additional land acquisitions from Dole could expand agriculture northward from Wahiawa to the north shore of Oahu, all of which have the potential to utilize R-1 water from Wahiawa WWTP.

Monsanto has also expressed interest in the use of recycled water for irrigation of their seed production operations in the North Shore and Kunia areas. Monsanto's North Shore facility obtains irrigation water from Wahiawa Ditch, and their Kunia facility obtains irrigation water from the Waiahole ditch and wells owned by the Kunia Water association. Because Monsanto's operations involve seed crop, they do not find the use of recycled water to be as restrictive as it is for those farmers who use recycled water on food crops. Monsanto has had positive experiences with its use of recycled water for their operations on Maui.

An obstacle to agricultural use of recycled water in north and central Oahu is the lack of distribution infrastructure. One cost effective solution that is being explored is the use of the network of irrigation ditches installed by Oahu's sugar and pineapple growers. This extensive irrigation system, which has been greatly underutilized since the decline of Oahu's sugar and pineapple industry, could be retooled for the conveyance of recycled water. The *Central Oahu Non-Potable Water Master Plan*, which is currently being prepared for the CWRM, assesses opportunities for integrating North and Central Oahu's existing irrigation networks with sources of non-potable water for non-potable uses. Non-potable sources include recycled water, stormwater, and non-potable surface and ground water.

There is the potential for increased use of recycled water for agricultural irrigation.

Potential Expansion: Leilehua Golf Course

The Leilehua Golf Course is located in Central Oahu, less than two miles from the Schofield WRF. The Army has discussed the use of recycled water for irrigation at the golf course for more than ten years. However, a distribution main must be constructed for this to be realized.

4.2.3. Potential Eastern Oahu Expansion

Potential Expansion: Hawaii Kai WWTP

The Hawaii Kai WWTP is a privately-owned facility located in southeast Oahu. The WWTP, operated by Hawaii American Water, provides secondary treatment to 3.5 mgd of wastewater from the Hawaii Kai development. Effluent from the WWTP is discharged through an ocean outfall.

The Hawaii Kai WWTP has the unused capability to produce 2 mgd of R-1 water. At one point, R-1 water from the WWTP was used for irrigation at the nearby Hawaii Kai Golf Course; however, this practice was discontinued because the high salinity content of the effluent was damaging to the golf course turf. However, the treatment capability and distribution system remain in place. Subsequent improvements to the facility and collection system have reduced salinity levels, and there are plans to upgrade the plant's UV disinfection system.

4.3. Potential Expansions and New Development in Kauai County

Kauai County has a high percentage of its available recycled water already being utilized; however, there is potential to increase recycled water use at one of the County of Kauai's wastewater facilities and at a future facility planned for the Poipu area of southern Kauai.

4.3.1. Planned and Potential Expansions of the County of Kauai's Systems

The County of Kauai plans to construct an R-1 water distribution system in southwestern Kauai from its Waimea WWRF. Recycled water will be used to irrigate landscaping at commercial properties in Waimea. KLC will continue to receive recycled water from the facility, but usage will decrease as most of the recycled water will be used by the commercial properties in Waimea.

Planned Expansion: Waimea Area Commercial Properties

The County of Kauai is upgrading its Waimea WWRF to produce R-1 recycled water as explained in Chapter 3. A planned distribution system will deliver R-1 water to commercial properties in Waimea that currently use potable water for landscape irrigation, such as the County of Kauai's Waimea Park and local school yards. The County received earmarked federal funding though the Consolidated Appropriations Act of 2010 grant to design the R-1 water distribution system. Timing of this project is uncertain, but it is expected to be constructed by 2016, pending the acquisition of funding.

4.3.2. Potential Water Reuse Opportunities at Private Kauai County Developments

Potential Expansion: Koloa-Poipu Regional WWRF

The Koloa and Poipu areas of southern Kauai have 16 small package WWTPs and numerous cesspools that are used to treat the wastewater generated from the region's condominiums, hotels, and commercial establishments. Most of the commercial properties that have individual wastewater facilities utilize injection wells for effluent disposal. There are also future developments in the Poipu area that will cause wastewater flows to

exceed the capacity of the existing Poipu WRF. Estimated wastewater generation from existing and proposed commercial properties is approximately 2.0 mgd. To address the need for improved wastewater collection and reclamation, and water reuse in this region, HOH Utilities, LLC had an environmental assessment and environmental impact study prepared in 2008 (Wilson Okamoto Corporation, 2008). The plan called for the construction of a regional wastewater collection system and a new WWRF located at the site of the former Koloa Sugar Mill. The proposed WWRF would be designed to produce R-1 water that would be used for irrigation at the Poipu Bay Golf Course. The existing Poipu WRF was recently upgraded and will continue to supply R-1 water to the Kiahuna Golf Club; Future wastewater flows above the facility's 1.0 mgd design would be directed to the proposed new regional WWRF.

The first phase of the new regional wastewater facility, the wastewater collection, and R-1 water distribution systems were to be constructed in 2010; however, the project was postponed due to poor economic conditions. It is unknown when the project will be rescheduled. The ultimate design of the proposed facility is 1.9 mgd.

4.4. Potential Expansions and New Developments in the County of Hawaii

4.4.1. Kealakehe WRF

Construction of planned R-1 upgrades at the County of Hawaii's Kealakehe WRF is expected to start in FY 2013-2014. Plans call for a portion of the distribution main – from Kealakehe Parkway to Hulikoa Drive along Kaahumanu Highway – to be constructed in conjunction with Phase 2 of DOT's Queen Kaahumanu Highway Widening Project. However, a distribution main from the Kealakehe WRF to Kealakehe Parkway would have to be constructed before the proposed distribution system could be utilized. Recycled water from the Kealakehe WRF could supply a number of irrigation projects, including parks and future golf courses.

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5. OPPORTUNITIES AND OBSTACLES FOR IMPLEMENTATION OF WATER REUSE PROJECTS

The use of recycled water can be a key component of sustainable water resource management within communities. However, there are a number of obstacles that can delay or prevent the implementation of economically, socially, and environmentally beneficial water reuse projects. This chapter will identify some of the common obstacles associated with water reuse projects and make recommendations on how to overcome them.

5.1. Opportunities for Recycled Water Application

This section will provide a basic description of alternative uses of recycled water that are not commonly utilized in the State and explores areas where expanded recycled water use is a possibility.

5.1.1. Constructed Wetlands

Natural wetlands may not be recharged with recycled water because the DOH considers it an unauthorized discharge to State Waters, per Chapter 11-54, HAR. This does not apply to wetlands that are constructed without outlets to State Waters such as gulches, streams, rivers, or the ocean. Wetlands can provide additional treatment of recycled water, as water pollutants can be taken up by aquatic plants in the wetlands or by microbes present in the plants' roots and stems.

Constructed wetlands also provide much-needed habitats for endangered waterfowl such as the Hawaiian Stilt, the Hawaiian Coot, and the Hawaiian Duck. Native Hawaiian waterfowl are commonly observed at virtually all of the wastewater reclamation facilities that utilize aerated lagoon or stabilization pond treatment. Constructed wetlands using recycled water would be a very suitable use of this resource and help contribute to the recovery of the endangered native Hawaiian waterfowl populations.

5.1.2. In-Stream Flow Restoration

The restoration or augmentation of stream flows using recycled water is currently not allowed by the DOH as it is considered an unauthorized discharge to State Waters, per Chapter 11-54 of the HAR. For recycled water to be used for stream restoration, the DOH would have to amend this regulation. What differentiates stream augmentation from a surface water discharge is that augmentation seeks to accomplish a beneficial end, whereas discharge is primarily meant for effluent disposal. Augmentation is most useful in locations where large draws of water for potable or other uses reduce stream flows to levels that maybe harmful to the ecosystem.

The use of recycled water to restore streams and rivers is common on the U.S. mainland and in other countries. The San Antonio River in Texas is recharged with a continuous supply of tertiary-treated recycled water to insure that the river will flow during the summer. Without this supplemental recycled water, the scenic River Walk in San Antonio would not be the popular tourist attraction it is today.

Tertiary-treated recycled water (analogous to R-1 water) is also used to augment streams in Japan's urban areas and for creating ornamental streams and lakes (USEPA, 1992).

If highly treated recycled water meets stream water quality standards and is allowed to be discharged to streams, existing stream conditions could be greatly improved and aquatic life could be sustained or enhanced. Nutrient removal and high-level disinfection of the recycled water would be necessary prior to discharge. Chlorine removal may also be required to protect aquatic wildlife when chlorine is used as the primary wastewater disinfectant (Asano, 1998).

5.1.3. Recharge of Natural Wetlands

As with in-stream flow restoration, the use of recycled water to recharge natural wetlands is not currently allowed by the DOH, as it is considered an unauthorized discharge to State Waters. Should the DOH allow this type of use for recycled water, nutrient removal and dechlorination would be required prior to wetland recharge.

A location that could benefit from recycled water recharge is the Kanaha Pond in central Maui, which is adjacent to the Wailuku-Kahului WWRF. During periods of dry weather, pond evaporation increases, requiring the pumping of high salinity brackish water to replace evaporation losses. If recycled water were used instead of brackish water, nutrient removal would be needed to avoid causing eutrophication problems in the pond. This could be handled at the Wailuku-Kahului WWRF where nutrient removal capability is already available in its activated sludge process through the addition of anoxic zones. The salinity level of Kanaha Pond may decrease since the salinity of the recycled water is lower than the brackish water in the pond.

Monsanto installed dual distribution systems within its buildings at its south Maui Piilani farm to accommodate the use of R-1 water for toilet and urinal flushing.

5.1.4. Groundwater Recharge

The State's groundwater could be recharged using highly treated recycled water. Groundwater recharge is becoming an important water resources management tool to replenish depleted groundwater supplies associated with increased development. While groundwater recharge with recycled water is allowed per the DOH Guidelines, the DOH must evaluate each proposed project's feasibility on a case-by-case basis.

The two most common methods of recharging groundwater with recycled water are direct injection and surface spreading. Direct injection entails pumping recycled water into coastal aquifers to create hydraulic barriers that prevent seawater from encroaching into freshwater supplies. The Orange County Water District (OCWD) Water Factory 21 (WF-21) project is one such facility that practices direct injection. WF-21 utilizes disinfected tertiary-treated water that is treated further by either granular activated carbon or R-O to produce recycled water that has extremely low levels of nitrogen, organic carbon, and other trace organic constituents. The recycled water is blended with dilution water, such as desalted seawater or deep well water, and injected into a series of closely spaced barrier wells that reach coastal aquifers at various levels. This blend of recycled and dilution water prevents seawater intrusion into the inland freshwater aquifer and augments freshwater

supplies. Strict monitoring of the WF-21's product water is required to insure that it meets local water quality standards for nitrogen, boron, total organic carbon, trace organics, microbial constituents, and other constituents (Asano, 1998).

The surface spreading method entails applying recycled water in large infiltration basins, from which the water slowly percolates through the soil and into the groundwater table. This method is the simplest, oldest, and most widely used method of artificial groundwater recharge. It is also considered more favorable than direct injection as it allows efficient use of space and requires minimal maintenance. It is practiced in Los Angeles County and the OCWD (Asano, 2004). In the OCWD, water from the Santa Ana River is used for surface spreading. Prior to surface spreading, the river water, a high percentage of which is recycled water from cities along the waterway, is treated through a constructed wetlands system. The constructed wetlands reduce organic carbon compounds and remove up to 88% of nitrate-nitrogen. The removal of nitrate is vital, as high nitrate levels in drinking water can cause methemoglobinemia, or "blue-baby syndrome," a serious threat to infants under 6 months of age. The OCWD utilizes approximately 1,000 acres for surface water percolation along the Santa Ana River (Asano, 1998).

The OCWD uses highly treated
recycled water to replenish its groundwater supplies.

There are concerns that recycled water used in recharging potable supplies of groundwater may contain pathogens, trace amounts of toxic chemicals, pharmaceuticals, or personal care products. Extreme caution is warranted in using recycled water for groundwater recharge, as it is very difficult to remediate a groundwater basin once it is contaminated. Regulatory agencies across the nation are proceeding with caution when permitting water reuse applications that affect potable water supplies. Full-scale advanced wastewater treatment is being required including chemical clarification, filtration, air stripping, activated carbon absorption, microfiltration, nanofiltration, R-O, and advanced oxidation using hydrogen peroxide and UV irradiation (Asano, 2004). All things considered, it may not be feasible to utilize recycled water to recharge potable aquifers in the State; however, recharge of non-potable aquifers with recycled water may be considered.

5.1.5. Recreational Uses

The DOH approves the use of R-1 water as a supply source for restricted recreational impoundments and basins for fish hatcheries. The restricted recreational impoundments are water features that the general public has no direct access to, such as a water hazard at a golf course. An exception to these limitations is the Wahiawa Reservoir in central Oahu, which is used for unrestricted recreational purposes such as boating and fishing despite the R-2 water it receives from the City and County of Honolulu's Wahiawa WWTP. The WWTP actually produces "R-1 quality" water, but is not certified as R-1 by the DOH due to alternate disposal requirements. The DOH is not in favor of recreational uses of R-2 water and would like the discharge of R-2 water to the Wahiawa Reservoir to be discontinued.

In states such as California and Texas, tertiary-treated recycled water is utilized for unrestricted recreational uses that involve body contact, such as boating, fishing, swimming, and skiing. Before being used for unrestricted recreational applications, the water must be aesthetically enjoyable, clear, without objectionable odor, pathogen-free, without toxic substances or heavy metals, and have a pH of 6.5 to 8.3 to avoid irritation of the eyes. Nitrogen and phosphorous should also be controlled as these nutrients can cause unacceptable levels of algal growth (Asano, 1998).

5.1.6. Carwashes

In California, commercial car washes are allowed to use recycled water. Disinfected tertiary water (the equivalent of R-1 water) may be used if the water is not heated and direct human contact is not permitted. Car owners are not allowed to wash their own vehicles. One issue with this use is that dissolved solids can create water spots; however, deionizing systems are

effective at removing dissolved solids (WaterReuse Association, 2013) from recycled water.

5.1.7. Construction Uses

There are great opportunities for water reuse in Hawaii's construction industry. The most common use of recycled water for construction purposes is dust control, for which the DOH allows utilization of both R-1 and R-2 water. Other uses include cement mixing, street cleaning, and backfilling.

The MWWRD provides millions of gallons of recycled water each year to contractors for dust control at construction sites. All three of the wastewater reclamation facilities on Maui are equipped with recycled water fill stations and fire hydrants where the contractor can access recycled water. The DOH has a short application form to facilitate permitting for construction projects. The County of Maui's DWS limits the use of potable water for construction activities, and contractors are often directed to the MWWRD for recycled water service.

In 2006, the HBWS began providing recycled water for dust control in southwest Oahu. Currently, there are two fill stations off the main recycled water pipeline. Approximately 100,000 gallons are used for dust control each year. The only problem reported by contractors is that the HBWS only provides the recycled water on an "as needed" basis during a set time. Because the HBWS does not have elevated storage for its recycled water, a pump must be operated to pressurize the fill stations. Once the HBWS develops elevated storage in southwest Oahu for its R-1 water, the use of this resource will be more readily available as pumps will not be required to pressurize the fill stations.

These two examples clearly demonstrate that other Hawaiian counties could successfully utilize recycled water for construction activities on their respective islands.

5.1.8. Industrial Uses

Recycled water has been used for industrial purposes for many years, and there are many examples of successful industrial projects on the U.S. mainland. Examples include cooling systems, cooling towers, cooling ponds, boiler feed water, pulp and paper production, textile manufacturing, carpet dyeing, and petroleum and coal production (USEPA, 1992).

In Hawaii, there is one prime example where recycled water is provided to companies for industrial uses: Campbell Industrial Park in southwest Oahu, where R-O recycled water is fed to boilers to produce steam that is used for

electrical power. This example is a model of sustainable business activity for future industrial projects to follow. Beneficial products can be created with little impact on potable water resources.

Industrial use of recycled water also occurs at many of the wastewater reclamation facilities throughout the State. These facilities use recycled water for applications such as chemical dilution, pump mechanical seal lubrication, cooling, foam control, and wash down activities.

There is potential to expand the use of recycled water for industrial purposes in the State. Commercial properties in the State that are in close proximity to R-1 recycled water lines may consider utilizing R-1 water in their cooling towers. The DOH Guidelines allow R-1 water to be used in cooling, but any recycled water would need to contain a continuous biocide residual to restrict biological growth. The R-1 water would also need to be chemically softened to prevent scale build-up on cooling system components. Further, corrosion inhibitors may need to be added, as the R-1 water may also be corrosive due to its total dissolved solids concentration (Asano, 1998).

