# *INCREASED FOOD SECURITY AND FOOD SELF-SUFFICIENCY STRATEGY*

## *VOLUME III: ASSESSMENT OF IRRIGATION SYSTEMS IN HAWAII*


*Prepared by*

*OFFICE OF PLANNING*

*DEPARTMENT OF BUSINESS ECONOMIC DEVELOPMENT & TOURISM*

*IN COOPERATION WITH THE*

*DEPARTMENT OF AGRICULTURE*



*This report was prepared under an Award from the*
*U.S. Department of Commerce*
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*Award Number 07 69 06658*

*OCTOBER 2012*

# *INCREASED FOOD SECURITY AND FOOD SELF-SUFFICIENCY STRATEGY*

*A STATE STRATEGIC/FUNCTIONAL PLAN*
*PREPARED IN ACCORDANCE WITH HRS CHAPTER 226*
*HAWAII STATE PLAN*
***and the***
*HAWAII COMPREHENSIVE ECONOMIC DEVELOPMENT STRATEGY*

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This report was prepared by the Office of Planning, Department of Business of Economic Development & Tourism. The statements, conclusions, and recommendations are those of the author and do not necessarily reflect the views of the Economic Development Administration.

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## Abstract

This document is the third volume of a three volume report *Increased Food Security and Food Self-Sufficiency* Strategy prepared by the Office of Planning in cooperation with the Department of Agriculture. This strategy focuses on State of Hawaii government agencies and organizations. Volume I is comprised of the strategy framework and strategy. Volume II is a technical document containing a history of agriculture in Hawaii over the last 50 years as well as additional documents used to develop and support the strategy. Volume III is the general status and needs of agricultural irrigation systems owned by the State of Hawaii. Volume III contains an updated inventory and physical assessment of agricultural irrigation systems owned by the State of Hawaii. In addition there are estimated costs for rehabilitation and maintenance. A list of known Capital Improvement Projects (CIP) is also provided. Lastly, a summary of economic impacts/benefits of several inventoried agricultural irrigation systems is provided.

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## Acronyms

| | |
|---|---|
| ADC | Agribusiness Development Corporation |
| AMFAC | American Factors |
| AWUDP | Agricultural Water Use Development Plan |
| AWUDP 2004 | Agricultural Water Use Development Plan 2004 |
| CIP | Capital Improvement Project |
| CWRM | State Commission on Water Resource Management |
| CEDS | Hawaii Comprehensive Economic Development Strategy |
| DOA | State Department of Agriculture |
| DLNR | Department of Land and Natural Resources |
| EKIS | East Kauai Irrigation System |
| GIS | Geographic Information Systems |
| GPD | Gallons Per Day |
| GDP | Gross Domestic Product |
| GSP | Gross State Product |
| HRS | Hawaii Revised Statutes |
| HSWC | Hawaii State Water Code |
| HSWP | Hawaii State Water Plan |
| HPIS | Honokaa – Pauuilo Irrigation System |
| KAA | Kekaha Agricultural Association |
| KEDIS | Kekaha Ditch Irrigation System |
| KIS | Ka`u Irrigation System |
| KIS | Kahuku Agricultural Park Irrigation System |
| KOKIS | Kokee Ditch Irrigation System |
| KWC | Kunia Water Cooperative |
| KSC | Kekaha Sugar Company |
| MGD | Million Gallons Per Day |
| MIS | Molokai Irrigation System |
| SLH | Session Laws of Hawaii |
| UMIS | Upcountry Maui Irrigation System |
| WhIS | Wahiawa Irrigation System |
| WSC | Waialua Sugar Company |
| WaIS | Waimea Irrigation System |
| WIS | Waiahole irrigation system |
| WDIS | Waiahole Ditch Irrigation System |
| WIS | Waimanalo Irrigation System |

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## Foreword

The Office of Planning conducts statewide planning and coordination to implement the Hawaii State Planning Act, HRS Chapter 226. The Office of Planning is also the lead agency for the preparation of the Hawaii Comprehensive Economic Development Strategy (CEDS).

Plantation closures in Hawaii escalated in the 1990's. Closure of the plantations impacted the operation and maintenance of the associated irrigation systems. The need for a reliable, inexpensive source of irrigation water is critical in the transition from plantation agriculture to diversified agriculture. This project has been undertaken to review and summarize existing inventories of agricultural irrigation owned by the State of Hawaii and to identify the cost of repairing and maintaining these systems. Economic impacts/benefits of irrigation systems owned by the State of Hawaii were also identified. The project has been conducted with the assistance of and in cooperation with the Department of Agriculture—the lead agency for the promotion and development of agriculture in the State.

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## Executive Summary

This report is the third volume of a three volume report *Increased Food Security and Food Self-Sufficiency* Strategy prepared by the Office of Planning in cooperation with the Department of Agriculture. It contains an inventory, physical assessment, estimated costs for rehabilitation, and economic benefits of agricultural irrigation systems owned by the State of Hawaii.

Agricultural irrigation systems (Systems) were developed by sugar plantations and water companies, between 1876 and the 1920's, to provide a consistent source of water to sugar fields. Plantation closures in the 1980's and 1990's affected the operation and maintenance of the Systems as most were also owned by the plantations.

The passage of Act 101 in 1998 required the development of an Agricultural Water Use and Development Plan (AWUDP) and mandated that the plan would become part of the Hawaii State Water Plan. The AWUDP 2004 inventoried thirteen Systems and estimated future irrigation water requirements. Additionally AWUDP 2004 obtained data on the existing conditions, current concerns and needs, and estimated rehabilitation costs of nine State Systems. Total rehabilitation costs for these Systems were estimated at $91,648,000.00. Adjusted for inflation, the estimated cost in 2012 dollars is $111,328,096.22.

Economic assessment reports on the Wahiawa, Waiahole, and Kekaha systems confirm that these irrigation systems provide positive economic benefits/impacts to the State's economy. In 2007, Wahiawa system contributed $85.2 million and created approximately 986 full-time and part-time jobs to the state wide economy.

In 2000, Waiahole contributed $95 million and created roughly 2,000 jobs to the economy. The $95 million accounted for 51% of total crops, livestock, and aquaculture sales for the City and County of Honolulu. Through direct and indirect efforts in the overall State economy it was concluded that for every $1 increase in final demand for Hawaii's agriculture products from Waiahole, the output in Hawaii's economy is increased by $1.94. For 2012, Waiahole contributed $135 million and 2,000 jobs to the economy.

In 2002, Kekaha system and lands directly contributed $19.5 million and 387 jobs to the economy. In 2004, $34.9 million and 375 jobs were directly contributed into the economy. Potential direct contributions in 2010 were projected to range between $38.4 million and $50.8 million depending upon the amount of land in cultivation. With 3,500 acres in cultivation, approximately 60 full-time and 345 part-time jobs were projected to be created. With 7,325 acres of the most productive lands in cultivation, approximately 73 full-time and 440 part-time jobs could be created. The potential total contributions to Hawaii's GSP in 2012 with 3,500 acres cultivated are valued at about $71 million with 834 full and part-time jobs. If 7,325 acres are cultivated, $95 million dollars and approximately 1,056 farm and non-farm jobs could be created. For 2012, Kekaha contributed $80 million and 400 jobs to the economy.

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## Chapter I. Introduction

The purpose of this report is to support the implementation of Hawaii's food security and food self-sufficiency strategy by assessing agricultural irrigation systems. Sugar plantation closures in Hawaii escalated in the 1990's. Irrigation systems used by the plantations were also owned by the plantations. Thus the closure of the plantations also impacted the operation and maintenance of the associated irrigation systems. The need for a reliable, inexpensive source of irrigation water is critical in the transition from plantation agriculture to diversified agriculture.

Based on existing studies and information, this report describes the condition of former plantation irrigation systems which have been acquired by the State and identifies costs to repair and maintain these systems. In Fiscal Year 2012 and Fiscal year 2013, significant funding was appropriated to improve the irrigation systems. This report identifies the projects and funding provided. In addition, for those irrigation systems with existing economic impact studies, the report summarizes the direct and indirect economic impacts of these irrigation systems.

This report is the third volume of the three volume *Increased Food Security and Food Self-Sufficiency Strategy* (Strategy) prepared by the Office of Planning in cooperation with the State Department of Agriculture.

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## Chapter II. Background/Study Process

This report is a compilation of existing information on agricultural irrigation systems in Hawaii. The information was obtained by the following tasks:

- A literature search and review on Hawaii agricultural systems;
- Consultation with State Department of Agriculture (DOA) staff;
- Review and analysis of existing planning documents, reports, and other literature;
- Review of DOA annual reports;
- Interview with individuals; and
- Review of press releases.

The draft report was circulated to key persons involved with the management and operation of the irrigation systems for review and feedback.

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## Chapter III. Importance of Irrigation Systems and Hawaii's Economy

Agricultural irrigation systems (Systems) continue to play a major role in Hawaii's agricultural industry by providing a reliable source of irrigation water at a favorable rate. The water diverted and transported by these Systems supported the development and growth of the sugar and pineapple industries. These Systems were built by sugar plantations or water companies between 1876 and 1920. They significantly transformed Hawaii's landscape and economy. Both sugar and pineapple were the dominant crops in Hawaii agricultural industry and played a very significant role in Hawaii's economy.

The business of sugar was such that plantation closures and consolidations were a regular occurrence. However, plantation closures greatly accelerated through the 1980's and 1990's; releasing vast tracts of land from sugar and pineapple cultivation. Some of these lands were cultivated in diversified agriculture, while other lands remained fallow. Plantation closures also meant that little to no maintenance occurred on the irrigation system servicing plantation lands. Recognizing the significance of these systems, the State of Hawaii acquired a number of these systems.

Currently, the State owns eleven Systems located on the islands of Kauai, Oahu, Molokai, Maui, and Hawaii. Six of these Systems are operated by the Agriculture Resource Management Division (ARM) of the DOA. The remaining five Systems are managed by the Agribusiness Development Corporation (ADC), a State agency attached to DOA. Portions of former plantation lands serviced by these Systems are used for diversified agriculture. Reliable, inexpensive water is critical for this transition. The major challenge faced by the State is rehabilitating these Systems in order to continue to provide a reliable source of water, at a favorable rate, to support the expansion of diversified agriculture.

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# Chapter IV. General Status and Needs of Irrigation Systems

## Introduction

The late nineteenth century in Hawaii experienced the diversion of water from perennial streams on the windward side of the Hawaiian Islands into miles-long irrigation systems. These irrigation systems supplied water to Hawaii's numerous sugar and pineapple plantations. More than a century later, with only one plantation remaining operational in Hawaii, many of these irrigation systems have fallen into deterioration, abandonment, and disrepair. Due to the lack of maintenance, ditches have become overgrown with vegetation, intake structures on streams have remained damaged or clogged by storm flows, and steel siphons and wooden flumes have suffered deterioration. The State currently faces the challenge of rehabilitating these irrigation systems to provide reliable water sources to the growing diversified agricultural industry.

## Background

### Agricultural Irrigation Systems: Need and Development

> *Sugar is a thirsty crop. To produce one pound of sugar takes 4000 pounds of water, 500 gallons. One ton of sugar takes 4000 tons of water, a million gallons. One million gallons of water a day is needed to irrigate 100 acres of sugarcane.*[1]

The Reciprocity Treaty of 1876 (Treaty) between the United States and the Kingdom of Hawaii granted tax free trade for most products between the two countries. A new market for Hawaii sugar planters opened up as sugar was one of the products granted tax free status. This was good news for the handful of existing sugar plantations in existence as there would be a steady market for Hawaii sugar. Additionally, the Treaty provided an opportunity for new investment to support existing and new sugar plantations. A consistent source of irrigation water would be required to support any expansion of sugar cane cultivation.

At the time when the Treaty was signed, only one man made agricultural irrigation system diverted surface water to irrigate sugar lands. Rice Ditch on Kauai was the precursor to future agricultural irrigation systems constructed by sugar plantations and water companies. Opened in 1856, it was 10 miles in length and constructed similar to the series of ditches used to transport surface water to wet land taro fields. Rice Ditch diverted water from Hanamaulu Stream and transported the diverted surface water to lands in Lihue. Lihue Plantation founder William Harrison Rice, commissioned the construction of this ditch after the loss of an entire sugar crop in the previous year due to a "terrible drought".[2]

The irrigation systems were developed by the sugar plantations and water companies, between 1876 and 1920's, to provide a consistent source of irrigation water. Expansion of existing sugar plantations

[1] Wilcox, Carol
[2] Ibid

and establishment of new sugar plantations during this time period were on the drier, leeward side of the islands. In 1876, the Kingdom of Hawaii granted the first water license to Samuel Alexander, of the Haiku Sugar Company on Maui, to collect and divert water from the eastern slopes of Haleakala on Maui. Between 1876 and 1878, the 17 mile Hamakua Ditch was constructed; diverting surface water from Nailiilihaele, Kailua, Hoalua, Huelo, Hoolawa, and Honopu streams and transporting the diverted water towards Haiku.

By the 1920's, Systems were constructed on Kauai, Oahu, Molokai, Maui and the Big Island. Combined, these Systems diverted more than 800 million gallons per day (GPD) of water. Kauai has the largest number of irrigation systems; followed by Maui, Oahu, and Hawaii. In addition to supplying a consistent source of water to irrigate sugar fields, water from these irrigation systems was used for fluming, sugar mill operations, and hydropower production. Of significance is that most of these agricultural irrigation systems were built and maintained by private entities; mainly the sugar plantations and or water companies.

**Elements of an Agricultural Irrigation System**

Hawaii perennial streams are the primary source of water for all irrigation systems. Most of these perennial streams are located on the wetter, windward side of the islands. A combination of groundwater discharge and rain water from the mountain runs directly into the stream bed, eventually flowing downward towards the ocean.

Between the construction of Rice Ditch in 1859 and Hamakua Ditch in 1876, tremendous advances in technology occurred. Advances in technology related to tunneling, siphons, and flumes no longer made agricultural irrigation systems hostage to terrain[3]. The development and use of dynamite provided a new method to move solid rock and develop tunnels through the mountains. Metal and wooden siphons and flumes provided an alternative to the ditch to transport water across or through gulches.

Main elements of an irrigation system are water collection and distribution. Water is collected by diverting surface water using intakes and dams. Water is also diverted by tunnels developed into the mountain to capture the higher elevation groundwater prior to discharge into stream beds. Intake structures contain a dam across the stream bed, an inlet channel, control gates, trash screen, and a connecting tunnel or ditch into the main transmission structure.[4]

Miles of ditches, flumes, siphons, and tunnels were built to transport the captured water to the dryer, leeward side of the island. In some instances small reservoirs were constructed as part of the distribution system to ensure a reliable supply of irrigation water. A combination of gravity and water pumps are utilized to ensure the smooth flow of water within the distribution element. At several irrigation systems, hydro electric power plants were established to supply power to run the water pumps and other electrical elements of a plantation.

