Maui County Water Use and Development Plan

Central District

Final Candidate Strategies Report

Report Review Draft

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# Table of Contents

Table of Contents .................................................................................................................. 1
Introduction ............................................................................................................................. 4
Executive Summary ................................................................................................................ 5
  SUMMARY OF RECOMMENDED CENTRAL DISTRICT PLAN ........................................ 6
Background and Context ....................................................................................................... 8
  The Hawaii State Water Plan and the Water Use and Development Plan .......................... 8
  1990 Water Use and Development Plan and 1992 Draft Update .................................... 8
  CWRM Framework ............................................................................................................ 8
  The Current Maui County Update of the WUDP .............................................................. 8
  Final Candidate Strategies Report .................................................................................... 9
  What’s Next? ...................................................................................................................... 9
Description of the Analytical Process .................................................................................. 10
  The Integrated Resource Planning Process .................................................................... 10
  Identification of Planning Objectives ............................................................................... 11
  Characterization of Long Range Water Demand ............................................................. 11
  Characterization of Specific Resource Options ............................................................... 12
  Integrated Analysis of Candidate Strategies .................................................................. 13
  Formulation and Analysis of Final Candidate Strategies ............................................... 14
Independent Components Considered in All Strategies .................................................... 15
  DWS System Measures .................................................................................................. 15
  Demand Side Management (Conservation) Programs ..................................................... 15
  Supply Side Leak Detection and Reduction Measures .................................................... 16
  Recycled Water Use Options ........................................................................................... 16
  Production Energy Efficiency Measures ......................................................................... 17
  Potential Power Management Services ........................................................................... 17
  Energy Production Options ............................................................................................. 17
  Water Rate Design and Pricing Policies .......................................................................... 17
  Exploratory / Investigative Measures ............................................................................. 17
  County - Wide Measures ............................................................................................... 18
  Watershed Protection and Restoration .......................................................................... 18
  Stream Restoration Measures ........................................................................................ 18
  Wellhead Protection Ordinance ....................................................................................... 18
  Well Development Policies and Regulation ..................................................................... 18
  Landscape Irrigation Efficiency Requirements ............................................................... 19
  Drought Water Use Restrictions ...................................................................................... 19
Final Candidate Strategies .................................................................................................. 20
  General Characterization of Central District Strategy Analysis ....................................... 21
    System Reliability and Expansion Criteria ................................................................... 21
    Iterative Analysis and Public Review .......................................................................... 22
A. Northward Basal Groundwater ....................................................................................... 24
  Summary ........................................................................................................................... 24
  Project Design Scenarios ................................................................................................. 24
    Reference Strategy Versus Updated Northward Basal Wells Strategy ......................... 24
  Policy and Feasibility Considerations ............................................................................. 25
    Kahakuloa Valley Impacts ............................................................................................ 25
    Uncertain Hydrology ...................................................................................................... 26
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertainty Regarding the Viability of Strategies</td>
<td>84</td>
</tr>
<tr>
<td>Timing of Need for the Next Discretionary Resource</td>
<td>84</td>
</tr>
<tr>
<td>Uncertainty Regarding Energy Prices</td>
<td>86</td>
</tr>
<tr>
<td>Uncertainty Regarding Project Construction Costs</td>
<td>86</td>
</tr>
<tr>
<td>Capital Costs and Uncertainty in Future Water Demand</td>
<td>87</td>
</tr>
<tr>
<td>Recommended Central District Plan</td>
<td>88</td>
</tr>
<tr>
<td>Short Term Resources</td>
<td>88</td>
</tr>
<tr>
<td>Long Term Resource Acquisition</td>
<td>89</td>
</tr>
<tr>
<td>Regulatory Mechanisms</td>
<td>92</td>
</tr>
<tr>
<td>Resource Protection and Restoration</td>
<td>93</td>
</tr>
<tr>
<td>Watershed protection and restoration</td>
<td>93</td>
</tr>
<tr>
<td>Wellhead protection</td>
<td>93</td>
</tr>
<tr>
<td>Stream restoration</td>
<td>93</td>
</tr>
<tr>
<td>Protection of Cultural Resources</td>
<td>93</td>
</tr>
<tr>
<td>Energy Efficiency and Energy Production</td>
<td>94</td>
</tr>
<tr>
<td>Water Allocation Policies</td>
<td>95</td>
</tr>
<tr>
<td>Venues and Purposes for Allocations</td>
<td>95</td>
</tr>
<tr>
<td>Hierarchy of Priorities</td>
<td>97</td>
</tr>
<tr>
<td>Set-Asides</td>
<td>97</td>
</tr>
<tr>
<td>Allocations of Specific Water Sources to Land Use</td>
<td>98</td>
</tr>
<tr>
<td>Statements of Allocation Policies</td>
<td>99</td>
</tr>
<tr>
<td>Appendix A - Analysis of DSM Management (Conservation) Program Portfolios</td>
<td>101</td>
</tr>
<tr>
<td>Demand Side Management (Conservation) Programs</td>
<td>101</td>
</tr>
<tr>
<td>Characterization and Evaluation of Individual DSM Measures</td>
<td>101</td>
</tr>
<tr>
<td>Preliminary Analysis of Candidate DSM Programs</td>
<td>101</td>
</tr>
<tr>
<td>Characterization of Water End-Uses by District</td>
<td>102</td>
</tr>
<tr>
<td>Estimate of DSM Technical Potential</td>
<td>103</td>
</tr>
<tr>
<td>Estimate and Analysis of DSM Economic Potential</td>
<td>103</td>
</tr>
<tr>
<td>Analysis of Magnitude and Pacing of DSM Programs</td>
<td>104</td>
</tr>
<tr>
<td>Independent Expert Review of DSM Analysis and Program Design</td>
<td>107</td>
</tr>
<tr>
<td>Specific DSM Program Design and Contracting</td>
<td>108</td>
</tr>
</tbody>
</table>
Introduction

This draft of the Central District Final Candidate Strategies Report is intended to serve as a broadly distributed document for review of the major strategies being considered for the Central District in the Maui County Water Use and Development Plan (WUDP).

In order for this report to serve effectively as a “stand-alone” review document, a “Background and Context” section is included to summarize information provided in several previous chapters. The background information includes explanation of the role of the County WUDP as part of the Hawaii State Water Plan and the role of the Final Candidate Strategies Chapter as part of the County WUDP.

An “Executive Summary” section is provided as an overview of the Final Candidate Strategies Report. Several following sections explain the selection and formulation of the final candidate strategies and the methods used to analyze the strategies. Each of the final candidate strategies is then presented and discussed in more detail. An “Evaluation” section provides discussion and comparisons of the final candidate strategies. A “Recommendations” section provides several recommendations by the consultant / author of this report.

An Appendix presents the updated descriptions and detailed characteristics of the various resource options assumed in the analyses presented in this report.

The most recent versions of the previous supporting chapters listed below are available for download from the Maui County Department of Water Supply (DWS) web site. All documents remain in the form of “drafts” pending agency approval of the WUDP.

- Water Use and Demand - Department of Water Supply Systems (Draft), May 1, 2007
- DWS Finance and System Economics (Draft), August 23, 2005
- Resource Options (Draft), May 15, 2007
- Candidate Strategies - Central District Preliminary Draft, September 2006

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1. Documents are available for download at the County of Maui web site at the following page: Department of Water Supply | Departments | Department of Water Supply | Resources and Planning Division | Water Use and Development Plan | Draft Water Use and Development Plan Chapters. As of the date of publication of this draft report the URL for this download page is: http://himauicounty.civicplus.com/index.asp?NID=767
Executive Summary

The Maui County Water Use and Development Plan (WUDP) is being prepared in six sections according to geographic district. The Central District Final Candidate Strategies Report is expected to be the final document draft addressing the Central Department of Water Supply District until a complete Water Use and Development Plan is compiled including all six districts. This Report Review Draft is being circulated for comment to the Central District Water Advisory Committee, Maui County Board of Water Supply, Maui County Council and the Hawaii Commission on Water Resource Management (CWRM).

The WUDP is prepared in accordance with the CWRM "Statewide Framework for Updating the Hawaii Water Plan”. An "integrated resource planning" approach is used which includes identifying planning objectives, determining future water needs, identifying all feasible means to meet future water needs and determining, by careful analysis, the best strategy to meet the planning objectives and future needs.

The planning objectives for the Central District include a broad range of considerations including water service availability, reliability, quality, cost and broader considerations including protection of streams, water resources, cultural resources, sustainability, fairness, viability, and conformance with general and community plans. Strategies to meet future water needs were evaluated with respect to each of the planning objectives. Several programs and "resources" were incorporated into the strategies to address particular objectives as necessary.

Future water needs for the Central District were projected based on the planning assumptions currently being used in the preparation of the Maui general, island and community plan update. A range of high, base, and low water projections was developed to address uncertainty in future water demand. Water consumption for the DWS Central District system is expected to grow from 22 million gallons per day (MGD) in 2005 to 34 MGD in 2030 (base case). Water production requirements are higher than consumption requirements by about ten percent to account for unmetered uses (such as fire protection and line flushing) and system losses.

A wide range of possible "resource options" was identified and considered. These included various options to provide new sources of water, options to conserve and use water more efficiently and options to protect stream and groundwater resources.

The most promising resource options were examined in detail using an integrated capacity expansion and production cost simulation model. This analysis tool evaluates various combinations of resources (candidate strategies) in the context of operation of the overall Central District water system.

The most promising candidate strategies (final candidate strategies) were investigated, characterized and analyzed in greater detail. This is the subject of this report.

The final candidate strategies presented in this report are:

A. Northward Basal Groundwater Well Development
B. Eastward Basal Groundwater Well Development
C. Na Wai Eha Surface Water Treatment
D. Desalination of Brackish Groundwater
E. Maximization of Water Conservation and Recycled Wastewater Use

As explained in this report, each of these strategies was examined in detail to determine possible policy issues, implementation variations, costs and impacts. The strategies were compared to one another regarding each of the planning objectives. Uncertainties regarding the pace of growth in water demand, future energy costs and the viability of the strategies were analyzed...
and considered. Based on all of the analyses and considerations a Recommended Central District Plan was developed that comprises the proposed draft Central District Plan. This plan features the following principal recommendations:

SUMMARY OF RECOMMENDED CENTRAL DISTRICT PLAN

SHORT TERM RESOURCES

Diligently acquire the committed and near term supply resources that are currently planned and underway.

Optimize production from existing resources

Continue and accelerate leak detection and repair programs

Explore demand response options

LONG TERM RESOURCE ACQUISITION

Monitor Na Wai Eha surface water proceedings

Defer but be prepared to continue Waiale water treatment plant contract negotiations

Commission study to consider an alternative Na Wai Eha water treatment plant site

Implement programmatic conservation measures

Commission study to verify the feasibility of expanding use of Kihei R-1 recycled wastewater

Monitor ongoing feasibility and preserve options of other long term strategies

REGULATORY MECHANISMS

Maintain and/or extend inverted block and progressive rate designs

Review system expansion financing policies and/or establish sufficient system development fees

Establish water source development contract standards

Establish clear, meaningful criteria for determining availability of water and need for new system supply resources

RESOURCE PROTECTION AND RESTORATION

Watershed Protection and Restoration

Support watershed partnership agreements

Support reforestation programs

Wellhead Protection

Implement a wellhead / aquifer protection ordinance for each island

Stream Restoration

Support CWRM amendment of interim and/or permanent instream flow standards

Support programs to protect and restore streams

Consider impacts on reliance on water from streams in County land use determinations

Protection of Cultural Resources

Support stream restoration measures

Consult with Burial Council and local kuleana representatives regarding DWS actions
ENERGY EFFICIENCY AND ENERGY PRODUCTION

Establish a DWS Energy Resource Coordinator position
Identify and implement energy efficiency opportunities
Identify and implement load management opportunities
Identify and implement energy generation opportunities

WATER ALLOCATION POLICIES

This section of the Recommended Central District Plan includes a discussion of the following subjects and possible approaches to establish water allocation policies:

Venues and Purposes for Allocations
Hierarchy of Priorities
Set-Asides
Allocations of Specific Water Sources to Land Use
Statements of Allocation Policies

This draft of the Central District Final Candidate Strategies Report and the Recommended Central District Plan is intended to serve as a review document to promote further discussion of the issues, analyses, policies and recommendations.
Background and Context

The Hawaii State Water Plan and the Water Use and Development Plan

The Hawaii State Water Plan is required and specified as part of the State Water Code, Chapter 174C of the Hawaii Revised Statutes. The Water Use and Development Plan (WUDP) adopted by each county comprises one of the five principal components of the Hawaii State Water Plan:

- Water Resource Protection Plan - prepared by the State Commission on Water Resource Management (CWRM)
- Water Quality Plan - prepared by the State Department of Health (DOH)
- State Projects Plan - prepared by the Department of Land and Natural Resources (DLNR)
- Agricultural Water Use and Development Plan - prepared by the State Department of Agriculture (DOA)
- County Water Use and Development Plans - prepared by each County

In accordance with the State Water Code each county is required to prepare, periodically update and adopt its WUDP by ordinance. The CWRM must then adopt the WUDP as part of the Hawaii State Water Plan.

1990 Water Use and Development Plan and 1992 Draft Update

In 1990 each County in the State of Hawaii prepared and adopted its first WUDP. These WUDP's were adopted by the CWRM and were incorporated into the Hawaii State Water Plan. Each County prepared a 1992 draft update to the 1990 WUDP's. These draft WUDP's extended and updated the 1990 WUDP's but none were approved by the CWRM. The 1990 Maui County WUDP is the most recent WUDP adopted by the county and approved by the CWRM.

CWRM Framework

The CWRM adopted a “Statewide Framework for Updating the Hawaii Water Plan” (CWRM Framework) in February, 2000. This document serves as a guideline to the state and county agencies to prepare each of the components of the Hawaii Water Plan. A flowchart from the Framework showing the principal components and process for updating the Hawaii Water Plan is shown [above/below].

The CWRM Framework provides detailed specifications for preparation of the county WUDP's including an Integrated Resource Planning (IRP) analytical process and a public participation process. The IRP process outlined in the CWRM Framework and utilized by the DWS in the current WUDP update is described in more detail below.

The Current Maui County Update of the WUDP

In accordance with the Framework, the Maui County DWS presented a “Project Description” to the Maui County Council and the CWRM outlining the process that would be used by the Department of Water Supply to prepare its update of the WUDP. The Maui County WUDP is being prepared in accordance with the guidelines specified in the CWRM Framework.

For the DWS Central District the development of the WUDP has progressed through most of the phases of the IRP process including identification of planning objectives, determination of water use demand projections, identification of supply and demand-side resource options and formulation and analysis of various sequences of options and “strategies".
All stages of the IRP process have been conducted openly with substantial public review by water advisory committees. There have been twelve public meetings of the Central District water advisory committee. Participation in the public meetings is open and unrestricted.

Several previous documents explain the analysis and progressive derivation of the components of the strategies included in the Final Candidate Strategies Report. The most recent versions of the documents below are available for download from the Department of Water Supply web site. All documents remain in the form of “drafts” pending agency approval of the WUDP.

- Water Use and Demand - Department of Water Supply Systems (Draft), May 1, 2007
- DWS Finance and System Economics (Draft), August 23, 2005
- Resource Options (Draft), May 15, 2007
- Candidate Strategies - Central District Preliminary Draft, September 2006
- Final Candidate Strategies Analysis Update - Central District, January 8, 2008
- Final Candidate Strategies Analysis Update - Central District, March 18, 2008

**Final Candidate Strategies Report**

The Central District Final Candidate Strategies Report builds upon the previous analyses described in the documents listed above. A brief description of the previous analyses is provided in the following section of this report. Based on the previous analyses, updated information, and comments from the Water Advisory Committees, several “final candidate strategies” were characterized. The final candidate strategies include most of the previously considered strategies except that they are “reframed” and grouped to facilitate more rigorous analysis. The final candidate strategies are identified and discussed in detail in a following section of this report.

The Final Candidate Strategies Report includes a Recommended Central District Plan to serve as the starting point for review and discussion. This is the first presentation of specific recommendations regarding the final candidate strategies for the Central District.

Updated assumptions regarding the characteristics of the resource options incorporated in the final candidate strategies are provided in an Appendix B.

**What's Next?**

The Final Candidate Strategies Report is intended to serve as a review document for consideration by the DWS, the Central District WUDP Water Advisory Committee, the Board of Water Supply, the CWRM, the Maui County Council and the general public. Based on comments and discussion of this Report a Draft Central District Plan can be amended and compiled for consideration for adoption (along with the drafts addressing other Maui districts and non-DWS users and purveyors) as the updated Maui County WUDP.
Description of the Analytical Process

The Integrated Resource Planning Process

The CWRM Framework provides detailed specifications for the procedures to update the county WUDP’s including an Integrated Resource Planning (IRP) process. The IRP process is adapted from similar planning procedures used widely in the electric power industry. IRP provides for “integration” of several types of planning components:

- Integration of conventional water supply resources with “demand-side” conservation resources (implemented on the customer “side” of the water meter)
- Integration of public participation in the planning process
- Integration of non-monetary, societal, cultural, environmental and economic consideration in long range utility planning

The IRP process begins with identification of the planning objectives that are to be fulfilled by the WUDP and used to evaluate the merits of alternate planning strategies. Long range projections of water needs are prepared to serve as the basis for water resource planning. A wide and inclusive spectrum of supply-side and demand-side resource options are identified and characterized. These resource options are considered and the more promising options are assembled into resource “strategies.” Each strategy is a sequence of resource options designed to meet the water needs and planning objectives over a long term (twenty-five year) planning time frame.

![Figure 2-2 Elements of an IRP Process](image-url)
The alternative “candidate” strategies are evaluated and compared to one another to determine a set of “final candidate strategies” for rigorous analysis and consideration for the WUDP.

The IRP process implemented for the Central District is described below in greater detail.