5.1.9. Composting

The composting of waste materials such as green waste, biosolids, and waste paper not only produces valuable soil amendments, but also aids in landfill diversion. Composting requires water, and typically non-potable water is used. In the Hawaii, there are two projects that utilize recycled water for composting: the Mauna Lani Resort in west Hawaii has a small green waste composting operation and the Maui Earth Compost Company in south Maui which is adjacent to the County of Maui's Kihei WWRF. The former composts green waste in static piles using R-2 water from the resort's WWRF. The latter uses R-1 water from the adjacent Kihei WWRF with green waste composted in windrows and typically blended with soil, sand, or seaweed.

Larger-scale versions of these projects could greatly increase landfill diversion in the State, and the additional compost would benefit Hawaii as the State currently imports much of its fertilizer and compost products from the U.S. mainland. Large land areas with available recycled or some other non-potable water would be required.

5.1.10. Toilet and Urinal Flushing

In the DOH Guidelines, use of recycled water in toilet and urinal flushing is allowable in approved buildings and institutions and where counties have adopted plumbing code provisions for potable and non-potable distribution (also known as dual piping systems). In 1991, the Irvine Ranch Water District (IRWD) in Southern California pioneered this innovative use of recycled water

and became the nation's first water district to obtain health department permits for interior recycled water use in a community system. Currently, recycled water is used in toilet flushing in IRWD's facilities and high-rise office buildings equipped with dual piping systems. The volume of potable water required by these buildings has decreased up to 75% due to the use of recycled water (IRWD, 2013).

An example of this recycled water use in Hawaii is at Monsanto's Piilani Farm in south Maui. R-1 water from the County of Maui's Kihei WWRF is used for flushing toilets and urinals at the farm's office building, workshops, employee break buildings, and bagging facility. The use of R-1 water for this purpose was required because no other water sources were available when the farm was constructed.

The Haleakala Crater Visitor Center planned on utilizing a blend of rain water and R-1 water from its WWRF, but has been unable to meet R-1 standards due to problems with their filtration system. They expect to use R-1 water for toilet flushing in the near future with the installation of a new filtration system.

As in the case of the IRWD, recycled water could be used for toilet flushing if buildings throughout the State are designed with dual distribution systems. A backup water supply with proper backflow prevention is recommended should the R-1 water not meet DOH standards. It is probably not economically feasible to retrofit existing buildings with dual distribution systems.

5.1.11. Water Features

The use of recycled water in zoos and similar locations for cleaning, water features, and landscape irrigation can potentially result in significant savings in potable water. The Denver Zoo began installing recycled water infrastructure in 2004, with the intended purpose of irrigation and cleaning of animal exhibits. In conjunction with other water saving practices, the Denver Zoo has reduced its overall potable water use by half, and is currently installing infrastructure for recycled water use throughout its 80-acre campus. (Denver Zoo, 2013)

The Honolulu Zoo has plans to install a filtration system for its hippopotamus pool that will save approximately 40,000 gallons of groundwater per day. The Zoo also has a water filtration system for its elephant pool.

5.1.12. Sewer Mining

Sewer mining is the process of tapping into a wastewater system and extracting sewage to be treated and reused. Recycled water produced from a sewer mining operation can be used to irrigate sports fields, parks and golf

courses, as well as commercial buildings and industrial sites. Solids generated at the sewer mining treatment plants are typically returned to the collection systems for treatment at downstream wastewater treatment facilities.

Sewer mining is being used in Sydney, Australia for both urban and park irrigation. The Sydney Olympic Park Authority's Water Reclamation and Management Scheme at Homebush Bay is Australia's first large-scale urban recycling scheme using sewer mining. The recycled water is reused for irrigation and residential non-potable uses. Recycled water replaces 50% of the potable water that would otherwise be used at Sydney Olympic Park and Newington Estate (Sydney Water, 2013).

A potential area in Hawaii where sewer mining may be feasible is the resort community of Wailea, Maui. Wastewater from this area is pumped approximately seven miles to the County of Maui's Kihei WWRF for treatment. Research conducted for the MWWRD's South Maui Verification Study revealed that up to 1.0 mgd of potable water is currently used for landscape irrigation at Wailea's resorts and multi-family townhouses. A sustainable approach to managing Wailea's wastewater and reducing the substantial use of potable water for irrigation would be to construct a scalping MBR plant that treats wastewater from the region and produces R-1 water. The R-1 water could then be used locally, closer to where the wastewater was generated and treated, to supplant the use of potable water for landscaping irrigation at the resorts and townhouses. Waste solids from the MBR plants would be discharged back into the County's sewer system.

Urban Oahu also has potential sewer mining applications at commercial properties that use large volumes of water for irrigation and are close to main sewer lines. These properties include Kapiolani Park (300 acres with an estimated irrigation demand of 1.8 mgd), the Ala Wai Golf Course (121 acres with an estimated irrigation demand of 0.73 mgd), and the Honolulu Zoo (42 acres with an estimated irrigation demand of 0.25 mgd).

5.1.13. Agriculture

There is great potential for the use of recycled water at agricultural projects throughout Hawaii, as large volumes of water are necessary for irrigating crops. Should the agriculture industry accept the use of R-1 water as a viable and safe irrigation source, demand could easily outpace supply In addition to reducing uses of other water sources, recycled water also carries useful nutrients beneficial to crops that can help lower the need for fertilizer. R-1 has been approved for direct contact with edible food crops by the DOH, and is used to grow many vegetables in the U.S. and throughout the world. Many

local markets in the State sell imported produce irrigated by recycled water. One issue that must be addressed for this application is that a concerted public outreach program must be launched to ensure the support of the farming community in regards to using recycled water on their crops. The main concern expressed by farmers is that the general public may be hesitant to purchase food crops that have been in direct contact with recycled water due to the fear that pathogens or other harmful constituents may be present in the recycled water. As a result, some agricultural customers have restricted use of recycled water to ornamental, seed, or orchard crops.

This concern may be compounded by new regulations concerning food safety that would require farmers to monitor the quality of their water. In January 2012 the United States Food and Drug Administration (FDA) released two of five proposed draft rules tied to the Food Safety Modernization Act (FSMA) (Satran, 2013). The new regulations may result in new restrictions or reporting requirements for irrigation water sources.

Currently, there is limited use of recycled water for agricultural irrigation in the State. However, there are irrigation projects that have great potential for replacing or supplementing their existing water sources with recycled water. On Maui, the use of recycled water would greatly benefit the large sugar cane fields, which primarily use stream water for irrigation. Doing so could potentially help restore stream flows, recharge aquifers and make more stream water available for other uses.

5.2. Public Support

An important consideration for all water reuse projects is public support. The lack of public support can be a monumental barrier for the implementation of water reuse projects. Water reuse programs that do not have a sustained educational component run the risk of public opposition and may be doomed for failure. The former Public Education Officer with the IRWD aptly stated the need for public education in the 1998 text book: Wastewater Reclamation and Reuse. "*People's perceptions and attitudes are forces that can mean the difference between success or failure – survival or extinction. This is a reality that must be recognized in the planning and implementation of every water reuse program.*" (Asano, 1998).

The MWWRD and the HBWS have the two most progressive water reuse programs in the State. Both agencies realized that public acceptance was critical for their water reuse programs to succeed and have invested substantial time and resources towards proactive public education and community involvement. Both agencies give presentations and tours of water recycling facilities to politicians, schools, the general public, community organizations, environmental groups, and new/potential recycled water users.

Further, the need for recycling wastewater must be established within the community. The primary reasons for implementing water reuse programs are to supplement limited fresh water supplies and to address concerns related to effluent disposal practices. The public needs to be made aware that the use of recycled water can be an important component to preserving the community's water supply, while also reducing the reliance on injection wells or outfalls for effluent disposal. The public must also understand that there are significant costs required to implement water reuse projects and that there may be an increase in water or sewer rates to pay for these costs.

The public may have safety concerns regarding the use of recycled water for food crop irrigation or landscape irrigation, and therefore must be provided with a basic understanding of how wastewater is treated and why it is safe for reuse. Providing local communities with a basic understanding of how recycled water is produced - with an emphasis on disinfection, monitoring, and quality assurance - has proven to be a successful strategy employed by recycled water champions in gaining support for water reuse initiatives.

The educational programs initiated by Maui and Honolulu may be used as templates by other municipalities in the State during the development of their respective water reuse programs. It is strongly recommended that all recycled water purveyors, regardless if they are from municipalities or private developments, implement proactive, sincere, and open communication with the public and recycled water users to gain the support required for successful water reuse projects.

5.3. Mandatory Use Ordinances

Mandatory use ordinances requiring commercial properties to utilize recycled water for irrigation or other applications have been used in several states to establish a strong customer base and maximize recycled water usage. Mandatory use ordinances are established because of a shortage of potable water resources or due to environmental degradation associated with effluent disposal. Several cities in the mainland U.S. have ordinances as part of their water reuse programs. Thus far, the County of Maui is the only county in the State to have a mandatory use ordinance in place. The DOH attempted to establish such an ordinance in 2001, but it was not approved by the State legislature.

The County of Maui's mandatory use ordinance was based on other similar ordinances that were enacted in other states. The ordinance was passed primarily as a means to reduce the use of injection wells for effluent disposal. A secondary reason was to proactively supplement the limited potable water supplies within Maui County. The EPA limited the volume of effluent that could be discharged to the Lahaina WWRF's injection wells to 6.7 mgd because it believed that nitrogen in the

effluent was causing periodic algal blooms in the coastal waters of west Maui. This action concerned the County because it effectively delays or stops development.

The ordinance was seen as a mechanism to reduce the use of the injection wells by increasing the volume of recycled water utilized. Despite the obvious need for the ordinance, an extensive educational effort was required to educate politicians. Some of Maui County's large landowners were opposed to the ordinance and lobbied the County Council to kill it. In the end, the bill was passed and the ordinance was established and eventually included in the Maui County Code, Title 20 Environmental Protection; Chapter 20.30 Use of Reclaimed Water in 1996.

Chapter 20.30 was initially applicable only in regions where R-1 water was available such as in west Maui and in south Maui. It has since been revised to include central Maui where R-2 water is available. The ordinance requires commercial properties that are within 100 ft of the County's recycled water distribution system to connect to the system within one year of the system's availability and use the recycled water for irrigation. This legislation has helped establish a broad customer base, especially in south Maui where numerous commercial properties have connected to the County's recycled water distribution system. It will play an important role in west Maui as improvements to the MWWRD's R-1 water production and distribution capability are made by 2015.

Other counties in the State could follow Maui's lead and pass a mandatory reuse ordinance to accelerate development of their respective water reuse programs. The DOH could also attempt to pass a mandatory reuse ordinance. This broader approach would allow the DOH to meet its goal of increasing the volume of recycled water reused in the State. Also, the Section 174-C-51.5, Hawaii Revised Statutes (State Water Code) allows the CWRM to require installation of dual line water supply systems at new commercial and industrial developments in designated water management areas. However, this requirement is not specific to recycled water. In either case, an educational effort should be undertaken at an early stage to convince politicians and community groups of the many benefits a mandatory reuse ordinance can provide.

Any proposed mandatory use ordinance should be based on previous studies or reports and should contain sections on connection requirements, cross-connection control measures, an inspection policy, system reliability, and water quality requirements. The ordinance should also make reference to established rules, penalties, and fees/rates for recycled water service.

5.4. Encouraging Demand for Recycled Water

Creating a sound customer base for recycled water can be challenging during the early stages of a municipality's water reuse program. As explained in Section 5.1,

public information and outreach programs should be initiated during the early stages of the program. The reason for recycling wastewater must be firmly established. Also, recycled water purveyors should actively seek the involvement and input of the public and potential recycled water users in the development of water reuse policy as early as possible. Building a water reuse program around the needs of the community will greatly improve its chance for success. A sense of environmental stewardship can be fostered within the community through a proactive public involvement effort.

An equally, if not more, important tactic to encourage demand for recycled water is the inclusion of economic incentives in recycled water rate structures. The County of Maui created a number of economic incentives to be included into its recycled water rate structure to "kick start" the water reuse program. The incentives included a two-year waiver of connection fees, a mechanism to recover irrigation system retrofit costs, setting usage rates slightly lower than the water sources typically used, and establishing an avoided cost category that allows the recycled water rate to match what was previously spent on other non-potable water sources (Parabicoli, 2001). Economic incentives will generally encourage most project managers to convert to recycled water from other water sources. Please refer to Section 5.4, which will further examine the economics of recycled water.

A third approach to encourage demand for recycled water is to integrate recycled water use into planning policies as a condition of development for future commercial properties. This concept has already been used on Maui and requires future developments to contribute funding towards the County's recycled water system development and utilize R-1 water for landscape irrigation. Building permits would only be issued if the developments pay for their fair share contributions and utilize recycled water for irrigation purposes.

5.5. Understanding the Economics of Recycled Water

An important component of water reuse programs is determining how to pay for recycled water reuse projects. Water reuse systems are expensive to construct and operate. The revenues earned from selling recycled water are often insufficient to pay for capital and operating costs associated with the production and delivery of the recycled water. This is particularly the case if the recycled water purveyor sets rates comparable to traditional water rates. To establish rates to allow full capital and operating cost recovery, the rates will likely be significantly higher than traditional water rates. Thus, there would be no economic incentive for a user to convert to recycled water.

Spreading the cost of financing water reuse projects is preferred and is a more sustainable financial model. Potential revenue sources can be obtained from a number of options including:

- Recycled water users
- Potable water users
- Sewer users
- Developers
- Special groups (i.e. tourism industry)
- Government grants
- Avoided costs

Recycled water users can be charged through recycled water rates (dollars per 1,000 gallons of recycled water used) and through direct up-front payment of a portion of the project costs. These up-front payments can be classified as assessment fees, capacity fees, connection fees, impact fees, or system development fees. In any case, they all represent a “joint venture” between the recycled water purveyor and the user to pay for capital costs.

Potable water users may be charged a portion of recycled water project costs if they benefit from the implementation of the recycled water program. Similarly, sewer users may be charged for full collection, treatment, and disposal costs. Because future injection wells or outfalls in the State may be limited by regulatory agencies, water reuse will continue to be an acceptable alternate disposal method. It is appropriate for sewer users to pay for a portion of water reuse projects.

Government grants currently represent an unlikely source of funds due to limited state and federal budgets, but recycled water purveyors in the State should be vigilant in the search for government grants. (Note that government loans are not considered sources of funds because they must be repaid. They do, however, represent a low-cost method of obtaining construction funding and are desirable for that reason.) (Brown and Caldwell, 1995). Please refer to Chapter 6, which discusses potential funding sources for water reuse projects.

The County of Maui created a community-based committee to help develop its recycled water rate structure. The committee consisted of representatives from large landowners on Maui, the Maui Chamber of Commerce, the Maui Hotel Association, and the Maui Realtor Association; members from the MWWRD and the Department of Finance; and the County’s consultant. The committee decided upon a “composite” rate structure for its water reuse program that identified three main user classes: Major Agriculture ($0.10 per 1,000 gallons), Agriculture-including golf courses ($0.20 per 1,000 gallons), and All Other ($0.55 per 1,000 gallons).

The recycled water rates were set to levels that were somewhat less expensive than the conventional alternative water sources used by the three user classes. These rates have been increased over the years but continue to be less than alternative sources of irrigation water. Connection fees were also set for south and west Maui

where recycled water distribution systems were constructed. Meter fees were also developed. Because effluent disposal was an important factor driving County of Maui's water reuse program, sewer user rates were also slightly increased and are the major source of funds utilized to finance the water reuse program.

The County of Maui's financial approach has allowed recycled water to become an attractive non-potable water source because it is less expensive than conventional water sources. At the same time, sewer users help pay for the majority of the water reuse program costs on the premise that they must fund the collection, treatment, and disposal of wastewater, whether it be through injection well, ocean outfall, or water reuse (Shimogawa, 2012). Sewer users currently finance approximate 75% of the MWWRD's water reuse program costs.

This funding approach helped the County of Maui to construct a portion of its recycled water production and distribution systems during the early stages of its water reuse program. As time has passed, the need to fund necessary sewer system improvements has taken precedence over water reuse projects. Sewer fees within Maui County have been steadily rising in recent years to pay for these sewer improvement projects. As a result, development of the MWWRD's recycled water systems was delayed.