[3] Ibid
[4] AWUDP 2004

Once the water reached the planted fields, it was released into furrows which then flooded the fields. Eventually overhead sprinklers and drip irrigation were also connected to the irrigation systems to water the fields.

## Agricultural Water Use and Development Plan

The closure of sugar and pineapple plantations accelerated during the mid 1980's and through the 1990's. These closures adversely impacted the agricultural irrigations systems owned and maintained by the respective plantations. It was envisioned that diversified agricultural would be able to expand and utilize former plantation lands and that the existing agricultural irrigation systems would be used to support diversified agriculture activities.

Act 101 Session Laws of Hawaii (SLH) 1998 amended the Hawaii State Water Code (HSWC) by requiring the State Department of Agriculture (DOA) to develop an agricultural water use and development plan (AWUDP) for agricultural uses in the State in accordance with Hawaii Revised Statutes (HRS) Chapter 167 Irrigation Water Development. Further the State Commission on Water Resource Management (CWRM) was required to incorporate the AWUDP into the Hawaii State Water Plan (HSWP). The minimum AWUDP components are:

1. Inventory the irrigation water systems;
2. Identify the extent of rehabilitation and maintenance required;
3. Subsidize cost of repair and maintenance of the systems;
4. Establish criteria to prioritize the rehabilitation of the systems;
5. Develop a five-year program to repair the system; and
6. Set up a long-range plan to manage the systems.

The AWUDP is envisioned to be one of a number of tools available to assist state policy makers in the transition from plantation agricultural to diversified agriculture.

**Agricultural Water Use and Development Plan, December 2004 (Revised)**

The main objective of the 2004 Agricultural Water Use and Development Plan, (AWUDP 2004) was to assess and plan for the orderly rehabilitation of former plantation irrigation systems in order to expand diversified agriculture in the State of Hawaii. A secondary objective was to determine the reliability and adequacy of the irrigation water to meet current and future water requirements for diversified agriculture.

Thirteen active irrigation systems were studied. At the time of the study there were five irrigation systems owned and operated by the DOA, five "Select" irrigation systems owned by the ADC, and the remaining three irrigation systems were privately owned. The location and ownership of these irrigation systems are provided on the next page in Figure 1.

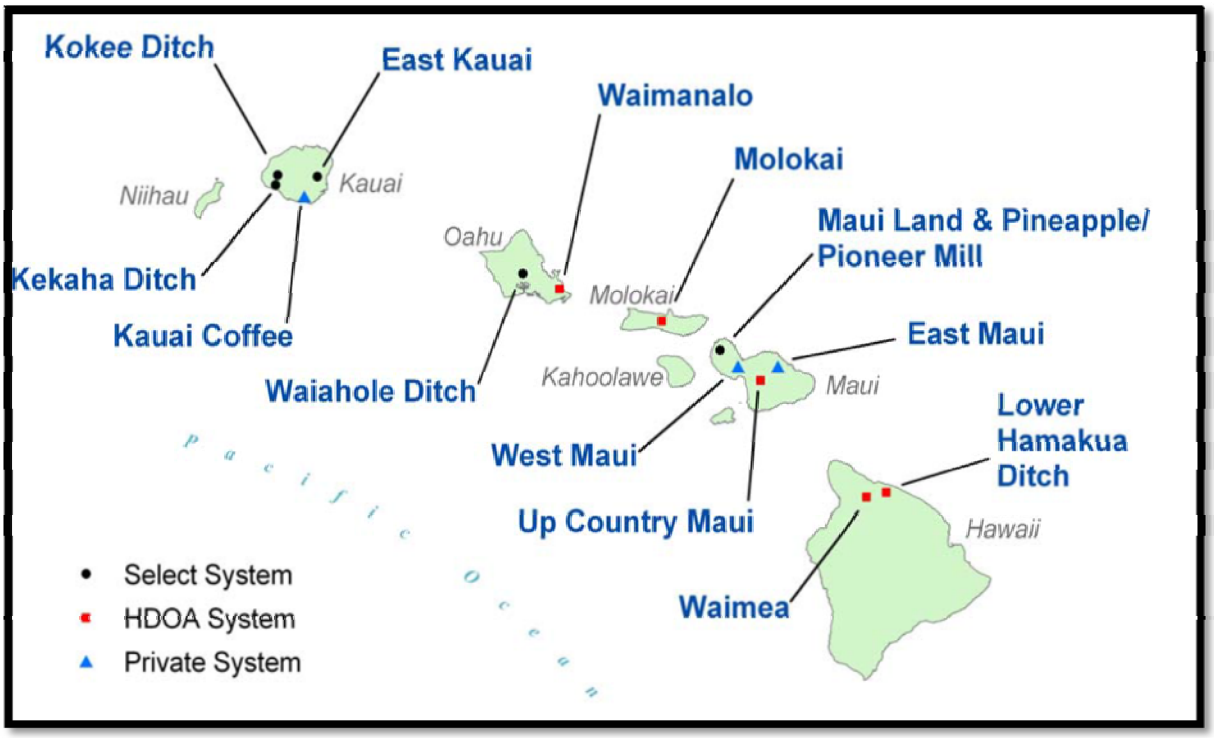


**Figure 1: Location of 13 Irrigation Systems Studied in 2004 AWUDP**

The AWUDP 2004 inventory, assessment, and estimated rehabilitation costs for the ten State owned irrigation systems were obtained from the *Hawaii Water Resources Study, Agricultural Water Systems, September 2003* U.S. Bureau of Reclamation and DOA. Information on the three private water systems was provided by their current operators.

Each assessment of the ten irrigation systems contains existing condition, current concerns and needs, and estimates of rehabilitation costs. Once the assessments were completed, lists of improvements were generated for the eleven irrigation systems. These improvements were then categorized either as capital or maintenance improvements. For the purposes of the AWUDP 2004 capital improvements are improvements considered to add or improve the value of the irrigation system. Additionally, they require additional costs associated with engineering and design, environmental studies, as well as construction. Maintenance improvements are improvements necessary to maintain regular operations of the irrigation system.

Estimating future water requirements for diversified agricultural associated with each irrigation system was a multi-step process with a number of challenges due to the limited amount of existing data available. The initial step was to identify and estimate the current and future markets for diversified agricultural through selected crops. Four actions were identified to increase demand and expand the diversified agricultural market. These actions are:

- Replacing imported produce with locally grown produce
- Pursuing niche and off season markets of fruits and vegetables for export

- Growing new or Asian-based specialty crops for export; and
- Meeting increased demand for tourism and cruise ship industries for fresh fruits and vegetables.

These demand estimates were then translated into additional acreage required for farming based upon yield per acre per crop. Then this increase in acreage was allocated to the studied irrigation systems. Lastly, the amount of required irrigation water was calculated utilizing the water use rate of 3,400 gallons per day/ per acre for diversified agriculture.

## Status and Needs of Irrigation Systems owned by the State of Hawaii

As mentioned earlier in this report, the State of Hawaii owns eleven irrigation systems located on the islands of Kauai, Oahu, Molokai, Maui, and Hawaii (only ten systems were studied in the AWUDP 2004 inventory). These irrigation systems are managed by either the Agribusiness Development Corporation or the Department of Agriculture. Table 1 identifies the lead State agency for the respective irrigation systems.

**Table 1: Irrigation Systems Owned by the State of Hawaii**

| Irrigation System | State Agency | |
|---|---|---|
| | **Agribusiness Development Corp.** | **Dept. of Agriculture** |
| East Kauai Irrigation System | X | |
| Kekaha Ditch Irrigation System | X | |
| Kokee Irrigation System | X | |
| Kahuku Agricultural Park Irrigation System | | X |
| Waiahole Irrigation System | X | |
| Waimanalo Irrigation System | | X |
| Molokai Irrigation System | | X |
| Upcountry Maui Irrigation System | | X |
| Honokaa – Paauilo Irrigation System | | X |
| Waimea Irrigation System | | X |
| Kau Irrigation System | X | |

Individual write-ups on each of the State owned irrigation systems are provided in the remaining portions of this chapter. A majority of the information contained in each write up was obtained from the *Agricultural Water Use Development Plan, 2004* or the Department of Agriculture web site. Additional information was provided by the Agribusiness Development Corporation and the Department of Agriculture.

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**EAST KAUAI IRRIGATION SYSTEM**

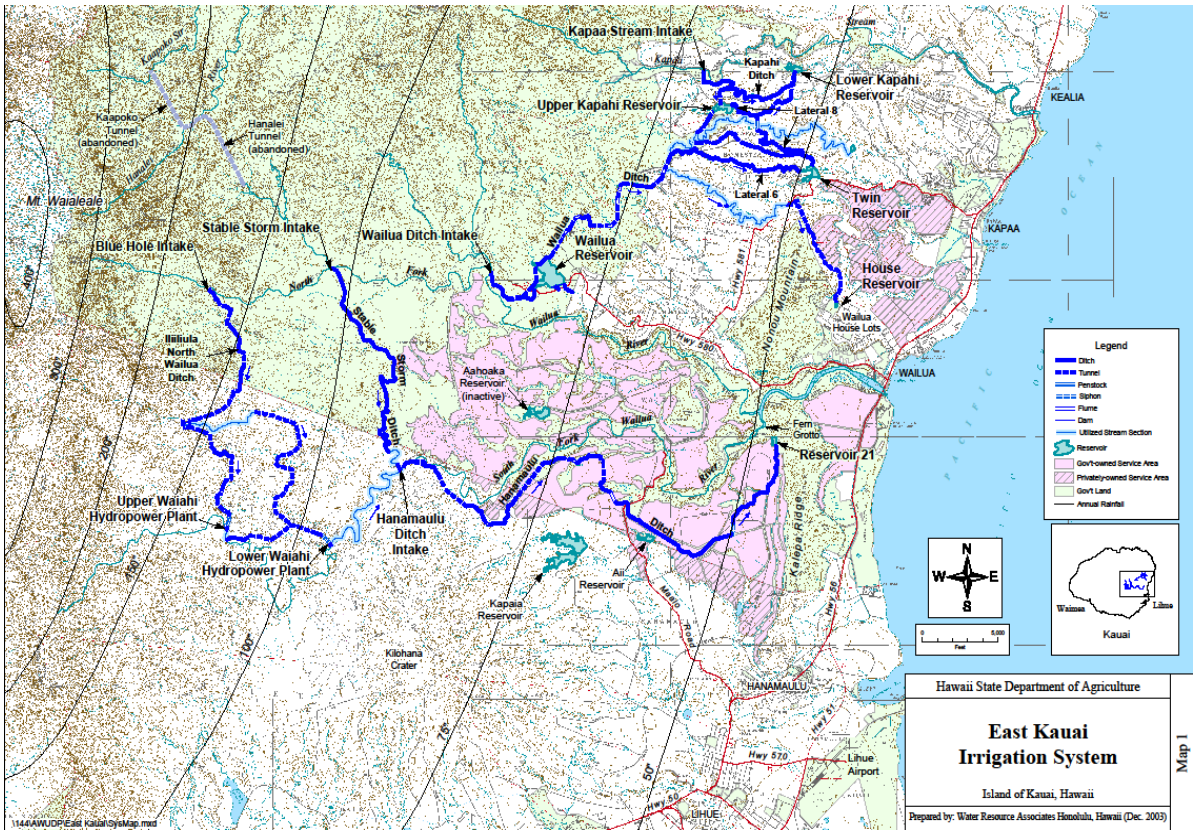


**Figure 2. East Kauai Irrigation** *Source: AWUDP, 2004*

The East Kauai Irrigation System (EKIS) is located on the eastern portion of the island of Kauai. EKIS was built in the 1920's by the Lihue Plantation Company and the East Kauai Water Co. There are three sections to this complex system of interconnecting ditches, tunnels, flumes and reservoirs that collects surface water from the Hanalei and Wailua Rivers. EKIS includes 51 miles of ditches and tunnels, 18 stream intakes, three reservoirs, and two hydropower plants.

**Kapaa Section.** The Kapaa Section is the northern most section of the EKIS. There are 22.5 miles of ditches and tunnels diverting water from the Wailua River and the Kapaa Stream. Water from the Wailua Ditch Intake of the Wailua River flows through the Wailua Ditch to the 240 million gallon (MG) Wailua Reservoir. This water then flows through a series of tunnels and ditches to the 30 MG Upper Kapahi Reservoir and 25 MG Lower Kapahi Reservoir in the Kapaa area. From the Kapaa Stream Intake of the Kapaa Stream, water flows through ditches and into the Upper and Lower Kapahi Reservoirs. This section of the EKIS consists of old facilities which are generally in fair condition

**Kalepa Section**. The Kalepa Section is the middle section of the EKIS and is comprised of two parallel ditch systems. The Stable Storm Ditch system originally diverted Hanalei River water through the Hanalei Tunnel that flowed through the Stable Storm Intake, then through the Stable Storm Ditch, and finally into the Hanamaulu Ditch Intake located on the South Fork of the Wailua River. The Iliiliula-North Wailua Ditch system diverts the headwaters of the North Folk of the Wailua River at the Blue Hole

Intake into the Iliiliula-North Wailua Ditch which flows south to the Upper Waiahi Hydropower Plant, east to the Lower Waiahi Power Plant, then to the South Fork of the Wailua River. Water from both ditch systems is diverted by the Hanamaulu Ditch Intake into the Hanamaulu Ditch, then continue to flow through a series of ditches, tunnels, and flumes to the Kalepa and Hanamaulu – Lihue area.

**Hanamaulu-Lihue Section.** The Hanamaulu-Lihue Section is the southernmost section of the EKIS that also provided water to the Hanamaulu-Lihue area. Water was diverted from both the Stable Storm Ditch and the Iliiliula-North Wailua Ditch into the Upper and Lower Lihue Ditches.