**Identification of Planning Objectives**

A set of planning objectives was determined for the Central District based on input from the Central District Water Advisory Committee (Central WAC). At the first meeting of the Central WAC suggestions for planning objectives were solicited. A resulting extensive list of objectives, comments, policies and suggested resources was recorded. These were sorted and grouped to determine a more concise list of planning objectives. At subsequent Central WAC meetings the list of planning objectives was reviewed, extended and amended. The resulting list of planning objectives for the Central District is provided below:

**PLANNING OBJECTIVES**

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

**Characterization of Long Range Water Demand**

Projections of water demand for the twenty-five year planning period were derived for the DWS Central District. The projections and the analyses, assumptions and procedures used to derive the projections are presented in detail in the *Water Use and Demand* chapter. Water demand for the Central District for the planning period is depicted below for a range of assumptions that results in a base case and high, low and medium high and medium low water demand growth scenarios.

The econometric model used to make the water demand projections predicted reductions in consumption in the near term in the base case and low cases due to recent increases in water prices (despite continued increases in new customer accounts). Consumption for the year 2008 was predicted to be lower than prior years. Actual consumption for the year 2008 has been substantially lower and is more than one MGD lower than predicted by the model. The lower consumption is due in part to higher water prices and in part to lower defacto population resulting from the
recent economic downturn starting in mid-2008. The system and economic analysis described in this report presume that water demand will increase in the long term as shown consistent with the assumptions in the socio-economic studies prepared by the County supporting the current General Plan update process.

**Characterization of Specific Resource Options**

Resource options are broadly defined to include any actions, programs or measures that serve to fulfill the planning objectives. Resource options include, for example, programs to protect and restore watersheds as well as conservation programs and rate design policies.

An extensive list of resource options was compiled and extended with review by the Central WAC. The resource options are documented in the previous *Resource Options* chapter.

Several specific supply resource options were identified for the DWS Central District system. For meaningful incorporation in the analysis of candidate strategies these resource options were characterized in detail and were classified as follows:

- **Committed Resource Options** - options that are in the process of being implemented but are not yet in service
- **Short Term Resource Options** - options that could mitigate immediate capacity reserve shortfalls
- **Long Term Resource Options** - alternative options that would form the fundamental basis of the resource strategies and would address the identified planning objectives over the time frame of the planning period
- **General Resource Options** - options that are not exclusive and can be implemented in conjunction with most other combinations of options.

The Committed and Short Term resource options are included in each of the candidate strategies. The Long Term resource options are the major options that are alternatives to one another and are evaluated against one another in the analysis of the candidate strategies. The General resource options are consistent with any of the strategies and are evaluated independently for inclusion in the WUDP.

The characteristics of each of these resource options are identified in substantial detail in the *Candidate Strategies* chapter. Updated detailed characterizations used in the analysis of the Final Candidate Strategies are provided as an appendix to this report.

**Integrated Analysis of Candidate Strategies**

The specific resource options and candidate strategies were analyzed in the “integrated” context of the operation of the DWS Central District system. An integration model was developed for the Central District system that serves as a capacity expansion and production cost model.

The integration model considers the following elements:

- The forecast of water demand for the twenty-five year planning period (2006 - 2030)
- Average, annual peak, daily peak and drought year variability of water demand
- The characteristics and costs of operating the existing water system resources
- Inflation, escalation, cost of capital estimates and discounting assumptions
- Limits on allowed aquifer withdrawals
- System expansion criteria based on engineering capacity reserve standards
- Costs and characteristics of available resource options
- Forecast of electricity costs and calculation of system production costs

The integration model analyzes and calculates the following elements:

- Calculation of system fixed operation and maintenance costs
- Calculation of system capital costs
- Determination of annual and discounted planning period costs
  - Costs by category including Variable, Fixed O&M and Capital costs
  - Costs by perspective including “utility”, “total resource” and “participant” costs
  - Rate impacts stated as average annual % rate increase and levelized rates.
  - Determination of unserved water demand and reserve capacity shortfalls
  - Tabular and graphic portrayal of input assumptions and analysis results

Using the integration model the analysis of the specific resource options and candidate strategies was conducted in several stages. These are documented in further detail in the *Candidate Strategies* chapter:

- **Determination of a Reference Strategy**: A base case combination and sequence of resource options was determined to serve as a reference strategy against which other possible strategies were compared.

- **Integrated Analysis of Individual Resource Options**: Each of the principal resource options was analyzed in the integrated context of the operation of the DWS Central District system.
Formulation and Preliminary Optimization of Candidate Strategies: Each principal resource option was analyzed to determine what combination of other resource options would best combine to comprise a candidate strategy.

Evaluation and Comparison of Candidate Strategies: The candidate strategies were analyzed and compared.

The analysis of the candidate strategies is described in detail in the Candidate Strategies chapter.

**Formulation and Analysis of Final Candidate Strategies**

Several of the candidate strategies were formulated into “final” candidate strategies in order to facilitate more rigorous analysis and development of detail. Based on discussion with the Central WAC a “Maximization of Water Conservation and Recycled Wastewater Use” strategy was formulated. The list and analysis of final candidate strategies was presented for review and discussion to the Water Advisory Committee, the Board of Water Supply and the Water Resources Committee of the Council. The final candidate strategies and analysis are described in detail in the next section of this report.
Independent Components Considered in All Strategies

This section of the Final Candidate Strategies Report considers several resources and possible plan components that could be included in any of the final candidate strategies. These “independent components” are presented below in two categories: (1) measures that apply primarily to the DWS water system and (2) measures that apply County-wide.

**DWS System Measures**

The following measures apply primarily to the DWS system. Measures that apply more broadly are listed in a following section on County-Wide Measures.

**Demand Side Management (Conservation) Programs**

“Demand side management” (DSM) is a utility industry term for actions taken by a utility to promote conservation the utility’s customers. Originally applied to the electric utilities and applied now also to gas and water utilities, DSM options have proven to be valuable “resources” to meet utility planning objectives.

DSM resource options are usually programs undertaken by a utility to encourage the use of efficient appliances or practices by its customers or to encourage customers shift their time of use. DSM programs often provide for direct installation of efficient fixtures or appliances or use incentives such as monetary rebates to encourage purchase of efficient fixtures or appliances.

DSM programs are evaluated based on a comparison of the costs of programs to promote water savings with the costs the utility and its customers would otherwise incur to develop and operate new supply resources. For the Central District system DSM conservation programs cost less than new supply resources.

- A conservation program spending $1 million dollars per year for five years would reduce DWS expenditures by $9.4 million.
  - Capital requirements would be reduced by $4.2 million
  - Operating costs would be reduced by $5.2 million (assuming the low energy price scenario)

DSM programs at a spending level of approximately $1 million per year (for the Central District system) are included in all of the final candidate strategies. It is recommended that a DSM specialist be retained by the DWS to determine and assist the DWS to implement a portfolio of DSM programs including the following elements:

- Residential / Commercial Audit and Direct Installation Program for Indoor and Landscape Irrigation Users
- Education and publicity program to encourage water conservation and promote program participation
- Direct installation of efficient fixtures at customer premises including toilet, showerhead and sink faucet flow restrictors
- Audit of existing irrigation system equipment and practices and specific resulting recommendations to customer to improve efficiency
- Direct Installation of Targeted “High Payback” Fixtures in Commercial Premises
- High Efficiency Fixture Rebates
- High efficiency washing machines
- High efficiency toilets and waterless urinals
- Hotel Awards Program
• Building Manager User Group and Services
• Agricultural User Group and Services

There are several issues associated with utility implementation of DSM programs that should be considered from a policy perspective:

• DSM programs, if cost-effective, will reduce total customer bills (utility revenue requirements). Rates, however, will not necessarily be reduced because effective DSM lowers the amount of water produced and sold. Lowering the volume of water sold in the long term tends to increase rates since the fixed costs of the utility must be collected from fewer units of water sold.

• Program costs are supported by all utility ratepayers generally but provide more benefits to participating customers than non-participating customers. All customers benefit to some extent because DWS costs are reduced in the long term (if the DSM programs are, in fact cost-effective) but non-participating customers may not have a net benefit if DSM implementation results in higher rates. For this reason it is important that all customers have some reasonable opportunity to participate in DSM programs.

• Mandatory codes and requirements are possible alternatives or complimentary measures to DSM programs. Mandatory codes could be established that require installation of fixtures that are more efficient than existing federal standards or that restrict some types of water use. Mandatory measures are generally less expensive for the County to implement because they do not require utility expenditures on incentives to customers or program administration costs. In order to be effective, however, some programmatic enforcement measures may be required.

Supply Side Leak Detection and Reduction Measures

The DWS examines its system for leaks in transmission and distribution pipes using special equipment designed for this purpose. Contractors are available to provide services to the DWS to conduct leak detection surveys using several techniques.

Supply side leak detection and reduction is an option that is consistent with all other options under consideration and can be expected to be implemented on an ongoing basis to the extent that measures are determined to be cost effective.

Recycled Water Use Options

The Maui Department of Environmental Management (DEM) is a purveyor of reclaimed “recycled” nonpotable water in the Central District areas. The DEM produces and distributes R-1 treated water from its Kihei wastewater facility and R-2 treated water from its Kahului facility. An existing ordinance requires commercial properties to use DEM recycled water for non-potable uses if the property is adjacent to DEM R-1 distribution lines.

Some DEM recycled water displaces DWS potable water use and some displaces brackish or other non-potable water source use. Displacement of DWS potable water by recycled water reduces the water and reserve capacity requirements of the DWS Central District system. Extension of DEM transmission and distribution lines to serve additional displacement of DWS potable water uses is a viable resource option that serves several WUDP planning objectives including: Availability, Cost, Efficiency, Environment, Sustainability, and Reliability.

In one of the final candidate strategies (Maximize Conservation and Use of Recycled Wastewater) the use of DEM water to displace DWS potable water demand is a featured resource. The expansion of the DEM distribution systems to displace potable water use is consistent with and can play a constructive role in any of the final candidate strategies.
**Production Energy Efficiency Measures**

Energy use is a substantial component of DWS costs. Investments in energy efficient equipment can reduce long term costs of providing water service. Measures to increase the energy efficiency of water production are consistent with any of the candidate strategies. Specific measures are included in the Recommendations section of this report.

**Potential Power Management Services**

The DWS is the largest single consumer of electricity on the Island of Maui. Most energy consumed by the DWS is used to operate motors for pumps that lift water to storage tanks and reservoirs. The DWS water storage capacity is not generally sufficient to provide classic “pumped storage” benefits for the electrical system by “firming” intermittent renewable energy sources. The DWS system does, however, have a unique capability to provide valuable short term electric demand response needed by the island's electrical utility to manage growing penetrations of wind energy generation on the island electrical system. The more recent needs of the electrical system are for short term “stabilizing” power management capability to accommodate growing proportions of variable renewable energy sources. The DWS can potentially provide economical short term energy management services to help follow more rapidly changing “transients” as the output of renewable energy sources change during the course of each day. This capability has a value to the electric company which, if effectively implemented and negotiated, could benefit both Maui's electricity and water customers.

**Energy Production Options**

Energy production for use by the DWS is a potentially cost effective option that would be consistent with any of the candidate strategies. One specific option using water from high level tunnels to produce hydroelectric power was analyzed in the Candidate Strategies Chapter. Wind generation is being analyzed in the Upcountry District Final Candidate Strategies Report.

Energy production and energy efficiency measures serve several of the WUDP planning objectives including: Cost, Efficiency, Environment, and Sustainability.

**Water Rate Design and Pricing Policies**

The design of water rates is an effective means to encourage efficient water use. The DWS now has an inclining block water pricing structure. Each customer pays increasing rates for increasing volumes of water. This is a means to encourage water conservation because the savings to the customer resulting from reduced consumption are based on the highest price block for the customer and are thus higher than the average cost of water. This subject is discussed in more detail in the DWS Finance and System Economics Chapter of the WUDP. Specific recommendations are provided in the Recommendations section of this report.

**Exploratory / Investigative Measures**

Several potential supply resource options were identified that could ultimately contribute to the Central District DWS system but are not sufficiently proven or available to provide dependable components of current plan strategies. These options are included in each of the strategies as measures that could be further explored and/or investigated:

- Deep Aquifer Wells
- Perched Water Sources
- New Production Tunnels
- New Transmission from Existing Production Tunnels
- Directional “Deviated” Drilling
County - Wide Measures

Watershed Protection and Restoration

Watershed protection and restoration measures are consistent with all of the candidate strategies and are presumed to be part of all of the candidate strategies. These measures will be discussed in detail in a separate section of the WUDP.

Maintaining healthy forests is essential to maintaining the healthy streams and groundwater aquifers that are our source of our water supplies. These resources need protection and, in some places, substantial restoration. Healthy forests invite and capture precipitation, retain water to replenish aquifers, maintain base flow in streams, prevent soil erosion and flooding and maintain stream water quality.

The DWS currently supports watershed partnership agreements, control of invasive species that threaten watershed areas and reforestation programs.

These measures serve several WUDP planning objectives including: Environment, Sustainability, Quality, Streams, and Resources.

Stream Restoration Measures

Stream restoration measures are consistent with any of the candidate strategies and may be an integral component of some of the surface water treatment strategies. The county has supported the establishment of amended interim instream flow standards for the Na Wai Eha streams taking the position that there is sufficient water in these streams to serve a balance of several uses. Law provides that priority must be given to instream and kuleana public trust uses.

Stream restoration measures affect several WUDP planning objectives including: Availability, Cost, Environment, Equity, Sustainability, Streams, Resources, Agriculture and Culture.

Wellhead Protection Ordinance

A wellhead protection ordinance was presented to the WAC and will be described in detail in a separate section of the WUDP. A wellhead protection ordinance would limit activities in areas around potable wells that could potentially contaminate groundwater aquifers.

A wellhead protection ordinance would serve several WUDP planning objectives including: Environment, Sustainability, Quality, and Resources.

Well Development Policies and Regulation

Well development policies and regulation measures are possible options to ensure that wells are sited in suitable and preferred locations and that contracts for the development of water sources are fair and provide equitable benefits to developers and DWS customers. Provisions of a well development policy could address the following matters:

- Determination of well locations to ensure water quality, proximity to DWS water lines, minimize DWS system operation costs and provide wellhead protection and water quality
- Determination and denomination of source credits and water entitlements in source development contracts

Specific recommendations are provided in the Recommendations section of this report.

These measures would serve several WUDP planning objectives including: Cost, Efficiency, Environment, Quality, and Resources.
**Landscape Irrigation Efficiency Requirements**

A draft conservation ordinance has been drafted for consideration by the County of Maui that includes landscape irrigation efficiency requirements. This ordinance will be described in a separate section of the WUDP. The proposed ordinance would reduce future water needs by limiting landscape irrigation uses to reasonable alternatives.

The proposed ordinance would serve several WUDP planning objectives including: Availability, Cost, Efficiency, and Sustainability.

**Drought Water Use Restrictions**

Restrictions on water use during drought conditions is a demand management measure now used for the DWS Upcountry District system. If the Central District system relies increasingly on surface water sources drought water restrictions could be a means to manage water demand and reduce system costs.

Several alternative forms of drought water restrictions are possible. The restrictions now applied to the Upcountry system limit water use for each customer based on historical use volume. Another way to implement drought water restrictions would be to limit the types of uses for which water could be used during drought conditions.
Final Candidate Strategies

In previous analysis, presentations and reports various strategies were considered to meet the planning objectives for the DWS Central District. The “final candidate strategies” for the Central District represent five fundamental alternative approaches to meet projected water needs for the twenty-five year planning period. Each strategy is distinguished by a different featured major approach to meeting new water needs:

- **A. Northward Basal Groundwater Well Development**
- **B. Eastward Basal Groundwater Well Development**
- **C. Na Wai Eha Surface Water Treatment**
- **D. Desalination of Brackish Groundwater**
- **E. Maximization of Water Conservation and Recycled Wastewater Use**

In addition to these distinguishing features there are many components that are included in all the strategies. These include:

- **Existing Resources** - Resources that are currently part of the DWS Central District system
- **Committed and Near Term Resources** - New supply resources that are already in the process of acquisition, development or construction\(^2\)
  - Maui Lani Wells (2009)
  - Kupaa Well (2009)
  - Iao Tank Site Well (2009)
  - Waikapu Tank Well (2009)
  - Waikapu South Wells (2010 and 2011)
- **Demand Side Management (Water Conservation) Programs** - Based on previous and updated analysis a water conservation program is included in all strategies. The programs are designed to attain 15 percent of Central District technical conservation potential in a period of five years.\(^3\)
- **Independent Components Considered in All Strategies** - A list of independent resources and plan components that could be implemented in any of the final candidate strategies was described in an earlier section of this report. It is presumed that these components would be included in any of the strategies but are not explicitly evaluated in the economic analyses or considered in the comparisons between the final candidate strategies.

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2. The dates assumed in the integration analyses supporting this report are one year earlier based on previous estimates of project completion dates. The use of earlier dates in the analyses underestimates the degree of shortfall in water system capacity standards in the next couple of years but does not affect later years or otherwise perturb the analysis of the final candidate strategies.

3. In one final candidate strategy “Maximization of Water Conservation and Recycled Wastewater Use” more intensive conservation programs are included designed to reach 45 percent of technical conservation potential in a period of ten years.
General Characterization of Central District Strategy Analysis

All of the strategies are designed to meet the water needs of the Central District for the twenty five year planning period. Water need projections are based on the base case demographic projections that were prepared for and are being used in the current update of the Maui County General, Island and Community Plans.  

System Reliability and Expansion Criteria

In order to make meaningful comparisons of the economics of diverse resource strategies it is necessary to apply system design reliability standards that are meaningful, consistent, specific and explicit. The objective of the economic analysis is to compare different approaches to providing water supply to meet projected needs over the planning period at a standard and consistent level of service reliability.

In order to ensure that sufficient and uniform water service capability and reliability is maintained it is necessary to consider two design criteria. First, it is necessary to maintain sufficient water sources to provide the amount of water required (water production capability). Second, it is necessary to maintain sufficient equipment and infrastructure redundancy to meet maximum production flow requirements even if some equipment is out of service (system capacity). The timing of the need for additional resources is determined considering both of these criteria. Regarding both criteria, it is prudent for purposes of long range planning and economic analyses to apply some conservative assumptions to account for uncertainties regarding efficacy of resources and possible delays in implementation.