A community working group (CWG) was founded in 2010 by former Mayor Charmaine Tavares to solicit input from community members on ways to fund the increased use of recycled water and reduce the use of injection wells for effluent disposal. The CWG developed a number of financing recommendations. The highest priority recommendation was to utilize a variety of revenue sources in addition to sewer fees and recycled water fees paid by users. These sources included the County of Maui's Department of Water Supply, property taxes, and a "flush fee" levied on the tourist industry (County of Maui, 2013). The recommendations of the CWG have not been implemented by the current County administration, and sewer users continue to be the major revenue source to finance municipal recycled water system improvements.

Cooperation between multiple agencies is required to overcome funding challenges associated with recycled water system development. A cost sharing approach will spread the cost of developing recycled water infrastructure over a wide base and consequently lessen the financial burden on individual participating user groups. A water reuse champion may be necessary to foster this cooperation. Such a person could be a state legislator, county mayor, county councilmember, department head, or a chief executive officer. A common vision must be established to elevate the priority of water reuse projects receiving the required funding necessary for each project.

5.6. Regulatory (State) Issues

Title 11 of the HAR contains various sections that pertain to the use of recycled water. The WWB is the regulatory branch that administers the DOH Guidelines and Title 11-62, HAR, where the Guidelines now reside. Title 11-54, HAR also affects potential recycled water use as this chapter pertains to the State's water quality standards that surface water discharges, including recycled water, must meet. Title 11-54, HAR is administered by the State Department of Health, Clean Water Branch. Two potential recycled water applications that are not currently allowed by the DOH are single-family lot irrigation, where irrigation systems are operated and maintained by the homeowners, and the introduction of recycled water into State Waters. If allowed, these applications could significantly increase the volume of recycled water used in the State, resulting in significant potable water savings and a decrease in the use of alternative disposal mechanisms such as injection wells and outfalls.

5.6.1. DOH Limitation of the Use of R-1 Water for Single Family Lot Irrigation

The irrigation of single-family lots in the State requires large quantities of potable water, especially on the dry leeward sides of each island of the Hawaiian chain. Up to 65% of a single-family residence's total water consumption is used for landscape irrigation. The DOH Guidelines state that R-1 water may be used for "*any form of irrigation served by fixed irrigation system supplied by buried piping for turf and landscape irrigation of a residential property where managed by an irrigation supervisor*" (DOH, 2002). This clause means single-family lots may be irrigated with R-1 quality recycled water only if the respective irrigation systems are operated and maintained by an irrigation contractor through such an entity as a homeowner association. As discussed in Section 3.3.2.1, the Hokulani Golf Villas in Kihei, Maui is an example of this scenario. However, this condition eliminates most single-family residences from being able to utilize recycled water since homeowners typically operate and maintain their own landscapes and irrigation systems.

Other states allow the use of recycled water for irrigation of single-family lots where homeowners operate and maintain their irrigation systems. The City of St. Petersburg, Florida is recognized as a pioneer in urban water reuse and now operates one of the largest urban reuse systems in the world. Over 37 mgd of tertiary-treated recycled water is currently provided to more than 10,000 customers through 291 miles of pipeline for irrigation of lawns at single-family residences. A cross connection program was established to insure that recycled water does not contaminate the potable water system. Potable water backflow preventers are also required to be installed at each lot (SPWRD, 2013). The extensive use of recycled water for single-family lot

irrigation within St. Petersburg has significantly contributed to reducing potable water demands.

The DOH has historically not been comfortable with the concept of irrigating single-family lots with recycled water because they lack sufficient manpower to adequately monitor for conditions such as cross connections to the potable water system and overspray of recycled water. The DOH intends to update the DOH Guidelines in 2013 and may consider allowing R-1 water to be used at single-family lots. Should this use be approved by the DOH, it is reasonable to expect that the DOH will require recycled water purveyors in the State to establish a cross connection program and that every lot provided with recycled water must have backflow preventers to protect potable water systems. These conditions will involve additional manpower and resources and may slow single-family reuse development. Retrofitting existing single-family lots with dual distribution systems to accommodate R-1 water would probably not be cost effective; however, future single-family developments could be designed with such systems. To address overspray concerns, the single-family lots could install low impact stream heads and subsurface drip irrigation systems.

The use of R-1 water for landscape irrigation at single family homes is only approved by the DOH when maintenance of irrigation systems is conducted by contractors. The Hokulani Golf Villas in south Maui is an example of a “managed” irrigation system.

5.6.2. DOH Regulations Pertaining to Discharge of Recycled Water to State Waters

Recycled water is commonly used on the U.S. mainland and in foreign countries for recharging natural wetlands and for in-stream flow restoration. In fact, the federal Bureau of Reclamation encourages the use of recycled water for these purposes. In Hawaii, this type of application of recycled water has historically not been allowed as it is considered an unauthorized discharge to State Waters. Section 11-54-04 Basic water quality criteria applicable to all waters, subpart (a) states that all waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including substances or conditions or combinations thereof in concentrations which produce undesirable aquatic life Additionally, Title 11-54, HAR establishes water quality standards for parameters like nitrogen and phosphorous and a prohibition of waste discharges to certain types of water bodies. To allow discharges of recycled water to some water bodies, revisions to Title 11-54 will be required. (HAR 11-4).

A significant hurdle that lies within Title 11-54, HAR is that the discharge of recycled water to irrigation ditches may be prohibited if the irrigation ditches inevitably overflow into State Waters. For example, HC&S on the island of Maui utilizes ditches to convey irrigation water (primarily diverted stream water) to its cane fields. Many of these ditches are considered State Waters since they have the potential of flowing to natural steams, gulches, or the ocean. So, while the MWWRD has viewed sugarcane irrigation as a potential use for recycled water generated at its existing or future Wailuku-Kahului WWRF, HC&S is concerned that Section 11-54-04 will be an obstacle.

However, Title 11-54 was amended in October, 2012 and Section 11-54-5.1 pertains to flowing waters and reads: "*All flowing waters in classes 1 and 2 in which water quality exceeds the standards specified in this chapter shall not be lowered in quality unless it has been affirmatively demonstrated to the director that the change is justifiable as a result of important economic or social development and will not interfere with or become injurious to any assigned uses made of, or presently in, those waters*" (HAR 11-54).

This section could be the basis of allowing recycled water to be introduced into irrigation ditches that are considered State Waters. The benefits of a large agricultural user such as HC&S substituting recycled water for at least a portion of the diverted stream water it uses are significant. Stream flows could be restored, which may also significantly increase groundwater recharge of freshwater aquifers (Oki, 2010). This fact could be important for designated aquifers such as Maui's Iao Aquifer that has been threatened in recent years due to over pumping and insufficient recharge rates.

Nutrients such as nitrogen and phosphorous present in recycled water could potentially pose challenges. Excessive algal growth could occur in storage reservoirs or in the case of sugar cane cultivation, a long standing concern is that excess nitrogen could reduce sugar yields. These concerns could be addressed by requiring that before recycled water is introduced into any State Water, it be subjected to nutrient removal processes at the wastewater reclamation facilities from which it originates. Activated sludge facilities with anoxic zones that are effective in reducing both nitrogen and phosphorous concentrations in wastewater. Anoxic zones are already being used at several wastewater reclamation facilities in the State; wastewater operators at the County of Maui's Lahaina WWRF have been able to reduce the total nitrogen content of the facility's effluent to concentrations as low as 5 mg/L using anoxic zones. Additional nutrient removal could be accomplished with enhanced nutrient technologies at wastewater reclamation facilities that can reduce total nitrogen to 3 mg/L or less and total phosphorous to 1 mg/L or less. Wastewater reclamation facilities in the Chesapeake Bay region in the eastern United States are now utilizing enhanced nutrient removal to reduce nitrogen and phosphorous loadings in effluent discharged to rivers and streams that enter Chesapeake Bay (Chesapeake Bay Program, 2012).

Nutrient concentrations could be lowered even further with the use of constructed wetlands. These constructed wetlands could be located after wastewater reclamation facilities and upstream of irrigation ditches. Dialogue needs to occur with the CWB to determine if they would allow recycled water with reduced nutrient concentrations to be discharged to State Waters. As part of this dialogue, it could be argued that in many cases, utilization of recycled water for these purposes could actually improve the water quality of these waterways and provide an opportunity of indirectly restoring stream flows by having large agricultural entities irrigate their crops with recycled water instead of stream water.

5.7. Impacts of Recycled Water on Potable Groundwater Aquifers

Many of the State's potable water resources are contained in potable groundwater aquifers. Protecting the integrity of these irreplaceable resources is paramount. The intensified use of recycled water, particularly in large-scale land application practices such as golf course irrigation and agriculture, has raised questions regarding potential impacts of recycled water use on these aquifers.

Water reuse projects have been operated successfully for decades. Sugar cane fields in Waialua, Oahu, have been irrigated using recycled water since 1928. Groundwater recharge projects, as discussed in **Section 5.1.4**, have also increased in also prominence. The OCWD has used direct injection of

highly treated recycled water from WF-21 to block salt water intrusion in California since 1977 (OCWD, 2013). Despite the long history of recycled water use, both in the State and abroad, there are still many questions regarding the precise impacts of recycled water use on the State's groundwater aquifers.

The impacts of recycled water use on the potable water aquifer depend on numerous factors, including recycled water quality, depth of the unsaturated soil zone, physical and mineralogical characteristics of the soil layers, heterogeneity, hydraulic load, and infiltration schedule (Aertgeerts & Angelakis, 2003). Although there are many studies of the impacts on recycled water use on groundwater outside of the State, the unique properties of Hawaiian soils mean that not all lessons learned from those studies can be applied locally (Brown and Caldwell, n.d.).

To explore these impacts, the HBWS commissioned a study in which percolate from recycled water would be compared to percolate from typical groundwater. In this study, various plots at the Central Oahu Regional Park were irrigated with either R-1 quality recycled water or typical groundwater, with the ground water-irrigated plots serving as the control group. Lysimeters were installed to collect percolate samples at a depth of 5 ft below the ground surface for a 12-month period. The percolate was tested for various constituents including various hormones, nutrients, organics, inorganics, and metals. The study found that, for total-organic-carbon and other health-related constituents of concern, there was no significant difference between the recycled water percolate and the control percolate. As such, the study concluded that recycled water can be used safely for irrigation in Central Oahu. However, the study also found that the percolate water quality was significantly different from the control percolate in some inorganic compounds and metals: these were characteristic of the recycled water from Honouliuli which was used in the study (Brown and Caldwell, n.d.).

Although the finding of this study are promising – recycled water can be used safely for irrigation in Central Oahu – impacts of recycled water use are highly dependent on recycled water quality and geological conditions at the application site. Since this study was limited to the application of R-1 quality effluent from Honouliuli in a single geographic area in Central Oahu, more studies may be warranted to represent the varying degrees of recycled water used at various locations throughout the State.

5.8. Summary and Recommendations

5.8.1. Summary

Water reuse is firmly established in Hawaii and has gradually increased since the DOH established its "Guidelines for the Treatment and Use of Reclaimed Water" in 1993. Golf course irrigation continues to be the main use for recycled water in Hawaii, while the availability of higher quality recycled water has spurred increases in urban landscape irrigation and industrial use.

Water reuse is approached differently in each County. The MWWRD and the HBWS have the most progressive water reuse programs and are gradually adding new customers as they expand recycled water production and distribution capabilities. Kauai County has the highest percentage of recycled water reused primarily due to the relatively small wastewater reclamation facilities being located near golf course and major agricultural operations; both use large quantities of recycled water on a daily basis. Most of the water reuse on the island of Hawaii occurs at golf courses in resort areas that are serviced with their own wastewater reclamation facilities.

Water reuse projects are driven by both water supply and effluent disposal issues. While water supply is the driving factor behind many of Hawaii's water reuse projects, effluent disposal concerns have and will continue to play a significant role in the development of water reuse programs in Hawaii. Tightening regulatory requirements on wastewater treatment and disposal are indirectly creating more recycled water opportunities.

The potential for more water reuse in Hawaii is great. A number of expansions are already planned for private and municipal recycled water production facilities and distribution systems; several expansion projects are expected to be constructed when the State's economy improves. The expansion of current water reuse applications are expected to boost water reuse and the demand for recycled water irrigation for agriculture could easily outpace supply.

Obstacles that can delay or prevent the implementation of water reuse projects exist, but with proper planning, these obstacles can be overcome. Public acceptance is a critical component for all water reuse projects. A concerted effort by recycled water purveyors must be commissioned to gain community support. Additionally, the cost to construct facilities needed to produce and distribute recycled water is significant, but several funding sources are available to help pay for these improvements.

5.8.2. Recommendations

1. Water reuse programs should designate a program coordinator to champion water reuse and implement water reuse initiatives.
2. All recycled water purveyors should implement a proactive public education program to promote that recycled water is a safe and viable water resource. Public education programs must be sustained throughout the duration of the water reuse program.
3. Political support is required for acquiring funding for water reuse projects. Politicians including County administrative officials, County council members and State legislators must be educated to gain their support.
4. Since agricultural irrigation with recycled water has such great potential in Hawaii, local farmers must be educated on the benefits and safety aspects associated with recycled water irrigation. Mainland farmers who utilize recycled water for direct contact irrigation of food crops should be consulted and brought to Hawaii to share information with local farmers. (These mainland food crops, irrigated with recycled water, are shipped to Hawaii and are common items sold in our grocery stores.)
5. Municipal recycled water purveyors should utilize SRFs as a primary funding mechanism for the design and construction of recycled water facilities since the DOH has placed a priority for such facilities to receive SRF support. Other funding sources such as the BOR Title XVI program should be explored.
6. County Planning Commissions should require new developments to contribute funding to create or improve recycled water facilities. When possible, a specific formula shall be used to calculate fair share contributions.
7. Since water reuse addresses water supply and wastewater treatment and disposal issues, a broad customer base – beyond just the recycled water users – should help fund the recycled water program. This customer base could include the recycled water users, potable water users, sewer users, property taxes, the visitor industry and new developments.
8. The price of recycled water should be set to encourage its use. Recycled water should not be more expensive than other water sources, particularly drinking water. Subsidies (such as from potable water users or sewer users) can assist in keeping the price of recycled water competitive with competing water sources.

9. Recycled water purveyors who have constructed distribution systems must dedicate a trained staff to properly operate and maintain the distribution infrastructure.

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6. FEDERAL FUNDING OPPORTUNITIES

6.1. Federal Funding Sources Recommended for Recycled Water Distribution Construction

6.1.1. Bureau of Reclamation, Title XVI, Waste Reclamation and Water Reuse

Title XVI gives the Secretary of the Interior the ability to undertake programs to investigate and identify opportunities for the reclamation and reuse of wastewater and naturally impaired ground and surface water. The act authorizes the Bureau's wastewater reclamation and reuse projects, allowing the participation in numerous reuse projects and feasibility studies and providing a program for Federal participation via cost sharing of specific water reuse projects.

To be eligible to receive Federal funding via Title XVI, a project must take place in the seventeen Western States or Hawaii. Projects also require an appraisal investigation and feasibility report to be completed by the Secretary of the Interior, who must also determine if the non-Federal project sponsor is financially capable of funding its share of the project. A cost-sharing agreement must also be approved by the Secretary of the Interior with the non-Federal sponsor, committing the sponsor to annually funding its appropriate share of the project's construction costs. Construction funds may only be supplied for projects specifically authorized by Congress, where the Bureau typically makes funding recommendations on authorized construction projects in the President's annual budget request.

The program gives partial grants with construction costs shared between the Federal government and local, non-Federal project sponsors; the Federal share is limited to 25% of the total project cost with a maximum of $20 million per project, dispersed through non-reimbursable grants with an average of $2.1 million. A maximum Federal share of up to 50% of the total demonstration project may be authorized if the Secretary determines that the project is not feasible without such funding. In all cases, the non-Federal project sponsor must provide the remainder of the project cost.

Projects proposed for Title XVI funding must be used for the following purposes: water for municipal and industrial water supplies (non-potable and indirect potable uses), irrigation, groundwater recharge, fish and wildlife enhancement, and outdoor recreation. Funding may also be used for water quality improvement features, should such improvements be required to allow reuse.