The EKIS is managed by the East Kauai Water User's Cooperative under an agreement with Agribusiness Development Corporation.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004.

| **East Kauai Irrigation System Needs Assessment** |
|---|
| System is being maintained adequately; however facilities are old and show signs of long-term neglect. |
| Most of the control gates, ditch service laterals, "pain" (control) gates require rehabilitation, retrofit or replacement. |
| Unlined reservoirs show signs of heavy siltation and root intrusion on embankments. |
| Damage to concrete rubble masonry diversion dams and intakes; some are near point of failure. |
| Tunnels show spalling from loose rocks and soil: work is needed to prevent flow blockage. |
| Most of the control gates, ditch service laterals, and "pani" (control) gates need rehabilitation and retrofit to meet the need of precise flow control of diversified agriculture. |
| One wooden flume near Kapaa Stream urgently needs repairs. |
| Construction of an access road to Stable Storm Intake is required. It is in a remote location currently accessible only by foot. |
| Relocate portion of system that traverses private lands onto State owned lands. |

| **East Kauai Irrigation Systems Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Rehabilitate Lateral 8 Transmission Line. |
| CIP | Hanamaulu Ditch Flume: replacement of approximately 100 feet of wooden flume. |
| CIP | Twin Reservoir Rehabilitation. |
| CIP | Upper Kapahi Reservoir Rehabilitation. |
| CIP | Wailua Reservoir Rehabilitation. |
| CIP | Reservoir 21 New Control Valve. |
| CIP | Control Gates Retrofit. |
| CIP | Diversion Works Renovations. |
| Maintenance | Prepare Root Intrusion Removal Program. |
| Maintenance | Wailua Ditch Access Road Repairs. |

**KEKAHA DITCH IRRIGATION SYSTEM**

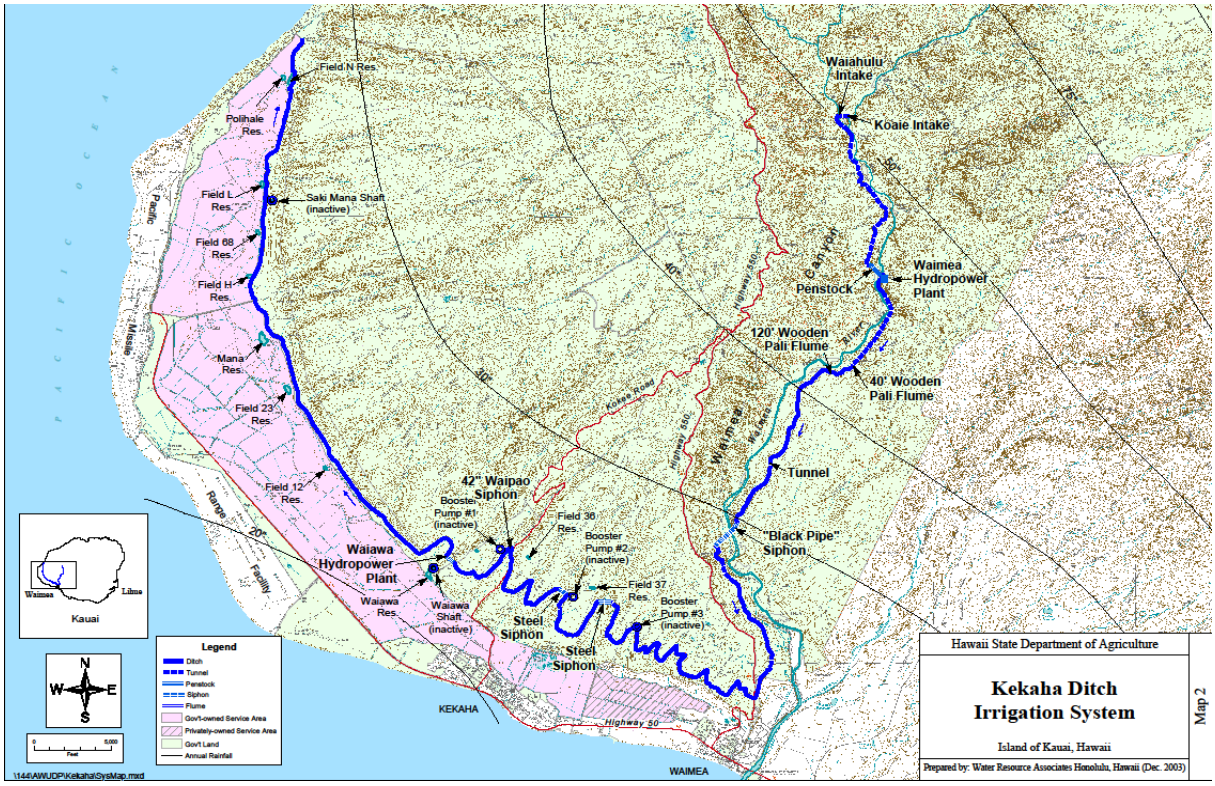


**Figure 3. Kekaha Ditch Irrigation System** *Source: AWUDP, 2004*

The Kekaha Ditch Irrigation System (KEDIS) is located on the western portion of the island of Kauai. KEDIS was built in 1906 by the Kekaha Sugar Company and includes 27 miles of ditches, tunnels, steel siphons, wooden flumes, and two hydropower plants.

Water is diverted from the western side of the Waimea Canyon, at the Koaie and Waiahulu Stream intake, and flows through a penstock that crosses underneath the Waimea River to the Waimea Mauka Hydropower Plant. Upstream from this hydropower plant, additional water is diverted from the Waimea River and then combined with effluent from the power plant. These combined waters then flow along the eastern side of Waimea Canyon through a series of ditches, tunnels and wooden flumes until they cross underneath the Waimea River to the west side of the canyon.

KEDIS then flows south and westward, following the steep coastal bluffs at an elevation of 400 feet. As water approaches Waiawa Gulch, it drops 280 feet down steep bluffs into a steel penstock that flows into the Waiawa Hydropower Plant. Several unlined reservoirs, scattered at the foot of the bluff, serve as filter stations to provide clear water for drip and sprinkler irrigation.

The KEDIS is managed by the Kekaha Agriculture Association under an agreement with the Agribusiness Development Corporation.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural Annual reports provided information regarding recent activity.

| **Kekaha Ditch Irrigation System Needs Assessment** |
|---|
| System is able to meet current water needs though it is old and many features need rehabilitation. |
| Lack of access road hampers periodic cleaning and removal of mud and rocks along unlined ditch on the foot of coastal bluffs. |
| Damage to diversion dams and intake channels at Koaie and Waiahulu. |
| Exterior of penstock corroded by spillage from the motorized carrier trash rack. |
| Badly deteriorated bypass valve used on penstock and associated catwalk. |
| Prevent ditch overflow damage with retrofit of ditch bypass gate. |
| Wood rot on wooden flumes. These flumes also lack protection from potential falling rocks. |
| Water flow impeded by Amaju plant. |
| Outdated control valves and wooden control gates need to be retrofitted to meet needs of diversified agriculture. |
| Outdated inlet trash screens, outfalls, control gates, and valves are dirty and need to be retrofitted to meet needs of diversified agriculture. |
| Unlined reservoirs need to be cleaned and lined. |
| Reservoir embankments that are dams require a dam hazard assessment. |

| **Kekaha Ditch Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Waipao Gulch Pipe Crossing: realignment. |
| CIP | Equipment Access Roads. |
| CIP | Renovate Koaie Stream Intake. |
| CIP | Renovate Waihulu Stream Intake. |
| CIP | "Black Pipe" Siphon Inlet: rehabilitate concrete lining. |
| CIP | Retrofit Various Control Gates. |
| CIP | Pali Flume: replace two sections wooden flumes. |
| CIP | Reservoirs: clean, grade and install HDPE lining on 14reservoirs between Waiawa Hydropower Plant and system terminus at Polihale. |
| Maintenance | Clean Open Ditches: remove sedimentation and side banks of growth at various locations. |
| Maintenance | "Black Pipe": repair corrosion and deterioration. |

| **Recent Activity for the Kekaha Irrigation System** |
|---|
| **2009 –** December 2008 widespread damage to cane haul road due to storms. Polihale Road closed. |
| **2009** – September 2008 Gay and Robinson exited sugar business, 544 acres returned to ADC. |
| **2008** – ADC continued to work on the issuance of long-term land licenses to its tenants. |
| **2008** – The Halemanu stave pipe, which supplies water to the Puu Lua reservoir, was replaced with a HDPP pipe. Security gates were also installed on main entrances to and from the property. |

| |
|---|
| **2007 –** Record rainfall in March and April 2006 led to structural damages. ADC funded approximately $400,000 of work to repair the irrigation/drainage system and roadways. FEMA reimbursed about 75% of expenditures. |
| **April 2007 –** ADC established a 20-year agreement with the Kekaha Agriculture Association (Coop) to operate and maintain common infrastructure. |
| **2007 –** ADC nearing completion of contract with US Navy to operate and maintain the Kawaiele and Nohili pump stations and the related drainage canals. |
| **2006 –** Continued operation and maintenance of Kawaiele and Nohili pump stations and the related drainage canals. |
| **2006 –** ADC initiated the process of preparing Emergency Action Plans for the Puu Lua, Kitano, and Mana Reservoirs as a result of the Kaloko Dam failure on March 14, 2006. |

The Agribusiness Development Corporation and the Kekaha Agriculture Association provided the status on the following projects:

- Waipao Gulch Crossing: Project completed, pipe replaced.
- Equipment Access Roads: Project complete, roadways installed.
- Renovate Koaie Stream Intake: Project completed.
- Renovate Waiahulu Stream Intake: Project completed.
- Black Pipe Siphon Inlet Rehabilitation: Project under Department of Agriculture design, funds released.
- Retrofit Various Control Gates: Project started and is ongoing.
- Pali Flume: Project completed, both flumes replaced.
- Reservoir: Complete irrigation systems re-design is in progress. Two of the nine makai reservoirs upgraded, one makai reservoir, Mana (is a registered dam) is in design phase, while two other reservoirs have been abandoned.

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**KOKEE DITCH IRRIGATION SYSTEM**

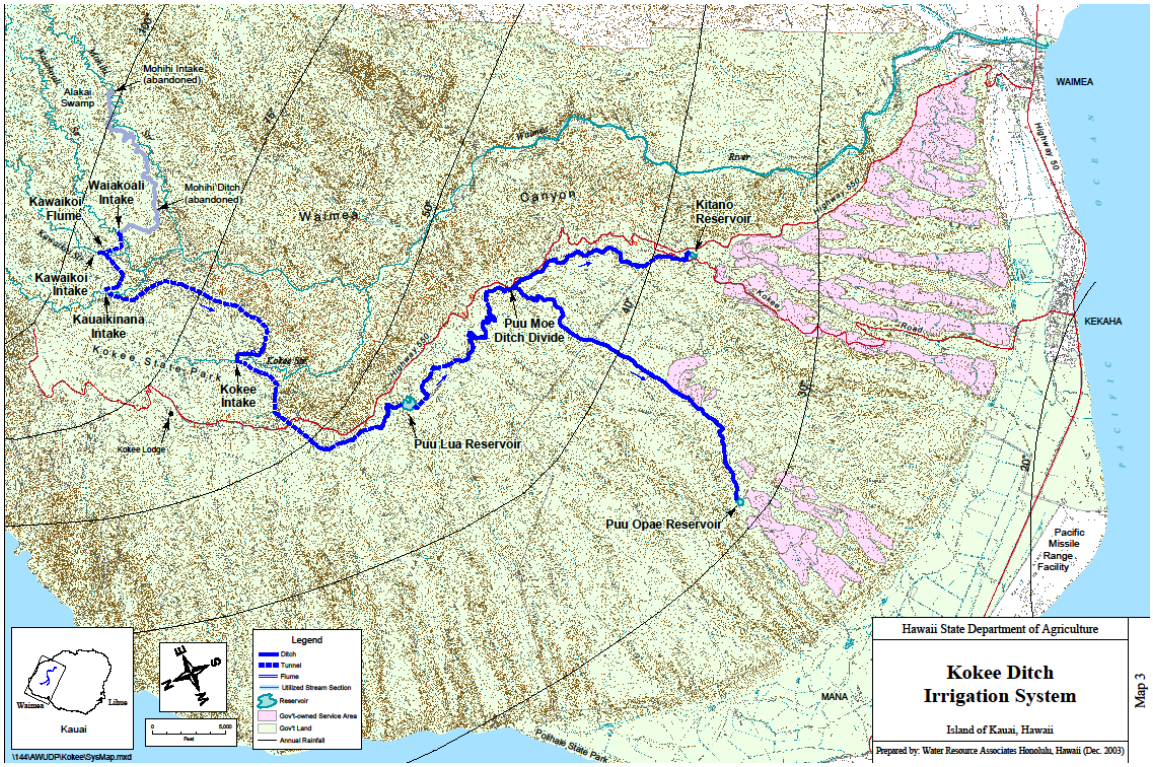



**Figure 4. Kokee Ditch Irrigation System**

*Source: AWUDP, 2004*

The Kokee Ditch Irrigation System (KODIS) is also located on the western portion of the island of Kauai. It was built by the Kekaha Plantation in the 1920s and consists of a network of tunnels, ditches, flumes, and intakes. KODIS has 37 miles of ditches and tunnels and three reservoirs.

KODIS water is diverted from four tributaries of the Waimea River: Waiakoali, Kawaikoi, Kauaikinana, and Kokee Streams. Beginning at Waiakoali Stream, water is diverted by the Waiakoali Stream Intake and transported across Kawaikoi Stream by flume. Upstream from this flume is the Kawaikoi Stream Intake which diverts water from Kawaikoi Stream. The diverted waters are then discharged by tunnel into Kauaikinana Stream just above Kauaikinana Stream Intake. These combined waters then flow along the rim of Waimea Canyon until they reach Kokee Stream, the location of the final intake. Water then flows through the canyon's rim and along its western slopes until it reaches Puu Lua Reservoir which is also a public game fishing area. Inside this reservoir is also a trout hatchery and fingerling holding pen that are managed by the Department of Land and Natural Resources (DLNR). Out flow from Puu Lua Reservoir continues to travels along the canyon's western rim until it reaches the Puu Moe Divide. It is here where the ditch splits and by-passes Kitano Reservoir with the remaining water flowing to Puu Opae Reservoir.