The water production capability of the existing Central System is modeled assuming that the Iao aquifer basal groundwater withdrawals are limited to 16 MGD (equal to 80% of the 20 MGD sustainable yield). This assumed level of production is lower than the currently permitted rate of withdrawal and provides an appropriate margin of conservatism to account for planning uncertainties.

The sufficiency of the system capacity of the Central District system is determined according to DWS system design reliability standards with some modifications. The modified system design reliability standards are used in conjunction with the maintaining sufficient water production capability to determine the dates that additional resources are necessary to ensure that the strategies provide sufficient and comparable levels of service reliability.

Currently the DWS Central System is deficient with respect to meeting system design capacity standards. The addition of the committed and near term resources identified above is necessary as soon as possible. With the addition of these resources, however, the DWS would have sufficient water production capacity and capability to serve its needs until the year 2012. With the addition of the DSM water conservation programs included in each of the final candidate strate-

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5. The system design standards used for planning purposes in the capacity expansion and production cost model used in the analyses presented in this section are a modification of the system standards for groundwater resources adopted collectively by the Hawaii county water departments. The standards applied here provide that sufficient installed well capacity must be maintained to supply the system day capacity (1.5 times average annual metered consumption) in sixteen hours of pumping (using two thirds of installed pumping capacity). Surface water resources are assumed to contribute to system reliable capacity based on the Department of Health capacity deration based on allowed filtration flux with one filter train out of service.

6. For a discussion of the characterization of the dates additional resources are needed, see the section later in this report titled “Uncertainty and Contingency Planning”.

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gies the next discretionary resource addition would be needed in the year 2013. Each of the final candidate resource strategies provides for the addition of new capacity by the year 2013.

**Iterative Analysis and Public Review**

The analyses supporting this report were conducted in several iterative rounds.

- **First Round - Presented to the Water Advisory Committee on January 8, 2008**
  - Resources characterized in the Candidate Strategies report were configured into more completely integrated strategies.
  - Characterization of the resource option components were updated. This included updating and refinement of energy costs, project capital costs and expected well yields.
  - Conservation, wastewater recycling and raw water storage reservoir options were examined in more detail.

- **Second Round - Presented to the Water Advisory Committee on July 23, 2008**
  - Incorporation of comments received in presentations of the first round analyses to the DWS staff, the CWRM and the Maui County Board of Water Supply.
  - Water conservation program characterization and analysis was refined. A DSM program design consultant was retained to review the analysis methods and assumptions and to make recommendations for a portfolio of conservation programs for the Maui districts.
  - Additional options and scenarios were examined including expanded raw water storage reservoir scenarios, reconfiguration and optimization of the Eastward Basal Groundwater scenarios and a scenario incorporating ditch transport of water from East Maui to the Central District system.
  - The Northward Basal Groundwater Strategy was reconfigured based on updated information regarding the hydrology and expected well yields.
  - Recent higher energy costs were incorporated in the economic analysis.
  - Capital cost and depreciation accounting methods were refined.
  - A fifty year economic study period was added to supplement the twenty-five year planning period. This was provided to more thoroughly account for the long term operation cost benefits of some of the more capital intensive resource options (large water storage reservoirs and major water transmission systems)

- **Third Round - Presented in this report**
  - Economic analysis is presented for a range of possible future energy costs.
  - Strategies were refined based on updated information, comments received and ongoing review.
  - The “Reference Strategy” from previous analyses is retained as a basis for economic comparisons but the reconfigured and updated Northward Basal Groundwater strategy resources are incorporated uniformly as follow-up resources in all strategies that require additional capacity towards the end of the planning period.
  - Additional scenarios are examined based on Water Advisory Group requests.
Optimization of the strategy configurations was re-examined based on the most recent assumptions.

A description of several more specific considerations and scenarios examined in the progressive rounds of analysis is provided in the discussion of the economic analysis for each of the final candidate strategies below.

In addition to the features and components explicitly considered in the analysis of the final candidate strategies there are several independent components (described in a section below) that can be considered for implementation with any of the final candidate strategies. These include measures that address county-wide planning objectives as well as measures to address DWS system objectives. For discussion of the independent components refer to the section above "Independent Components Considered in All Strategies."
A. Northward Basal Groundwater

Summary

This strategy features a series of basal groundwater wells located north of the current extent of the DWS Central District system in the north side of the Waihee aquifer and the Kahakuloa aquifer. The first phase of this strategy would be a substantial investment in water transmission across Makamakaole Gulch. The strategy would proceed in phases extending northward with additional wells with associated transmission, storage tanks and booster pumps:

All of the implementations of this strategy include a “basic” Demand Side Management program that is designed to attain 15% of the water efficiency technical potential in a period of five years.7

Project Design Scenarios

Several project design alternatives were explored including variations in project extent, well locations and the number, size and expected yield of wells.

Reference Strategy Versus Updated Northward Basal Wells Strategy

An initial characterization of a Northward basal well development strategy was used as the reference strategy in the previous candidate strategies analysis reported in the Candidate Strategies Central District Preliminary Draft, September 12, 2006. This strategy was selected as a reference strategy in that report because it is comprised of a series of incremental capacity additions which makes it a good basis for comparison with other strategies. The other strategies feature a single large capacity addition (such as a water treatment plant or very large transmission line) as a dominant capital expenditure.

The original reference strategy has been maintained as a reference strategy in the presentations of the economics of the final candidate strategies. The reference strategy is not, however, one of the final candidate strategies. The Northward Basal Groundwater strategy has been re-charac-

7. The DSM program portfolio included in each of the final candidate strategies is described in a separate section on this subject and in Appendix A.
terized based on updated information about hydrology and expected well yield in the north half of the Waihee aquifer and the Kahakuloa aquifer.

The initial reference strategy included three new wells in the north half of the Waihee aquifer and three wells in the Kahakuloa aquifer. The revised Northward Basal Well strategy includes twice as many, much smaller wells than the reference strategy and assumes costs that have been updated with more recent information. The revised Northward strategy is more expensive due to higher estimated project costs and lower expected production capability.\(^8\)

To summarize, in the analyses presented in this report, the original reference strategy is still used as the zero point against which differences in strategy costs are compared but is not one of the final candidate strategies. The Northward “reconfigured” Basal Well strategy is also included for reference in the economic analyses and is one of the final candidate strategies.

The final version of the Northward basal well strategy is comprised of a series of phases extending northward with additional wells with associated transmission, storage tanks and booster pumps:\(^9\)

- Maluhia (2) 500 GPM Wells - North Waihee Aquifer, North of Makamakaʻole Gulch
- Wailena (2) 500 GPM Wells - North Waihee Aquifer, Extending Further North
- Waipili (2) 500 GPM Wells - North Waihee Aquifer, Extending Further North
- Kahakuloa (4) 500 GPM Wells - Kahakuloa Aquifer, North of Kahakuloa Valley
- Waihali (2) 500 GPM Wells - Kahakuloa Aquifer, Extending Further North
- Poʻelua (4) 500 GPM Wells - Kahakuloa Aquifer, Extending Further North

Each of these phases is characterized in detail in Appendix B.

The sustainable yield of the Waihee aquifer is 8 MGD. The Northward basal well strategy assumes that 6.8 MGD would be withdrawn from this aquifer (85% of sustainable yield) including new and existing wells.

The sustainable yield of the Kahakuloa aquifer was recently lowered in the recent revision of the CWRM Water Resource Protection Plan (WRPP) from 8 MGD to 5 MGD. The WRPP states that the expected sustainable yield from this aquifer is uncertain and within a range of 5 MGD to 8 MGD. The Northward basal well strategy assumes that 4.8 MGD would be withdrawn from this aquifer.

**Policy and Feasibility Considerations**

**Kahakuloa Valley Impacts**

This strategy would transport water from the Kahakuloa aquifer for Central District use. Although there would be no wells in the Kahakuloa valley there may be concerns from local residents. Impacts in the valley would include installation of the water transmission line, access roads and power lines. County water service could be made possible to the Kahakuloa Valley with this strategy. This strategy has not been presented to or reviewed by Kahakuloa area residents.

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8. In the first two rounds of analysis of the final candidate strategies the reference strategy wells were also assumed to be implemented as follow-up resources in the other strategies when additional capacity or water production was required after implementation of the featured resources. In the analysis presented in this report any follow-up resources that are required are consistent with the revised Northward Basal Well strategy.

9. The names of most of the phases of the Northward Basal Groundwater strategy are changed from the previous Candidate Strategies report to reflect the fact that these are different well configurations and in order to more accurately match the place names of the vicinities of the areas the wells could be sited. No specific sites were identified in the analyses.
Uncertain Hydrology

The hydrology of the North Waihee aquifer and the Kahakuloa aquifer is not well investigated and the productivity of wells in this area is unproven. Well efficacy should be demonstrated prior to substantial investments in transmission across Makamakaʻole Gulch.

As noted above, the sustainable yield of the Kahakuloa groundwater aquifer was recently lowered from 8 MGD to 5 MGD. Modeling being performed by the USGS indicates that the freshwater lens of this aquifer is likely to be thinner than in the Iao and southern Waihee aquifer areas. This aquifer is therefore less promising for high production large capacity wells.

Economic Analysis

Economic analysis of this strategy was presented in the Candidate Strategies Chapter and previous presentations to the Water Advisory Committee. The updated economic analysis of this strategy is presented in this report in the section below comparing the final resource strategies.

In all of the charts showing the results of the economic analyses presented in this report the original Northward basal strategy presented in the Candidate Strategies Chapter is maintained as the “Reference Strategy” providing the “zero point” for the comparative economic charts. The reconfigured Northward basal final candidate strategy is also included for reference in all of the comparative economic charts.
B. Eastward Basal Groundwater

Summary

This strategy features a series of new basal groundwater wells in the Haiku groundwater aquifer with water transmission to the DWS Central District system. As discussed below, several alternate configurations of this strategy were considered and analyzed but were rejected in favor of the Haiku aquifer strategy. Other configurations considered included transmission and development of wells in the Honopou and Waikamoi aquifers and use of the Lowrie Ditch to transmit water to the central Maui area.

Interconnection of the Central District and Upcountry District water systems was also considered and is discussed in this section. Since the development of a Haiku aquifer wellfield for the Central District would provide close proximity of major transmission components of these two water systems interconnection could provide benefits to each system if the Haiku strategy were implemented. Interconnection in and of itself, however, does not provide a solution to the needs of the two water systems without development of new water sources.

All of the implementations of this strategy include a “basic” Demand Side Management program that is designed to attain 15% of the water efficiency technical potential in a period of five years.\(^\text{10}\)

The Eastward Basal Groundwater strategy is an expensive strategy because of the capital costs associated with the necessary transmission improvements and because energy requirements for pumping would be relatively high because of the elevation of the wells. Organized opposition to wells in the Haiku aquifer in the past led to litigation and a Consent Decree. As discussed below, several terms of the Consent Decree would have to be met before this strategy could be implemented.

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10. The DSM program included in each of the final candidate strategies is described in a separate section on this subject and in Appendix A.
**Project Design Scenarios**

**Well Field Location: Haiku vs. Honopou vs. Waikamoi**

Several variations of this strategy were analyzed to determine the optimum location for wells. An initial round of analysis was conducted to determine whether it was more economical to locate wells in the Haiku aquifer or further east in the Honopou aquifer. Wells in the Haiku aquifer would need to be located at sufficient elevation to stay above groundwater contamination from historical and existing land uses. Wells at the higher elevation require additional costs to pump water. Wells located in the Honopou aquifer would require additional transmission system costs but could be located at a lower elevation and save long term pumping power costs. The initial analysis compared Haiku wells located at 1500 foot elevation with wells located further east in the Honopou aquifer at an elevation of 600 feet.\(^{11}\)

As a result of comments received from the DWS and the Central District Water Advisory Committee a second round of analysis was conducted with several modifications. The elevation of the wells in the Haiku area scenario was changed to 1000 feet to be consistent with the minimum elevation necessary to avoid groundwater contamination. The Honopou scenario was changed in several significant ways. First, the number and size of the wells was changed in consideration of the expected characteristics of the groundwater hydrology. Lower yields are expected from each well than was assumed in the initial analysis. A larger number of smaller wells was configured. Second, the well locations were moved further east to the Waikamoi aquifer in order to avoid drilling new wells above the existing wells and springs currently in use by Honopou residents. Third, costs of the water transmission system were updated based on more recent information.

**Lowrie Ditch Water Transmission Scenario**

In response to a suggestion made by a member of the Water Advisory Committee an additional analysis was conducted to determine the economics of using the Lowrie ditch to transport water to the Central Maui area rather than the expensive transmission line. In this scenario water from the wells would be pumped into the Lowrie ditch at approximately 600 foot elevation. Water would be taken from the ditch downstream eliminating a substantial length of new transmission pipe but requiring construction and operation of a water treatment plant to bring the water to potable standards.

**Interconnection Between Central and Upcountry District Water Systems**

Interconnecting the Central DWS water system with the Upcountry DWS water system could provide benefits to the reliability and operation economics of one or both systems. The costs and benefits of interconnection of these systems were considered in the analysis of the Candidate Strategies. In particular the possibilities of (1) alternate uses of the Hamakuapoko wells, (2) expansion and interconnection of the Kamole Water Treatment Plant with the Central system and (3) dual purpose service of the East Maui basal well expansion strategy were considered. It

\(^{11}\). A 600 foot wellhead elevation was analyzed because it provides approximately the minimum elevation to provide sufficient pressure to flow to the pressure gradient of the distant Central Maui DWS system.
was determined that each of these interconnection options provided some benefits but none provided sufficient supplemental benefits to serve as the fundamental basis for a final candidate strategy.

HAMAKUAPOKO WELLS

The Hamakuapoko wells are prohibited by county ordinance from serving potable uses. These wells could provide water to the EMI Hamakua ditch, possibly in trade for raw ditch water withdrawn by the DWS at other locations and/or times. This trading arrangement could provide additional potable production capability to the extent that it would allow the DWS to withdraw additional raw water from the EMI ditch system for either treatment for potable use or to displace use of existing uses of DWS potable water for irrigation uses. This option is potentially valuable as a reliability contingency measure during times of drought when Wailoa/Hamakua ditch flows are restricted but it is not otherwise cost effective due to the costs of pumping the basal groundwater from the Hamakuapoko wells to the elevation of the Hamakua ditch. This option would not provide sufficient additional effective water source to serve as the fundamental basis for a final candidate strategy.

EXPANSION AND INTERCONNECTION OF THE KAMOLE WATER TREATMENT PLANT

Expansion and interconnection of the Kamole Water Treatment Plant with the Central system could provide a limited amount of additional redundancy of production equipment for the Central system and the Upcountry system (with the addition of sufficient additional booster pumps). The amount of this contribution is limited, however, because there would be some extended periods of time when all available source water to the Kamole WTP would be needed for existing source needs for the Upcountry system.

Some economic benefit would also result during times that ample water is available in the Wailoa ditch (supplying the Kamole WTP) that could serve the Central system and displace more expensive Central system resources. The costs of expanding the Kamole WTP, however, exceed these system operation efficiency benefits (even without considering the costs of necessary interconnecting transmission improvements).

Because the amount of water available to the DWS is ultimately limited by the flows in the Wailoa ditch and this capacity is currently relied upon to meet existing and future needs of the Upcountry system, this option would not provide any substantial additional new water sources that would effectively meet new water demands on either system.

DUAL PURPOSE SERVICE OF HAIKU AQUIFER BASAL WELLS

One of the final candidate strategies for the DWS Central District is development of a series of wells at approximately 1000 foot elevation in the Haiku aquifer with new transmission to the Central system. Implementation of this strategy would provide a relatively inexpensive means to interconnect the Central and Upcountry systems due to the proximity of substantial capacity transmission piping.

Interconnection could provide a limited amount of additional redundancy of production equipment for the Upcountry system with the addition of sufficient additional booster pumps. This is of limited value, however, since the Upcountry system is not limited by equipment redundancy but is limited instead by drought period source water availability. New resources planned for the Upcountry system are necessary to provide a reliable source of water during times of low production capability of the surface water sources during periods of drought. With the exception of booster pump capacity, the Upcountry system already has sufficient equipment capacity redundancy.

Interconnection would not provide substantial new drought period source water capability for the Upcountry system. The Haiku wells are relied upon in the Central District strategies to provide new effective source water production for the Central system. For periods of short duration,
other water sources on the Central system could provide supplemental production to make up for water that would be required from the Haiku wells to meet upcountry needs. This would not be possible, however, for moderate or extended drought periods which typically last several months per year.

Interconnection would also provide economic benefits during times that ample water is available in the Wailoa ditch (supplying the Kamole WTP) that could serve the Central system and displace more expensive Central system resources. The costs of expanding the Kamole WTP for this purpose, however, exceed these system operation efficiency benefits (even without considering the costs of necessary interconnecting transmission improvements). It would not be economical to use treated water from the Lower Kula system or Upper Kula system to serve Central system needs. This would be possible only during wet winter months with ample surface water source flows and when upcountry storage reservoirs are full. These times tend to coincide with periods of minimum demand and lowest production costs on the Central system.

Although there are benefits to interconnecting water systems, interconnection of the Central and Upcountry systems would not, in itself, avoid the need to develop new water sources for both of these systems. Interconnection could provide a limited amount of additional redundancy in system capacity (equipment) but both systems are in need of new sources of water to meet growing water demand.

**Policy and Feasibility Considerations**

**Compliance with EMPLAN Consent Decree**

The 1990 Maui County WUDP identified the development of wells in the Haiku aquifer (and associated water transmission) as a featured strategy to supply water to the Central District system. A concurrent East Maui Water Study was commissioned to develop this strategy. The draft 1992 WUDP update (never adopted) also featured this strategy as the primary means to provide new Central District water supply. The project, named the East Maui Water Development Plan (EMPLAN), moved forward with preparation of an environmental impact statement (EIS) and a supplemental EIS which were challenged in court. The court case was settled between the plaintiffs and the County by a Consent Decree.