For further information, contact the U.S. Department of the Interior, Bureau of Reclamation at:
https://www.cfda.gov/index?s=program&mode=form&tab=step1&id=b0164f8ea66d74b230b480615150d085 (USDOI, 2013)

6.1.2. Clean Water State Revolving Fund Loan Program

The Clean Water SRF programs, co-funded by the federal government (80%) and state governments (20%), provide funding for water quality protection projects such as wastewater treatment, nonpoint source pollution control, watershed and estuary management, and gray water recycling through low or no-interest loans. These loans can fund 100% of a project's cost and provide flexible repayment terms for up to 20 years. The repaid funds are then recycled back into the fund to other water quality projects. The Clean Water SRF annually provides approximately $5 billion in water quality project funding at a 0.75% interest rate in seven different types of assistance: making loans, buying or refinancing existing local debt obligations, guaranteeing or purchasing insurance for local debt obligations, guaranteeing SRF debt obligations, providing loan guarantees for sub-state revolving funds, earning interest of fund accounts, and supporting reasonable costs of administering the SRF. States cannot use the SRF as a source of grants because projects that receive SRF funding are publicly-owned.

The Clean Water Act of 1987 sets standards for performance levels of municipal sewage treatment plants to prevent the release of harmful waste into surface waters; to assist municipalities with achieving those performance levels, it also authorizes the Clean Water SRF to fund point source, nonpoint source, and estuary projects. The SRF program provides assistance in constructing publicly-owned municipal WWTPs, implementing nonpoint pollution management programs, and developing and implementing management plans under the National Estuary Program. In Hawaii, the Clean Water SRF is administered by the Grants Management Section within the DOH Environmental Resources Office.

Eligible recipients for Clean Water SRF funding are any municipality, inter-municipality, interstate, or state agencies. Projects and activities eligible for funding are those needed for constructing or upgrading publicly-owned municipal WWTPs, including devices and systems used in the storage, treatment, recycling, and reclamation of municipal sewage. This encompasses construction or upgrading of treatment plants as well as construction of new collector sewers, interceptor sewers or storm sewers and projects to correct existing problem of sewer system rehabilitation, infiltration/inflow, and combined sewer overflows. The DOH has indicated that preference for SRF loans will be given to projects that contribute to

sustainability such as water reuse projects. Operations and maintenance activities are ineligible for funding.
For more information:
http://hawaii.gov/health/environmental/water/sdwb/dwsrf/dwsrf.html or
http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm . (USEPA, 2013)
The Grants Management Section may also be contacted at (808) 586-4294.

6.1.3. Rural Utilities Service for Water and Waste Disposal Programs

The Rural Utilities Service Program of the U.S. Department of Agriculture (USDA) provides funding for basic human amenities and to alleviate health hazards and promote the growth of the rural areas of the nation by meeting needs for new and improved rural water and/or waste disposal facilities, including costs of distribution lines and well-pumping. Funds may be used for the installation, repair, improvement, or expansion of rural water and waste disposal facilities, including the collection and treatment of sanitary waste, storm water, and solid wastes. The USDA provides funding through loans and grants for water and waste disposal - loans are the Department's preferred option, while grants are only offered when necessary to reduce the average annual user charge to a reasonable level. Funding of this program was authorized by the Consolidated Farm and Rural Development Act, Section 306, Public Law 92-419, 7 U.S.C. 1926.

Loans and grants are offered to develop storage, treatment, purification, or distribution of water or collection, treatment, or disposal of waste in low-income rural areas. These loans are either offered by or are guaranteed by the USDA for up to 90% of the value when offered by non-Federal lenders and are repayable in 40 years or the life span of the facility, whichever is less. In FY 2011, the Rural Utilities Service Program authorized loans totaling $1 billion, grants for $379 million, and guaranteed loans totaling $32 million; the average assistance totaled approximately $2 million.

Organizations eligible for Rural Utilities Service Program funding include municipalities, counties, and other subdivisions of a state; associations, cooperatives, and organizations operated on a non-profit basis; tribal agencies and other authorities; and associations, cooperatives, and Indian tribes that are Federally-recognized. USDA's loans and grant programs are limited to communities with a population of no more than 10,000 with poverty and intermediate rate incomes. Loans and grants given through this program are meant to allow communities to meet health and sanitary standards set by the Clean Water Act and Safe Drinking Water Act.

For additional information, look up the Gillibrand Water and Wastewater Funding Report, http://www.gillibrand.senate.gov/download/?id=e504c042-6a6d-4365-950b-6606bc7c50aa (Gillibrand, 2012)

6.1.4. Army Corps of Engineers Environmental Infrastructure

Beginning in 1992, Congress has authorized the Army Corps of Engineers (USACE) to assist rural and small communities with design and construction of infrastructure for both wastewater and drinking water, as well as projects for surface water protection and development. 75% of a project's total costs are financed federally by Congress while the remainder must be provided by the non-Federal or local sponsors. The specifics of how the USACE manages the non-Federal portion vary from project to project.

Environmental infrastructure projects are not typical missions for the USACE, so no clear eligibility requirements are defined. Congress normally authorizes USACE assistance for projects in a specific location, such as a small city, or a defined geographic location, such as a state or county. Projects are only approved if there is authorization for the work in the specified location and the activity to be undertaken is covered by the authorization.

Contact Information: http://www.usace.army.mil/CEMP/iis/Pages/Home.aspx, referenced in the Gillibrand Report (Gillibrand, 2012), (917) 780-8209

6.1.5. Public Works and Development Facilities Program

This program, also known as the Public Works and Economic Development Program (PWED), provides assistance to distressed communities to help attract new industry, encourage business expansion, diversify local economics, and generate and maintain long-term private sector jobs. Projects funded by the program include water and sewer facilities primarily to serve industry and commerce, access roads to industrial parks and sites, port improvements, business incubator facilities, technology infrastructure, sustainable development activities, export programs, brown fields redevelopment, aquaculture facilities, and other infrastructure projects. Activities allowed in these projects include demolition; renovation and construction of public facilities; provision of water or sewer infrastructure; and the development of storm water control mechanisms, such as retention ponds, as part of an industrial park.

Funding for this project has been authorized by the Economic Development Administration Reform Act (Public Law 105-393), which replaces and amends the Public Works and Economic Development Act of 1965 that previously funded the program. PWED assistance totals no more than 50% of the project's total cost. In FY 2004, the program's funding level was set at $232

million without the need for matching funding, whereas in FY 2009, FY 2010 and FY 2011, funding levels were set at $240 million, $133.28 million, and $158 million, respectively, with 50% fund matching required. FY 2012's funding level has not yet been determined at the time of the writing of this report. Organizations eligible for funding under the act include community and watershed groups; non-profit groups; educational institutions; private landowners; conservation districts; water and wastewater utilities; local governments; and state, territorial, and tribal agencies. All projects proposed must be consistent with an approved regional Comprehensive Economic Development Strategy. Qualified projects must fill a pressing need of the area and be intended to improve opportunities for the creation of businesses, create long-term employment, and benefit long-term unemployed or underemployed persons and low-income families. Projects must also be consistent with the economic development plans of the area.

Additional Information: contact U.S. Department of Commerce, Economic Development Administration: www.cfda.gov program 11.300 or call (202) 482-5628. Catalog of Federal Funding Sources for Watershed Protection: http://cfpub.epa.gov/fedfund/program.cfm?prog_num=51 (USEPA, 2013)

6.1.6. Community Development Block Grant Program

The Community Development Block Grant (CDBG) program, sponsored by the Department of Housing and Urban Development, is a flexible program intended to help develop communities by providing housing and a suitable living environment by expanding economic opportunities, especially for persons with low and moderate income rates, and providing resources to address a wide range of unique community development needs. Organizations that receive assistance may direct actions toward neighborhood revitalization, economic development, and provision of improved community facilities and services, with specific activities including public services; acquisition of property; relocation and demolition; rehabilitation of structures; and provision of public facilities and improvements, such as new or improved water and sewer facilities.

The program's funding is authorized by the Housing and Community Development Act of 1974, Title 1, with the funding level for FY 2004 set at $4.3 million. Since then, the budget has fluctuated - the highest was $4.45 million in FY 2010, while the current FY 2012 funding level is $3 million with matching funds not required. Organizations eligible for CDBG program assistance include community and watershed groups, non-profit groups, educational institutions, private landowners, water and wastewater utilities, local governments, and state and territorial agencies.

Additional information: Department of Housing and Urban Development at (202) 708-3587 or www.hud.gov/offices/cpd/communitydevelopment/programs (Gillibrand, 2012)

6.2. Federal Funding Sources Recommended for Individual Water Reuse Projects

6.2.1. USDA Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP), under the USDA Natural Resources Conservation Service, is a voluntary conservation program that provides financial, technical, and educational assistance to agricultural producers (farmers and ranchers) through contracts up to ten years in length. These contracts provide financial assistance for planning and implementing conservation practices that address natural resource concerns as well as opportunities to improve soil, water, plant, animal, air, and related resources on agricultural land and non-industrial private forestland. 60% of the EQIP is targeted to livestock-related natural resource concerns, while the remainder is dedicated to more general conservation priorities. The EQIP is most available where significant natural resource concerns and objectives are present.

Funding for the EQIP was authorized by the Food, Agriculture, Conservation and Trade Act of 1996. For FY 2004, the project funded $832 million in contracts, with required matching funding amounts between 25% and 50%. In FY 2011, the EQIP funded approximately $865 million in contracts. Those eligible for EQIP participation include owners of land in agricultural or forest productions and persons who are engaged in livestock, agricultural, or forest productions on eligible land that have a natural resource concern on the land, such as businesses, community and watershed groups, non-profit groups, educational institutions, private landowners, water and wastewater utilities, state and territorial agencies, and tribal agencies.

For more information and how to apply for EQIP assistance, contact the U.S. Department of Agriculture's Natural Resources Conservation Service at (202) 720-1840 or visit their website at: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip (USDOA, 2013)

6.2.2. Coral Reef Conservation Fund

The National Fish and Wildlife Foundation's Coral Reef Conservation Fund supports the restoration of damaged reef systems and reduces and prevents damage of reefs and associated habitats (i.e., sea grass beds, mangroves, etc.) through both "on-the-water" and "up-the-watershed" projects, as well as projects that build public-private partnerships to pursue these goals. Projects may address causes of coral reef degradation from inland areas to coastal

watersheds to the reefs themselves and surrounding marine environment. In regards to how this program applies to wastewater reclamation, there are concerns that nutrients returned to the ecosystem could be contributing to the growth of invasive algae that can slow the development of coral reefs. Recycling wastewater allows the nutrients in recycled water to play a beneficial role rather than a detrimental one when associated with effluent disposal.

Funding for this program was authorized by the Coral Reef Conservation Act of 2000. Funding levels for FY 2003 were set at $900,000 in grants, while for FY 2012 the total amount of all awards were not to exceed $500,000, with the majority of awards falling between $20,000 and $70,000. All proposed projects must include matching funds from the non-Federal project partners at a minimum ratio of 1:1, though ratios of 2:1 are preferred.

For further information, call (202) 857-0166, or you can visit either www.nfwf.org/coralreef/ or http://cfpub.epa.gov/fedfund (USEPA, 2013)

6.2.3. Clean Water Act Section 319: Nonpoint Source Management Program

The Clean Water Act of 1987 amendments established Section 319 (Nonpoint Source Management Program) to address the need for greater Federal leadership in focusing state and local nonpoint source efforts. States, territories, and Native American tribes may receive grants from Section 319 to support a wide variety of activities such as technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

Section 319 is sponsored by the EPA and administered by the CWB. In Hawaii, the Section 319 program is able to offer grants with 25% fund matching that may be fulfilled with cash or with the value of in-kind services.

Grants from this source of funding were utilized by the Hawaii Water Environment Association in 2000 to administer a statewide educational outreach program to gain support for water reuse projects; the educational video “Water Recycling in Hawaii” was produced as part of this effort. In 2003, Haleakala Ranch on Maui also utilized this program for the development of its sedimentation control project utilizing R-1 recycled water.

For additional information, call the CWB at (808) 586-4309,
http://hawaii.gov/health/environmental/water/cleanwater/prc/index.html

(USDOA, 2013) or visit the EPA's website at http://www.epa.gov/owow_keep/NPS/ cwact.html (USEPA, 2013)

6.2.4. Coastal Services Center Cooperative Agreements

The National Oceanic and Atmospheric Administration (NOAA) directs the conservation and management of coastal resources via a variety of programs. The Coastal Services Center (CSC) is established within NOAA to support the environmental, social, and economic well-being of the coast by linking people with information and technology to assist in conservation efforts. The goal of the CSC is to be a resource to those who manage and care for the nation's coasts. In FY 2004, the CSC supported efforts and activities in the following areas: landscape characterization and restoration, coastal remote sensing, information resources, Pacific Services Center, and integrated ocean observing systems. Much like the Coral Reef Conservation Fund, the connection between the CSC and wastewater reclamation is the concern that nutrient additions can have detrimental effects on aquatic ecosystems like the coastal areas the CSC seeks to protect.

Funding levels for this program fluctuate greatly and are awarded as grants: FY 2004 - $3 million, FY 2009 - $25 million, FY 2011 - $0.5 million, and FY 2012 - estimated $10.4 million. Awards ranged from as low as $40,000 to as high as $3.5 million; as they are grants, there is no matching funding required. Eligible organizations include businesses, community and watershed groups, non-profit groups, educational institutions, conservation districts, water and wastewater utilities, local governments, state and territorial agencies, and tribal agencies.

For more information, call (843) 740-1222 or go to www.csc.noaa.gov , search for Cooperative Agreements or go to http://cfpub.epa.gov/fedfund /program.cfm?prog_num=13 (USEPA, 2013)

6.3. Federal Funding Recommended for Water Reuse Education

6.3.1. Environmental Education Grant

The Environmental Education Grant Program, under the EPA, strives to promote environmental education, environmental stewardship and the development of knowledgeable and responsible students, teachers, and citizens. This grant program provides financial support for projects that design, demonstrate, and/or disseminate environmental education practices as well as target techniques specified by the EPA. Two rounds of environmental education grants are expected to be awarded by the EPA from the ten regional offices.

Funding levels for this grant program remain relatively stable; funding was $3.4 million for FY 2009 and 2010 and an estimate of funding is $3.5 million for FY 2012. Typical awards were between $15,000 and $100,000. While this is a grant program, a 25% non-federal matching fund is required for any project receiving financial assistance in this manner, which may be provided in cash or by in-kind contributions and other non-cash support. Organizations eligible for funding include non-profit groups, educational institutions, state and territorial agencies, and tribal agencies.

For more information, go to http://cfpub.epa.gov/fedfund/search2.cfm?prog_num=25 (6.4) or www.cfda.gov (Search on program 66.951)

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7. REFERENCES

The following references were utilized during the preparation of this report. In addition to the references cited below, information used to prepare this report was obtained during interviews, telephone conversations, and e-mail correspondences with recycled water purveyors, water reuse project managers, various City and County of Honolulu and County water and wastewater officials, and DOH representatives.

Asano, T., Ed. (1998), Wastewater Reclamation and Reuse: Boca Raton, FL: CRC Press pp. 391-392

Asano, T. & Cotruvo, J.A.; (2004), Groundwater Recharge with Reclaimed Municipal Wastewater: Health and Regulatory Considerations. *Water Research*, 38, pp. 1941-1951

Belt Collins Hawaii LLC; (2012), Villages of Leialii Affordable Housing Environmental Impact Statement, Appendix I Wastewater and Reclaimed Water.

Brown and Caldwell; (1995), *County of Maui – Rate and Fee Alternatives for Reclaimed Water Service*, pp. 1-1 to 1-3.

Brown and Caldwell (n.d.), *Technical Paper #971 Water Reuse and Groundwater Protection in Central Oahu.*

Brown and Caldwell (n.d.), *Technical Paper #1051 Assessment of Recycled Water Irrigation in Central Oahu*.

Chang, C. (2010), HARC Plans an Ag Complex for Kunia. *Midweek*. June 2010.

Chesapeake Bay Program (2013), http://www.chesapeakebay.net/issues/issue/wastewater.

County of Maui. *Chapter 20.30 Use of Reclaimed Water*. Maui Index, 1996, 1997, 1998. Web. 18 June 2011. http://ordlink.com/does/maui/index.htm.

County of Maui (2013), http://www.co.maui.hi.us/documents/11/28/339/CWG%20Final%20report_reduced_file_size.PDF

County of Maui Wastewater Reclamation Division; (2009), *South Maui R-1 Recycled Water Verification Study*.

County of Maui Wastewater Reclamation Division; (2010), *Central Maui Recycled Water Verification Study*.