The KODIS is managed by the Kekaha Agriculture Association under an agreement with the Agribusiness Development Corporation.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural Annual reports provided information regarding recent activity.

| **Kokee Ditch Irrigation System Needs Assessment** |
|---|
| Significant decrease in ditch flow warrants a seepage loss study. |
| Survey of all the reservoir capacities. |
| An evaluation of optimum reservoir inflows relative to planned or current water demands. |
| Additional flow meters or measuring devices required. |
| Kawaikoi flume is badly deteriorated. |
| There is sedimentation, small boulder accumulation, and debris from tunnel spalling inside ditches, tunnels, and flumes. |
| Safety assessment of Puu Lua Reservoir earthen dam and maintenance of the discharge pipe and control valve. |
| Severe erosion at Puu Moe divide. |
| Lining of Puu Opae Reservoir. |
| Cleaning and lining of Kitano Reservoir. |

| **Kekaha Ditch Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Kawaikoi Flume Reconstruction. |
| CIP | Puu Lua Reservoir Rehabilitation. |
| CIP | Puu Moe Ditch Divide Reconstruction. |
| Maintenance | Retrofit stream intake aprons, ditch screens, and control gates. |
| Maintenance | Clean Kitano Reservoir. |
| Maintenance | Replace Halemanu wood stave pipe flumes. |

| **Recent Activity for the Kokee Ditch Irrigation System** |
|---|
| **2005** – Design Phase of the Kokee Irrigation System Improvements. |

The Agribusiness Development Corporation and the Kekaha Agriculture Association provided the status on the following projects:

- Kawaikoi Flume Reconstruction: Project completed, flume replaced.
- Puu Lua Reservoir Rehabilitation: ADC/DOA in progress.
- Puu Moe Ditch Divide Reconstruction: Planning phase.
- Retrofit stream intake aprons, ditch screens, and control gates: 50% completed work in progress.
- Clean Kitano Reservoir: ADC/DOA considering decommissioning.
- Replace Halemanu wood Stave pipe flumes: Project completed, pipe replaced.

## WAIAHOLE DITCH IRRIGATION SYSTEM

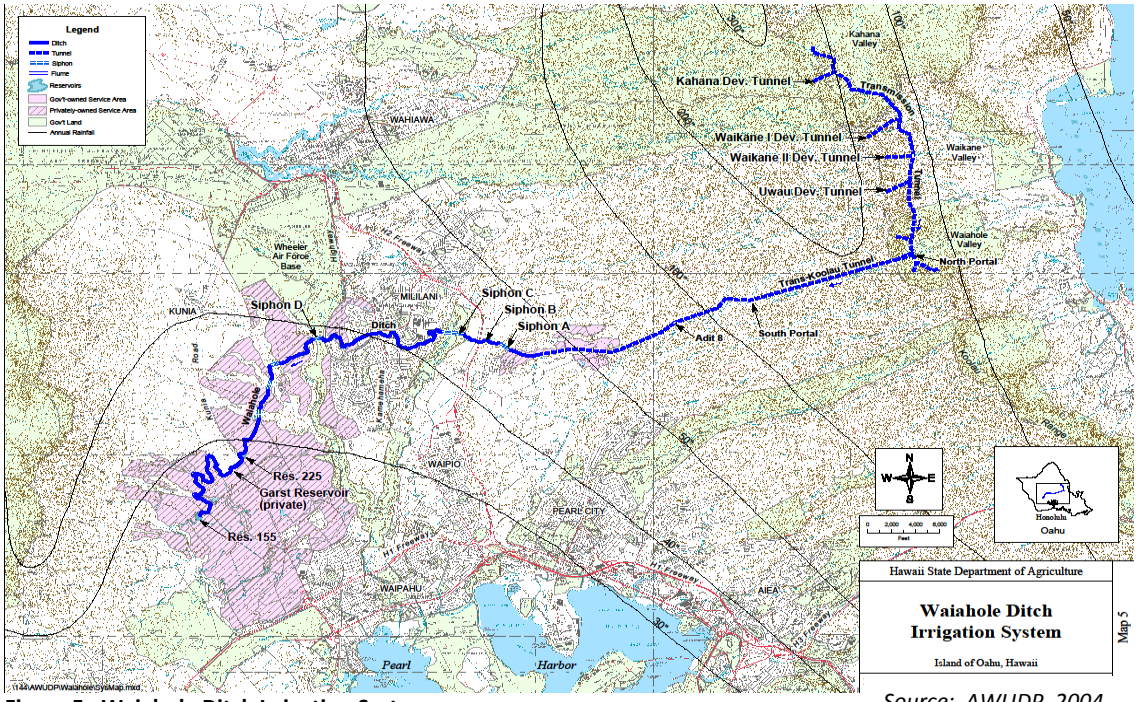



**Figure 5. Waiahole Ditch Irrigation System** *Source: AWUDP, 2004*

The Waiahole Ditch Irrigation System (WDIS) is located on the central portion of the island of Oahu. WDIS was built in 1913 by the Waiahole Water Co. and includes 26.3 miles of ditches tunnels, concrete lined ditches and two reservoirs. In 1925, six additional groundwater tunnels were constructed in the Koolau Mountains and added to the WDIS.

Originally, water was diverted from Kahana, Waikane, and Waiahole Valleys and then transported west through the Koolau Mountains to Central Oahu. Currently water is diverted from four development tunnels; Kahana, Waikane I, Waikane II, and Uwau to Reservoirs 225 and 155.

The WDIS is under the jurisdiction of the Agribusiness Development Corporation.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural Annual reports provided information regarding recent activity.

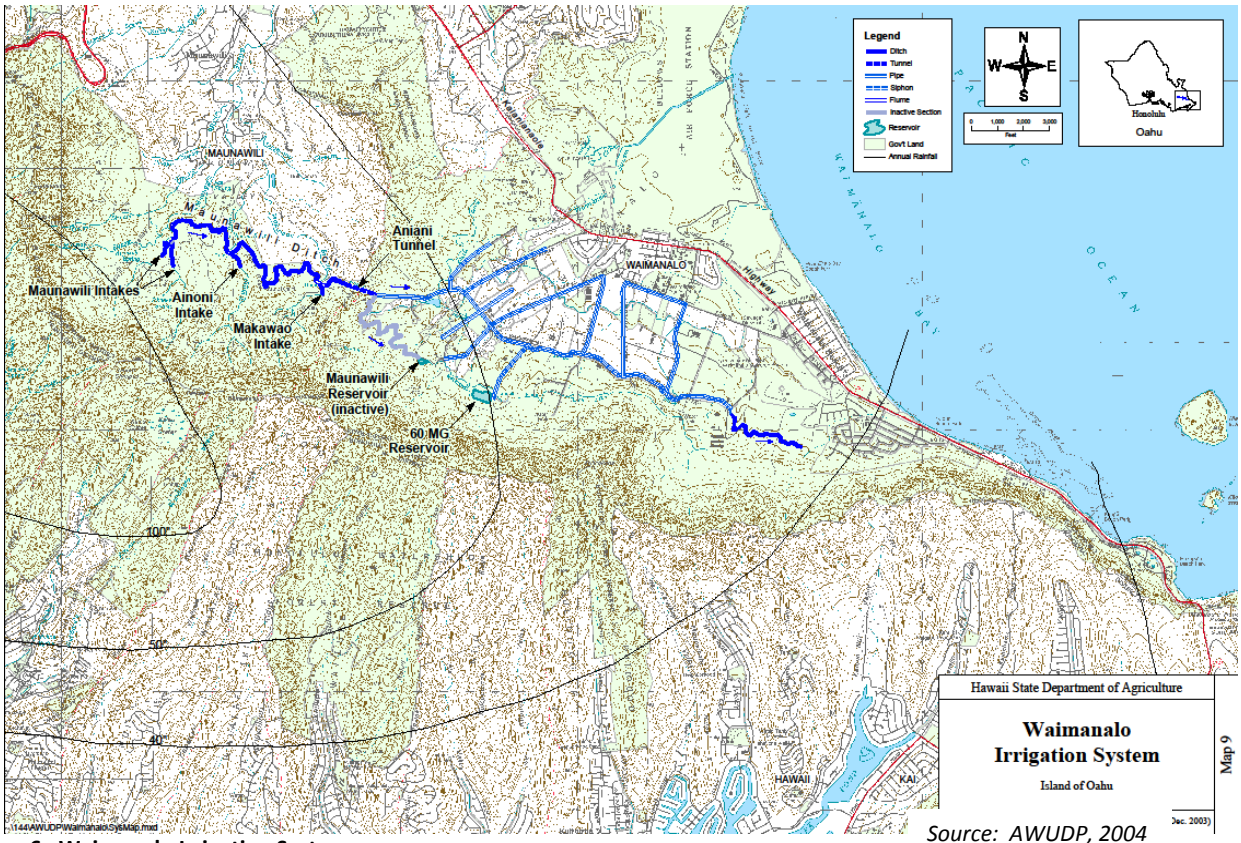
| **Waiahole Ditch Irrigation System Needs Assessment** |
|---|
| Evaluate storage capacity of Kahana development tunnel. |
| Open ditches have tree root intrusion, damaged concrete lining exposing underlying soils, impeded water flows by Amaju plant. |
| Four steel siphons are corroded. |
| Soil erosion undermining one of the concrete cradle supports of a steel siphon. |
| Reservoirs 225 and 155 require major work in a number of areas. |

| **Waiahole Ditch Irrigation System Needs Assessment** |
|---|
| Water loss observed from Garst Seed Co. supply ditch. |
| Obtain easements for portions of system that traverse private property. |
| Urban trash and storm water runoff restricts and or blocks water flow. |

| **Waiahole Ditch Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Rehabilitate Reservoir 155. |
| CIP | Rehabilitate Reservoir 225. |
| CIP | Replace Garst Seed Company Water Supply Ditch. |
| CIP | Rehabilitate Four Steel Siphons. |
| CIP | Construct Two to Three Lined Reservoirs. |
| Maintenance | Inspect and Repair Damaged Ditch Side Banks. |
| Maintenance | Install Bank Diversion Bypass and Swales of Storm Flows. |
| Maintenance | Reactivate and Renovate Existing Kahana Bulkhead. |
| Maintenance | Conduct Study to Eliminate Evaporation, Etc. |

| **Recent Activity for the Waiahole Ditch Irrigation System** |
|---|
| **2009 –** December 2008 heavy rains collapsed two wooden flumes. High water volumes led to the installment of two new culvert pipes. |
| **2009** – Easement acquired for land on Kahana and Waiahole land parcels. |
| **2009** – Delay of Reservoir 255 and 155 lining project due to new dam safety rules and dam safety issues. |
| **2008** – Completed installation of a pump-back system at Reservoir 225. |
| **2008 --** As part of the Waiahole Combined Contested Case Decision and Order III, developed plans to line Reservoirs 225 and 155 with an impermeable material and ADC's reduce system loss permit would be reduced from 2.03 mgd to 1.42 mgd by June 2008. |
| **2007 –** Del Monte ceased its Kunia pineapple operation in 2006. Diversified ag picked up resulting loss in water sales. |
| **2007 –** ADC initiated work on the installation of a pump-back system at Reservoir 225. |
| **2007 –** Kunia Water Users Cooperative agreed to turn over the farmers' water meters to the ADC. |
| **2006 –** Closure of Del Monte plantation. Del Monte consumed 25-30% of water. Closure has created the potential for overflow, as well as lost resources. |
| **2006 –** ADC board approved the installation of a pump-back system at Reservoir 225. |
| **2006 –** Elimination of unnecessary 800 ft stretch of unlined wing ditch. |
| **2006 –** ADC initiated contract to obtain easement over land owned by Campbell Estate. |
| **2005** – Design Phase Waiahole Irrigation System Reservoir Improvements. |
| **2005 –** ADC began design portion of project with US Army Corps of Engineers to improve system and reduce water loss by lining reservoirs. To better monitor system loss, two Partial flumes have been installed. |
| **2005** – Dredged by-pass ditch at Reservoir 155 and soil erosion control measures taken near Del Monte fields. |
| **2004 –** Design Phase of Waiahole Irrigation System Reservoir. |

## WAIMANALO IRRIGATION SYSTEM




*Source: AWUDP, 2004*

**Figure 6: Waimanalo Irrigation System**

The Waimanalo Irrigation System (WIS) is located along the southern windward slopes of the Koolau Mountain Range on the island of Oahu. It is comprised of tunnels, ditches, siphons, and pipe.

Surface water is diverted from Maunawili, Ainoni, and Makawao Streams and transported from Maunawili Valley to Waimanalo Valley through the Aniani Nui Tunnel. From here the water then flows into existing pipelines and a 60 MGD reservoir. This reservoir also serves as an additional distribution point for the WIS.

The WIS is under the jurisdiction of the Department of Agriculture.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural provided the information on recent activity.

| **Waimanalo Irrigation System Needs Assessment** |
|---|
| The system is in fairly good condition and presently undergoing improvements based on the Waimanalo Watershed Plan, prepared by the United State Department of Agriculture, Natural Resources Conservation Service. |

| **Waimanalo Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Improve Water Collection System at Maunawili Source. |
| CIP | Install Irrigation Pipeline from 60 MGD Reservoir. |
| CIP | Replace Portion of Ditch with Pipeline. |
| CIP | Modify Old Irrigation Ditch. |
| CIP | Sewage Effluent Pumps, Pipeline System, and Storage Reservoir. |
| CIP | Solid Waste Collection Site. |
| CIP | Restore Three Abandoned Reservoirs. |
| Maintenance | Annually replace reservoir gates control structure, pumps, motors, valves, racks, flow control, etal. |
| Maintenance | Aniani Tunnel Routine Maintenance. |
| Maintenance | Remove Abandoned Ditches, Return Land to Original Condition, and Cancel Easements. |

| **Recent Activity for the Waimanalo Irrigation System** |
|---|
| **2012:** Construction of the State Irrigation Systems Reservoir Safety Improvements, Waimanalo Reservoir project is in progress. |
| **2012**: Construction of the Waimanalo Irrigation System, Maunawili Valley and Miscellaneous Improvements is in progress. |
| **2008**: Installation of sheet metal lining at breached sections of the open ditch. |
| **2008:** Debris catchment baskets were fabricated and installed at several open ditch sections to reduce potential clogging of downstream grates. |
| **2008:** Restoration of Waimanalo Well No. 1 completed. |

The Department of Agriculture provided the status of the following project:

- Annually replace reservoir gates, control structures, pumps, motors, valves, racks, flow control, etal: Instead of an annual replacement, these items are repaired or replaced as needed.

**KAHUKU AGRICULTURAL PARK IRRIGATION SYSTEM**

The Kahuku Agricultural Park Irrigation System (KIS) is located on the north shore of Oahu. This system pumps irrigation water from ground water wells into an aboveground storage tank. Water then gravity flows through a pipe system to each parcel of the agricultural park.[5]

No assessment of needs or proposed capital and maintenance improvements has been made available.

The KIS is under the jurisdiction of the Department of Agriculture.