The County is bound by a list of terms specified in the EMPLAN Consent Decree including the following:

- Only Phase I of the EMPLAN will be implemented until a completely new EIS is prepared. This includes construction of the Hamakuapoko wells and limited transmission connection to the Central District system.
- The County will not develop groundwater in an agreed upon portion of the East Maui region until a rigorous cost / benefit analysis is performed which shall, among other things, address planning for stream restoration in the agreed upon region.
- The County will “rigorously investigate and pursue the availability of surface water” from the Waikapu, Iao and Waihee areas including a rigorous cost / benefit analysis.
Any new groundwater development projects in the agreed upon East Maui region will be consistent with the County WUDP and the State Water Code.

The County will work with the USGS and plaintiffs to develop a test well to determine whether development of groundwater resources in the agreed upon East Maui region would affect surface water resources in the region.

As long term agricultural water needs are reduced, a stream restoration program will be studied, developed and initiated by the County.

Compliance with the terms of the EMPLAN Consent Decree would be necessary prior to development of wells within the EMPLAN area. This area is shown on the map above.

**Potential Impacts of Groundwater Pumping on Existing Wells, Springs and Uses**

In both the Haiku and Honopou aquifer areas there are existing wells, springs and surface water sources used by residents. Impacts of basal groundwater pumping in these areas upon these existing uses must be considered. Substantial concerns were raised by residents in these areas at the Water Advisory Committee meetings.

The impacts of basal groundwater pumping on down-gradient wells, springs and surface water sources in the Haiku aquifer have been debated previously in several venues including agency and judicial reviews of the environmental assessments and environmental impact statements for the East Maui Water Plan. There are strongly held beliefs and no broad consensus regarding these potential impacts.

There has been substantially less discussion of impacts of basal well pumping in the Honopou aquifer. The hydrology of the Honopou aquifer differs from the Haiku aquifer in several respects. It is expected that the basal water lens is thinner in this area and expected well yields would be substantially lower for the wells contemplated at an elevation of approximately 600 feet. There are established uses in this area by residents at low elevations that could be affected by up-gradient wells.

**Acceptance by East Aquifer Area Residents**

At Water Advisory Group meetings substantial and passionate concerns were raised by Haiku and Honopou aquifer area residents regarding the impacts and propriety of developing basal groundwater wells in these aquifers. Concerns were expressed about impacts on area residents (discussed above) and regarding pumping water from these areas to serve distant uses.

Honopou area residents expressed frustration that they have suffered from decades of surface water diversions from the streams in their vicinity to support irrigation uses in the Central Maui area. The prospect of developing basal wells in these aquifers to serve additional uses in central Maui raised considerable concern and objections.

In order to address concerns from Honopou area residents the Honopou aquifer scenario of the Eastward Basal Groundwater strategy was reconfigured to reach beyond the Honopou aquifer to the Waikamoi aquifer in an area with fewer existing down-gradient uses. This alternate scenario may not fully address the concerns of the Honopou area residents.

Acceptance by east aquifer area residents is both a policy and a tactical concern. The merits of concerns of the residents of these areas should be considered as a matter of policy. The passion of opposition of area residents and the potential for organized opposition to projects in these areas should also be considered as a tactical concern.

**Efficacy and Water Quality of Wells at 1000 ft. Elevation**

It is presumed in the economic analyses that wells at the 1000 ft. elevation in the Haiku area will be productive and that they will be free of contamination from DBCP and other toxic chemicals.
used in the area in the past. Although the efficacy and the water quality at this elevation in this area are expected to be acceptable this is yet untested.

**Capital Cost Financing**

Development of basal wells in the Haiku, Honopou or Waikamoi aquifers would require substantial capital investments for water transmission improvements. Since completion of the major water transmission components of the strategy is necessary before any substantial water production could benefit the Central District system it is not possible to effectively “phase” the installation of water transmission. The full capital requirements of the strategy would have to be provided at the onset of implementation.

**Economic Analysis**

The economic analysis of the Eastward Basal Groundwater strategy was conducted in several iterative rounds. Analysis of wells in the Haiku area at 1500 ft. elevation and wells in the Honopou area at 600 ft. elevation were examined and presented in the Candidate Strategies Chapter. In later analyses several additional scenarios were examined including wells at a lower 1000 ft. elevation in the Haiku area, wells further east in the Waikamoi aquifer and use of the Lowrie Ditch to transmit water to the Central Maui region. These scenarios are described above. Alternate assumptions regarding possible future power costs were incorporated in several rounds of analysis. In the analyses presented in this report strategies are characterized for two alternate electric power cost scenarios representing lower and higher future energy prices.

Economic analysis of the final resource strategies was performed using an integrated resource analysis model that was configured for the Central District system.

The results of the economic analyses are presented in charts that show the net present value of total DWS Central District system costs over a fifty year study period. The charts show the net present value of the following cost categories for each of the strategies:

- **Variable Operating Costs** - These are operating costs that vary as a direct function of the amount of water produced by each of the resources in the analysis in each year of the study period. These are primarily energy costs and costs for purchase of source water where applicable.

- **Fixed Operating Costs** - These are operating costs that change with the addition of new resources but are not directly affected by the amount of water produced by each resource. These costs include the costs of maintaining and operating the existing system and new resources as they are added to the system, including labor, and an apportioned share of DWS administrative operations and repair expenses.

- **Capital Costs** - These are the amortized capital carrying costs of the Central District system, including capital carrying charges (interest and depreciation) for new resource assets and depreciation and replacement costs for existing system assets.

- **DSM Costs** - These are the total costs of implementing demand-side management (water conservation) programs, including the full measure and installation costs (whether born by the program participant or by the utility and including any utility incentives) and costs to administer the programs.

- **Total Costs** - These are the sum of the four categories of costs listed above.

Two types of charts are presented:

- Total 50 year study period costs for each strategy
- Differences in 50 year study period costs with respect to a reference strategy

The first chart shows the total costs for the DWS Central District system for the fifty year study period. Later charts show the same data presented as differences for each cost category for
each strategy compared to a reference strategy. This format focuses on the differences between the strategies and makes differences easier to see. It is important to remember, however, that the costs represent total DWS system costs, not only the costs of the featured resources in each strategy.

The two strategies presented at the left of each chart are identical in all of the charts presented. The first strategy at the far left is the “Reference Strategy”. This strategy provides the “zero point” for all of the charts that present costs as differences from the reference strategy. The second strategy from the left is the “Northward Reconfigured” basal well development strategy. This strategy is one of the final candidate strategies and is provided in all of the charts as a standard basis of comparison and to indicate a reference for the magnitude of costs portrayed.12

Two charts are presented for each set of strategies that represent alternate energy cost scenarios. During the time in 2008 that the final candidate strategies were analyzed and presented to the Water Advisory Committee, the cost of electrical power changed dramatically as crude oil prices increased from about $60 per barrel to $140 per barrel and then decreased again to about $60 per barrel. Energy costs are a significant component of the total costs of the DWS system. In order to consider the uncertainty regarding future energy costs a “low” energy cost scenario (starting at $75 per barrel) and a high energy cost scenario (starting at $125 per barrel) are pre-

12. This is convenient since the scale of charts varies considerably depending on which strategies are included in each chart.
Alternate Eastward Basal Groundwater Strategies

“Low” Energy Price Scenario: $75/bbl 2008 Equiv. Electric Power Costs Escalated at 1.0 % (Real) per Year

sent for each set of candidate strategies. In each scenario energy costs are assumed to increase at a rate 1% higher than the rate of general inflation.\(^\text{13}\)

Alternate Eastward Basal Groundwater Strategies

The chart above shows the net present values for the DWS Central District system over a fifty year study period (2005 - 2055). Variable operating, fixed operating and capital costs are all substantial components of total costs in all strategies. The cost of the DSM (conservation) programs included in each of the strategies is a small component of costs.

The differences between the cost components of the strategies is discernible but is more clearly seen in the following chart that shows the same data presented as differences with respect to the Reference Strategy shown at the far left.

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\(^\text{13}\). In addition to the analyses presented in this report several alternate assumptions regarding future energy prices were examined.
The chart above shows the same data as the previous chart except all costs are portrayed as differences from the Reference Strategy costs at the far left. The “Northward Reconfigured” strategy is provided as a reference. Four strategies are shown for comparison in the center and right side of the chart.

The center two strategies are the Haiku Wellfield strategies featuring a series of eight basal wells in the Haiku aquifer with transmission to the Central District system. The difference between these strategies is the location and elevation of the wells (1500 ft. and 1000 ft.) which primarily affects variable operating costs (electrical energy for pumping) and to a lesser extent affects transmission capital costs. Locating the wells at the lower 1000 ft. elevation is more economical due to the lower electrical pumping costs.

The two strategies at the right are the Waikamoi Wellfield strategies with wells located at 600 ft. elevation further east in the Waikamoi aquifer. The Waikamoi strategy has substantially lower electrical pumping costs due to the lower elevation of the wells but this is much more than offset by the higher capital costs of transmission to the farther Waikamoi aquifer. The rightmost strategy features the Waikamoi wellfield using the Lowrie Ditch to transfer water to a water treatment plant in the Central Maui area. This strategy has lower transmission costs than the Waikamoi strategy shown to its left but also has the additional capital and variable and fixed operating costs associated with constructing and operating the water treatment plant.

The Haiku wellfield strategy with wells at an elevation of 1000 ft. is the most economical of the Eastward Basal Groundwater options shown. This strategy is used to characterize the Eastward Alternate Eastward Basal Groundwater Strategies
“Low” Energy Price Scenario: $75/bbl 2008 Equiv. Electric Power Costs Escalated at 1.0 % (Real) per Year
Basal Groundwater strategy in the comparisons of the final candidate strategies in the following section of this report.

The chart above shows the same strategies as the previous chart except that higher energy costs are assumed. The electrical costs assumed in the analyses shown on this chart are the “high” energy cost scenario. These costs reflect crude oil prices of $125 per barrel in 2008 ($0.34 per KWH marginal cost in the high power consumption block for large customer MECO Schedule P tariff) assumed to escalate at 1% per year in real terms (1% higher than general inflation).14

The higher electrical power costs shown on this chart make the cost advantages of the lower elevation wells more pronounced. The 1000 ft. Haiku wellfield strategy shows more economy compared to the higher elevation 1500 ft. Haiku wellfield strategy. The Waikamoi wellfield strategy with 600 ft. elevation wells is less expensive than the 1500 ft. Haiku wellfield due to the increased magnitude of energy costs savings from the lower well elevations. The Haiku wellfield at 1000 ft. elevations remains the most economical strategy assuming the higher energy costs.

14. The marginal power costs included in the variable costs do not include customer charge and demand charge components of electricity bill. These components of electrical costs are included in fixed operating costs.
C. Na Wai Eha Surface Water Treatment

Summary

This strategy features one or more water treatment plants using surface water from the areas of the Na Wai Eha streams. These four streams flow eastward from Mauna Kahalawai (the West Maui Mountain): Waikapu, Iao, Waiehu and Waihee Streams.

Several alternate implementations of this strategy were examined including several treatment plant locations, operational configurations and storage reservoir alternatives. These alternatives were examined to consider alternate scenarios regarding possible water source agreements, financing options, source water costs, future energy prices and study period assumptions.

All of the implementations of this strategy include a “basic” Demand Side Management program that is designed to attain 15% of the water efficiency technical potential in a period of five years.\(^\text{15}\)

This strategy is perhaps one of the least expensive alternatives but is not viable until a long term source of water is confirmed and the price of the source water is determined. These uncertainties may not be resolved for several years. This strategy would use water for municipal uses that would otherwise be available for agricultural and landscape irrigation uses.

Treatment Plant and Reservoir System Alternatives

There are several possible implementations of water treatment using water from the Na Wai Eha streams. These are discussed below.

Treatment Plant Location

Two water treatment plant locations were considered.

Waialae Water Treatment Plant: One alternative is the water treatment plant proposed by Alexander and Baldwin (A&B) at the site of its existing Waialae raw water reservoir. Design engineering for this water treatment plant is essentially complete and contract negotiations with the County have been ongoing. This alternative would use water from the Waihee Ditch systems.

\(^\text{15}\) The DSM program included in each of the final candidate strategies is described in a separate section on this subject and in Appendix A.
Waihee Water Treatment Plant: A second alternative location that was analyzed is a generic unspecified site on the Waihee Ditch system north and “upstream” of the urbanized Wailuku area. There is no specific current proposal for a water treatment plant at this location. This site was considered in light of several features. It would avoid some water contamination issues associated with the Waiale WTP which would use water transported in open ditches through urban areas. Analysis of this site also measures the economic advantages of using a higher elevation site which would require less energy to pump water to the Central system hydraulic gradient pressure.

Because the Waiale WTP is essentially fully engineered and is characterized in substantial detail it is used as the basis for characterizing the construction and operation costs for water plants in the Na Wai Eha area. In order to focus on the merits of the two alternate sites, assumptions regarding the type, size and engineering of the water treatment plants was kept the same for both sites. Only parameters that differed due to the siting of the water treatment plants were distinguished in the analysis.16

A Lowrie Ditch Water Treatment Plant is considered in the Eastward Basal Groundwater Well Development strategy. As characterized in that strategy the WTP would be used to treat water produced by wells in the Waikamoi aquifer transported to the Central District via the EMI Lowrie Ditch. One alternative scenario that was examined but is not further characterized in this report is using water from the Lowrie Ditch from existing stream diversion sources as a source of raw water for a WTP for the Central District. The costs of this option are greater than a WTP located at the Waiale site, would require a reservoir to provide reliable capacity and would use water for which there is no agreement with EMI.

Economic analysis of alternate locations is presented later in this section.

Assurance of Long Term Availability of Source Water

The County of Maui does not currently control the surface water from the Na Wai Eha streams. The primary diversions and ditch systems in the Na Wai Eha area are owned and controlled by the Wailuku Water Company and its new subsidiary, the Wailuku Water Distribution Company, LLC. (referred to collectively here as: WWC).

In order to build and operate a water treatment plant for reliable potable water service to the DWS system some guaranteed assurance of a long term supply of source water is necessary. There are several ways the County could possibly assure a long term supply of water but none are certain:

- The County could possibly negotiate a long term water supply agreement with WWC.
- The County could possibly acquire title to the Na Wai Eha diversion and transmission appurtenances from WWC by negotiated purchase or by eminent domain.17
- The County could seek and possibly obtain an allocation of water for its proposed municipal use from the CWRM in the process of the recent establishment of the Na Wai Eha area as a Surface Water Management Area. Note that an allocation from

16. In the previous Candidate Strategies Chapter analyses, the costs and operating parameters of the Waihee water treatment plant option were characterized based on engineering feasibility and economic studies for a water treatment plant at a site at Reservoir 37, performed for C. Brewer & Co. Water Master Plan Report performed by Mecalf & Eddy. The size and configuration of the “Brewer” water treatment plant were different than what is being considered for the Waiale WTP. For analysis using the Brewer plant size and configuration see the Candidate Strategies Chapter.

17. The County previously budgeted $7 Million towards acquisition of the Na Wai Eha diversions and initiated the initial steps of a process to acquire the diversions by eminent domain. This appropriation has expired. Depending upon resolution of water prices by the Public Utility Commission, acquisition of the Na Wai Eha diversion and transmission by the County could reduce long term costs of this strategy.
the CWRM would also be necessary in conjunction with either of the two cases above.\textsuperscript{18}

The means and terms of assurance of a long term source of water from the Na Wai Eha streams affect several aspects of this candidate resource strategy. These include the cost of source water, the reliability of the water treatment plant and the need for and costs associated with building raw water storage reservoir capacity. This is discussed further below.

**Source Water Cost**

The cost of source water for the Na Wai Eha water treatment plant options is a major factor in the cost effectiveness of this strategy to meet future DWS potable water needs. A number of scenarios was examined with a range of alternate water costs. Most of the scenarios evaluated in the final candidate strategy analyses assume that water would be provided at a fixed or escalating price, presumably according to a water source agreement or a tariff established by the Hawaii Public Utility Commission. The cost of source water is a dominant but uncertain factor. For example, at a price of $0.30 per thousand gallons of source water the Na Wai Eha water treatment strategies are among the least expensive strategies. At the price of $0.90 per thousand gallons (the price WWC proposes in its application for a certificate of public convenience and necessity with the Public Utilities Commission) the same water treatment strategies are among the more expensive strategies. Charts showing a comparison of total system costs assuming different raw water source costs is presented later in this section.

For the scenarios which assume substantial investments by the County for large raw water storage reservoirs, the unit cost of source water is presumed to be zero. These scenarios include instead the extensive capital costs to provide storage and transmission to create a reliable water source for water treatment facilities utilizing water available in high stream flow conditions (giving base flow preference to instream uses according to instream flow standards and preference to existing agricultural diversions).

**Base Steam Flow Operation vs Raw Water Reservoir Storage**

The means and circumstances of assuring a long term reliable source of water supply will affect the reliability, treatment system operation protocols and the need for long term raw water storage. If priority uninterrupted access to sufficient base flow from the ditch system is assured, a water treatment plant could provide reliable capacity for the DWS system without additional raw water storage. Without such reliable access, either sufficient raw water storage would have to be built or the water treatment facility would not provide reliable capacity to the DWS system.

Reliable priority access to the ditch system base flow would depend on a conjunction of several as-yet uncertain conditions. First, either by acquisition of ownership of appurtenances or by long term water source agreement, the DWS would have to gain uncontested priority control of sufficient ditch base flow to provide a reliable supply of water to the water treatment plant. Second, there would have to be sufficient base flow in the ditch system after any amended interim instream flow standards (or permanent instream flow standards) are established by the CWRM. Third, the DWS would have to obtain a sufficient allocation of water from the Na Wai Eha streams from the CWRM for the intended municipal uses of the treated water. None of these conditions have been established with any certainty and some may not be established for several years.