County of Maui Wastewater Reclamation Division; (2012*), West Maui Recycled Water Verification Study*.

Dailer, M.L. et al; (2010), *Using $\delta^{15}N$ Values in Algal Tissue to Map Locations and Potential Sources of Anthropogenic Nutrient Inputs on the Island of Maui, Hawaii, USA.* Marine Pollution Bulletin 60 (2010) 655-671.

Denver Zoo (2013), http://www.denverzoo.org/conservation/green.html

Freedman, Carl; (2009), Maui County Water Use and Development Plan, Central District, Final Candidate Strategies Report, Report Review Draft, pg. 97.

Gillibrand, K. (2012). *A Guide to Water and Wastewater Funding Programs.* http://www.gillibrand.senate.gov/download/?id=e504c042-6a6d-4365-950b-6606bc7c50aa

Hawaii Agriculture Research Center (2013), http://www.harc-hspa.com/

Hunt, C.D.; (2006), *Ground-Water Nutrient Flux to Coastal Water and Numerical Simulation of Wastewater Injection at Kihei, Maui, Hawaii*. Scientific Investigations Report 2006-5283; U.S. Department of Interior, U.S. Geological Survey: Honolulu, Hawaii.

Irvine Ranch Water District (2013), www.irwd.com

Oki, D.S.; Wolff, R.H., Perreault, J.A., (2010), *Effects of Surface-Water Diversion on Streamflow, Recharge, Physical Habitat, and Temperature, Na Wai `Eha, Maui, Hawai`i*, U.S. Geological Survey Scientific Investigations Report 2010-5011, 154 p.

Olowalu Town (2013), http://www.olowalu.net/index.cfm?fuseaction=ig.page&CategoryID=1

Orange County Water District; (2013), *Historical Information*. http://www.ocwd.com/About/HistoricalInformation.aspx

Parabicoli, S.; (2001), How to Sell Reclaimed Water – Setting the Right Price in Maui. *Water 21, Magazine of the International Water Association*. August 2001, pp. 26-33.

Parabicoli, S.; (1997), *Water reuse in Hawaii: An Overview*. Proceedings of the Water Environment Federation 70th Annual Conference, Volume 6, October, pp. 175-186.

Satran, J. (2013), FSMA Regulations on Produce, Manufactured Food Finally Released for Public Comment. Huffington Post, January 2013. http://www.huffingtonpost.com/2013/01/04/fsma-regulations_n_2410456.html

Scheuring, I; Daysog, R. (2013), *Tesoro Corp. Announces Sale of Kapolei Refinery, Local Operations*. Hawaii News Now. June 2013. http://www.hawaiinewsnow.com/story/22613918/breaking-tesoro-corp-announces-sale-of-kapolei-refinery-local-operations-details-at-hawaiinewsnowcom

Shimogawa, D. (2012), Oracle's Larry Ellison says Lanai to be a Model of Sustainability. *Bizjournals.* http://www.bizjournals.com/pacific/blog/2012/10/oracles-larry-ellison-says-lanai-to.html?page=all

State of Hawaii, Hawaii Administrative Rules, Title 11-54-5.1.

State of Hawaii Department of Health's Clean Water Branch, http://hawaii.gov/health/environmental/environmental/water/cleanwater/index.html

State of Hawaii, Department of Health, Wastewater Branch (2002), *Guidelines for the Treatment and Use of Recycled Water*, pg. 1.

St. Petersburg Water Resources Department (2013), http://www.stpete.org/water/reclaimed_water/index.asp

Sydney Water (2013), http://www.sydneywater.com.au/Water4Life/recyclingandreuse/RecyclingAndReuseInAction/SewerMining.cfm

Tanji, K., et al (2006) *Salt Management Guide for Landscape Irrigation with Reclaimed Water: A Literature Review,* WateReuse Foundation, Alexandria VA.

U.S. Department of the Interior, Bureau of Reclamation, Title XVI. *Catalog of Federal Domestic Assistance*. https://www.cfda.gov/index?s=program&mode=form&tab=step1&id=b0164f8ea66d74b230b480615150d085

U.S. EPA Polluted Runoff (Non-point Source Pollution) http://www.epa.gov/owow_keep/NPS/cwact.html

United States Environmental Protection Agency, Region IX, Docket No. UIC-09-2011-0002 (2011), Consent Agreement and Final Order; pg. 8, item 52.

US EPA Office of Technology Transfer and Regulatory Support. EPA/624/R-92/004; (1992), *Guidelines for Water Reuse*, pp. 90-93

U.S. EPA Watershed Academy website (2013). *Catalog of Federal Funding Sources for Watershed Protection*, http://cfpub.epa.gov/fedfund/

Department of Agriculture's Natural Resources Conservation Service (2013), http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip

WaterReuse Association (2000). Recycled Water Uses Allowed in California. City of Santa Rosa California. Retrieved: 2012, from http://ci.santa-rosa.ca.us/doclib/Documents/RW_Uses_in_CA.pdf

Wilson Okamoto Corporation; (2008), *Environmental Assessment and Environmental Impact Statement for Koloa-Poipu Regional Wastewater Reclamation Facility.*

APPENDIX A
State of Hawaii Water Reuse Project & Purveyor Directories (July 2013)

STATE OF HAWAII WATER REUSE PURVEYOR DIRECTORY (July, 2013)

WWTP/WRF	TREATMENT LEVEL	DESIGN CAPACITY (MGD)	RECYCLED WATER PRODUCED (MGD)	RECYCLED WATER SOLD (MGD)	RATE	PLANNED UPGRADES (Year)
County of Kauai						
Eleele WWRF	R-2	0.80	0.60	0.00	N/A	None
Grand Hyatt WWRF	R-2	0.35	0.10	0.10	Free	None
Kukuiula - South Shore Community	R-2	1.20	0.05	Not Available	Not Available	Not Available
Lihue WWRF	R-1	2.50	1.20	0.65	Free	None
Lihue-Puhi WWTP	R-1	1.00	0.40	0.40	$90,000/year	None
Poipu WWRF	R-1	0.80	0.30	0.30	$1.30/1000 gallons	None
Princeville WWRF	R-2	1.00	0.60	0.60	$0.16/1000 gallons	None
Wailua WWRF	R-2	1.50	0.50	0.43	$0.20/1000 gallons	None
Waimea WWRF	R-1	0.70	0.35	0.35	Free	None
City & County of Honolulu						
Hawaii Kai WWTP	R-1	5.30	2.00	0.00	N/A	UV disinfection (2014)
Honouliuli WRF	R-O/R-1	12.00 (2 R-O/10 R-1)	5.75 (1.74 R-O/4.01 R-1)	5.75 (1.74 R-O/4.01 R-1)	$5/1000 gallons (R-O) Individual Agreements (R-1)	None
Kuilima WWTP	R-2	1.32	0.20	0.20	Free	None
Kunia Villages WWTP	R-2	0.07	0.03	0.03	Free	None
Laie WWRF	R-1	0.90	0.40	0.40	$1.00/1000 gallons	None
Makua Military Reservation	R-2	Not Available	Not Available	Not Available	Not Available	Not Available
Marine Corps Base Hawaii WWRF	R-2	2.00	1.00	0.60	Free	None
Schofield WRF	R-2	4.20	2.36	2.30	N/A (Schofield pays Dole for disposal rights)	None
Wahiawa WWTP	R-2	2.50	1.60	No Direct Reuse	N/A	MBR, biofilter, UV disinfection (2013)
Waiawa WWTP	R-2	0.07	0.07	0.07	Free	None
County of Hawaii						
Heeia WRF	R-2	1.80	0.50	0.50	Pumping Costs	None
Hokulia Phase I WWTP	R-3	0.04	< 0.01	Not Available	Not Available	Not Available
Kalahuipuaa Lagoons Treatment Facility	R-2	0.75	0.30	0.30	Free	None
Kaloko Housing Project	R-2	0.03	Not Available	Not Available	Not Available	Not Available
Keahole Airport	R-1	0.13	0.03	0.03	Free	None
Kealakehe WWTP	R-2	5.30	2.00	0.00	N/A	None
South Kohala WWRF	R-1	0.60	0.18	0.18	$2.70/1000 gallons	None
Waikoloa Resort WRF	R-1	1.30	0.50	0.50	$0.26/1000 gallons	None
Waimea Wastewater Company, Inc. fka Parker Ranch	R-3	0.10	0.07	0.00	N/A	None
County of Maui						
Kaluakoi WWRF	R-2	0.10	0.04	< 0.01	$1.28/1000 gallons	None
Kaunakakai WWRF	R-2	0.30	0.15	0.01	$1.28/1000 gallons	None
Kihei WWRF	R-1	8.00	3.41	1.68	$0.33-$1.28/1000 gallons	Disk Filters (2013)
Lahaina WWRF	R-1/R-2	9.00	3.75	1.43	$0.20-$1.28/1000 gallons	Disk Filters, UV disinfection up to 9 mgd (2013)
Lanai City Auxiliary WWRF	R-1	0.40	0.17	0.13	$3.18/1000 gallons	None
Makena WWRF	R-1	0.75	0.08	0.08	Free	None
Manele WWRF	R-1	0.14	0.07	0.07	$0.25/1000 gallons	None
Midway Center	R-3	Not Available	< 0.01	Not Available	Not Available	Not Available
Pukalani WWRF	R-1	0.28	0.19	0.19	$0.55/1000 gallons	None
Puu O Hoku Ranch Constructed Wetlands System	R-3	Not Available	< 0.01	< 0.01	Free	None
Wailuku-Kahului WWRF	R-2	7.90	3.70	0.00	N/A	None

STATE OF HAWAII WATER REUSE PROJECT DIRECTORY (July, 2013)

*Note: Recycled water used for in-plant applications at Hawaii's wastewater reclamation facilities not included.

REUSE PROJECT	PROJECT TYPE	CONTACT	TEL. # (808)	RECYCLED WATER PRICE	VOLUME (MGD)	QUALITY	APPLICATION	SOURCE
County of Kauai								
Kauai Lagoons Resort	Golf Course	Scott Ashworth	241-6000	Free	0.65	R-1	Blend w/brackish/undiluted	County of Kauai-Lihue WWRF
Wailua Golf Course	Golf Course	Craig Carney	241-6672	Free	0.55	R-2	Blend w/brackish/undiluted	County of Kauai-Wailua WWRF
Lygate Park Soccer Fields	Landscape	George Ahlgren	241-4461	0.20/1000 gallons	0.04	R-2	Supplement w/potable water	County of Kauai-Wailua WWRF
Kikiaola Land Company	Agriculture	Mike Faye	639-3900	Free	0.3	R-1	Blend w/stream water	County of Kauai-Waimea WWRF
Princeville Makai G.C.	Golf Course	Matt Bachman	826-9229	$0.16/1000 gallons	0.6	R-2	Blend w/rain water	Princeville Utilities Company
Puakea Golf Course	Golf Course	Dan Urwiler	245-8740	$90,000/year	0.4	R-1	Blend w/stream water	Grove Farm Development-Lihue-Puhi WWRF
Kiahuna Golf Club	Golf Course	Victor Nemeth	742-9595	Free	0.3	R-1	Blend w/stream water	Poipu WRF
Koloa Landing	Landscape	Myron Lindsey	346-6320	$1.30/1000 gallons	0.07	R-1	Undiluted	Poipu WRF
Poipu Bay Resort G.C.	Golf Course	Andy Meikle	742-1013	Free	0.1	R-2	Blend w/stream water	Hyatt WWTP
City & County of Honolulu								
AES Hawaii	Industrial	Stan Riner	682-5330	$5.00/1000 gallons	0.13	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
Chevron	Industrial	John Ikeda	682-2295	Not Available	0.64	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
Hawaii Gas	Industrial	Leyten Kubota	535-5933	$5.00/1000 gallons	0.05	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
HECO Campbell Industrial Park Plant	Industrial	Kirk Tomita	543-7834	Not Available	0.02	R-O	Undiluted (demineralized & addtl R-O)	C&C of Honolulu - Honoululi WRF
HECO Kahe Plant	Industrial	Kirk Tomita	543-7834	Not Available	0.15	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
Kalaeloa Partners	Industrial	Bili Hoffheimer	682-5288	Not Available	0.5	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
Tesoro Hawaii	Industrial			Not Available	0.25	R-O	Undiluted (demineralized)	C&C of Honolulu - Honoululi WRF
Barber's Point Golf Course	Golf Course	Neil Nakagawa	306-8319	Free (Paid By United States Navy)	0.5	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Coral Creek Golf Course	Golf Course	Kenneth Kim	441-4653	Not Available	1	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Ewa Beach Golf Club	Golf Course	Liane Otake	689-6565	$0.55/1000 gallons	0.45	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Hawaii Prince Golf Club	Golf Course	Willy Suckoll	952-4719	$0.55/1000 gallons	1	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Hoakalei Country Club	Golf Course	Ian Hunt	599-0998	$0.50/1000 gallons	0.06	R-1	Blend w/ brackish water	C&C of Honolulu - Honoululi WRF
Kapolei Golf Course	Golf Course			Not Available	1	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Ewa Villages Golf Course	Golf Course	Heidi Madirgal	681-0033	$1.59/1000 gallons	1	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Ewa Villages Development	Landscape	Garrick Iwamuro	733-7383	$1.59/1000 gallons	N/A (included in Ewa Villages GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Ewa Mahiko District Park	Landscape	Dexter Liu	675-6030	$1.59/1000 gallons	N/A (included in Ewa Villages GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Golf Course	Golf Course	Tony Balada Jr.	675-6075	$1.59/1000 gallons	0.9	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Villages Elderly Housing	Landscape	Garrick Iwamuro	733-7383	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Fairways & Townhouses	Landscape	Garrick Iwamuro	733-7383	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Estates	Landscape	Garrick Iwamuro	733-7383	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Estates-Laulaunui	Landscape	Garrick Iwamuro	733-7383	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Asing Community Park	Landscape	Dexter Liu	675-6030	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
West Loch Shoreline Park	Landscape	Dexter Liu	675-6030	$1.59/1000 gallons	N/A (included in West Loch GC volume)	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Ewa Makai Middle School	Landscape	Edward Oshiro	687-9500	Not Available	0.07	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Fort Weaver Road Medials	Landscape			Not Available	0.125	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Kulana Malama Nursing Facility	Landscape	Paul Bursey	294-2829	Not Available	0.03	R-1	Undiluted	C&C of Honolulu - Honoululi WRF
Kahuku Farms	Agriculture	Melvin Matsuda	223-2251	$0.42/1000 gallons	0.03	R-2	Blend w/stream water	C & C Honolulu-Wahiawa WRF, Army-Schofield Barracks
UH Poamoho Research Station	Agricultural Research	Susan Migita	637-4735	Not Available	0.03	R-2	Blend w/stream water	C & C Honolulu-Wahiawa WRF, Army-Schofield Barracks
Oahu Flowers	Agriculture (Bird of Paradise)			$0.30/1000 gallons	0.7 (2x/mo.)	R-2	Blend w/stream water	C & C Honolulu-Wahiawa WWRF, Army-Schofield Barracks
Pioneer Hybrid International	Agriculture (Seed Corn)			Not Available	0.475	R-2	Blend w/stream water	C & C Honolulu-Wahiawa WWRF, Army-Schofield Barracks
Hawaii Agriculture Research Center	Agricultural Research	Stephanie Whalen	621-1352	Free	0.03	R-2	Undiluted	Kunia Village WRF
Turtle Bay Resort Palmer Course	Golf Course	Ralph Makaiau	332-7381	Free	0.2	R-2	Blend w/brackish water	Kuilima WRF
Waiawa Correctional Facility	Agriculture, Landscape Irrigation	Archie Yu	587-1333	Free	0.07	R-2	Undiluted	Waiawa Correction Facility WRF
Hawaii Reserves	Agriculture, Landscape Irrigation	Jeff Tyau	293-6432	N/A	0.4	R-1	Undiluted	Laie WRF
M.C.B.H. Klipper Golf Course	Golf Course	Jeff Larson	257-6920	Free	0.6	R-2	Undiluted	Marine Core Base Hawaii WWRF
County of Hawaii								
Kona Country Club	Golf Course	Mike Yukon	322-9915	Pumping Costs (rate agreement pending)	0.3	R-2	Undiluted	Heeia WWRF
Kona International Airport	Landscape Irrigation	Stefan Borduz	938-2552	Free	0.03	R-1	Blend w/potable water	State DOT-Keahole Internation Airport WWRF
Mauna Kea Resort	Golf Course	Paul Goolsby	882-5400	Free	0.18	R-1	B;emd w/brackish water	South Kohala WWRF
Mauna Lani Resort	Sod Farm/Composting	George Oliva	885-6866	Free	0.3	R-2	Undiluted	Kalahuipuaa Lagoons Treatment Facility
Waikaloa Beach Resort	Golf Course	Rory Allison	886-6232	$0.26/1000 gallons	0.5	R-1	Blended w/brackish water	Waikoloa Resort WRF

STATE OF HAWAII WATER REUSE PROJECT DIRECTORY (July, 2013)

*Note: Recycled water used for in-plant applications at Hawaii's wastewater reclamation facilities not included.