The Department of Agriculture provided the status of the following project:

- Construction pending for the Kahuku Agricultural Park Subdivision Improvements Project.[6]

[5] Department of Agriculture Letter dated September 13, 2012
[6] Ibid

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**MOLOKAI IRRIGATION SYSTEM**

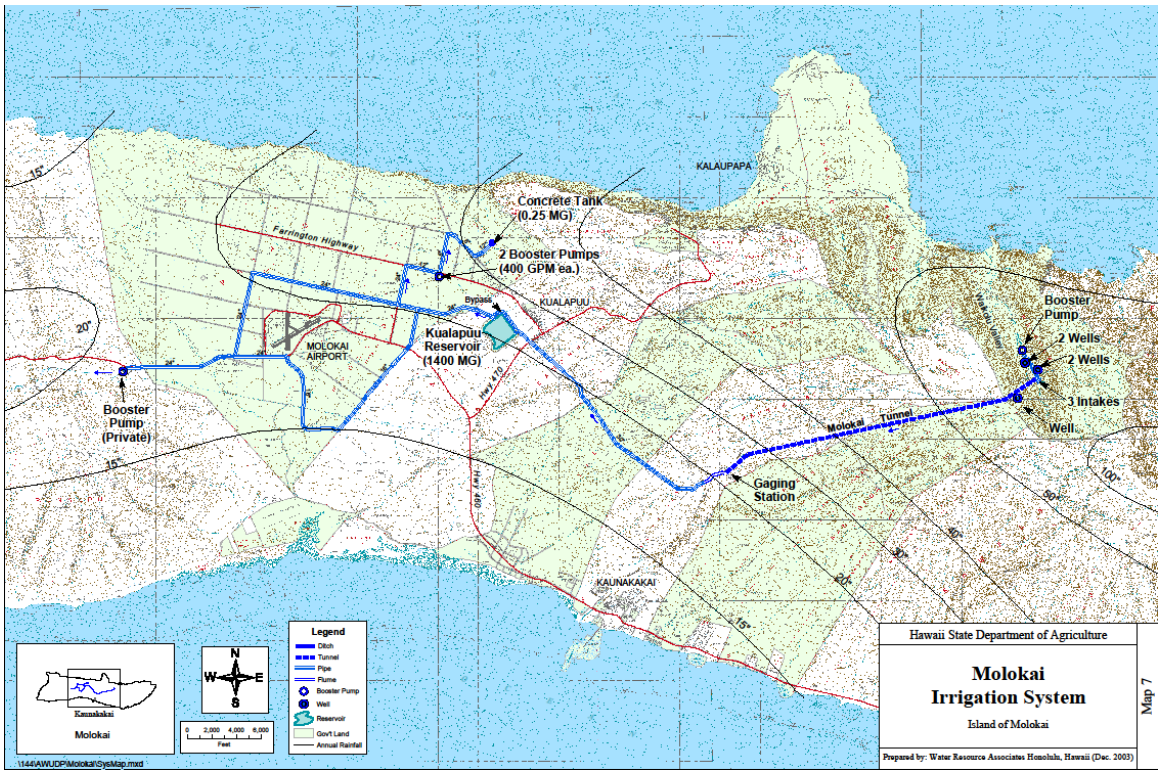



**Figure 7. Molokai Irrigation System**

*Source: AWUDP, 2004*

The Molokai Irrigation System (MIS) is located in the central portion of the island of Molokai. MIS was planned, designed, and constructed under a special Act of Congress. It includes 25 miles of tunnel, flume, pipeline, and the 1.4 billion gallon Kualapuu Reservoir.

The Waikolu Valley Watershed is the source of the MIS water. Water is diverted by three intakes located at the 1,000 foot elevation into the Molokai Tunnel. A fourth intake at the 800 ft elevation has a pump station to lift stream flow up to the Molokai Tunnel inlet portal. During periods of low flow and drought, five groundwater wells supplement the surface water. Water is transported through the Molokai Tunnel, exiting into a concrete flume into a 30-inch steel pipeline, and then flowing into the Kualapuu Reservoir. The distribution of water from Kualapuu Reservoir is mainly through gravity fed pipelines. A small section of land to the north of the reservoir has a booster pump and small tank to provide sufficient hydraulic pressure.

The MIS is under the jurisdiction of the Department of Agriculture.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural provided information regarding recent activity.

| **Molokai Irrigation System Needs Assessment** |
|---|
| Determine Appropriate Reservoir Size. |
| Project Life; Begin Replacement of Major System Component. |
| Develop Additional Water Sources. |

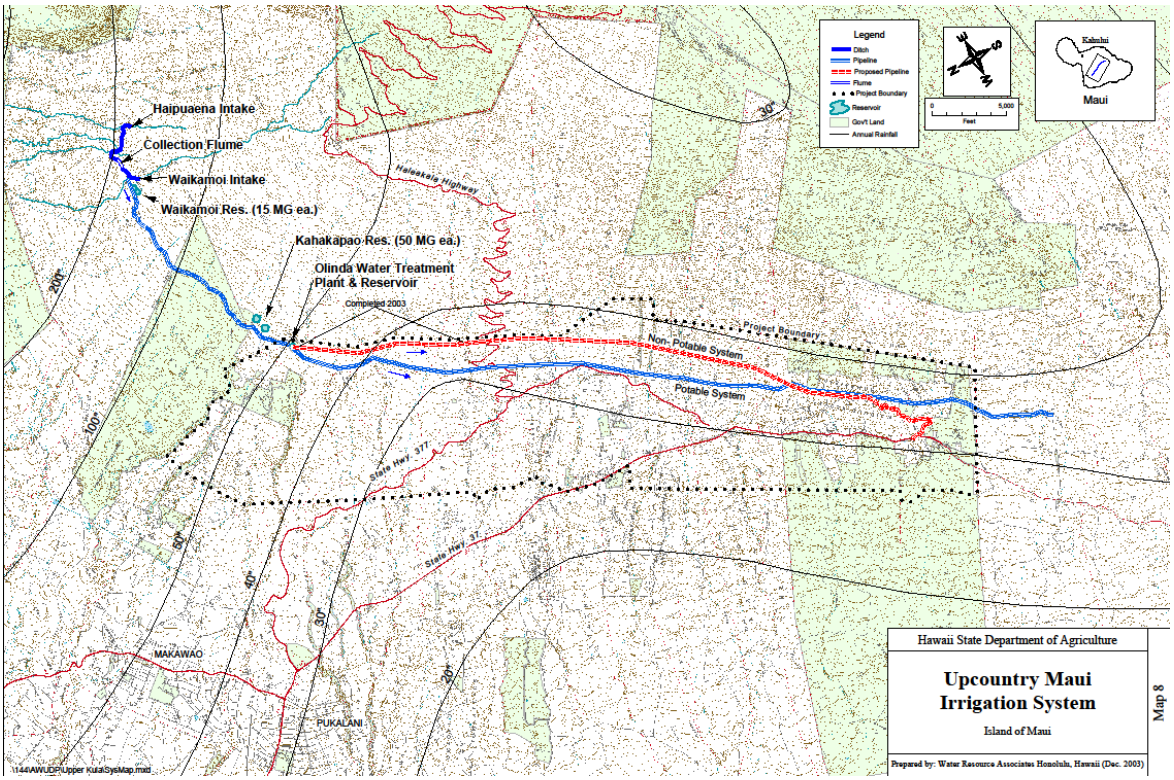
| **Molokai Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Raise Existing Kawela Stream Diversion. |
| CIP | Activate Unused Well. |
| CIP | Renovate Waihanau Stream Diversion. |
| CIP | Install a New telemetry System. |
| Maintenance | Convert Existing Facilities From Electrical to Diesel Operation. |
| Maintenance | Replace mechanical valves, meters, etc. |
| Maintenance | Construct concrete "curtain" Walls Inside Kualapuu Reservoir. |

| **Recent Activity for the Molokai Irrigation System** |
|---|
| **2012:** Construction of the State Irrigation Systems Reservoir Safety Improvements, Kualapuu Reservoir project is in progress. |
| **2012:** Construction of the Electrical, Control, and Telemetry project is in progress. |
| **2009** – Continued efforts to conserve water; call for less reduction in acreage planted. |
| **2008 –** Mandatory conservation measure enacted requiring reduction in water use. |
| **2005 –** Design/construction phase of Emergency Irrigation System Improvements. |
| **2005** – Planning phase of Molokai Irrigation System Reservoir Improvements. |

The Department of Agriculture provided the status of the following projects:

- Determine Appropriate Reservoir Size: Completed.
- Project Life; Begin Replacement of Major System Component: Construction project in progress
- Develop Additional Water Sources: Not feasible at this time.
- Install a New telemetry System: Construction in progress.

**UPCOUNTRY MAUI IRRIGATION SYSTEM**




*Source: AWUDP, 2004*

**Figure 8. Upcountry Maui Irrigation System**

The Upcountry Maui Irrigation System (UMIS) is located along the western slopes of Haleakala on the island of Maui. Construction on the UMIS was started in 1912 and includes flumes, pipes, seven reservoirs, and numerous small capacity tanks.

Surface water is diverted from Haipuaena, Puohokamoa, and Waikamoi Streams as well as their tributaries into the twin Waikamoi Reservoirs with a combined storage capacity of 30 MGD. Water then flows to the two Kahakapao Reservoirs, with a combined storage capacity of 100 MGD, and finally the Olinda Water Treatment Plant and Reservoir. A dual water system is currently being installed to provide non-potable water for agricultural use. Approximately four of the ten miles of the planned non-potable main distribution line has been installed[7].

The non-potable water of the UMIS is under the jurisdiction of the Department of Agriculture. The proposed plan for the non-potable water line is for the Department of Water Supply to maintain the system[8].

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural provided information regarding recent activity.

[7] Ibid.
[8] Ibid.

| **Upcountry Maui Irrigation System Needs Assessment** |
|---|
| Not able to provide adequate water supply during periods of low rain fall. |
| System unable to optimize water resources of the region due to inadequate collection, transmission, and storage capacities. |
| Inadequate transmission and storage to meet peak irrigation demands. |

| **Upcountry Maui Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Install Distribution Pipeline from Olinda to Keokea. |
| CIP | Install Lateral Pipelines. |
| CIP | Construct Road and Gulch Crossings. |
| CIP | Construct Access Road. |

| **Recent Activity for the Upcountry Maui Irrigation System** |
|---|
| **2012**: Design of the Upcountry Maui Watershed, Distribution Pipeline Phase VIB and Phase VIC projects in process. |
| **2012**: Construction pending for the Upcountry Maui Watershed, Pulehuiki Lateral project. |
| **2012**: Construction pending for the Upcountry Maui Watershed, Distribution Pipeline Phase VII project. |
| **2012**: Construction pending for the Upcountry Maui Watershed, Distribution Pipeline Phase VIA project. |
| **2012:** Construction of the Upcountry Maui Watershed, Distribution Pipeline, Phase V project completed |
| **2011**: Construction of the Upcountry Maui Watershed, Distribution Pipeline, Phase IV project completed. |
| **2006**: Construction of the Upcountry Watershed, Kimo Road Lateral project completed. |
| **2005**: Construction of the Upcountry Maui Watershed, Distribution Pipeline, Phase III project completed. |
| **2005**: Construction of the Upcountry Maui Watershed, Distribution Pipeline, Phase II project completed. |
| **2003:** Construction of the Upcountry Maui Watershed, Distribution Pipeline Phase I project completed. |

**LOWER HAMAKUA DITCH IRRIGATION SYSTEM**

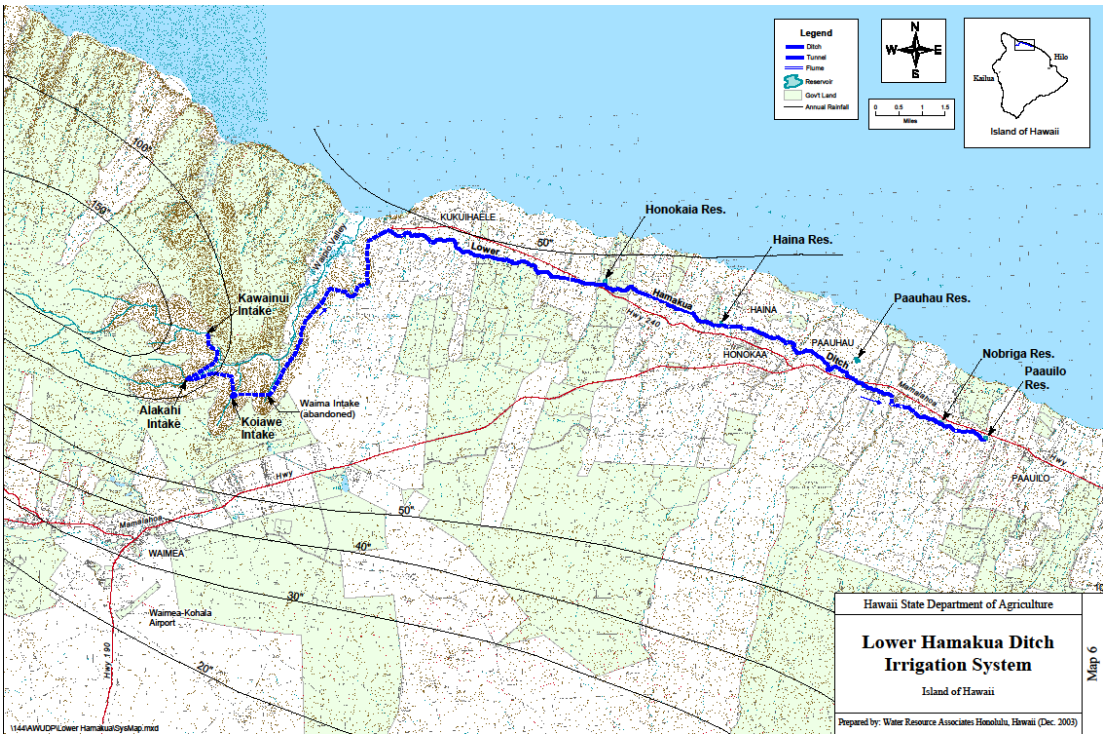



**Figure 9. Lower Hamakua Ditch Irrigation System** *Source: AWUDP, 2004*

The Lower Hamakua Ditch Irrigation System, (LHDIS) aka Honokaa – Paauilo Irrigation System, is located on the north eastern coast of the island of Hawaii. The LHDIS includes 26 miles of ditches, tunnels, flumes, service laterals, and five reservoirs.