\textsuperscript{18} An allocation of water from the CWRM for County municipal use is identified here as one method to assure a long term supply of water for a water treatment plant. A CWRM allocation would also be necessary in conjunction with either of the two other methods cited. Unless there is an allocation of water by the CWRM for treatment for municipal use, neither acquisition of title to the diversion appurtenances nor a long term water agreement would assure a reliable long term supply of water. Water available for agricultural and municipal uses may also be affected by amended interim instream flow standards or the establishment of instream flow standards.
Unless priority access to sufficient ditch system base flow is provided, raw water storage capacity would be necessary to enable a water treatment plant to provide reliable potable water supply for the DWS system. Building new reservoir capacity, however, is expensive.

The necessary reservoir capacity for a WTP with an average output of 9 MGD (the size of the proposed Waiale WTP) would depend upon several factors, primarily the amount of water and the flow profile of water available to the WTP system. Necessary reservoir capacity would vary between zero and over one billion gallons depending upon available source water supply availability characteristics. Recent cost estimates for a new lined reservoir in the Central Maui area are about $0.11 per gallon, or about $110 million for a one billion gallon reservoir.

Several analyses were performed to determine the necessary reservoir size for alternate source water availability assumptions. Costs of these strategy alternatives were determined and compared. See discussion in the Economic Analysis section below.

**Reservoir System Design and Operation Objectives**

A water treatment plant could be designed and operated to provide several types of benefits for the DWS water system.

**Design and Operation for Maximum Reliable System Capacity**

A surface water treatment facility could be designed and operated to optimize the amount of reliable capacity provided to the DWS water system. The operation of the system would prioritize maintaining substantial reservoir levels to ensure adequate water supply during potential extended durations of low stream flows. A primary benefit of operating a reservoir to maximize reliable capacity would be deferral of other capital improvements that would otherwise be necessary to provide equivalent reliably capacity.

**Design for Reducing Groundwater Withdrawals**

An alternative objective in Central District surface water system design and operation would be maximization of treated water use to reduce groundwater withdrawals. The operation of the system would maximize production of treated water whenever water is available in the reservoir. A benefit of this operational protocol would be maximizing the reduction of groundwater withdrawals. If the variable costs of providing treated water are less than the costs of pumping groundwater sources, this operational protocol would reduce system operation costs. The variable costs of providing treated water would depend primarily upon the cost of source water for the water treatment plant.

Maximizing reservoir capacity is consistent with furthering either of the operation objectives identified above. The cost effectiveness of providing ample reservoir storage, however, depends on different factors in each case. Several alternate reservoir operating protocols were examined in the analysis of the economics of Na Wai Eha raw water storage options.

**Project Financing Alternatives**

There are several alternatives by which water treatment plants and associated reservoirs and transmission improvements could be owned and financed:

**Project Design, Construction, Ownership and Operation - DWS vs Developer**

A water treatment plant (and/or reservoir) could be constructed, owned and/or operated either by the DWS or by a project developer. Some combinations are possible. For example, according to the proposal under discussion for the Waiale WTP, the project would be designed and constructed by A&B. Upon completion of the WTP ownership would be transferred to the DWS and the plant would be operated by the DWS.

It is presumed that, generally, a private project developer could construct a water treatment plant in less time than the County. In the specific case of the A&B proposed Waiale WTP initial steps
are already in process. Design for the proposed plant is essentially complete and contractual terms have been discussed with the County.

A water treatment plant could be owned and operated by the plant developer or transferred to a third party or the County. If the plant would not be operated by the County, the water produced by the plant either would be sold to the County or would be distributed to users by an independently developed water transmission and distribution system\(^\text{19}\).

**Project Capitalization**

A water treatment plant could be financed by several methods. The County could provide all necessary financing. Financing could be provided by a project developer. Financing could be shared. Some of the financing (or project funds outright) could be provided by State or Federal sources.

The method of financing affects costs to the County and DWS customers. Clearly any financing or project funds provided by the State or Federal government could reduce costs to the County and DWS customers. Financing by project developers may reduce or may increase costs to the County and DWS customers depending upon the terms of contractual agreements. This is discussed further below.

To the extent that it is has been publicly disclosed, the evolving proposal for the Waiale WTP that is under consideration provides that A&B would finance one half or two thirds of the project costs. A&B would be reimbursed by the County by provision of “source credits” good towards payment of the source component of the System Development Fees due for obtaining water meters for future land development projects by A&B. It is not clear what entitlements or priority access to acquiring future water meters would be included in the contract.

**Policy and Feasibility Considerations**

**Water Allocation Issues**

There are two general water allocation issues regarding use of water from the Na Wai Eha streams for treatment for potable DWS use. First, two proceedings that will allocate water from these streams are currently underway by the CWRM. Second, use of water from these streams would decrease the amount of water that would otherwise be available for agricultural and other uses. These issues are discussed briefly below:

**CWRM ALLOCATIONS OF NA WAI EHA STREAM WATER**

The CWRM has two proceedings now underway that will formally determine allocations of water to Kuleana, instream, agricultural and municipal uses:

- **Petition for Amendment of Interim Instream Flow Standards:** A contested case before the CWRM to consider amending the interim instream flow standards for the Na Wai Eha streams is in progress. The evidentiary hearing phase of the proceeding has been concluded and parties will next prepare briefs. A proposed order is expected from this contested case sometime in 2009 with a final decision and order from the CWRM possibly by the end of 2009.\(^\text{20}\) It is very possible that any decision by the CWRM may be appealed to the Hawaii Supreme Court.

- **Designation as a Surface Water Management Area:** The Na Wai Eha streams have been designated as a surface water management area by the CWRM. This designation initiated a process that includes a one year period of time for existing users to file

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\(^{19}\) In order for a non-County entity to sell water directly to “general public” customers it would have to become a public utility regulated by the Hawaii Public Utility Commission.

\(^{20}\) This time line is an estimate by HDA.
claims with the CWRM followed by a process to allocate water to existing and new uses. A final decision and order from CWRM designating water for a new water treatment plant (as contemplated by the strategy outlined in this section) would certainly not be made before 2010 and would more likely be made in 2011 or later.\textsuperscript{21} It is very possible that any decision by the CWRM would be appealed to the Hawaii Supreme Court.

In its decision regarding interim instream flow standards the CWRM will determine allocations of water for Kuleana and instream uses versus the amount of water that is allowed to be diverted from the streams for off-stream uses. In its decisions in the designation of the surface water management area and in ongoing decisions as an authority overseeing the surface water management area, the CWRM will determine allocations of water diverted from the streams to competing off-stream users as well as ongoing allocations for Kuleana and instream uses.

Water from the streams that is currently used by the DWS for treatment at the Iao Water Treatment Plant would be considered an existing use and would be given some priority over new uses. Water for a new water treatment plant would be a new use and would defer, at least to some extent, to existing uses. On the other hand, DWS municipal use would also likely be considered a reasonable and beneficial use and, to the extent water would be used by DWS to serve domestic uses, could be considered a public trust use. In this respect it may ultimately be given some priority in allocations by the CWRM.

In considering this strategy the uncertainty and timing of expected allocations should be considered. There is not currently a guaranteed long term source of water for a new water treatment plant using water from the Na Wai Eha streams. CWRM determinations regarding allocations of water will not be finalized for several years.

**AGRICULTURAL, LANDSCAPE AND GOLF COURSE IRRIGATION VERSUS MUNICIPAL USE OF STREAM WATER**

Water diverted from the Na Wai Eha streams is currently used for agricultural, landscape and golf course irrigation uses (off-stream irrigation uses) with some existing use by the DWS for treatment for potable municipal uses. The Na Wai Eha water treatment strategy outlined in this section would increase the amount of water from the streams for DWS municipal uses. This strategy would therefore decrease the amount of water ultimately available for off-stream irrigation uses after in-stream and kuleana uses are provided for.\textsuperscript{22} In this respect this strategy is different from the other final candidate strategies which would provide new potable water supplies without substantially decreasing the amount of water available for other uses.\textsuperscript{23}

The variations of this strategy that incorporate large raw water storage to capture high stage stream flows for municipal uses would substantially mitigate the impacts on existing agricultural uses.

As a matter of policy, the impacts of this strategy on the amount of water available for other uses should be considered in weighing it merits against other strategies.

\begin{itemize}
\item[21.] This time line is an estimate by HDA and presumes that there will be a contested case hearing.
\item[22.] Several versions of the Na Wai Eha water treatment strategy consider using large raw water storage reservoirs to capture water during high stream flow events. This approach would decrease the impacts of using additional water from the streams on other uses. If the new treatment plant is to provide reliable potable supply, however, there will be some water taken from the streams that would otherwise be available for other uses unless the amount of additional treated water is small or unless the new raw water reservoir capacity substantially exceeds one billion gallons.
\item[23.] To some extent any use of water could be argued to affect other uses. Groundwater withdrawals, for example, can affect down-gradient surface and groundwater availability and fresh water flow to the ocean.
\end{itemize}
Capitalization, Credits and Entitlements

Generally speaking, there are two distinguishable instruments of property created in contracts for developer financed water source projects.

SOURCE CREDITS

First is a “source credit” which is a “fiscal” credit good towards payment of the source component of the system development fee which is required to obtain a new water meter account with the DWS. Depending upon the terms of the applicable contract, source credits may or may not be tradable to other parties and may or may not expire at a determined date. Source credits can be denominated either in terms of a specified number of water meters (or meter equivalents) or in terms of a specified amount of dollars towards payment of system development fees.

ENTITLEMENTS

The second instrument created in contracts for source development is an “entitlement” to obtain water meters from the DWS upon demand and to obtain certification by the DWS director that the developer has provided or shown that there is a water source consistent with requirements of the County Code. Depending upon the terms of the applicable contract, any entitlements may pertain to specific land developments identified in the contract, may or may not be tradable and may or may not expire at a determined date.

Entitlements may be calculated or conjoined with source credits in the language of the contract terms but are nevertheless a distinguishable instrument of property and a distinguishable policy consideration. Source credits are a financial instrument good towards payment of a future source development fee. Entitlements are an obligation by the DWS to provide a DWS water meter (and/or a “verification” of availability of water source) upon demand of the holder at some future date.

The source credits and entitlements created in source development contracts are both real DWS liabilities. Although these liabilities are not documented in DWS standard accounting reports they are necessary to consider in the economic assessment of the candidate resource strategies. The disposition of source credits is necessary to consider in the calculation of DWS capital costs, depreciation and debt service. Entitlements are important to consider in determining applicability of the resource capacity and water production to meet projected system water demands.

In the analyses presented in this report it is presumed that the capacity and production capability of a resource financed by a source developer by contract will be available to meet projected DWS system water demands. It is also presumed that capitalization of the water treatment plants would be financed by the DWS. If the water treatment plants are financed by a source developer by contract with the DWS it is probable that a different stream of costs would result.

From the perspective of the County, the DWS and its customers, the costs or benefits of private developer project financing depend upon specific contract terms, particularly the terms that specify how the source credits are to be denominated. Source credits are credits towards payment for the source component of DWS system development fees. Source credits are most often denominated in terms of a specified number of water meters (or 5/8” water meter equivalents) or a specified number of gallons per day credit towards land development requirements. These means of denomination are also typically applied to contractual water entitlements.

As an alternate approach, source credits could be denominated as a specified number of dollars credit towards system development fees charged for new water meters. This would have two advantages for the DWS. First, it would ensure that, if source development fees increase, the value of the source credits (like dollars) would not appreciate at the expense of other new DWS customers. Second, if source credits are tied to the costs of development of new sources, this would remove the incentive for source developers to develop only the cheapest sources and
would remove the disincentive for source developers to provide sources desired by the DWS that might be more expensive, on a capacity unit basis, in terms of capital costs.

Several scenarios regarding alternate project capitalization arrangements were analyzed to determine the relative costs and benefits to the County and DWS customers. For the Waiale WTP, if the project is financed half by A&B (the project developer) and half by the DWS, the County (and DWS customers) would save about 13% compared to full DWS financing assuming that the cost of the DWS system development fees does not increase.24 If the DWS system source development fees increase significantly, developer financing could be more expensive to the County and its customers than full DWS financing.

The relative costs and benefits of developer versus DWS financing of projects other than the Waiale WTP may be very different due to several factors. One factor is the fact that the project costs are not necessarily a direct function of project production capacity whereas the source credits are typically denominated in terms of project production capacity. In other words, the value of a source credit to the developer (and the equivalent liability to the DWS) is not directly related to the project cost. Another factor is that the value of the project to the DWS system is not always directly related to the project production capacity or its capital cost. For example, a source that is expensive to operate is not as valuable to the DWS as an source with equivalent capacity that is economical to operate.

From a policy standpoint, it is important to keep in mind that when a project developer “pays” for all or some portion of a project and receives source credits towards system development fees, the developer is really only providing financing for the project, not funding the project. The potential benefit to the DWS and its customers is the savings that accrue from having to borrow less money to build the project. This benefit is offset by the decreased stream of revenue from system development fees when source credits would otherwise be redeemed. The extent to which project financing ultimately is a benefit or a cost to DWS customers depends upon a number of factors including the rate at which the source credits are used, how the source credits are denominated and whether system development fees increase in the meanwhile.

Reservoir Land Use and Land Acquisition

Construction of a large storage reservoir would require a substantial parcel of land. It is most economical to site a reservoir at an optimum location along the hydraulic gradient of the water source and transmission conduit. Availability of land for optimal reservoir siting is challenging in the area of the Waihee ditch system upstream of the Wailuku urbanized area.

Construction of a large storage reservoir in this area would require careful review of environmental impacts and impacts on cultural resources.

Non-Point Source Pollution in Developed and Urbanized Areas

The Waiale reservoir WTP location would use water transported in open ditches through some developed and urbanized areas. Some of the runoff from these areas enters the ditch system. The lower Spreckels Ditch runs through more urbanized areas than the higher elevation Waihee Ditch. Some system improvements may be required to limit these components of non point source pollution by preventing runoff from entering the ditches and/or to limit the source water for the WTP to the Waihee Ditch. Locating the WTP at a location upstream of the developed and urbanized areas would mitigate this issue.

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24. This analysis also assumes that the source credits would be denominated as a specified number of meters, meter equivalents and that the source credits would be used at the same rate as general development growth in the overall DWS Central District.
Environmental Impacts

Construction of a water treatment plant could have associated environmental impacts depending upon the location. Neither of the locations discussed above are in particularly sensitive areas.

Economic Analysis

The economic analysis of the Na Wai Eha water treatment strategies was done in several iterative rounds. Analysis of various water treatment plant scenarios is documented in the Candidate Strategies Chapter. An initial round of analysis of the final candidate strategies was presented to the Water Advisory Committee in January of 2008. This round of analysis included more thorough formulation of resource strategies including comparison of water treatment plant location and source water pricing. A second round of analysis was presented to the Water Advisory Committee in June of 2008. This round of analysis included several refinements to the economic analysis model including a longer fifty year economic study period, incorporation of updated higher electrical energy costs and refined resource cost estimates. The analyses presented in this report include several further refinements. In this report all of the final candidate strategies incorporate updated and normalized assumptions regarding resources added in the later years of the planning period. Results assuming a range of possible energy price scenarios are presented.

Economic analysis of the final resource strategies was performed using an integrated resource analysis model that was configured for the Central District system. The results of the economic analyses are presented in charts that show the net present value of total DWS Central District system costs over a fifty year study period. The charts show the net present value of several cost categories for each of the strategies, including variable operating costs, fixed operating costs, capital costs, DSM program costs and total costs.

Five charts are shown on the following pages that show:

- Total costs for the fifty year study period for alternate WTP locations and source water costs (Low Energy Price Scenario)
- Differential costs for the same strategies in the first chart. (Low Energy Price Scenario)
- Differential costs for the same strategies in the first chart. (High Energy Price Scenario)
- Differential costs for the same strategies with higher capital costs assumed for the Waihee WTP. (Low Energy Price Scenario)
- Differential costs for the same strategies with higher capital costs assumed for the Waihee WTP. (High Energy Price Scenario)

The first chart shows the total costs for the DWS Central District system for the fifty year study period. Later charts show the same data presented as differences for each cost category for each strategy compared to a reference strategy. This format focuses on the differences between the strategies and makes differences easier to see. It is important to remember, however, that the costs represent total DWS system costs, not only the costs of the featured resources in each strategy.

The two strategies presented at the left of each chart are identical in all of the charts presented. The first strategy at the far left is the “Reference Strategy”. This strategy provides the “zero point” for all of the charts that present costs as differences from the reference strategy. The second strategy from the left is the “Northward Reconfigured” basal well development strategy. This strategy is one of the final candidate strategies and is provided in all of the charts as a standard basis of comparison and to indicate a reference for the magnitude of costs portrayed.25
Two charts are presented for each set of strategies that represent alternate energy cost scenarios. During the time in 2008 that the final candidate strategies were analyzed and presented to the Water Advisory Committee, the cost of electrical power changed dramatically as crude oil prices increased from about $60 per barrel to $140 per barrel and then decreased again to about $60 per barrel. Energy costs are a significant component of the total costs of the DWS system. In order to consider the uncertainty regarding future energy costs a "low" energy cost scenario (starting at $75 per barrel) and a high energy cost scenario (starting at $125 per barrel) are presented for each set of candidate strategies. In each scenario energy costs are assumed to increase at a rate 1% higher than the rate of general inflation.26

Alternate WTP Locations and Source Water Costs

“Low” Energy Price Scenario: $75/bbl 2008 Equiv. Electric Power Costs Escalated at 1.0% (Real) per Year

Alternate WTP Locations and Source Water Costs

The chart above shows the net present value costs for the DWS Central District system over a fifty year study period (2005 - 2055). Variable operating, fixed operating and capital costs are significant components of total costs. The costs of the DSM conservation programs included in each of the strategies is a small component of total costs.

25. This is convenient since the scale of charts varies considerably depending on which strategies are included in each chart.