REUSE PROJECT	PROJECT TYPE	CONTACT	TEL. # (808)	RECYCLED WATER PRICE	VOLUME (MGD)	QUALITY	APPLICATION	SOURCE
County of Maui								
Experience at Koele	Golf Course	Rick Dunwell	559-4172	Free (15 yr. agreement w/Cof M)	0.15	R-1	Undiluted & blend w/rain water	C of M/Lanai Water Company
Challenge at Manele	Golf Course	Rick Dunwell	559-4172	Free	0.08	R-1	Blend w/brackish water	Manele Bay Resort WWRF
Elleair Maui Golf Club	Golf Course	Lance Sokugawa	870-9536	$0.33/1000 gallons	0.57	R-1	Undiluted	County of Maui-Kihei WWRF
Monsanto-Seed Corn	Agriculture, Landscape, Toilet Flushing	Dan Clegg	283-4028	$0.33 & $1.28/1000 gallons	0.18	R-1	Undiluted	County of Maui-Kihei WWRF
Kalama Park	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.06	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Community Center	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.042	R-1	Undiluted	County of Maui-Kihei WWRF
Piilani North Park	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.02	R-1	Undiluted	County of Maui-Kihei WWRF
South Maui Community Park	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.056	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Bikeway	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.014	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Roundabout	Landscape Irrigation	Ray Catiel	875-4108	$1.28/1000 gallons	0.011	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Fire Station	Landscape Irrigation	Mike McDougal	879-2741	$1.28/1000 gallons	0.001	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Library	Landscape Irrigation	Janet Fehr	875-6833	$1.28/1000 gallons	0.005	R-1	Undiluted	County of Maui-Kihei WWRF
Goodfellow Brothers Const.	Dust Control	Ray Skelton	242-1875	$1.28/1000 gallons	0.02	R-1	Undiluted	County of Maui-Kihei WWRF
Kaanapali Resort/G.C.	Golf Course/Landscape Irrigation	Craig Trenholme	661-0991	$0.20/1000 gallons	0.89	R-1	Undiluted	County of Maui-Lahaina WWRF
Mauna Loa Hwy.-Kaunakakai	Landscape Irrigation	Martin Kahae	553-1701	$1.28/1000 gallons	0.0017	R-2	Undiluted	County of Maui-Kaunakakai WWRF
Pukalani Country Club	Golf Course	Oswaldo Carnenes	572-0779	$0.55/1000 gallons	0.25	R-1	Blend w/potable well water	Hawaii Water Services Co. - Pukalani WWRF
Haggai Institute	Landscape/Fish Pond	Mark Menzies	870-1458	$0.56/1000 gallons	0.036	R-1	Undiluted	County of Maui-Kihei WWRF
Piilani Shopping Center	Landscape Irrigation	Graham Peake	874-8900	$1.28/1000 gallons	0.011	R-1	Undiluted	County of Maui-Kihei WWRF
Maui Tropical Algae Farm	Landscape/Composting	Brad Reeves	283-3161	$1.28/1000 gallons	0.001	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Elementary School	Lancscape Irrigation	Lynette Ducosin	244-1905	$1.28/1000 gallons	0.023	R-1	Undiluted	County of Maui-Kihei WWRF
Lokelani Intermediate School	Lancscape Irrigation	Vernan Kalanikau	244-3522	$1.28/1000 gallons	0.037	R-1	Undiluted	County of Maui-Kihei WWRF
Piilani Gardens	Lancscape Irrigation	Marilyn Silva	874-1800	$1.28/1000 gallons	0.045	R-1	Undiluted	County of Maui-Kihei WWRF
Piilani Villages	Lancscape Irrigation	Bert Sugimoto	283-6466	$1.28/1000 gallons	0.011	R-1	Undiluted	County of Maui-Kihei WWRF
Sunshine Vetiver	Agricultural Irrigation	John Astilla	385-4136	$0.33/1000 gallons	0.0005	R-1	Undiluted	County of Maui-Kihei WWRF
Hope Chapel	Landscape Irrigation	John Martin	879-3853	$1.28/1000 gallons	0.039	R-1	Undiluted	County of Maui-Kihei WWRF
Haleakala Ranch	Sedimentation Control/Pasture Irrigation	Richard Sylva	250-1706	$0.16/1000 gallons	0	R-1	Undiluted	County of Maui-Kihei WWRF
Maui Earth Composting	Green Waste Composting/Vermiculture	Tim Gunter	877-0403	$0.33/1000 gallons	0.003	R-1	Undiluted	County of Maui-Kihei WWRF
Hale Mahaolu Ehiku	Landscape Irrigation	Jason Smith	891-8588	$1.28/1000 gallons	0.012	R-1	Undiluted	County of Maui-Kihei WWRF
Hokulani Golf Villas	Landscape Irrigation	Kathy Wong	264-9658	$1.28/1000 gallons	0.103	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Kauhale	Landscape Irrigation	Hawaiiana Maintenance	270-3218	$1.28/1000 gallons	0.0031	R-1	Undiluted	County of Maui-Kihei WWRF
Kihei Recycling Center	Landscape Irrigation	Elaine Baker	250-2484	$1.28/1000 gallons	0.0021	R-1	Undiluted	County of Maui-Kihei WWRF
Honua Kai Resort	Landscape Irrigation	Lance Gilliland	662-2831	$1.28/1000 gallons	0.15	R-1	Undiluted	County of Maui-Lahaina WWRF
Hyatt Regency	Landscape Irrigation	Ryne Ushigome	667-4706	$1.28/1000 gallons	0.033	R-1	Undiluted	County of Maui-Lahaina WWRF
Kaluakoi Resort & Golf Course	Golf Course	Rex Kamakana	552-2394	Free	0.04	R-2	Blend w/potable backwash water	Kaluakoi WWRF
Makena South Golf Course	Golf Course	Brian Taylor	874-1111	Free	0.075	R-1	Blend w/brackish water	Makena WWRF
Haleakala Crater Visitor Center	Toilet/Urinal Flushing	Peter Kafka	572-4420	Free	0.0001	R-1	Blend w/captured rain water	Haleakala National Park WWRF
Puu O Hoku Ranch	Landscape	Rune Pederson	588-8109	Free	0.0037	R-3	Constructed Wetland	Puu O Hoku Ranch Constructed Wetland
Misc. Dust Control	Dust Control	Steve Parabicoli	270-7426	$1.28/1000 gallons	0.025	R-1/R-2	Undiluted	County of Maui-Kihei, Lahaina, Kahului, Kaunakakai WWRFs
Maui Research & Technology Park	Lancscape Irrigation	Steve Perkins	270-5944	$1.28/1000 gallons	0.087	R-1	Undiluted	County of Maui-Kihei WWRF

APPENDIX B
2013 House Resolution No. 187 and House Concurrent Resolution No. 232

HOUSE OF REPRESENTATIVES
TWENTY-SEVENTH LEGISLATURE, 2013
STATE OF HAWAII

H.R. NO. 187

HOUSE RESOLUTION

REQUESTING THE ESTABLISHMENT OF A TASK FORCE TO STUDY AND MAKE RECOMMENDATIONS ON THE RE-USE OF R-1 WATER FOR AGRICULTURAL PURPOSES IN CENTRAL OAHU.

WHEREAS, through the natural water cycle, the earth has recycled and reused water for millions of years, and modern water recycling uses technology to speed up these natural processes; and

WHEREAS, recycled water can satisfy most water demands, provided it has been adequately treated to ensure water quality that is appropriate for its corresponding use, and thus saves money and increases the effective water supply; and

WHEREAS, there is a long history of water recycling activities in the United States, and regulatory oversight at the state and federal levels has ensured the safety of various water recycling projects undertaken in this country; and

WHEREAS, no documented cases of human health problems due to contact with recycled water that has been properly treated to standards, criteria, and regulations have been reported, according to the U.S. Environmental Protection Agency; and

WHEREAS, recycled water is most commonly used for non-potable purposes, such as agriculture, landscaping, golf course irrigation, dust control, and construction activities; and

WHEREAS, with regard to agriculture, a number of other states already use recycled water for agricultural purposes, such that a significant amount of imported produce sold in Hawaii is produced with recycled water of the R-1 grade, and large-scale agricultural users of recycled water in other states have been passing audits that anticipate the implementation of the FDA Food Safety Modernization Act; and

WHEREAS, Hawaii consumes the most water per capita in the U.S., eighteen per cent higher than the national average; and

WHEREAS, the Hawaii 2050 Sustainability Plan calls for, among other things, measures to encourage greater production and use of recycled water; and

WHEREAS, land use in Central Oahu is currently in transition following the decline of the sugar and pineapple industries, and agriculture must compete with other users of non-potable water such as military housing and new urban development; and

WHEREAS, R-1 water is the highest designation for recycled water being used in Hawaii and is approved for agricultural use on low-lying crops, unlike R-2 water, which is of lower quality and restricted to use in circumstances where human contact is minimized; and

WHEREAS, various sources of recycled water exist on Oahu but are under-utilized, such as water from the U.S. Army Schofield Barracks Wastewater Treatment Plant, which is treated and brought up to an R-1 designation, only for the excess to be drained into a ditch; now, therefore,

BE IT RESOLVED by the House of Representatives of the Twenty-seventh Legislature of the State of Hawaii, Regular Session of 2013, that the Department of Land and Natural Resources is requested to establish a Task Force to consider and make recommendations on the re-use of R-1 water for agricultural purposes in Central Oahu; and

BE IT FURTHER RESOLVED that, more specifically, the Task Force is requested to consider and make recommendations regarding:

(1) The feasibility of increasing the amount of R-1 water available for agricultural use;

(2) Methods by which to pump and transport the water to Central Oahu for agricultural use while maintaining the water's R-1 designation;

(3) The location(s) to which the R-1 water should be pumped, based on both need and practicality;

(4) The possibility of a pilot program implementing agricultural use of R-1 water from the Schofield Barracks Wastewater Treatment Plant, and if successful, further use of the pilot program as a model for statewide implementation with other wastewater treatment plants;

(5) Ways to increase public awareness about the safety and benefits of using R-1 water for agricultural purposes; and

(6) Any other relevant factors; and

BE IT FURTHER RESOLVED that the Department of Land and Natural Resources is requested to determine, at its discretion, who shall serve on the Task Force; and

BE IT FURTHER RESOLVED that the Department of Land and Natural Resources is requested to submit a report to the Legislature no later than twenty days prior to the convening of the Regular Session of 2014, containing the recommendations of the Task Force, including any proposed legislation; and

BE IT FURTHER RESOLVED that the task force is requested to be dissolved on June 30, 2014; and

BE IT FURTHER RESOLVED that certified copies of this Resolution be transmitted to the Chairperson of the Board of Land and Natural Resources.

OFFERED BY: _____

HOUSE OF REPRESENTATIVES
TWENTY-SEVENTH LEGISLATURE, 2013
STATE OF HAWAII

H.C.R. NO. 232

HOUSE CONCURRENT RESOLUTION

REQUESTING THE ESTABLISHMENT OF A TASK FORCE TO STUDY AND MAKE RECOMMENDATIONS ON THE RE-USE OF R-1 WATER FOR AGRICULTURAL PURPOSES IN CENTRAL OAHU.

WHEREAS, through the natural water cycle, the earth has recycled and reused water for millions of years, and modern water recycling uses technology to speed up these natural processes; and

WHEREAS, recycled water can satisfy most water demands, provided it has been adequately treated to ensure water quality that is appropriate for its corresponding use, and thus saves money and increases the effective water supply; and

WHEREAS, there is a long history of water recycling activities in the United States, and regulatory oversight at the state and federal levels has ensured the safety of various water recycling projects undertaken in this country; and

WHEREAS, no documented cases of human health problems due to contact with recycled water that has been properly treated to standards, criteria, and regulations have been reported, according to the U.S. Environmental Protection Agency; and

WHEREAS, recycled water is most commonly used for non-potable purposes, such as agriculture, landscaping, golf course irrigation, dust control, and construction activities; and

WHEREAS, with regard to agriculture, a number of other states already use recycled water for agricultural purposes, such that a significant amount of imported produce sold in Hawaii is produced with recycled water of the R-1 grade, and large-scale agricultural users of recycled water in other states have been passing audits that anticipate the implementation of the FDA Food Safety Modernization Act; and

WHEREAS, Hawaii consumes the most water per capita in the U.S., eighteen per cent higher than the national average; and

WHEREAS, the Hawaii 2050 Sustainability Plan calls for, among other things, measures to encourage greater production and use of recycled water; and

WHEREAS, land use in Central Oahu is currently in transition following the decline of the sugar and pineapple industries, and agriculture must compete with other users of non-potable water such as military housing and new urban development; and

WHEREAS, R-1 water is the highest designation for recycled water being used in Hawaii and is approved for agricultural use on low-lying crops, unlike R-2 water, which is of lower quality and restricted to use in circumstances where human contact is minimized; and

WHEREAS, various sources of recycled water exist on Oahu but are under-utilized, such as water from the U.S. Army Schofield Barracks Wastewater Treatment Plant, which is treated and brought up to an R-1 designation, only for the excess to be drained into a ditch; now, therefore,

BE IT RESOLVED by the House of Representatives of the Twenty-seventh Legislature of the State of Hawaii, Regular Session of 2013, the Senate concurring, that the Department of Land and Natural Resources is requested to establish a Task Force to consider and make recommendations on the re-use of R-1 water for agricultural purposes in Central Oahu; and

BE IT FURTHER RESOLVED that, more specifically, the Task Force is requested to consider and make recommendations regarding:

(1) The feasibility of increasing the amount of R-1 water available for agricultural use;

(2) Methods by which to pump and transport the water to Central Oahu for agricultural use while maintaining the water's R-1 designation;

(3) The location(s) to which the R-1 water should be pumped, based on both need and practicality;

(4) The possibility of a pilot program implementing agricultural use of R-1 water from the Schofield Barracks Wastewater Treatment Plant, and if successful, further use of the pilot program as a model for statewide implementation with other wastewater treatment plants;

(5) Ways to increase public awareness about the safety and benefits of using R-1 water for agricultural purposes; and

(6) Any other relevant factors; and

BE IT FURTHER RESOLVED that the Department of Land and Natural Resources is requested to determine, at its discretion, who shall serve on the Task Force; and

BE IT FURTHER RESOLVED that the Department of Land and Natural Resources is requested to submit a report to the Legislature no later than twenty days prior to the convening of the Regular Session of 2014, containing the recommendations of the Task Force, including any proposed legislation; and

BE IT FURTHER RESOLVED that the task force is requested to be dissolved on June 30, 2014; and

BE IT FURTHER RESOLVED that certified copies of this Concurrent Resolution be transmitted to the Chairperson of the Board of Land and Natural Resources.

OFFERED BY: _____

APPENDIX C
Acknowledgements

APPENDIX C: ACKNOWLEDGMENTS

During the development of this report, several representatives of local government agencies, wastewater reclamation facilities and water reuse projects were contacted to provide information about their respective programs, facilities and projects. The Limtiaco Consulting Group is grateful to these individuals as the information they provided allowed the report to provide the CWRM with an accurate view of the current state of water reuse in Hawaii. The individuals who contributed information for the report along with their respective affiliations are listed below.