The source of water for the LHDIS is the headwaters of four streams in Waipio Valley at the 1,000-ft elevation. Water is initially diverted at the Kawainui Intake, then at the Alakahi, Koiawe, and finally at the Waima Intake. Once collected, the water is gravity fed through a series of unlined, carved basalt lava transmission tunnels excavated behind the Waipio Valley cliff face. Water continues to flow into the ditch at the Kukuihaele Weir. Service laterals were installed along the entire length of the system to the terminus at Paauilo Reservoir. Additionally, there are five reservoirs along the LHDIS; Honokaia, Haina, Paauhau, Nobriga, and Paauilo reservoirs.

The State Department of Agriculture took over the operation of the LHDIS with the closure of the Hamakua Sugar Company.

The LHDIS is under the jurisdiction of the Department of Agriculture (DOA). However, the Haina, Paauhau, and Nobriga reservoirs are not operated and maintained by DOA[9].

[9] Ibid

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agriculture provided an updated list for the recent activity section.

| **Lower Hamakua Ditch Irrigation System Needs Assessment** |
|---|
| Flume Replacement and Repair. |
| Ditch Lining Repair and Sediment Removal. |
| Increase Water Storage Capacity by Rehabilitating Existing and Constructing New Reservoirs. |
| Increase water storage demands during nighttime. |
| Install and Repair Lateral Distribution Systems. |
| Install Water Meters. |
| Reconstruct Water Intakes. |
| Reconstruct intakes as needed. |
| Install a Supervisory Control and Data Acquisition System to allow for remote data collection. |

| **Lower Hamakua Ditch Irrigation System Proposed Capital and Maintenance Improvements** | |
|---|---|
| Category | Project |
| CIP | Land Treatment: Conservation, Technical Assistance, and Waipio Valley Assistance. |
| CIP | Repair Flume. |
| CIP | Repair Concrete Lining and Remove Sediment. |
| CIP | Modify Existing Intakes. |
| CIP | Install Lateral System. |
| CIP | Install Exclusion Fencing. |
| CIP | Install Supervisory Control and Data Acquisition System. |
| CIP | Reactivate Waima Intake. |

| **Recent Activity for the Lower Hamakua Ditch Irrigation System** |
|---|
| **2012:** Study/Design of the Lower Hamakua Ditch Supervisory Control and Data Acquisition System is in progress. |
| **2012:** Construction pending for the State Irrigation Systems Reservoir Safety Improvements, Pauuilo Reservoir project. |
| **2012**: Construction pending for the Repairs to the Lower Hamakua Ditch, Main Weir to Flume 16 project. |
| **2012**: Construction pending for the Repairs to the Lower Hamakua Ditch, Flume 16 to Paauilo Reservoir. |
| **2012:** Construction pending for the Lower Kalopa Lateral Project. |
| **2009:** Completed Phase IV of the Flume Improvements. |
| **2007**: Completed Paauilo Distribution Pipeline Improvements Phase II. |
| **2005**: Completed Paauilo Distribution Pipeline Improvements Phase I. |
| **2005:** Completed Phase 3 of Flume Improvements. |
| **2004**: Completed Phase 2 of Flume Improvements. |
| **2003:** Completed Phase I of Flume Improvements. |
| **2003:** Completed Hakaloa Falls Emergency Bypass Tunnel. |

The Department of Agriculture provided the status of the following projects:

- Flume Replacement and Repair: Completed.
- Ditch Lining Repair and Sediment Removal: Project awarded.
- Increase Water Storage Capacity by Rehabilitating Existing and Constructing New Reservoirs: Pauuilo Reservoir was lined.
- Reconstruct Water Intakes: Completed.
- Install a Supervisory Control and Data Acquisition System to allow for remote data collection: Study/Design in progress.
- Repair Flume: Completed.
- Repair Concrete Lining and Remove Sediment: Project awarded.
- Modify Existing Intakes: Completed.
- Install Lateral System: Project awarded.

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## WAIMEA IRRIGATION SYSTEM

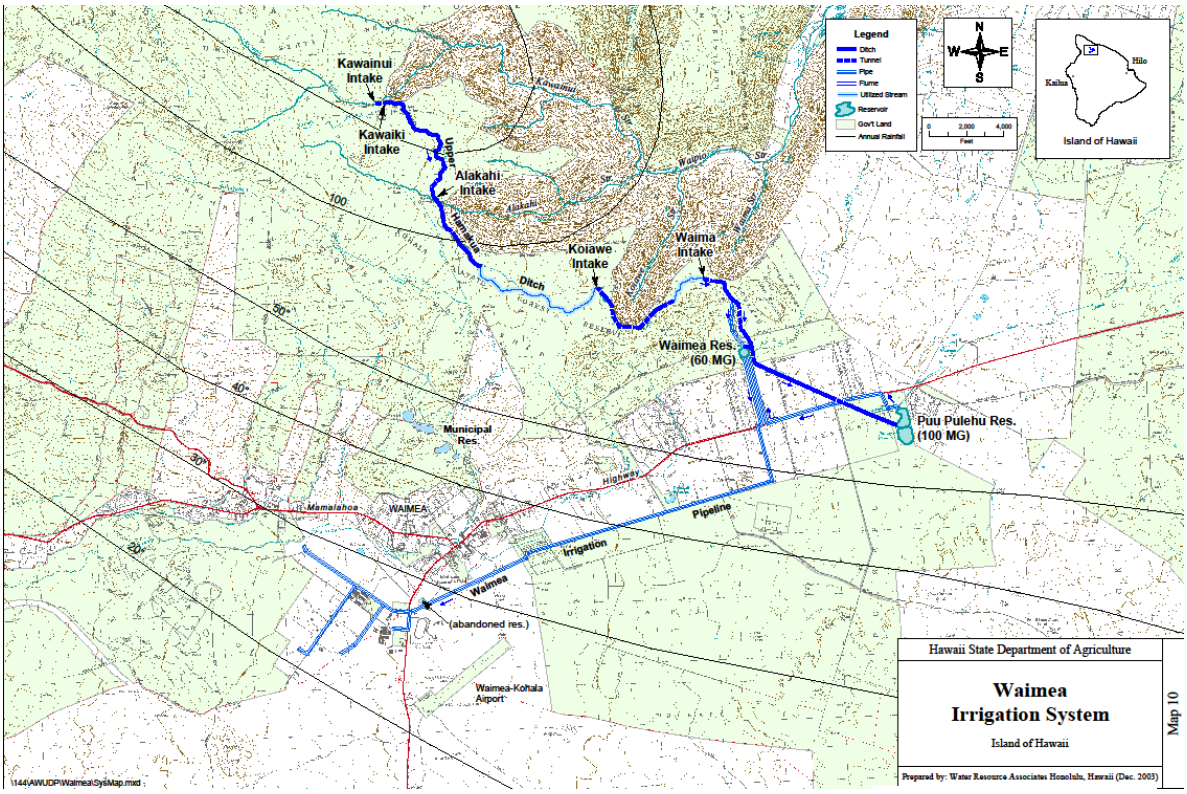


**Figure 10: Waimea Irrigation System** *Source: AWUDP, 2004*

The Waimea Irrigation System (WaIS) is located on the northern portion the island of Hawaii. WaIS has been active since the 1970s and serves the agricultural needs in Lalamilo and Puukapu. The WaIS is 15 miles in length and transports 307.2 million gallons annually. The main water sources for the system are the watersheds of Kohala Mountain. Water for the WaIS is supplemented by the recently rehabilitated 100 MG Puu Pulehu Reservoir. The WaIS is a State-operated system fully funded and managed by the State Department of Agriculture under authority of HRS Chapter 167. It is managed by an irrigation manager and two irrigation systems service workers, all of whom are employed by the State Department of Agriculture. The Hawaii Board of Agriculture provides administrative support. Capital improvements are funded with State bonds and operation and maintenance costs are provided through water revenues.

The main problem with the WaIS is a lack of an adequate system to collect, store, and distribute agricultural water. However, the WaIS can distribute water from the new Waimea Reservoir, a 60 MG reservoir supplemented by the Puu Pulehu Reservoir, to area farmlands during frequent periods of droughts. Water distribution is through pressurized pipelines that run through several populated areas, which impact maintenance work.

The WaIS is under the jurisdiction of the Department of Agriculture.

The following needs assessment and proposed capital and maintenance improvements were taken directly from the AWUDP, 2004. The Department of Agricultural provided information for the recent activity section.

| **Assessment of Needs for the Waimea Irrigation System** |
|---|
| Systems being maintained adequately, but facilities are old and show signs of neglect. |
| Provide improved water conveyance efficiency of the existing transmission ditch system. |
| Construct another storage reservoir increased capacity. |
| Install new distribution pipelines to provide drinking water for livestock. |

| **Proposed Capital and Maintenance Improvements for the Waimea Irrigation System** |
|---|
| Construct 133 MG Waimea II Reservoir. |
| Construct a 30-inch diameter supply pipeline to move water from Upper Hamakua Ditch collection system to Waimea II Reservoir. |
| Improve upper reaches of WaIS ditch system. |
| Dam safety review for a concrete masonry unit (CMU) wall to be installed on the crest of the Puukapu Reservoir. |

| **Recent Activity for the Waimea Irrigation System** |
|---|
| **2012:** Construction pending for the Waimea Transfer Ditch Improvements project. |
| **2012:** Construction pending for the State Irrigation Systems Reservoir Safety Improvements, Puukapu and Puu Pulehu Reservoirs project. |
| **2011:** Construction of the Lalamilo Distribution Pipeline Improvements, Phase II project completed. |
| **2010:** Waimea Irrigation System, Flume No. 2 Replacement and Flume No 3 Repair projects completed. (Earthquake). |
| **2008:** Waimea Irrigation System, Flume No. 1 Restoration project completed (Earthquake). |
| **2008:** Waimea Irrigation System, Ditch Bank Lining & Repair project completed (Earthquake). |
| **2008:** Waimea Irrigation System, Puukapu Deep WII Restoration project completed (Earthquake). |
| **2008:** Waimea Irrigation System, Access Trail Restoration project completed (Earthquake). |
| **2008**: Waimea Irrigation System, Kawainui Intake Repair project completed (Earthquake). |
| **2008:** Waimea Irrigation System, Tunnel Debris Removal project completed (Earthquake). |
| **2007:** Waimea Irrigation System, Flume No. 1 Emergency Bypass project completed (Earthquake). |
| **2007:** Construction of the Lalamilo Distribution Pipeline Improvements project completed. |
| **2004**: Construction of the Lalamilo Distribution Pipeline Improvements project completed. |

**KA`U IRRIGATION SYSTEM**

The Ka`u Irrigation System (KIS) was developed in the early 19th century to meet the water demands of the then Hawaiian Agricultural Company, which would become the Ka`u Sugar Company in 1972. Initially, the water was brought seven miles from the forest reserve through 16 tunnels. Reservoirs and pumps were developed to conserve the water flow. Water was available for both domestic and factory use.[10]

The Agribusiness Development Corporation is in the process of transferring the state-owned water sources that feed Ka`u District irrigation systems from DLNR ownership to ADC ownership. A total of seven working water systems remain from the former plantation in the Ka`u area. [11]

No assessment of needs or proposed capital and maintenance improvements has been made available.

The KIS is under the jurisdiction of the Agribusiness Development Corporation.

The Department of Agricultural Annual reports provided information regarding recent activity.

| **Recent Activity for the Ka`u Irrigation System** |
|---|
| **2009** – Engineering firm awarded contract to survey water source tunnels. |
| **2008** – ADC is required to provide a CAD map with metes and bounds descriptions of the water sources. ADC enlisted the help from key members of the Ka`u master coop to help locate the water tunnels and to identify the tunnels with GPS coordinates. |
| **2007 –** ADC Board of Directors approved to take on the Kau irrigation systems as a project. |
| **2006 –** ADC continued to meet with farmers to build an irrigation co-op. |

[10] http://www2.hawaii.edu/~speccoll/p_kauhaw.html
[11] http://hawaii.gov/hdoa/adc/ADC_brochure_lowres.pdf

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# Chapter V. Cost of Rehabilitation

### Agricultural Water Use and Development Plan, December 2004 (Revised)

Table 3 examines the costs of completely upgrading the systems based on 2004 numbers and modified for inflation to reflect costs in 2012. The 2004 numbers were taken from the 2004 Agricultural Water Use and Development Plan. Total costs associated for each irrigation system are based on Capital Improvement Costs (CIP) and rehabilitations costs that deal with construction and maintenance. Construction costs are comprised of actual construction (building) costs, construction management and contract administration costs, environmental permits and clearances, design engineering, and easement acquisitions. Based on the subtotal for the CIP and rehabilitation costs, a 15% percent overhead cost is calculated into the final total cost as well as an 8% contingency cost, 10% profit cost, and the state general excise tax. Maintenance costs are calculated separately and are based on the type of maintenance required plus design engineering and environmental permitting and clearance costs.

**Table 2: Summary of Estimated Rehabilitation Costs in 2004 and 2012 Dollars**

| Irrigation System | Constr'n Costs | Constr'n Mgmt.& Contract Admin. | Environ. Permits & Clearances | Design Engineering | Easements Acquisition | Total Cost | Latest Year Data is Available | Updated Total Cost with Inflation as of 2012* |
|---|---|---|---|---|---|---|---|---|
| East Kauai | 6,750,000 | 2,025,000 | 500,000 | 1,012,000 | 100,000 | 10,387,000 | 2004 | 12,618,252.97 |
| Kekaha Ditch | 3,907,000 | 1,172,000 | 1,000,000 | 586,000 | 125,000 | 6,790,000 | 2004 | 8,245,573.6 |
| Kokee Ditch | 502,000 | 150,000 | 1,000,000 | 60,000 | None | 1,712,000 | 2004 | 2,079,758.26 |
| Waiahole Ditch | 7,787,000 | 2,336,000 | 50,000 | 545,000 | None | 10,668,000 | 2004 | 12,955,615.16 |
| Lower Hamakua | 7,111,000 | 853,000 | -- | 1,422,000 | 200,000 | 9,586,000 | 2004 | 11,645,188.50 |
| Molokai | 10,768,000 | 3,231,000 | 1,000,000 | 1,077,000 | 700,000 | 16,776,000 | 2004 | 20,379,687.28 |
| Upcountry Maui | 6,959,000 | 1,044,000 | -- | 1,044,000 | 227,000 | 9,274,000 | 2004 | 11,266,167.14 |
| Waimanalo | 3,191,000 | 957,000 | 1,000,000 | 319,000 | 25,000 | 5,492,000 | 2004 | 6,671,747.89 |
| Waimea | 14,058,000 | 4,218,000 | 1,000,000 | 1,687,000 | None | 20,963,000 | 2004 | 25,466,105.42 |
| Wahiawa | | | | | | No Data | | No Data |
| Ka`u | | | | | | No Data | | No Data |
| Kahuku | | | | | | No Data | | No Data |
| *Based on the latest US government CPI data released on July 17, 2012. (http://www.usinflationcalculator.com/ ) | | | | | **Total** | **91,648,000** | **Total** | **$111,328,096.22** |

### Capital Improvement Projects

During the 2011 and 2012 legislative sessions, there was renewed commitment to agriculture irrigation systems. The Administration requested and the legislature approved several millions of dollars for renovation and repair of the systems.