26. In addition to the analyses presented in this report several alternate assumptions regarding future energy prices were examined.
The differences between the costs of the strategies is discernible but is more clearly seen in the following chart that shows the same data presented as differences with respect to the Reference Strategy shown at the far left.

The chart above shows the same data as the previous chart except all costs are portrayed as differences from the Reference Strategy costs at the far left. The “Northward Reconfigured” strategy is provided as a reference. Four strategies are presented for comparison at the right side of the chart. The primary differences between the costs of these strategies is the variable costs which include primarily the power costs and costs of purchasing raw source water for the WTP plants.

The two strategies in the center show the Waiale WTP strategy assuming raw water source costs at $0.30 and $0.90 per thousand gallons (kgal) respectively. The energy costs of the WTP strategy are lower than the Northward basal well strategy but the additional raw water costs at $0.30 per kgal make the total variable operating costs comparable to the Northward basal well strategy. At this assumed cost of source water the Waiale WTP strategy is less expensive than the Northward basal well strategy.

At $0.90 per kgal for raw source water, however, the variable costs of the Waiale WTP strategy are substantially higher over the life of the study period. At this assumed cost of source water the overall cost of the Waiale WTP strategy is higher than the Northward basal well strategy.

The two strategies shown at the right of the chart show the costs of the same WTP design and configuration located at a higher elevation upstream of the developed and urbanized areas of
Wailuku. This location would provide for gravity flow into the Central system and would not require pumping treated water up to the hydraulic gradient of the Central System as required at the Waiale location. The operating and capital costs are assumed here to be equal to the Waiale WTP but the difference in operating costs is apparent over the fifty year planning period. The variable costs and the resulting total costs are lower at the Waihee location.

All of the WTP strategies have higher fixed operating costs than the Northward Expansion strategy due to the higher costs of operation of treatment plants compared to groundwater wells. The capital costs of the WTP strategies are substantially lower due to the high capital costs associated with the water transmission improvements necessary in the Northward basal well strategy.

The electrical power costs included in the variable costs in this chart are the “low” energy cost scenario. These costs reflect crude oil prices of $75 per barrel in 2008 ($0.24 per KWH marginal cost in the high power consumption block for large customer MECO Schedule P tariff) assumed to escalate at 1% per year in real terms (1% higher than general inflation).27

All of the WTP strategies depicted here treat the capital costs of WTP construction as DWS costs financed by the County. Alternate assumptions regarding project financing were examined and are discussed in the preceding text in this section.

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27. The marginal power costs included in variable costs do not include customer charge and demand charge components of electricity bills. These components are included in fixed operation costs.
are assumed. The electrical power costs included in the variable costs in this chart are the “high” energy cost scenario. These costs reflect crude oil prices of $125 per barrel in 2008 ($0.34 per KWH marginal cost in the high power consumption block for large customer MECO Schedule P tariff) assumed to escalate at 1% per year in real terms (1% higher than general inflation).  

In the high energy price scenario the variable costs are a higher proportion of total costs but the relative ranking of these particular strategies does not change. Since the WTP options are more energy efficient than the Northward basal wells, the WTP strategies look more cost effective compared to the Northward basal well strategy when higher energy costs are assumed.

The chart above and the following chart show the same strategies as the immediately preceding charts except that higher capital costs (+20%) are shown for the Waihee WTP. Since the Waihee WTP would be more remote and might have to be built on a site that is not ideally graded, the construction costs could exceed the estimated costs for the Waiale WTP. This analysis examines the extent to which increased construction costs would offset the long term efficiency advantages of the higher elevation Waihee location.

28. The marginal power costs included in variable costs do not include customer charge and demand charge components of electricity bills. These components are included in fixed operation costs.
The chart above shows that for the low energy cost scenario, the Waihee location is still more cost effective than the Waiale WTP location if construction costs would turn out to be 20% more expensive than the Waiale location.

The chart above shows that for the high energy cost scenario the Waihee WTP location is substantially more cost effective than the Waiale location even if the capital costs of the Waihee location are 20% higher.
Analysis of Reservoir System to Capture High Stage Stream Flows

As described above, one method to use Na Wai Eha stream water for municipal uses that would minimize impacts on existing instream and offstream irrigation uses would be to capture high stage stream flows in a large raw water storage reservoir for treatment for potable municipal use. In order to characterize this strategy the streamflow characteristics of the Iao and Waihee streams were analyzed, assumptions were specified regarding allocation of water to instream
and offstream uses, a mass flow reservoir analysis was performed and the resulting system characterization was analyzed in the integrated resource analysis model.

The chart above shows flow duration curves for the Iao and Waihee streams. The flow duration curves show the percentage of time (indicated on the horizontal axis) that stream flows exceed the daily stream flow volume (indicated on the vertical axis).

The maximum recorded flows for the Iao and Waihee streams for the 1984 - 2007 period of record are 1099 MGD and 750 MGD respectively. Daily flows larger than 200 MGD are infrequent and are not shown on this flow duration chart.

For the Iao Stream minimum daily flow for the period of record is 7.1 MGD, mean flow is 41.1 MGD and median flow is 25.2 MGD.

For the Waihee Stream the minimum daily flow is 14.2 MGD, mean flow is 47.4 MGD and median flow is 33.6 MGD.

The contribution of the Waiehu and Waikapu streams was not considered in this analysis.
The chart above is based on the same stream flow data as the previous chart. On this chart, stream flows are expressed as the fraction of stream flow volume over the period of record (vertical axis) that occurs when stream flow is less than the stream flow rates indicated on the horizontal axis. This chart shows the fraction of total stream flow that would be diverted by diversion structures that take all stream flow from minimum flows up to the diversion capacity. This is characteristic of the existing diversion structures on the Iao and Waihee streams.

The Iao stream diversion currently diverts base stream flow from the stream to a control weir that, according to WWC estimates, diverts 20 MGD for offstream uses and returns the remainder to the stream, downstream of the diversions structure. As shown on the chart, this results in about 44% of the stream flow volume diverted to offstream uses.

The existing diversions of the Waihee Stream have a capacity of approximately 80 MGD and divert approximately 85% of the stream flow volume.
In order to make a meaningful analysis of optimum reservoir size or economics it is necessary to use specific assumptions regarding how much water will be available as source for the reservoir and how the reservoir system will be operated. The chart above shows a hypothetical allocation of Iao Stream water for purposes of analysis of a reservoir storage system considered in this section of the report. A ten MGD instream flow standard is assumed. This would result in approximately 25% of the volume of the stream water to remain in the stream undiverted.

The next 20 MGD of streamflow above the instream flow standard would be diverted to the existing offstream irrigation uses (agriculture, landscape and golf course irrigation). This would be about 30% of the stream flow volume. This allocation would allow the same capacity (20 MGD) to be diverted but would amount to less total water volume (30% rather than the current 45%) for existing offstream irrigation uses.

The next 40 MGD of streamflow, equal to about 22% of the Iao Stream volume would be diverted through the existing ditch system (with some capacity improvements) to a large storage reservoir for treatment for potable municipal use. Note that, for purposes of this analysis only Iao Stream water is assumed to be used. Waiehu and Waihee stream flows are assumed to contribute to the reservoir system.

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29. The CWRM is currently considering amending interim instream flow standards for the Na Wai Eha streams but no decision has been reached regarding whether or to what extent the instream flow standards will be amended. The current standard allows diversion of all stream water up to the capacity of the existing diversions. It is expected that these standards would provide some minimum amount of stream flow that would have to remain in the stream before diversions would be allowed.
The charts above depict a sample of the mass flow reservoir analyses that were performed to determine the reliable yield of different sizes of raw water storage reservoirs under a spectrum of assumptions regarding instream flow standards, offstream water uses and water management priorities. The charts show daily streamflows and calculated reservoir levels from 1984 through 2007.\textsuperscript{30}

The mass flow analyses consider the daily streamflows, instream flow minimums, diversion and transmission capacities and losses, offstream irrigation demand, contributions to irrigation needs from precipitation, resulting flows to the storage reservoir, evaporation losses and reliable productive system yield.\textsuperscript{31}

The mass flow analyses are based on historical stream flows. No specific consideration is made regarding trends in drought severity or frequency or anticipated climate change. The analyses could be revised based on specific assumptions regarding future stream flows.

\textsuperscript{30} The charts are not legible in detail here printed at letter size but can be viewed or printed in more detail from the PDF version of this report.

\textsuperscript{31} The yield is the amount of water assumed to be withdrawn from the reservoir for useful purposes, in this case for treatment to produce potable municipal water supply.
The chart above shows the results of a series of mass flow reservoir analyses showing the percentage of days the storage reservoir would be empty assuming a range of reservoir capacities and average yields. In addition to the flows from diversions from high stage stream flows as described above, the results shown in the chart above include contribution to the reservoir from diverted flows that are normally used for existing offstream irrigation uses on days that precipitation is high enough that no diverted water would be necessary for irrigation purposes.

For the Central District system the reservoir would have to be empty a small percentage of the time to provide reliable potable water supplies. As shown in the chart, a one billion gallon reservoir would be empty 13% of the time with a 9 MGD average withdrawal for water treatment according to the assumptions outlined above. Larger reservoir capacities would provide diminishing additional reliable system yields. Other methods to increase reliable system reliable yield would be more cost effective than extensive increases to reservoir size, such as reductions in ditch transmission losses or reduction in offstream irrigation water requirements through efficiency measures.

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32. Note that adding an additional 200 MG of reservoir capacity between 800 MG and 1000 MG capacity changes the number of days the reservoir would be empty by less than 2%.
For purposes of further economic analysis it is assumed that a 9 MGD reliable yield can be main-
tained with a one billion gallon reservoir and a 6 MGD reliable yield with a 300 MG reservoir.  This considers that only the contribution of the Iao Stream was included in the analysis. Nevertheless, this is not a conservative presumption since it would require reservoir system manage-
ment protocols and possible demand response measures in extended drought periods that could be restrictive to some extent.

The center two strategies shown in the chart above depict the costs of the Waiale WTP strate-
gies assuming a full 9 MGD commitment of ditch base flow.  These are the same analyses and 
results shown in the previous charts except for the difference in the vertical scale of the chart.

The right two strategies on the chart are the WTP strategies that use storage reservoirs to cap-
ture high stage stream flows from the Iao Stream as source water.  These strategies assume the 
allocations of stream water previously discussed.  Costs for raw water are assumed to be zero in 
the storage reservoir strategies depicted.33

The 300MG reservoir was determined to provide sufficient storage to provide 6 MGD “semi-relia-
ble” yield.  This strategy is characterized with a 9 MGD capacity WTP assumed to produce up to 6 MGD average output.  Since this WTP produces less water than the other WTP strategies

33.  In the analyses depicted here it is presumed that, if the County incurs the costs of the reservoirs, it would not have to pay volumetric fees for source water.  Other assumptions have also been examined.
depicted, other following resources are assumed to be brought online sooner than the other strategies.

The 1000MG reservoir was determined to provide sufficient storage to provide 9 MGD “semi-reliable” yield (assuming the specific hypothetical stream water allocations). This strategy is characterized with a 9 MGD average capacity WTP, identical to the Waiale WTP featured in the strategies that assume an allocation of 9 MGD guaranteed base flow from the ditch system.

The strategies that incorporate raw water storage reservoirs have substantially higher capital costs but lower variable operating costs (since no volumetric water charges are assumed). Based on the assumed stream water allocations used to characterize these strategies, the strategy that features the smaller 300 MG reservoir and 6 MGD average output WTP is more economically feasible. The additional costs of providing sufficient storage reservoir capacity to provide sufficient reliable yield for the larger 9 MGD average output WTP make that strategy substantially more expensive. Different assumptions regarding the allocation of Na Wai Eha stream water to instream and various offstream uses would have different economic results but the diminishing returns in reliable yield that result from increasing storage reservoir size beyond 300 MGD are difficult to justify on purely economical grounds.

Note that the two strategies in the center that feature the Waiale WTP supplied by water from the ditch system without a reservoir would reduce the amount of water available for offstream irrigation uses. The two strategies at the right that incorporate raw water storage reservoirs would substantially reduce but would not entirely eliminate impacts on offstream irrigation water availability.

Note that all of the analyses described above are based on several hypothetical assumptions regarding the allocation of stream water to instream, offstream irrigation and reservoir system uses. These hypothetical assumptions are necessary to conduct meaningful reservoir system economic analyses. Different assumptions regarding water allocation or reservoir system operation protocols would be expected to yield different results. These analyses described above could be revised to reflect specific determinations regarding stream water allocations when these are determined.
The chart above shows the same strategies as the previous chart except that high scenario energy costs are assumed.
D. Desalination of Brackish Groundwater

Summary
This strategy features construction and operation of a water treatment plant to desalinate brackish groundwater to potable standards. The characteristics of the desalination plant were derived from a recent study performed for the County of Maui.\textsuperscript{34}

All of the implementations of this strategy include a “basic” Demand Side Management program that is designed to attain 15% of the water efficiency technical potential in a period of five years.\textsuperscript{35}

This strategy is one of the most expensive strategies due to the combination of capital and operation costs. Water produced by desalination of brackish water is the most expensive alternatives in terms of operation costs.

Project Design Scenarios
The configuration of a desalination plant was examined in the Candidate Strategies Chapter. The configuration of the plant in the final strategies analysis is the four train configuration that was optimized in the previous analysis. The characteristics of this project are reported in detail in the Appendix.

Policy and Feasibility Considerations
Desalination of water is particularly energy intensive. For this reason extensive water desalination represents a commitment to energy consumption and its corollary considerations: needs for energy generation resources, impacts on greenhouse gas emissions and energy price volatility.

Desalination also requires disposal of brackish water. Removal of salt from source brackish water increases the salinity of desalination plant effluent. Concern regarding disposal of brack-

\textsuperscript{34} Central-South Maui Desalination Feasibility Study, Brown & Caldwell

\textsuperscript{35} The DSM program included in each of the final candidate strategies is described in a separate section on this subject and in Appendix A.
ish effluent is not as serious as similar concerns regarding the desalination of seawater which results in a much more concentrated effluent.

Brackish source water in the Central Maui area could contain contaminants that may pose public acceptance concerns.

**Economic Analysis**

The economics of brackish water desalination were addressed in the Candidate Strategies chapter and its supporting analysis. It was determined in those analyses that brackish water desalination was clearly preferable to seawater desalination for economic reasons. In addition it was determined that for reasonable additional capital costs a treatment plant with multiple independent parallel filter trains would provide cost effective benefits by increasing the effective reliability of the plant.

In the analysis of the final candidate strategies in this report the desalination strategy is characterized identically to the characterization in the Candidate Strategy chapter except that several alternate scenarios regarding future energy costs are considered. The economic analysis of this strategy is presented and discussed in the Comparison of Final Candidate Strategies section below.
E. Extensive Conservation and Wastewater Recycling

Summary
This strategy features meeting new water needs by increasing recycled water use and implementing water conservation measures to capture three times as much conservation potential as the programs in the other final candidate strategies. This strategy characterizes maximizing the efficient use of water.

This strategy includes building a new non-potable water transmission line from the existing Kihei Wastewater Treatment Plant (WWTP) to the Wailea area where water could be used to displace existing potable water now used for outdoor irrigation purposes. The viability of this strategy needs to be verified by further study to determine the long term capacity of the Kihei WWTP to produce R-1 recycled water and the amount of potable water in the Wailea area the could be displaced by making R-1 water available.

This strategy is not the least expensive strategy but has several positive attributes regarding meeting the WUDP planning objectives and may play an important role as a contingency strategy if the viability of other strategies is not verified for an extended period of time.

Project Design Scenarios
There are two principal components to this strategy. One component is increased use of recycled wastewater to displace existing and future potable water use. The second component is more aggressive DSM water conservation programs than what are assumed in the other final candidate strategies. Several scenarios were considered to analyze the maximization and optimization of both of these components.

Wastewater Recycling Options
Several possible water recycling scenarios were examined:

- R-1 water transmission and distribution extension from the Kihei Wastewater Treatment Plant (WWTP) to the South Kihei and Wailea areas:
  - Designed with sufficient laterals to displace 3.0 MGD of potable water use
- Capital costs estimated at approximately $50 million
- R-1 water transmission extension from the Kihei WWTP to the Wailea area:
  - Designed to reach large consumption properties to displace 1.5 MGD of potable water use
  - Capital costs estimated at approximately $20 million
- Upgrading the Kahului WWTP from R-2 to R-1 capability and transmission and distribution extension to the Kahului area
  - This scenario was determined to be infeasible for economic and logistical reasons.

In previous analysis it was determined that the 1.5 MGD transmission extension option was more cost effective than the substantially more expensive 3.0 MGD option or upgrading the Kahului WWTP. The 1.5 MGD potable displacement Kihei WWTP option is the scenario examined as a strategy in this report.

**Water Conservation Program Options**

Several possible water conservation program scenarios were examined. In previous analyses the economics of different intensities of conservation program implementation was examined. Conservation programs can be designed to reach increasing proportions of conservation technical potential by providing more extensive program delivery mechanisms and by targeting progressively more expensive potential water saving fixtures, appliances and irrigation system improvements. Conservation programs can also be designed either to attain water savings at less cost to the utility by implementing programs at a slower pace or, alternatively, by accelerating the program water savings by more intensive and more expensive methods.

A series of alternative conservation program implementation scenarios was examined in each of the rounds of analysis of the final candidate strategies. In the most recent round of analysis several implementation scenarios were examined with respect to several assumptions regarding future energy prices. The programs designed to reach 45% of conservation technical potential in ten years that were assumed in the previous rounds of analysis were retained in this final candidate strategy presented in this report.

It should be noted that the first steps recommended to implement any of the conservation program scenarios are similar. Unless there is an urgent crisis regarding sufficient water supplies it is prudent and economical to be diligent but careful and methodical about establishing an aggressive DSM implementation capability in the DWS. The intensity of program implementation can be adjusted as experience with program implementation is attained and as future uncertain water needs and supply option situations continue to develop.