- United States Department of Defense
  - Marine Corps Base Hawaii
    - Jeff Larson

- State of Hawaii
  - Department of Education, Ewa Makai Middle School
    - Edward Oshiro, Principal
  - Department of Health, Environmental Management Division, Wastewater Branch
    - Stuart Shoji, Environmental Engineer
  - Department of Land & Natural Resources, Commission on Water Resources Management
    - Lenore Ohye, Hydrologic Planning Program Manager
    - Neil Fujii, State Drought and Water Conservation Coordinator
    - Jeremy Kimura
  - Department of Public Safety, Waiawa Correctional Facility
    - Archie Yu
  - University of Hawaii, Poamoho Research Station
    - Susan Migita

- County of Maui
  - County of Maui, Department of Parks & Recreation
    - Ray Catiel, South Maui Parks District Supervisor
  - County of Maui, Wastewater Reclamation Division
    - John Souza, Kaunakakai WWRF Supervisor
    - Matthew Mano, Lanai WWRF Supervisor
    - Tim Hartog-Hall, Kihei WWRF Supervisor
    - Kathleen Lawson, Lahaina WWRF Supervisor
    - Nicolas Estabilo, Wailuku-Kahului WWRF Supervisor
  - Eleair Maui Golf Club
    - Lance Sokugawa, Golf Course Superintendent
  - Haliimailie Development
    - Alan Arkakawa, A & B Properties, Senior Vice President, Planning
  - Haggai Institute
    - Mark Menzies, Maintenance Manager
  - Hale Mahaolu Ehiku

        - Jason Smith, Maintenance Manager
    - Haleakala National Park Visitor Center
        - Peter Kafka, Facilities Maintenance Manager
    - Hokulani Golf Villas
        - Fred Trott, Facilities Manager (former)
    - Honua Kai Resort
        - Lance Gilliand, Sustainability Manager
    - Honua`ula Development
        - Charles Jencks, Wailea 670 Associates, Inc.
    - Hope Chapel
        - John Martin, Maintenance Manager
    - Kaluakoi Resort and Golf Course
        - Rex Kamakana, Molokai Ranch, Utility Manager
    - Hyatt Regency Resort
        - Ryne Ushigome, Landscape Manager
    - Kaanapali Golf Courses
        - Craig Trenholme, Superintendent
    - Lanai Resorts
        - John Stubbart, Director of Utilities
    - Makena Wastewater Reclamation Facility
        - Frank Rodrigues, Operator IV
    - Maui Research & Technology Park
        - Steve Perkins, Property Manager
        - Geoff Kirkland, Landscape Manager
    - Monsanto
        - Dan Clegg, Land Manager
    - Piilani Gardens
        - Steve Snow, Landscape Manager
    - Pukalani Country Club
        - Oswaldo Carnenes, Superintendent
    - Pukalani Wastewater Reclamation Facility
        - Tom Johnson, Hawaii Water Services Company, Operator IV
    - Puu O Hoku Ranch
        - Rune Pederson, Maintenance Manager
    - Sunshine Vetiver
        - John Astilla, Owner
    - The Experience at Koele and The Challenge at Manele
        - Irwin Ozoa, Aqua Engineers, Team Leader of Operations
        - Rick Dunwell, Golf Course Superintendent

- City and County of Honolulu
    - AES Hawaii
        - Stan Riner
    - Aqua Engineers
        - John Nakagawa
    - Barber’s Point Golf Course

        - Neil Nakagawa
    - Board of Water Supply
        - Clayton Brown, Recycled Water System Coordinator
    - Chevron
        - John Ikeda
    - Coral Creek Golf Course
        - Kenneth Kim, General Manager
    - City and County of Honolulu, Department of Enterprise Services
        - Garrick Iwamuro, Golf Course System Administrator
        - Heidi Madrigal, Ewa Villages Golf Course Superintendent
        - Tony Balada, West Loch Golf Course Superintendent
    - City and County of Honolulu, Department of Environmental Services
        - Clyde Hudson, Wahiawa WWTP Supervisor
        - Jay Gonsalves, Laie WWRF Supervisor
    - City and County of Honolulu, Department of Parks and Recreation
        - Dexter Liu, Leeward Oahu District Manager
    - Ewa Beach Golf Club
        - Liane Otake, General Manager
    - Hawaii Agriculture Research Center
        - Susan Whalen, Executive Director
    - Hawaii American Water,
        - Bruce Zhang, Hawaii Kai WWTP Plant Superintendent
    - Hawaii Gas
        - Leyten Kubota
    - Hawaii Reserves
        - Jeff Tyau
    - Hawaiian Electric Company
        - Kirk Tomita
    - Hawaii Prince Golf Club
        - Willy Suckoll, Golf Course Superintendent
    - Hoakalei Country Club
        - Ian Hunt, Golf Course Superintendent
    - Kahuku Farms
        - Melvin Matsuda
    - Kulana Malama
        - Paul Bursey
    - Leilehua Golf Course
        - Stephen H. Takashige, Acting Director of Golf
    - Turtle Bay Resorts
        - Ralph Makaiau
    - Veolia Water North America
        - Alfred (Fred) Layi, Project Manager
        - Paul Hill, Assistant Project Manager

- County of Kauai
  - County of Kauai, Division of Wastewater Management
    - Ed Tshcupp, Chief
    - Bert Ueno, Superintendent of Operations
  - County of Kauai, Department of Parks and Recreation
    - Craig Carney, Wailua Golf Course Superintendent
    - George Ahlgren, Maintenance Manager
  - Kauai Lagoons Resort
    - Scott Ashworth, Director of Golf
  - Kiahuna Golf Club
    - Victor Nemeth, Superintendent
    - Ian Kagimoto, HOH Utilities President
  - Kikiaola Land Company
    - Mike Faye
  - Koloa Landing
    - Myron Lindsey
  - Lihue-Puhi WWRF
    - Herman Santos, Aqua Engineers, DRC Operator
  - Poipu Bay Resort Golf Course
    - Andy Meikle, Assistant Superintendent
  - Poipu Bay Resort WWRF
    - Matthew Louis, Aqua Engineers, Team Leader of Operations
  - Princeville Makai Golf Course
    - Matt Bachman, Director of Golf
    - Mike Loo, Princeville Utilities, Manager
    - Roy Constantino, Princeville WWRF Supervisor
  - Puukea Golf Course
    - Dan Urwiler, Superintendent

- County of Hawaii
  - Department of Environmental Management, Wastewater Division
    - Dana Riddle
    - Dora Beck, Division Chief
    - Lyle Hirota, Deputy Division Chief
  - Hawaii American Water
    - George Oliva, Kalahuipuaa Lagoons Treatment Facility Plant Manager
  - Kona Country Club
    - Mike Yukon, Golf Course Superintendent
  - Parker Ranch
    - Brandi Beaudet, Land Manager
  - Waikoloa Beach Resort
    - Rory Allison
    - Stephen Green

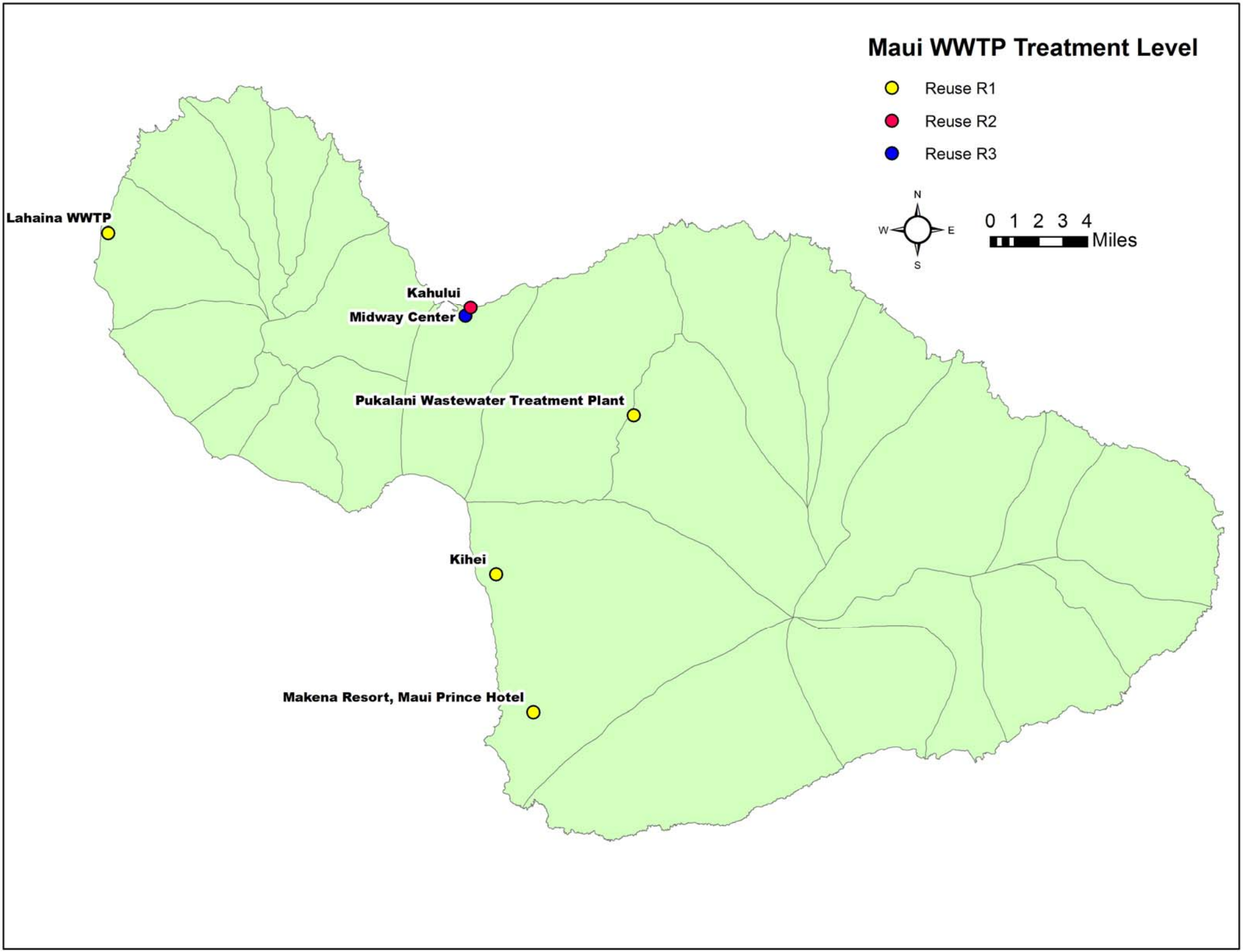
APPENDIX D
Secondary Treatment Methods

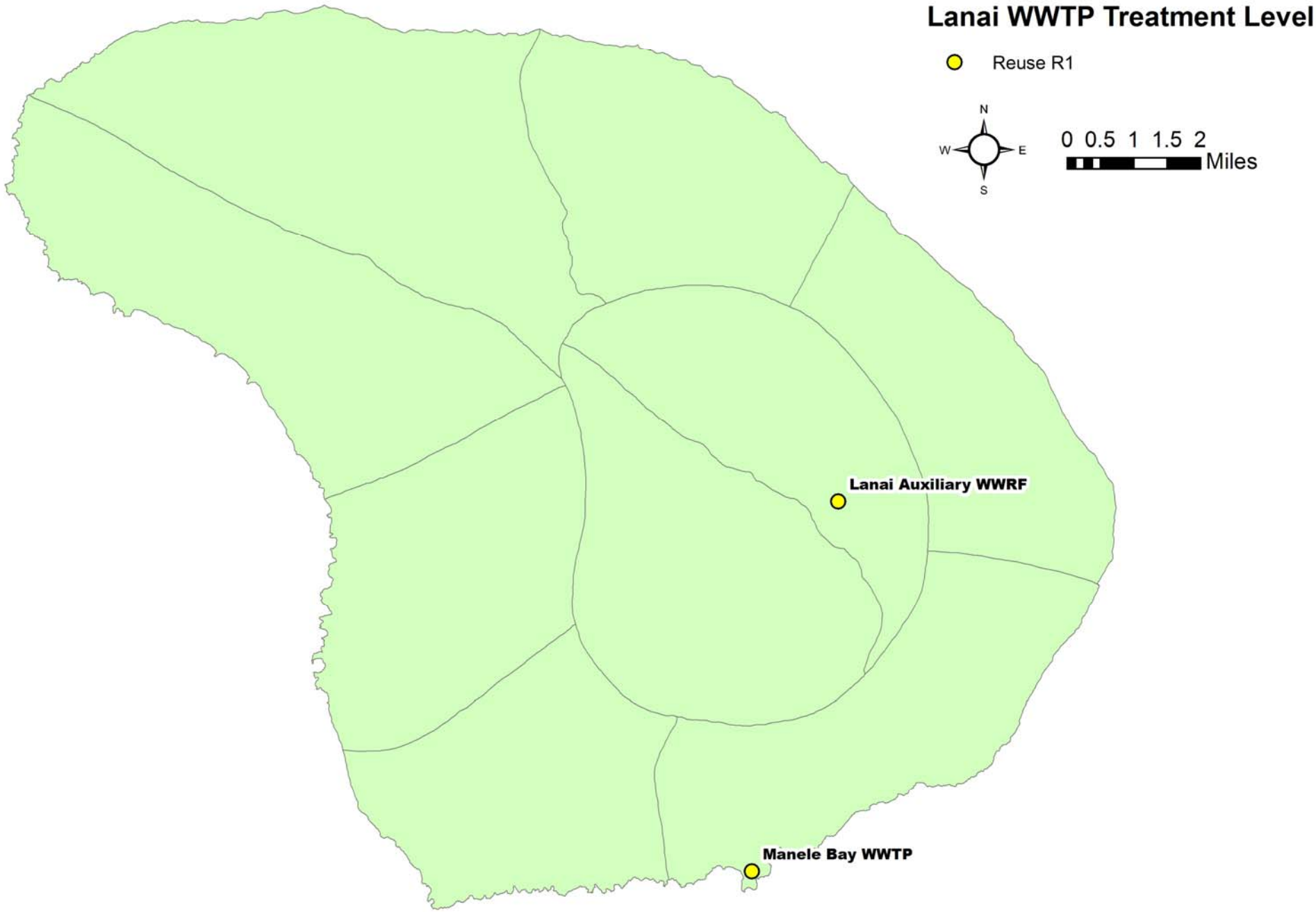
Secondary Treatment Process	Description
Suspended Growth Processes	• Air is mixed with microorganisms and wastewater • Variations include: o Conventional Activated Sludge (CAS) ▪ Very common wastewater treatment ▪ Process flexibility with a high degree of treatment ▪ Activated sludge microbes are continuously aerated in aeration basins ▪ Microbes convert dissolved solids into readily settleable solids ▪ Followed by gravity settling of solids in secondary clarifiers ▪ Settled solids are returned to the front of the aeration basins to reseed the basin with microbes (Return Activated Sludge) ▪ A portion of the settled solids (Waste Activated Sludge) is “wasted,” or removed from the system to maintain an optimal mass of microbes ▪ Clarified water overflows from weirs in the secondary clarifiers o Selector Activated Sludge (SAS) ▪ Anoxic (low dissolved oxygen) and anaerobic (no dissolved oxygen) zones are utilized to promote the removal of nutrients such as nitrogen and phosphorous ▪ Useful in areas where nutrient are negatively impacting the environment ▪ Followed by secondary clarification o Sequencing Batch Reactors (SBR) ▪ Combines oxidation and solids separation in one basin, eliminating the need for secondary clarifiers ▪ Processes are rotated in a sequence: filling the basin, aerating the basin, settling the basin, removal of effluent through decanting, and idling the basin contents ▪ SBR systems typically include at least two parallel process trains to allow for redundancy
Fixed Film Processes	• Uses media on which a slime layer of bacteria and other microbes develop • Wastewater flows past the media and absorption and adsorption of pollutants occurs • Typically set up in a series to allow for progressively increased treatment

	• Inherently stable and resistant to organic and hydraulic shock loads • Varieties of FFPs include: o Trickling Filters (TF): Wastewater is distributed over the top of the media and trickles down over the media to an under drain system. Media can include materials like rocks or high density plastic. o Rotating Biological Contactors (RBC): Wastewater flows past the rotating media, which is comprised of high density plastic. Typically 40% of the media is submerged in the wastewater. Supplemental diffused aeration is often utilized with RBCs.
Combined Biological Processes	• Combine fixed film systems with suspended growth systems • A Trickling Filter Solids Contact (TFSC) system is common in Hawaii o The TF removes the bulk of incoming food o A small activated sludge aeration basin removes soluble BOD, polishing the effluent
Integrated Biological Processes	• Combines the benefits of a fixed film system and the suspended growth activated sludge process • Media are inserted into aeration basins and allow for increased surface area for beneficial microbes to attach and grow • Reduces solids in the secondary clarifier, thereby allowing for increased treatment capacity. • Variations of IBP processes include: o Moving Bed Bioreactor (MBBR): Small media are dispersed throughout activated sludge aeration basins. Screens are installed at the outlets of aeration basins to prevent loss of media. Return of activated sludge is not utilized with MBBR systems. Settling of the activated sludge can be problematic o Stationary Bed Bioreactors: stationary versions of the MBBR process o Integrated Fixed Film Activated Sludge: These systems address the poor settleability of MBBR processes by adding return activated sludge capability. Increased recirculation helps add density of the biomass in the system.