During Fiscal Year 2012, the following capital improvement project (CIP) funds were appropriated by the State of Hawaii for state owned irrigation systems.

- $2.5 M for State Irrigation System Reservoir Safety Improvements, Statewide. Land Acquisition, Design and Construction for statewide reservoir safety improvements. This project is deemed necessary to qualify for federal aid financing and/or reimbursement ($2.5 M State / $1 M Federal).

- $3.2 M for Lower Hamakua Ditch Watershed, Hawaii. Land Acquisition, Design and Construction for improvements to the Lower Hamakua Ditch System, together with appurtenant works. The project is deemed necessary to qualify for federal aid financing and/ or reimbursement ($3.2 M State / $3.2 M Federal).

- $1.85 M for Waimanalo Irrigation System Improvements, Oahu. Design and Construction for improvements to the Waimanalo Irrigation System.

- $1.5 M for Upcountry Maui Watershed Improvements, Maui. Land Acquisition, Design and Construction for the installation of pipeline for the Upcountry Watershed, Maui. This project deemed necessary to qualify for federal aid financing and/ or reimbursement ($1.5 M State / $1.5 M Federal).

- $300,000 for Kekaha Ditch Improvements, Kauai. Plans and Design for improvements to the Black Pipe Siphon, Pali Wooden Flume, and Other structures.

- $1.25 M for Molokai Irrigation System, Molokai. Plans, Design, and Construction Improvements to the Molokai Irrigation System.

- $300,000 for Kahuku Agriculture Park Subdivision Miscellaneous Improvements, Oahu. Construction of miscellaneous improvements to the Kahuku Agriculture Park Subdivision.

- $1 M for State Agricultural Water Use Development Plan, Statewide. Plans for State Agricultural Water Use and Development Plan, Statewide. This project is deemed necessary to qualify for federal aid financing/ or reimbursement ($1 M State / $1 M Federal).

- $500,000 for Waiahole Water System Improvements, Oahu. Plans and Design for improvements to the Waiahole Water System.

- $500,000 for Kau Irrigation System Improvements, Hawaii. Plans and Design improvements to the transmission ditch and flume system of the former Kau Agribusiness Plantation's irrigation system.

During Fiscal Year 2013, the following CIP funds were appropriated by the State of Hawaii for state owned irrigation systems.

- $9.5 M for State Irrigation System Reservoir Safety Improvements, Statewide. Land Acquisition, Design and Construction for statewide reservoir safety improvements. This project is deemed necessary to qualify for federal aid financing and/ or reimbursement ($9.5M State / $2 M Federal).

- $1.5M for Lower Hamakua Ditch Watershed, Hawaii. Land Acquisition, Design and Construction for improvements to the Lower Hamakua Ditch System, together with appurtenants works. This project is deemed necessary to qualify for federal aid financing and/ or reimbursement ($1.5M State / $1.5 M Federal).

- $1.0M for Waimanalo Irrigation System Improvements, Oahu. Construction of improvements to the Waimanalo Irrigation System, Oahu.

- $1.5 M for Upcountry Maui Watershed Improvements, Maui. Land Acquisition, Design and Construction for the installation of pipeline for the Upcountry Maui Watershed, Maui. This project is deemed necessary to qualify for federal aid financing and/or reimbursement ($1.5 M State/ $1.5 M Federal).

- $1.4 M for Kekaha Ditch Improvements, Kauai. Construction of improvements to the Black Pipe Siphon, Pali Wooden Flume, and other Structures.

- $1 M for State Agricultural Water Use and Development Plan, Statewide. Plans for Agricultural Water Use Development Plan, Statewide. This project is deemed necessary to qualify for federal aid financing and/ or reimbursement ($1 M State/ $4.35 M Federal).

- $2.5 M for Waiahole Water System Improvements, Oahu. Construction of improvements to the Waiahole Water System.

- $1.5M for Kau Irrigation System Improvements, Hawaii. Construction of improvements to the transmission ditch and flume system of the former Kau Agribusiness Plantation's Irrigation System.

- $75,000 for East Kauai Irrigation System, Kauai. Plans, Design, and Construction to upgrade and repair the East Kauai Irrigation System.

- $40,000 for Waimea Irrigation System Improvements, Hawaii. Plans, Design, and Construction improvements to the Waimea Irrigation System.

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# Chapter VI. Economic Impacts/Benefits of Select Irrigation Systems

## Summary

A reliable, inexpensive source and efficient delivery of irrigation water are key components in expanding diversified agriculture. An examination of several existing studies on the economic impacts/benefits of irrigation systems within the State of Hawaii was conducted. These studies showed that private and State owned irrigation systems provide positive economic benefits to both the statewide and local economy.

As shown in Chapter III, many of these irrigation systems require structural rehabilitation to serve existing lands and future lands in diversified agriculture. Monies spent on rehabilitation will assist in expanding diversified agriculture.

Three studies identified the economic impacts of specific irrigation systems: Wahiawa Irrigation System, Waiahole Irrigation System, and Kekaha Irrigation Systems. These studies measured direct and indirect contributions to the statewide economy through job creation and contributions to Hawaii's Gross Domestic Product (GDP).

## Review of Previous Studies

The following summarizes the major findings of the Wahiawa Irrigation System; Waiahole Irrigation System; and Kekaha Irrigation System and Lands.

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## Wahiawa Irrigation System Economic Impact Study, 2008

The purpose of the 2008 "Wahiawa Irrigation System Economic Impact Study" (2008 Study) was to assess the economic impacts of the privately owned Wahiawa Irrigation System (WaIS) locally and throughout the State of Hawaii. The objective of the research was to assist decision-makers regarding the purchase and management of the WaIS by the State. The WaIS formerly served sugar and pineapple plantations in the northern part of Oahu. The WaIS now serves diversified agricultural operations located on these former plantation lands. The first part of the 2008 Study examines the productivity and current state of the WaIS. This is followed by an economic analysis of the sales value of farm products that use water from the WaIS and the WaIS's direct agricultural contribution to Hawaii's GDP. In addition, the research analyzes the total economic impact to Hawaii's economy including multiplier effects.

The WaIS was built in 1906 by the Waialua Sugar Company (WSC), a subsidiary of Dole Foods, with the ability to provide 50 MGD to 12,000 acres of sugarcane fields and 5,000 acres of pineapple fields located in the Wailua-Haleiwa region of Oahu. The WSC ceased operations in 1996. The WaIS consists of a reservoir, a dam, and an irrigation ditch system extending 30 miles.

Approximately 8,100 acres can be irrigated under the existing WaiS configuration. These lands are among the most productive agricultural lands in the State of Hawaii. Of the 8,100 acres, 6,400 acres are occupied by farms using WaIS water. Of these 6,400 acres, approximately 55% is utilized for agricultural operations, while 45% is not suitable for growing crops. The WaIS currently provides 10 mgd to 6,400 acres of diversified crops and a smaller number of acres of remaining pineapple crops. Eighteen commercial crop-producing farms currently access water from the WaIS. Crop types range from pineapple and seed corn to pasture grass and tree crops. The 2008 study found that the WaIS is the sole factor making agricultural production possible in the area.

R-2 water discharge from the Wahiawa Wastewater Treatment Plan (WWTP) and the Army's Schofield Barracks wastewater treatment plant into Lake Wilson currently limits irrigation use only trees and orchard crops. There are future plans to upgrade of these facilities to produce R-1 water for discharge. When these improvements are made, there will be no restrictions on the types of crops using the WaIS for irrigation.

In 2007, farm operations in the WaIS serviced area contributed to $37.7 million in farm production, about 569 full-time and part-time jobs, and $14.4 million in household earnings, including wages and business profits, in the City & County of Honolulu. After subtracting costs of farm inputs and locally supplied intermediate inputs from the aggregate farm sale value, farm production contributed nearly $28 million to the State's GDP.

Statewide, the indirect and induced effects of farm operations generated an additional $47.52 million of goods and services, 411 full-time and part-time jobs, and $14.25 million in household earnings. Combined, $85.2 million of goods and services were produced and sold in total across Hawaii's economy. Nine hundred and eighty full-time and part-time jobs were created and $28.7 million in

household earnings. Table 7 on this page illustrates the economic impacts and job creation linked to the WaIS beyond the City and County of Honolulu and into Hawaii, Kauai, and Maui Counties.

**Table 3: Wahiawa Irrigation System Economic Impacts: Regional Interdependence**

| | Output ($Million) | Earnings ($ Million) | Employment (Numbers) |
|---|---|---|---|
| Farm Production (in Honolulu County) | 37.66 | 14.43 | 569 |
| With Multiplier Effects | | | |
| Honolulu County | 41.59 | 12.43 | 357 |
| Hawaii County | 2.83 | 0.87 | 25 |
| Kauai County | 0.88 | 0.26 | 9 |
| Maui County | 2.21 | 0.68 | 19 |
| **Total Economy-Wide Impact** | **85.17** | **28.68** | **980** |

Table 8 below also shows industry interaction from farm operations. Construction benefited the most with $9.4 million, $2.98 million of earnings, and 369 jobs and approximately $6 million in the production and sale of goods in Hawaii, Kauai, and Maui Counties.

**Table 4: Wahiawa Irrigation System Economic Impacts: An Application of Hawaii's Inter-County I-O Model**

| | Output ($Million) | Earnings ($ Million) | Employment (Numbers) |
|---|---|---|---|
| **1. Initial Effects (at Farms)** | **37.66** | **14.43** | **569** |
| 1.1 Farm Direct Contributions to the State GDP | 27.98 | | |
| | | | |
| **2. Indirect & Induced Effects** | **47.52** | **14.25** | **411** |
| 2.1 Agriculture | 6.04 | 2.06 | 67 |
| 2.2 Construction | 9.40 | 2.79 | 69 |
| 2.3 Food processing | 0.37 | 0.09 | 3 |
| 2.4 Manufacturing | 2.06 | 0.51 | 13 |
| 2.5 Transportation | 1.69 | 0.47 | 13 |
| 2.6 Information | 0.71 | 0.20 | 6 |
| 2.7 Utilities | 0.51 | 0.09 | 2 |
| 2.8 Wholesale Trade | 2.28 | 0.71 | 18 |
| 2.9 Retail Trade | 4.33 | 1.36 | 49 |
| 2.10 Finance and Insurance | 2.41 | 0.66 | 16 |
| 2.11 Real Estate and Rentals | 5.17 | 0.76 | 23 |
| 2.12 Professional Services | 2.40 | 0.91 | 21 |
| 2.13 Business Services | 0.50 | 0.18 | 5 |
| 2.14 Educational Services | 0.64 | 0.24 | 8 |
| 2.15 Health Services | 4.89 | 1.84 | 48 |
| 2.16 Arts, Entertainment, and Recreation | 0.28 | 0.11 | 5 |
| 2.17 Accommodations | 0.60 | 0.18 | 5 |
| 2.18 Eating and Drinking places | 1.22 | 0.36 | 16 |
| 2.19 Other Services | 1.45 | 0.49 | 16 |
| 2.20 Government | 0.58 | 0.26 | 6 |
| | | | |
| **3. Total Economy-Wide Impacts (1+2)** | **85.17** | **28.68** | **980** |

The WaIS has created jobs and incomes beyond direct farming. A noni processing plant processes the noni fruit grown in the WaIS serviced area as well as processing noni fruits from other islands. In addition, agricultural tourism has developed from farm scenery and Dole's farming tourist destinations.

These activities provide incentive for visitors to travel to Oahu. Retail business, agricultural processing, and farm equipment and machinery maintenance are directly linked to these activities.

In addition, the study was not able to assess the extent to which the WaIS affects the economy and livelihood of residents in the Wahiawa, Waialua, Haleiwa, and the North Shore region.

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## Economic Impact of the Waiahole Irrigation System, 2002

The purpose of the "2002 Economic Impact of the Waiahole Irrigation System" is to assess the economic benefits of the State-owned Waiahole irrigation system (WIS) on Oahu. The WIS formerly served sugar and pineapple plantations in Central Oahu. It now serves diversified agricultural operations located on these former plantation lands. The study examines the history of the WIS; identifies the numbers of clients and water usages; compares Waiahole water rates to the rates of other systems; and assesses the economic impacts generated by the WIS. The economic assessment found that agribusinesses using WIS water created 2000 jobs, generated $95 million annually, and comprised 51% of total agricultural sales recorded in the City and County in 2000. The Agribusiness Development Corporation (ADC) indicated that approximately $135 million and 2000 jobs were generated in 2012.

The WIS was built between 1913 and 1916 by the Waiahole Irrigation Company, a subsidiary of Oahu Sugar Company (OSC), to serve its sugar plantation on Oahu's Leeward side. The WIS is currently 25.3 miles long and begins in Windward Oahu at Kahana Valley and ends in a reservoir in Honouliuli on Leeward Oahu. The WIS provides water to lands in Central Oahu. According to the study, 73% of all lands classified as agricultural by the U.S. Geological Survey are located in Central Oahu. In 1993 OSC announced it would close its sugar operations in 1995.

In 1999 the WIS was purchased by the ADC for $8.5 million dollars. The funds for acquisition came from the sale of state revenue bonds. The money generated from user fees from the WIS would be used to pay the ADC debt. This same year, existing WIS water users formed the Kunia Water Cooperative (KWC) to negotiate water rates and delivery terms with the ADC. The determined rate would have to be able to repay their debt from those fees. The rationale behind providing farmers with an inexpensive source of water was to induce investment into diversified agriculture.

WIS rates were compared with rates from agricultural irrigation systems operated by the DOA and county Board of Water Supply run systems. The study found that water from the DOA run systems is cheaper than water from WIS by approximately $.10 per 1,000 gallons. However, water from the county Board of Water Supply systems can run anywhere from four to five times as much as water from WIS If service and meter charges are included, this amount rises substantially.

At the time of the study, the WIS irrigated a wide range of crops from watermelon, tomato's, bell pepper, cabbage, pineapple, seed corn, onions, cucumber, eggplant and basil.