**Policy and Feasibility Considerations**

Both water conservation and wastewater recycling were consistently viewed as favorable options in discussions with the Water Advisory Committee. These options promote responsible use of water and promote the objective of sustainability.

The amount of potable water use that could be displaced by the assumed transmission extension to the Wailea area has been estimated for purposes of economic analysis but has not been rigorously verified. The cost effectiveness of this option from the perspective of the DWS and the County is sensitive to the amount of displaced potable water use. The magnitude of potential potable water displacement should be verified prior to substantial financial or planning commitments to this resource option.
Economic Analysis

The chart above compares the net present values of the costs for the DWS Central District system for the fifty year study period (2005 - 2055). All costs are shown as differences compared to the Northward Basal Groundwater strategy (Northward strategy) depicted at the far left. The Northward strategy includes the same DSM programs assumed in all of the other final candidate resource strategies designed to attain 15% of the DSM technical potential in a period of five years. The next three strategies depicted in the center of the chart show increasing intensities of DSM implementation to attain 30%, 45% and 60% of the technical potential (T.P.) in seven, ten and twelve years respectively. All of the programs are assumed to begin in calendar year 2010.

The costs of the DSM programs (in excess of the Northward strategy DSM costs) are shown. These are offset by lower variable operating costs (due primarily to reductions in energy costs that result from smaller water production requirements) and lower capital costs (that result from deferral of new supply resources). The 45% T.P. option is the most cost effective. The increasing program implementation and DSM measure costs of the 60% T.P option are not offset by corresponding variable and capital costs.

36. See discussion of the characterization and analysis of Central District DSM end uses, technical potential and DSM program analysis in Appendix A of this report.
The “Extensive Conservation and Wastewater Recycling” final candidate strategy is the second strategy from the right on the chart above. This strategy features the 45% T.P. DSM and 1.5 MGD Kihei WWTP R-1 transmission extension resources. Assuming the “low” energy cost scenario this strategy is more expensive than the Northward strategy. This strategy is compared to the other final candidate strategies in the next section of this report. If only 1.0 MGD of potable water would be displaced by the R-1 transmission line this strategy would be substantially less cost effective.

Shown just above the horizontal axis labels of the chart are the date that new “discretionary” supply resources would be needed to maintain reliable water supply for the Central District system. The sequence and dates for all resources in each strategy shown in the chart are shown on the table on the following page. Without any DSM programs, the next discretionary supply resource addition would be needed in 2012. With the DSM programs assumed in all of the other final candidate strategies in this report (designed to attain 15% technical potential) the next discretionary supply resource would be needed in 2013. More aggressive DSM program implementation to attain 30%, 45% and 60% of the technical potential defers the need for the next needed resource until 2014, 2014 and 2015 respectively. In conjunction with a DSM program designed to attain 45% technical potential the Kihei 1.5 MGD WWTP R-1 transmission extension strategy further defers the need for the next supply resource until 2019. If this strategy only defers 1.0 MGD of potable water otherwise supplied by DWS the next needed resource would be deferred until 2018.

Aside from any economic costs and benefits, these strategies represent viable options to meet mid-term (2012 - 2019) water demands if other strategies are delayed or are not feasible.

The following table indicates the source data for the chart above. The sequence and dates for new resource additions are shown for each of the strategies. The date of the next required discretionary new supply resource in each strategy is highlighted.

37. The next “discretionary” resource is the first resource needed beyond the committed and near term resources that are assumed to be implemented in all strategies.

38. The capacity of the R-1 transmission line extension would substantially exceed 1.5 MGD. The strategy assumes that the amount of recycled water supplied by the line would displace 1.5 MGD of potable water supplied by the DWS system that is or would otherwise be used for irrigation uses.
### Central District Final Candidate Strategies

**"Low" Energy Price Scenario: $75/bbl 2008 Equiv. Electric Power Costs Escalated at 1.0% (Real) Per Year**

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<th>System</th>
<th>Strategy Name</th>
<th>Description</th>
<th>Central System</th>
<th>Central System</th>
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<th>Central System</th>
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<td></td>
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<td>Multiple 350/1500 PPM Wells</td>
<td>DSM 35/TP</td>
<td>DSM 45/TP</td>
<td>DSM 60/TP</td>
<td>Recip. 1:5 DSM 45/TP</td>
<td>Northward w/ No DSM</td>
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#### Notes:
- Var. Op. Esc. Rate
  - 2.50%
  - 2.50%
  - 2.50%
  - 2.50%
  - 2.50%
  - 2.50%

- Fixed Op. Esc. Rate
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  - 3.00%
  - 3.00%
  - 3.00%
  - 3.00%
  - 3.00%

- Cap. Cost Esc. Rate
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  - 3.00%
  - 3.00%
  - 3.00%
  - 3.00%
  - 3.00%

- Discount Rate
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%

- Cost of Capital
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%
  - 6.00%

- Unserved Demand kgd
  - 741,826
  - 741,826
  - 741,826
  - 741,826
  - 741,826
  - 741,826

| Cap. Shortfall 2007-30 MGD-Yrs. | 4.370 | 4.360 | 4.359 |

#### 25 Year Planning Period Costs:
- Variable Operation Cost NPV
  - 0
  - 0
  - 0

- Fixed Operation Cost NPV
  - 0
  - 0
  - 0

- Capital Cost NPV
  - 0
  - 0
  - 0

- Total System Cost NPV
  - 0
  - 0
  - 0

| DSM Proportion | 3.00% | 3.00% | 3.00% |
| Levelized Unit Cost ($/kgal) | $3.652 | $3.657 | $3.658 |

| Avg. Annual DWS Rate Increase | 3.67% |
| Levelized Unit Cost ($/kgal) | $3.652 | $3.657 | $3.658 |

### Resource Addition Sequence:

<table>
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<th>Stre</th>
<th>Year</th>
<th>Notes</th>
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<tr>
<td>Generic Backup 1</td>
<td>2022</td>
<td>Waipake Tank Well</td>
<td>2022</td>
</tr>
<tr>
<td>Generic Backup 1</td>
<td>2023</td>
<td>Waipake Tank Well</td>
<td>2023</td>
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<tr>
<td>Generic Backup 1</td>
<td>2024</td>
<td>Waipake Tank Well</td>
<td>2024</td>
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<tr>
<td>Generic Backup 1</td>
<td>2025</td>
<td>Waipake Tank Well</td>
<td>2025</td>
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<tr>
<td>Generic Backup 1</td>
<td>2026</td>
<td>Waipake Tank Well</td>
<td>2026</td>
</tr>
<tr>
<td>Generic Backup 1</td>
<td>2027</td>
<td>Waipake Tank Well</td>
<td>2027</td>
</tr>
<tr>
<td>Generic Backup 1</td>
<td>2028</td>
<td>Waipake Tank Well</td>
<td>2028</td>
</tr>
<tr>
<td>Generic Backup 1</td>
<td>2029</td>
<td>Waipake Tank Well</td>
<td>2029</td>
</tr>
<tr>
<td>Generic Backup 1</td>
<td>2030</td>
<td>Waipake Tank Well</td>
<td>2030</td>
</tr>
</tbody>
</table>

#### 25 Year Planning Period Rate Impacts:
- Avg. Annual DWS Rate Increase: 3.67%
- Levelized Unit Cost ($/kgal): $3.652

#### 20 Year Planning Period Rate Impacts:
- Avg. Annual DWS Rate Increase: 3.67%
- Levelized Unit Cost ($/kgal): $3.657

#### 30 Year Planning Period Rate Impacts:
- Avg. Annual DWS Rate Increase: 3.67%
- Levelized Unit Cost ($/kgal): $3.658
The chart above shows the same options as the previous chart except that the “high” energy cost scenario is assumed. Assuming higher energy prices the more intensive 60% T.P. DSM program implementation is more cost effective than the less aggressive options. The “Extensive Conservation and Wastewater Recycling” final candidate strategy also becomes more cost effective and costs less than the Northward strategy.
Comparison of Final Candidate Strategies

The CWRM Framework provides for an Integrated Resource Planning (IRP) process that begins by identifying planning objectives and an assessment of future water needs. Various resources and strategies to meet these objectives are identified, characterized and analyzed. The selection of the best strategies is based on the extent to which they meet the planning objectives identified at the beginning and during the course of the IRP process. In this section the final candidate strategies are evaluated with respect to the planning objectives identified for the Central District.

**Planning Objectives and Attributes Matrix**

A difficult task in long range planning is presenting a large volume of information about complex issues regarding several alternatives in a way that is, at the same time, comprehensive, meaningful and comprehensible. It is a challenge to consider and present all necessary factors that need to be considered without creating confusing complexity. Indeed, this is one of the reasons that IRP incorporates the identification and application of planning objectives. This approach ensures that a wide spectrum of factors will be considered and encourages a methodical examination of the merits of the candidate strategies.
Early in the Central District public process, a matrix was developed to consider how each of an extensive list of resource options might affect each of the planning objectives. This served as a tool to elicit comments regarding each of the resources that was considered. A similar matrix format was used in the evaluation of the candidate strategies with each “cell” of the matrix colored to indicate positive impacts, caution and potential negative impacts (green, yellow and red, respectively). In preparing this report the Candidate Strategies matrix was developed in more detail for the Final Candidate Strategies by providing a short text description of impacts in each applicable cell.

The objective of using a matrix approach is ultimately to present enough information to make meaningful decisions by “getting everything on the same page”. The problem with this approach is that, even though the information provided in each cell is a very brief synopsis, the size of the matrix tends to get big and/or the type size tends to get small. The matrix is a helpful tool but is difficult to present “all-on-one-one-page” in the letter size format of this report. The matrix is presented in six sections on the following pages. A one page version of the matrix is also provided in scalable format which can be examined or printed in larger scale in the electronic PDF version of this report but will be illegible in the hard copy of the report.

This matrix is provided for viewing or printing from the scalable electronic PDF format of this report and may not be legible printed at letter size.

39. Samples of the earlier matrix format are provided in the Resource Options Chapter of the Central District WUDP, August 24, 2005.
<table>
<thead>
<tr>
<th>CANDIDATE STRATEGIES</th>
<th>Viability</th>
<th>Sufficiency of Water Supply</th>
<th>Municipal</th>
<th>DHHL</th>
<th>Agriculture</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTHWARD BASAL WELL DEVELOPMENT</td>
<td>- The groundwater hydrology of this area is relatively untested. Sustainable production output of new wells is uncertain.</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- High capital costs associated with necessary transmission system extension; Moderately high operation costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HA'AIKU AQUIFER BASAL WELL DEVELOPMENT</td>
<td>- Strategy would likely have organized opposition by East aquifer residents; - High project capital costs</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- High project capital and operating costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTENSIVE CONSERVATION AND RECYCLING</td>
<td>- Amount of DWS potable water that would be displaced by base scenario needs to be verified. Strategy economics depends on amount of potable water displacement.</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- Amount of DWS potable water that would be displaced by base scenario needs to be verified. Strategy economics depends on amount of potable water displacement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT</td>
<td>- Long term availability of source water needs to be assured. This depends on the outcome of several CWRM proceedings currently underway and finalization of contractual terms. - Cost of source water needs to be determined. Strategy economics depends on this and is sensitive to the Cost of source water from WWC.</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- Use of Na Wai Eha surface water for treatment for DWS municipal use would reduce amount of water available for agricultural and other offstream irrigation uses. - Cost of source water is very uncertain and significantly affects economics of strategy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT WITH LARGE RAW WATER STORAGE RESERVOIR</td>
<td>- Long term availability of source water needs to be assured. This depends on the outcome of several CWRM proceedings currently underway and finalization of contractual terms. - High capital costs to build large raw water storage reservoir</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- Development of large raw water storage reservoir would reduce impacts on amount of water available for offstream use but, unless reservoir capacity is very large there will be remaining impacts on agricultural use. - High capital costs for sufficient reservoir capacity to provide reliable potable supply without reducing amount of water for agricultural use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRACKISH WATER DESALINATION</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>+ Strategy provides sufficient water to meet projected demand</td>
<td>- High operation cost and energy use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### CENTRAL DISTRICT
**FINAL CANDIDATE STRATEGIES**

#### ATTAINMENT OF PLANNING OBJECTIVES

<table>
<thead>
<tr>
<th>Efficiency</th>
<th>Environment</th>
<th>Equity</th>
<th>Sustainability</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximize the Efficiency of Water Use</td>
<td>Minimize Environmental Impacts</td>
<td>Manage Water Equitably</td>
<td>Maintain Sustainable Resources</td>
<td>Maximize Water Quality</td>
</tr>
</tbody>
</table>

#### CANDIDATE STRATEGIES

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Efficiency</th>
<th>Environment</th>
<th>Equity</th>
<th>Sustainability</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTHWARD BASAL WELL DEVELOPMENT</td>
<td>Moderately high energy use</td>
<td>Construction impacts: wells, transmission pipe, roads, power lines</td>
<td></td>
<td>Moderately high energy use</td>
<td></td>
</tr>
<tr>
<td>HAIKU AQUIFER BASAL WELL DEVELOPMENT</td>
<td>Moderately high energy use</td>
<td>Construction impacts: wells, transmission pipe, roads, power lines</td>
<td>Export of water for use outside of source aquifer area</td>
<td>Moderately high energy use</td>
<td></td>
</tr>
<tr>
<td>EXTENSIVE CONSERVATION AND RECYCLING</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Reduces water source use + Reduces energy consumption + Construction impacts: Transmission line + Reduces injection well use</td>
<td></td>
<td>+ Prioritizes sustainability + Reduces water source use + Reduces energy consumption</td>
<td></td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT</td>
<td></td>
<td>Construction impacts: water treatment plant, minor ancillaries</td>
<td>Export of water for use outside of source aquifer area</td>
<td></td>
<td>- Water quality issues associated with surface water - Open ditch sources through urban areas</td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT WITH LARGE RAW WATER STORAGE RESERVOIR</td>
<td></td>
<td>Construction impacts: water treatment plant, minor ancillaries Reservoir construction impacts</td>
<td>Export of water for use outside of source aquifer area</td>
<td></td>
<td>- Water quality issues associated with surface water - Open ditch sources through urban areas</td>
</tr>
<tr>
<td>BRACKISH WATER DESALINATION</td>
<td>High energy use</td>
<td>Construction impacts: water treatment plant, minor ancillaries Brackish water disposal</td>
<td></td>
<td>High energy use</td>
<td></td>
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<tr>
<td>ATTAINMENT OF PLANNING OBJECTIVES</td>
<td>Reliability</td>
<td>Streams</td>
<td>Resources</td>
<td>Culture</td>
<td>Conformity</td>
</tr>
<tr>
<td>----------------------------------</td>
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<td>-----------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td></td>
<td>Maximiz Reliability of Water Service</td>
<td>Protect and Restore Streams</td>
<td>Protect Water Resources</td>
<td>Protect Cultural Resources</td>
<td>Maintain Consistency with General and Community Plans</td>
</tr>
<tr>
<td>CANDIDATE STRATEGIES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NORTHWARD BASAL WELL DEVELOPMENT</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td></td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HAIKU AQUIFER BASAL WELL DEVELOPMENT</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td>- Impacts on streams is an issue in prior litigation</td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td>- Export of water for use outside of source aquifer area</td>
<td></td>
</tr>
<tr>
<td>EXTENSIVE CONSERVATION AND RECYCLING</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td>+ Provides short and mid-term reliability benefits</td>
<td></td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td>+ Reduces water source use</td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td>- Additional use of stream water for municipal purposes would increase competition for stream water allocations</td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NA WAI EHA SURFACE WATER TREATMENT WITH LARGE RAW WATER STORAGE RESERVOIR</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td>+ Additional raw water storage capacity would minimize competition for stream water allocations</td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRACKISH WATER DESALINATION</td>
<td>+ Strategy meets analysis design reliability / capacity expansion criteria</td>
<td></td>
<td>+ Assumes withdrawals within sustainable yields</td>
<td>+ Reduces potable water source use</td>
<td></td>
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</tbody>
</table>
## CENTRAL DISTRICT
### FINAL CANDIDATE STRATEGIES

### ATTAINMENT OF PLANNING OBJECTIVES

<table>
<thead>
<tr>
<th></th>
<th>Viability</th>
<th>Municipal</th>
<th>DHHL</th>
<th>Agriculture</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Establish Viable Plans</td>
<td>Adequate Volume of Water for Municipal Uses</td>
<td>Adequate Volume of Water for DHHL Uses</td>
<td>Adequate Volume of Water for Agricultural Uses</td>
<td>Minimize Cost of Water Supply</td>
</tr>
</tbody>
</table>

### COMPONENTS IN ALL STRATEGIES

#### COMMITTED RESOURCE OPTIONS
- + These resources are necessary to provide sufficient production and capacity
- + These resources are necessary to provide sufficient production and capacity

#### NEAR TERM RESOURCE OPTIONS
- - Some uncertainty regarding timely implementation of Waikapu South #2 Well assumed to be online in integration analyses
- + These resources are necessary to provide sufficient production and capacity
- + These resources are necessary to provide sufficient production and capacity

#### DEMAND SIDE MANAGEMENT PROGRAMS
- + Can be implemented immediately without permitting barriers
- + Provides short and mid-term benefit to meet water demands
- + Provides short and mid-term benefit to meet water demands
- + Provides short and mid-term benefit to meet water demands
- + Reduces system costs
- + Reduces customer costs
- - Upward pressure on unit rates

### INDEPENDENT STRATEGY COMPONENTS

#### SUPPLY SIDE LEAK REDUCTION
- - Provides short and mid-term benefit to meet water demands
- - Provides short and mid-term benefit to meet water demands
- - Provides short and mid-term benefit to meet water demands
- + Reduces system costs
- + Reduces customer costs
- + Reduces customer costs

#### ENERGY PRODUCTION AND EFFICIENCY
- + Reduces system costs
- + Reduces customer costs

#### STREAM RESTORATION MEASURES
- + County WUDP can make recommendations and state policy but authority rests with CWRM
- + Increases useable surface and groundwater aquifer sources
- + Increases useable surface and groundwater aquifer sources
- + Provides water for kuleana and subsistence agriculture
- - Reduces water supply for Central Maui large agriculture
- - Programs cost money