Submerged Bed Filters	• Combine filtration and biological reactions to oxidize organic material and remove particulates. • An example is the Membrane Bioreactor (MBR) o The MBR process uses a fine membrane to extract clear water from concentrated activated sludge o Produces very high quality recycled water o MBRs have a small footprint compared to other wastewater reclamation processes o Operating cost is higher due to higher energy requirements.
Treatment Lagoons and Artificial Wetlands	• Treatment lagoons and artificial wetlands provide habitat that: o Allow for solids settling; o Allow for nitrogen and phosphorous reduction through biological processes; o Require large areas.

APPENDIX E
Wastewater Treatment Plant Maps


Maui WWTP Treatment Level
Reuse R1
Reuse R2
Reuse R3
N
W
E
S
0 1 2 3 4
Miles
Lahaina WWTP
Kahului
Midway Center
Pukalani Wastewater Treatment Plant
Kihei
Makena Resort, Maui Prince Hotel

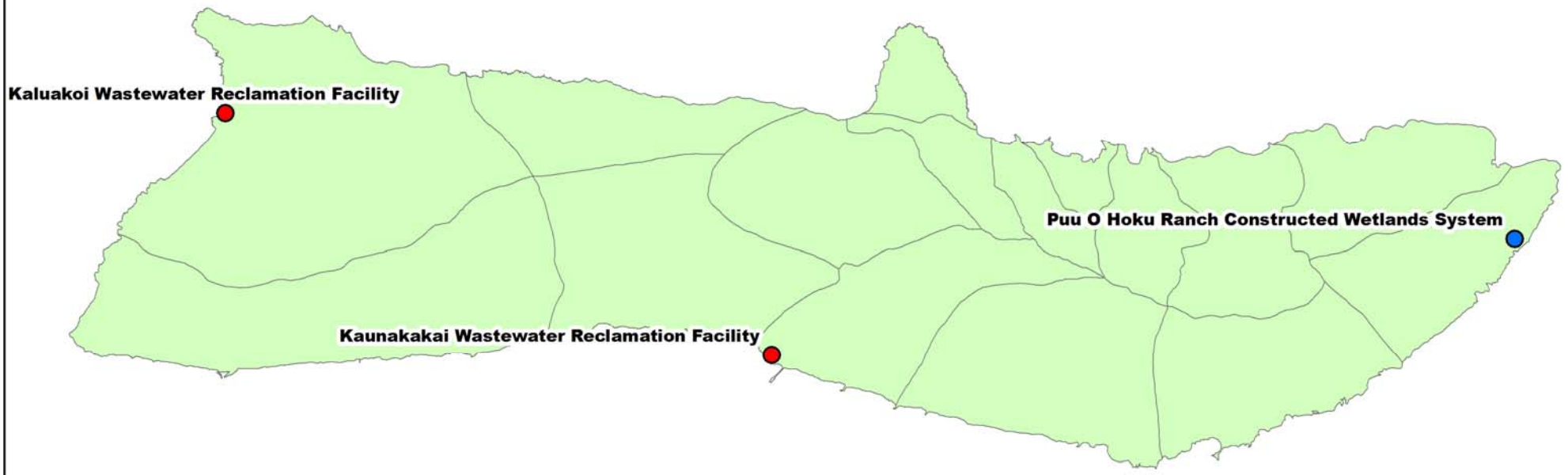

Lanai WWTP Treatment Level
Reuse R1
N
W
E
S
0 0.5 1 1.5 2
Miles
Lanai Auxiliary WWRF
Manele Bay WWTP

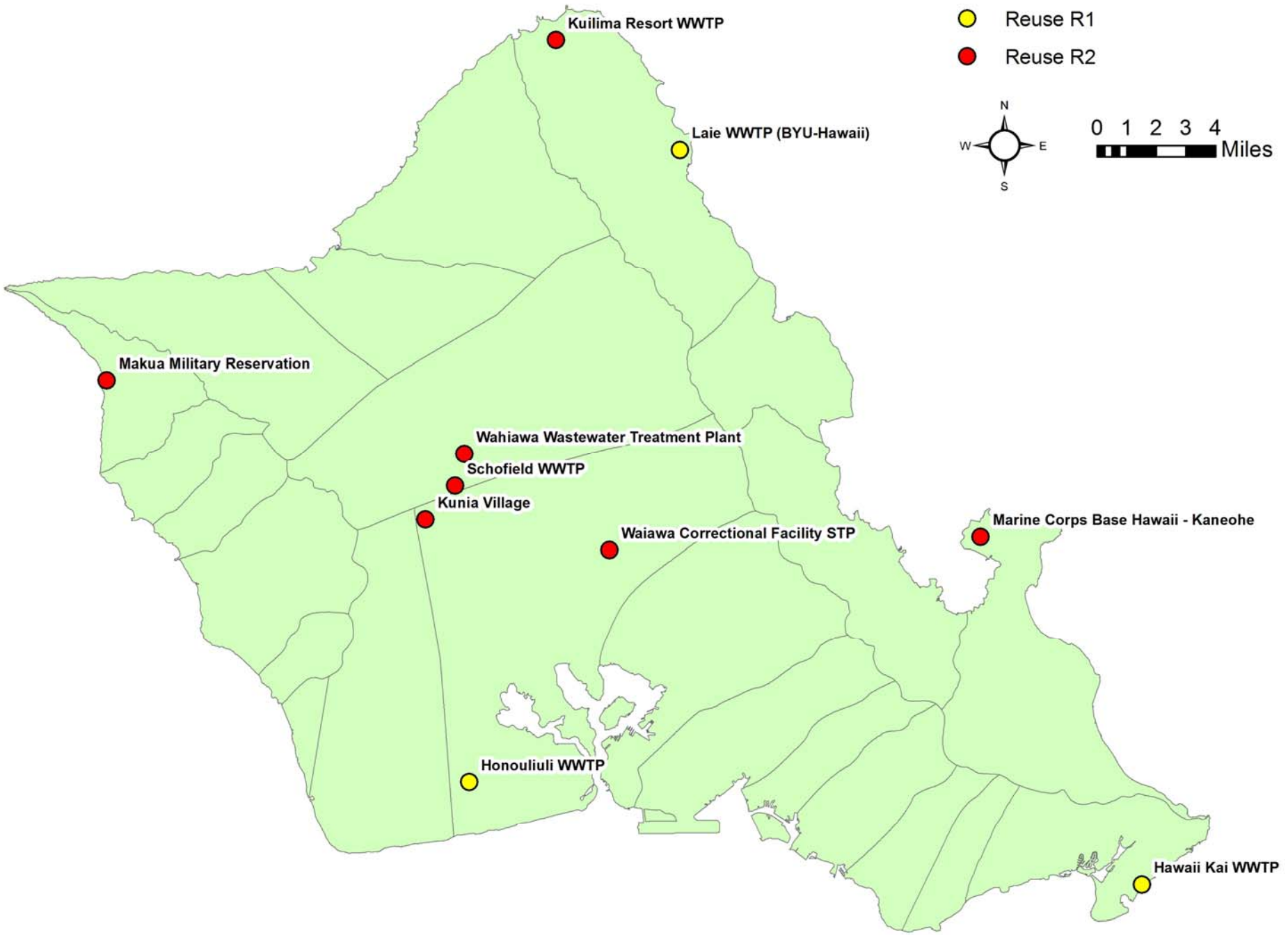
Molokai WWTP Treatment Level

- Reuse R3
- Reuse R2

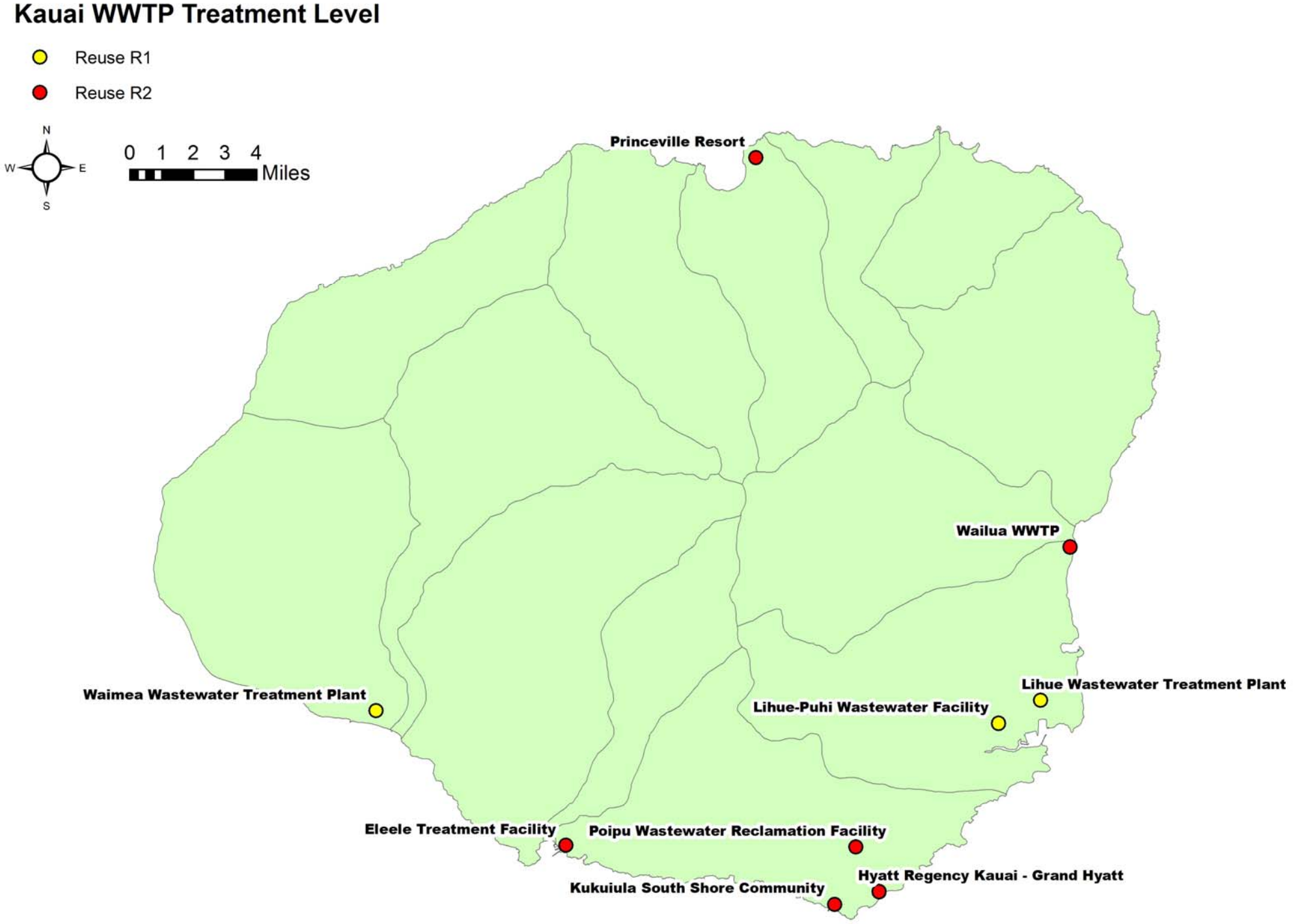
N
W E
S

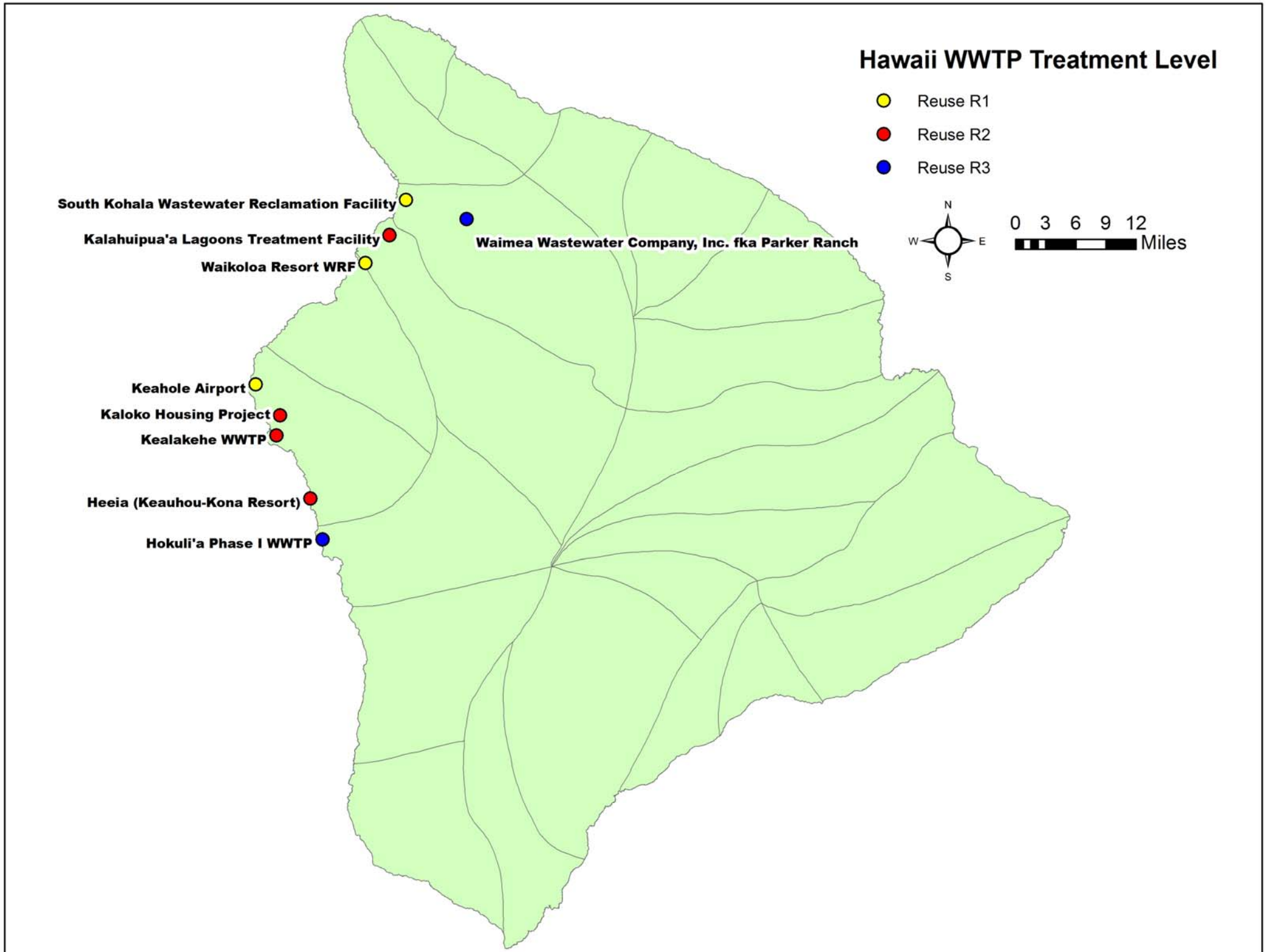
0 1 2 3 4
Miles




Oahu WWTP Treatment Level
Reuse R1
Reuse R2
N
W
E
S
0 1 2 3 4
Miles
Kuilima Resort WWTP
Laie WWTP (BYU-Hawaii)
Makua Military Reservation
Wahiawa Wastewater Treatment Plant
Schofield WWTP
Kunia Village
Waiawa Correctional Facility STP
Marine Corps Base Hawaii - Kaneohe
Honouliuli WWTP
Hawaii Kai WWTP

Kauai WWTP Treatment Level




Hawaii WWTP Treatment Level
Reuse R1
Reuse R2
Reuse R3
N
W
E
S
0 3 6 9 12
Miles
South Kohala Wastewater Reclamation Facility
Kalahuipua'a Lagoons Treatment Facility
Waikoloa Resort WRF
Waimea Wastewater Company, Inc. fka Parker Ranch
Keahole Airport
Kaloko Housing Project
Kealakehe WWTP
Heeia (Keauhou-Kona Resort)
Hokuli'a Phase I WWTP