The study found that there are approximately 80 agribusinesses in Central Oahu using approximately 10 million MGD of WIS water. These businesses generate employment for roughly 2,000 people. The combined value of agricultural production by the businesses is estimated at $95 million annually. This value accounts for 51% of total crops, livestock, and aquaculture sales for the City & County in 2000. Additionally, this $95 million promotes additional economic activities through direct and indirect efforts in the overall State economy. For every $1 increase in final demand for Hawaii's agriculture, the output in Hawaii's economy is increased by $1.94.

The most recent numbers provided by the ADC indicate that approximately $135 million and 2000 jobs were generated in 2012.

## An Economic Assessment of the Former Kekaha Sugar Company Land and Infrastructure: Its Current and Potential Economic Capacity, 2005

The purpose of the 2005 "An Economic Assessment of the Former Kekaha Sugar Company Land and Infrastructure: Its Current and Potential Economic Capability" is to evaluate the current and potential economic capability of existing agricultural lands and infrastructure. The first part of the paper examines the history of the Kekaha lands and its infrastructure. The second part of the paper provides an economic assessment of these lands. First, crops were identified in which Kauai can be competitive within the statewide agricultural industry. Secondly, the existing lands and infrastructure were assessed to determine economic contributions to the Gross State Product (GSP). Finally, the research assessed constraints and challenges faced by Kauai farmers. The economic assessment concluded that the Kekaha agricultural lands have considerable potential for generating income and employment for the people of Hawaii.

The Kekaha Sugar Company (KSC), a subsidiary of American Factors (AMFAC), operated a sugar plantation on approximately 12,592 acres of state owned lands until KSC's closure in February 2001. KSC also constructed both the Kekaha and Kokee irrigation systems in the early 1900's to support their sugar plantation operations. The lands are extensively irrigated by the Kekaha and Kokee Ditches. The Kekaha Ditch was built in 1907 and is approximately 27 miles long. It is one of three main ditches that originally served the KSC. Kokee Ditch is approximately 21 miles long and the other main ditch that originally served KSC. Other infrastructure remaining from KSC's closure is roads, hydroelectric plants, and pumping stations used to lower groundwater.

At the time of the KSC closure, these lands were managed by the Department of Land and Natural Resources. In 2001 a master lease was given to the ADC by the Board of Land and Natural Resources. The major challenge for the ADC is to maximize the potential of agricultural production and to generate income and employment from these Kekaha lands and existing infrastructure for Hawaii's residents.

To assess the economic potential of Kekaha lands, a list of crops currently doing well on Kauai was developed. This list of crops is then compared with the Honolulu market as it is the largest statewide. A review of Kauai's share of specific crops supplying the Honolulu market shows that Kauai has a large share of the Honolulu market for wetland taro, longan, rambutan, starfruit, and caimito. There is also a competitive advantage in products such as seedless melon, processed lettuce, sweet corn and taro. If these crops can be grown in Kekaha, there is an opportunity for import substitution with the Honolulu market.

Kekaha lands have considerable potential to generate income and employment for the county and state. However, how much of an economic contribution the Kekaha lands will make is dependent upon the crops and/or commodities produced. The existing infrastructure that supported KSC's sugar operations also supports diversified agriculture. Also, the climate is favorable for crop production.

Table 9 summarizes the direct and total economic potential of portions of the 12,592 acres of former Kekaha lands through direct and indirect contributions to the state's economy. Direct contributions to the economy in 2002 are $19.5 million and 387 jobs while in 2004 they are $34.9 million and 375 jobs.

Direct contributions in 2010, will range between $38.4 million and $50.8 million. With 3,500 acres in cultivation, approximately 60 full-time and 345 part-time jobs will be created. With 7,325 acres of the most productive lands in cultivation, approximately 73 full-time and 440 part-time jobs could be created.

The potential total contributions in 2012 with 3,500 acres cultivated are valued at about $71 million with 834 full and part-time jobs. If 7,325 acres are cultivated, $95 million dollars will be generated and approximately 1,056 farm and non-farm jobs could be created as well.

**Table 5: Economic Potential of the Former Kekaha Sugar Lands: Direct and Total Contributions to Hawaii's Economy**

| | **Direct Contribution (Farm output and jobs)** | | | | **Total Contribution** | |
|---|---|---|---|---|---|---|
| | 2002 | 2004 | 2010a | 2010b | 2010a | 2010b |
| 1. Potential Output Value ($ million) | 19.5 | 34.9 | 38.4 | 50.8 | 71 | 95 |
| 2. Actual Out Put Value (% of Potential) | 75-80% | 47-57% | 60-70%[a] | Na | Na | na |
| 3. Total Number of Jobs (actual & potential):[b] | 387 | 375 | 405 | 513 | 834 | 1056 |
| 4. Full - Time | 112 | 100 | 60 | 73 | na | na |
| 5. Part – Time and Seasonal | 275 | 275 | 345 | 440 | na | na |
| 6. Managerial/Professional (all Full-Time) | na | 19 | na | na | na | na |
| 7. Skilled Technical (all Full-Time) | na | 38 | na | na | na | na |
| 8. Laborer (Full, Part–Time and Seasonal) | na | 318 | na | na | na | na |
| 9. Total Acreage of Cropland Held by Tenants[c] | 5,000 | 6,127 | 3,500 | 7,325 | 3,500 | 7,325 |
| 10.Types of Crop Grown | Sugarcane Seed crops Vegetables & Melons | Sugarcane Seed crops Vegetables & Melons | Seed crops Fruits Vegetables & Melons | Seed crops Fruits Vegetables & Melons | Seed crops Fruits Vegetables & Melons | Seed crops Fruits Vegetables & Melons |

Notes: [a]This is an expected actual output value in aggregate based on existing tenants' growth plans. [b]Number of jobs for 2002 and 2004 are estimates of actual farm employments. For 2010, they are estimates of potential job creation. [c]Total acreages for 2002 and 2004 are based upon leasehold of the four farms used in the estimation; for $2010_a$, the total acreage is based upon business plans of the existing tenants; and for $2010_b$, it is the total acreage of the readily arable and most productive cropland of the 12,592 acres, with a hypothetical land allocation. Farm yields and prices of crops used for estimation are Kauai's average, except for seed crops, which are statewide averages.

The most recent numbers provided by the ADC indicate that approximately $80 million and 400 jobs were generated in 2012.

## Economic Summary of State of Hawaii Owned Irrigation Systems

### EAST KAUAI IRRIGATION SYSTEM

- Services 4,000 acres
- Diversified agriculture crops -- fruit orchards, vegetable farms and gardens, taro and cattle.
- 33 cooperative members with 300 lots on record
- Provides about 4 MGD. Two reservoirs are being renovated; when they are operational the system will deliver 6 MGD

### KEKAHA DITCH IRRIGATION SYSTEM

- Services 5,000 acres
- Diversified agriculture crops – corn, seed, taro, mixed vegetables
- 400 people utilizing irrigation system
- Distributes 33 MGD
- Economic Impacts
    - Direct contributions include
        - $38.4 million in farm output to Hawaii's GSP
        - 60 full-time and 384 part-time jobs
    - Direct contributions in 2012 include
        - $80 million dollars to Hawaii's GSP and
        - 400 jobs created
    - If the most productive croplands are utilized, direct contributions can amount to
        - $50.8 million in farm output to Hawaii's GSP
        - 513 jobs can be created
    - When linkages are considered, total contributions to Hawaii's GSP are amount to
        - $71 million
        - 834 jobs
    - If the most productive croplands are fully utilized, total contributions can reach
        - $95 million dollars to Hawaii's GSP and
        - 1,056 farm and non-farm jobs can be created

### KOKEE DITCH IRRIGATION SYSTEM

- Services 5,000 acres
- Diversified agriculture crops – corn, seed, taro, mixed vegetables
- 400-500 people utilizing irrigation system
- Distributes 33 MGD

### WAIAHOLE DITCH IRRIGATION SYSTEM

- Services 6,000 acres
- Diversified agriculture crops -- corn seed, mixed vegetables, watermelons, bananas, papaya, pumpkin, tomato, cucumbers, onions, taro, bell peppers, cabbage, bok choy, soybeans, squash, bitter-melon, melons, corn, pineapple, herbs and broccoli
- Delivers about 10 MGD. Approximately 1,500 people utilize the irrigation system.
- Economic Impacts
    - 73% of lands classified agriculture in the City and County located in Central Oahu.

- These lands account for $95 million generated annually in combined agricultural production for the City and County in 2000
- The lands generated $135 million in 2012
- 51% of total crops, livestock, and aquaculture sales for the City and County in 2000.
- For every $1 increase in demand for Hawaii agriculture, the output into Hawaii's economy is $1.94

## WAIMANALO IRRIGATION SYSTEM

- Services 1,100 acres
- Serves 160 farms
- Diversified agriculture
- Provides 350,000 GPD

## KAHUKU AGRICULTURAL PARK IRRIGATION SYSTEM

- Services 445 acres[12]
- Diversified agriculture crops
- 3 miles in length

## MOLOKAI IRRIGATION SYSTEM

- Services 2,800 acres
- Serves 250 farms
- Provides 3,000,000 gallons per day (GPD)
- Diversified agriculture
- 250 homesteaders and non-homesteaders[13]

## UPCOUNTRY MAUI IRRIGATION SYSTEM

- Will service 423 acres at full built out
- Diversified agriculture
- Replaces potable water with non-potable water

## LOWER HAMAKUA DITCH IRRIGATION SYSTEM

- Services 6,600 acres
- Serves 150 farms
- Provides 150,000 GPD
- Diversified agricultural crops including papaya, coffee, lettuce, watermelon, tomatoes, taro, orchids, vanilla, dairy products and grass-fed beef[14]

## WAIMEA IRRIGATION SYSTEM

- Services 750 acres
- Serves 150 farms
- Diversified agriculture

[12] http://hawaii.gov/hdoa/arm/arm_irrigation/
[13] http://archives.starbulletin.com/2008/02/21/news/story11.html
[14] http://hamakuatimes.com/hamakua-ditch-update-p128.htm?twindow=Default&smenu=133&mad=No

- Provides 1,000,000 GPD

## KAU IRRIGATION SYSTEM

- Diversified agriculture -- macadamia nut, coffee, truck crops, tropical flowers and ranching
- Farm gate value of crops and livestock produced in Kau district approximately $10-$15 million dollars
- Water was available for both domestic and factory use.
- From Kau to South Kona region, 1.9 MGD agricultural water demand as of 2000. 17.9 MGD water demand projected for 2020[15]

[15]http://www.hawaiidws.org/5%20events%20news%20notices/5c%20news/7%20hove%20updates/Kau%20%20South%20Kona%20Water%20MastPlan%20Final%20Septr%2004.pdf

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## Chapter VII: Conclusions

State-owned Systems continue to play a major role in Hawaii's agricultural industry by providing a reliable source of irrigation water at a favorable rate. These Systems were developed by the sugar plantations and water companies, between 1876 and 1920's, to provide a consistent source of irrigation water for the growing of sugar. Plantation closures in the 1980's and 1990's affected the operation and maintenance of the Systems as most were also owned by the plantations.

Hawaii policy makers and the agricultural community envisioned that diversified agriculture would utilize former plantation lands and Systems. They also recognized that reliable, inexpensive water is critical for this transition. Passage of Act 101 SLH 1998, required the DOA to develop an AWUDP specifically for the agricultural community. Further, the AWUDP would become part of the HSWP required by the HSWC.

State policy makers envisioned that the AWUDP would be one of a number of tools available to assist in the transition from plantation agricultural to diversified agriculture. The minimum requirements of the AWUDP are: inventory the irrigation water systems; identify the extent of rehabilitation and maintenance required; subsidize cost of repair and maintenance of the systems; establish criteria to prioritize the rehabilitation of the systems; develop a five-year program to repair the system; and set up a long-range plan to manage the systems.

The AWUDP 2004 inventoried thirteen Systems and estimated future water irrigation water requirements. In 2004, ten of the thirteen Systems were owned by the State of Hawaii. Data regarding the existing conditions, current concerns and needs, and estimated rehabilitation costs of these ten Systems were obtained from the *Hawaii Water Resources Study, Agricultural Water Systems*, September 2003, by the U.S. Bureau of Reclamation and the DOA.

Rehabilitation costs were categorized either as maintenance or capital improvements. Maintenance improvements are improvements necessary to maintain regular operating conditions for the specific irrigation system. Remaining improvements are considered capital improvements. Total rehabilitation costs for nine Systems were estimated at $91,648,000.00. Adjusted for inflation, the estimated rehabilitation cost in 2012 dollars is $111,328,096.22.

The Wahiawa, Waiahole, and Kekaha systems have made the transition from providing water for plantation use to providing water for diversified agriculture. A review of individual economic impact reports prepared for each system highlights the important role these Systems have in the State's economy.

In 2007, the privately owned Wahiawa system contributed $37.7 million in farm production, about 569 full-time and part-time jobs, and $14.4 million in household earnings, including wages and business profits, in the City & County of Honolulu. After subtracting costs of farm inputs and locally supplied intermediate inputs from the aggregate farm sale value, farm production contributed nearly $28 million to the State's GDP.

Statewide, the indirect and induced effects of farm operations generated an additional $47.52 million of goods and services, 411 full-time and part-time jobs, and $14.25 million in household earnings. Combined, $85.2 million of goods and services were produced and sold in total across Hawaii's economy. Nine hundred and eighty full-time and part-time jobs were created and $28.7 million in household earnings.

In 2000, the State owned Waiahole system contributed a combined value of $95 million in agricultural production and generated employment for roughly 2,000 people. The $95 million accounted for 51% of total crops, livestock, and aquaculture sales for the City & County of Honolulu in 2000. Additionally, this $95 million promoted additional economic activities in the overall State economy. It was concluded that for every $1 increase in final demand for Hawaii's agriculture products from Waiahole, the output in Hawaii's economy is increased by $1.94.

In 2002, the State owned Kekaha system and lands directly contributed $19.5 million and 387 jobs to the economy in 2002. In 2004, $34.9 million and 375 jobs were directly contributed into the economy. Potential direct contributions in 2010 will range between $38.4 million and $50.8 million depending upon the amount of land in cultivation. With 3,500 acres in cultivation, approximately 60 full-time and 345 part-time jobs will be created. With 7,325 acres of the most productive lands in cultivation, approximately 73 full-time and 440 part-time jobs could be created. The potential total contributions in 2012 with 3,500 acres cultivated to Hawaii's GSP are valued at about $71 million with 834 full and part-time jobs. If 7,325 acres are cultivated, $95 million dollars could be generated and approximately 1,056 farm and non-farm jobs could be created.

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