#### WATERSHED PROTECTION AND RESTORATION
- + Increases useable surface and groundwater aquifer sources
- + Increases useable surface and groundwater aquifer sources
- + Increases useable surface and groundwater aquifer sources
- - Programs cost money

#### WELL DEVELOPMENT POLICIES AND REGULATIONS
- + Clear policies promote contract approvals
- + Clear policies encourage investment and promote contract approvals
- + Clear policies encourage investment and promote contract approvals

#### WELLHEAD PROTECTION ORDINANCE

#### LANDSCAPE ORDINANCE
- - Limits water use for landscape irrigation
- - Limits water use in times of drought
- - Increases water availability in times of drought

#### DROUGHT WATER USE RESTRICTIONS
- - Limits water use in times of drought
- - Limits water use in times of drought
- + Increases water availability in times of drought
- + Allows maintenance of reliable water supply at reasonable cost

#### WATER RATE DESIGN AND PRICING POLICIES
- + Marginal pricing encourages conservation
- + Marginal pricing encourages conservation
- + Agricultural water rates are subsidized
<table>
<thead>
<tr>
<th>CENTRAL DISTRICT FINAL CANDIDATE STRATEGIES</th>
<th>Efficiency</th>
<th>Environment</th>
<th>Equity</th>
<th>Sustainability</th>
<th>Quality</th>
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<tbody>
<tr>
<td>ATTAINMENT OF PLANNING OBJECTIVES</td>
<td>Maximize the Efficiency of Water Use</td>
<td>Minimize Environmental Impacts</td>
<td>Manage Water Equitably</td>
<td>Maintain Sustainable Resources</td>
<td>Maximize Water Quality</td>
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<td>COMPONENTS IN ALL STRATEGIES</td>
<td></td>
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<tr>
<td>COMMITTED RESOURCE OPTIONS</td>
<td>- Construction impacts: wells, transmission pipe, roads, power lines</td>
<td></td>
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<tr>
<td>NEAR TERM RESOURCE OPTIONS</td>
<td>- Construction impacts: wells, transmission pipe, roads, power lines</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEMAND SIDE MANAGEMENT PROGRAMS</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>- All customers pay for program participant benefits</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td></td>
</tr>
<tr>
<td>INDEPENDENT STRATEGY COMPONENTS</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>SUPPLY SIDE LEAK REDUCTION</td>
<td>+ Prioritizes efficiency + Reduces water source use + Reduces energy consumption</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td></td>
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<tr>
<td>ENERGY PRODUCTION AND EFFICIENCY</td>
<td>+ Reduces energy consumption</td>
<td>+ Reduces energy consumption</td>
<td></td>
<td>+ Reduces energy consumption</td>
<td></td>
</tr>
<tr>
<td>STREAM RESTORATION MEASURES</td>
<td>+ Promotes health stream, estuary and reef environment</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Promotes aquifer recharge + Promotes sustainable kuleana subsistence</td>
<td>+ Promotes water quality for kuleana agricultural uses</td>
<td></td>
</tr>
<tr>
<td>WATERSHED PROTECTION AND RESTORATION</td>
<td>+ Improves forest and stream environmental quality</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Increases useable surface and groundwater aquifer sources</td>
<td>+ Increases quality of stream water</td>
<td></td>
</tr>
<tr>
<td>WELL DEVELOPMENT POLICIES AND REGULATIONS</td>
<td>+ Allows planning &amp; siting of new resources considering environmental quality</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>+ Promotes clear standards for allocation of water supply</td>
<td>+ Allows planning &amp; siting of new resources considering water quality</td>
<td></td>
</tr>
<tr>
<td>WELLHEAD PROTECTION ORDINANCE</td>
<td>+ Promotes environmentally sensitive practices in wellhead protection zones</td>
<td>+ Reduces water source use + Reduces energy consumption</td>
<td>- Could affect existing land uses</td>
<td>+ Protects well sources from contamination from land uses</td>
<td></td>
</tr>
<tr>
<td>LANDSCAPE ORDINANCE</td>
<td>+ Promotes efficient use of water resources</td>
<td>+ Promotes allocation of water to public trust and beneficial uses - Impacts on existing landscape irrigation users</td>
<td>+ Promotes use of sustainable plantings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DROUGHT WATER USE RESTRICTIONS</td>
<td>+ Reduces use of expensive resources in times of drought</td>
<td>+ Promises allocation of water to public benefit and beneficial uses - Impacts on existing landscape irrigation users</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WATER RATE DESIGN AND PRICING POLICIES</td>
<td>+ Marginal pricing encourages conservation</td>
<td>+ High volume users subsidize low volume users - Municipal users subsidize agricultural users</td>
<td></td>
<td>+ Marginal pricing encourages conservation</td>
<td></td>
</tr>
<tr>
<td>COMPONENTS IN ALL STRATEGIES</td>
<td>Reliability</td>
<td>Streams</td>
<td>Resources</td>
<td>Culture</td>
<td>Conformity</td>
</tr>
<tr>
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<td>---------</td>
<td>-----------</td>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>COMMITTED RESOURCE OPTIONS</td>
<td>+ These resources are necessary to provide sufficient production and capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEAR TERM RESOURCE OPTIONS</td>
<td>+ These resources are necessary to provide sufficient production and capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEMAND SIDE MANAGEMENT PROGRAMS</td>
<td>+ Provides short and mid-term system reliability benefits</td>
<td>+ Reduces source water use</td>
<td>+ Reduces source water use</td>
<td>+ Consistent with state and county policies and plans</td>
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<tr>
<td>INDEPENDENT STRATEGY COMPONENTS</td>
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</tr>
<tr>
<td>SUPPLY SIDE LEAK REDUCTION</td>
<td>+ Provides short and mid-term system reliability benefits</td>
<td>+ Reduces source water use</td>
<td>+ Reduces source water use</td>
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</tr>
<tr>
<td>ENERGY PRODUCTION AND EFFICIENCY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STREAM RESTORATION MEASURES</td>
<td></td>
<td>+ Prioritizes &amp; promotes healthy streams</td>
<td>+ Increases capture of precipitation and aquifer recharge</td>
<td>+ Promotes healthy streams and provides water for kuleana agriculture</td>
<td></td>
</tr>
<tr>
<td>WATERSHED PROTECTION AND RESTORATION</td>
<td></td>
<td>+ Promotes healthy streams</td>
<td>+ Increases capture of precipitation and aquifer recharge</td>
<td>+ Promotes healthy streams and provides water for kuleana agriculture</td>
<td></td>
</tr>
<tr>
<td>WELL DEVELOPMENT POLICIES AND REGULATIONS</td>
<td>+ Allows planning &amp; siting of new resources considering system integration issues</td>
<td></td>
<td>+ Allows planning &amp; siting of new resources considering protection of water resources</td>
<td>+ Allows planning &amp; siting of new resources considering protection of cultural resources</td>
<td>+ Allows planning &amp; siting of new resources considering general and community plans</td>
</tr>
<tr>
<td>WELLHEAD PROTECTION ORDINANCE</td>
<td></td>
<td></td>
<td>+ Protects well sources from contamination from land uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANDSCAPE ORDINANCE</td>
<td></td>
<td>+ Reduces source water use</td>
<td>+ Reduces source water use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DROUGHT WATER USE RESTRICTIONS</td>
<td>+ Increases drought period system reliability</td>
<td>+ Reduces source water use when sources have lowest yields</td>
<td>+ Reduces source water use when sources have lowest yields</td>
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<tr>
<td>WATER RATE DESIGN AND PRICING POLICIES</td>
<td>+ Provides short and mid-term system reliability benefits</td>
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</table>
### Candidate Strategies

#### CENTRAL DISTRICT FINAL CANDIDATE STRATEGIES

<table>
<thead>
<tr>
<th>Planning Objectives</th>
<th>Sufficient Water Supply</th>
<th>Attainment of Planning Objectives</th>
<th>Viability</th>
<th>Municipal</th>
<th>DIHL</th>
<th>Agriculture</th>
<th>Cost</th>
<th>Efficiency</th>
<th>Environment</th>
<th>Equity</th>
<th>Sustainability</th>
<th>Quality</th>
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<th>Resources</th>
<th>Culture</th>
<th>Conformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>strategy 1</td>
<td>strategy 2</td>
<td>strategy 3</td>
<td>strategy 4</td>
<td>strategy 5</td>
<td>strategy 6</td>
<td>strategy 7</td>
<td>strategy 8</td>
<td>strategy 9</td>
<td>strategy 10</td>
<td>strategy 11</td>
<td>strategy 12</td>
<td>strategy 13</td>
<td>strategy 14</td>
<td>strategy 15</td>
<td>strategy 16</td>
<td>strategy 17</td>
<td>strategy 18</td>
</tr>
</tbody>
</table>

**Candidate Strategies**

- **Finalization of Timing for Optimal Development**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Adequate Volume of Water for Municipal Uses**
  - Development of large raw water storage reservoir would reduce impacts on amount of water available for offstream use but, unless reservoir capacity is very large there will be remaining impacts on agricultural use.
  - These resources are necessary to provide sufficient production and capacity

- **Committed Resource Options**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Independent Strategy Components**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Energy Production and Efficiency**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Stream Restoration Measures**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Watershed Protection and Restoration**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **General and Community Plans**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Minimize Environmental Impacts**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

### Conformity

- **Resources**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Culture**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

- **Conformity**
  - Strategy provides sufficient water to meet projected demand
  - Strategy meets analysis design reliability/capacity expansion criteria

This chart is not legible printed at letter size but can be viewed or printed from electronic PDF file format.
Economic Analysis of the Final Candidate Strategies

The chart above shows the net present values for the DWS Central District system over a fifty year study period (2005 - 2055) for each of the Final Candidate Strategies. Variable operating, fixed operating and capital costs are all substantial components of total costs in all strategies. The cost of the DSM (conservation) programs included in each of the strategies is a small component of costs.

A table on the following page shows the data presented in this chart along with information about water rate impacts and the dates that each resource in each strategy is determined to be necessary and assumed to be put into service.

The differences between the cost components of the strategies is discernible in the chart above but is more clearly seen in the next chart that shows the same data presented as differences with respect to the Reference Strategy shown at the far left.

Figure 39
Central District Final Candidate Strategies - Net Present Value of Fifty Year Study Period Costs - “Low” Energy Cost Scenario = $75/bbl 2008 Equiv Electrical Energy Costs Escalated at 1% (Real) per Year
### Central District Final Candidate Strategies

**"Low" Energy Price Scenario: $75/bbl 2008 Equiv. Electric Power Costs Escalated at 1.0% (Real) Per Year**

<table>
<thead>
<tr>
<th>System</th>
<th>Central System</th>
<th>Reference System</th>
<th>Northward Reconfigured</th>
<th>Central System</th>
<th>Central System</th>
<th>Central System</th>
<th>Central System</th>
<th>Central System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy Name</td>
<td>Description</td>
<td>Multiple 350GPM Wells</td>
<td>Halo Welsfield (B) 1000'/1000' Wellfield Elevation</td>
<td>Brackish Desal 4T</td>
<td>Waiale WTP 30gpg</td>
<td>Waipio w/DSD 45%TP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Notes:
- Var Op-Exc Rate
- Fix Op-Exc Rate
- Cap Cost Exc Rate
- Discount Rate
- Cost of Capital
- Unserved Demand kgal
- Cap Shortfall 2008-30 MGD-Yrs.

#### Net Present Value Costs

<table>
<thead>
<tr>
<th>Year</th>
<th>Variable Operation Cost NPV</th>
<th>Capital Cost NPV</th>
<th>Total System Cost NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>$144,405</td>
<td>$172,601</td>
<td>$463,921</td>
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#### 25 Year Planning Period Costs:

<table>
<thead>
<tr>
<th>Resource Addition Sequence</th>
<th>DSD DTD Indoor 2010</th>
<th>DSM DTD Outdoor 2010</th>
<th>Maui DTD Indoor 2010</th>
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</thead>
<tbody>
<tr>
<td>Kupua Well 2006</td>
<td>Kupua Well 2008</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Generic Backup 1 2009</td>
<td>Generic Backup 1 2009</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Iao Tank Site Well 2009</td>
<td>Iao Tank Site Well 2009</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Waikapu South 2 2011</td>
<td>Waikapu South 2 2011</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
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</tbody>
</table>

#### 50 Year Study Period Costs:

<table>
<thead>
<tr>
<th>Resource Addition Sequence</th>
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<th>DSD DTD Outdoor 2010</th>
<th>Maui DTD Indoor 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kupua Well 2006</td>
<td>Kupua Well 2008</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Generic Backup 1 2009</td>
<td>Generic Backup 1 2009</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Iao Tank Site Well 2009</td>
<td>Iao Tank Site Well 2009</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
<tr>
<td>Waikapu South 2 2011</td>
<td>Waikapu South 2 2011</td>
<td>Maui Lanai Wells 2008</td>
<td></td>
</tr>
</tbody>
</table>

#### 25 Year Planning Period Rate Impacts:

<table>
<thead>
<tr>
<th>Revenue Addion Sequence</th>
<th>Average Annual DWS Rate Increase</th>
<th>Levelized Unit Cost ($/kgal)</th>
<th>$3.589</th>
<th>$3.859</th>
<th>$4.129</th>
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<tbody>
<tr>
<td>DSD DTD Indoor 2010</td>
<td>$3.49%</td>
<td>$3.635</td>
<td>$3.767</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Marahau Well 2013 Marahau (2) 2013 Halau Wellfield (B) 2014 Backup Desal 47m 2013 Waialae T.P. Recharge 2014 Kekaha Recharge 1.5MGD 2014

---

Maui WUDP Final Candidate Strategies Report REVIEW DRAFT Page 78
The chart above shows the same data as the previous chart except all costs are portrayed as differences from the Reference Strategy costs at the far left. The Reference Strategy is not a viable strategy and is included as a consistent reference for the charts presented in this report and the previous Candidate Strategies Chapter. The five final candidate strategies are presented to the right of the Reference Strategy for comparison to one another.

The cost data presented in this chart reflect the “low” energy price scenario of $75/bbl equivalent electric energy costs escalated through the planning period at an annual compound rate 1% above the rate of general inflation.

The least expensive strategy shown on this chart is the Waiale WTP strategy shown assuming (1) a commitment of sufficient base steam flow to provide adequate reliable source water to provide reliable potable water service without a raw water storage reservoir and (2) a raw water price for source water of 30 cents per thousand gallons. As discussed in the Na Wai Eha Surface Water Treatment strategy section earlier in this report, neither of these assumptions is certain. As previously discussed, building the same size and type of water treatment plant at a site north of Wailuku on grade with the Waihee Ditch would be more cost effective because pumping costs would be reduced.
The second least expensive strategy shown on this chart is the “Northward Reconfigured” strategy. This is the most recently reconfigured version of the Northward Basal Groundwater Strategy described earlier in this study. The strategy depicted here is a series of incremental installations of transmission pipe, wells, storage tanks and booster pumps starting with transmission to a well on the north side of Makamakaole gulch in the north half of the Waihee aquifer and continuing in stages into the Kahakuloa aquifer.

The “Recycle w 45% DSM” strategy depicted here is the “Extensive Conservation and Wastewater Recycling” strategy described earlier in this report. This strategy has relatively high capital costs associated with the installation of a $20 million R-1 recycled water transmission line from the Kihei Wastewater Treatment Plant to the Wailea area as well as higher costs associated with the more extensive conservation programs. These costs are offset by substantially lower variable operating costs. This results in total 50 year study period net present value (50 yr.NPV) costs about $5 million higher than the Northward Reconfigured strategy.

The Haiku Wellfield strategy depicted here is the least expensive of the Eastward Basal Groundwater strategies. This strategy includes a series of eight wells at approximately 1000 ft. elevation in the Haiku aquifer on the Hana side of Maliko Gulch and a transmission line to the Central District system. This strategy has relatively high energy costs associated with pumping water to the 1000 foot elevation resulting in total 50 yr. NPV costs about $19 million higher than the Northward Reconfigured strategy.

The most expensive strategy depicted in this chart is the Brackish Desalination strategy. This strategy has high capital costs associated with building the desalination plant and high unit variable operating costs. The total variable operating costs over the 50 year planning period are shown lower than the Haiku Wellfield strategy depicted. The units costs for the desalinated water are higher than the unit costs of pumping water from the Haiku Wellfield but the amount of water produced by the desalination plant over the planning period is smaller. This is due to (1) the size of the desalination plant in comparison to the output of the eight Haiku wells and (2) the fact that, due to the high costs of the desalinated water, the desalination plant is assumed to operate as little as possible by the integration analysis model.
The chart above shows the same strategies as the previous chart except that the “high” energy price scenario is assumed with $125/bbl equivalent electric energy costs. Assuming the higher energy costs the ranking of the economics of the strategies is similar except that the additional energy cost savings of the Extensive Conservation and Wastewater Recycling strategy make it slightly less expensive than the Northward Basal Groundwater strategy.
The chart above shows the final candidate strategies assuming the “low” energy price scenario with two alternate strategy scenarios on the right.

The Na Wai Eha Surface Water Treatment strategy scenario depicted in this chart is the 300 MG raw water storage reservoir strategy described earlier in this report. This strategy includes a 300 MG reservoir operated to capture high stage stream flows from the Iao Stream and incorporates a 9 MGD WTP (providing 6 MGD average output). As previously described, this strategy assumes the establishment of instream flow standards for the Waihee and Iao Streams and provides the existing amount of diversion capacity for existing offstream irrigation uses.\(^{40}\) This strategy is more expensive than the Waiale WTP strategy depicted in the previous two charts but provides more closely the same amount of water as the other strategies.\(^{41}\)

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40. The existing amount of diversion capacity is assumed but this results in less water volume diverted for off stream irrigation uses due to the assumption that instream flow standards are implemented. See discussion in earlier section of this report.

41. As explained in the Na Wai Eha Surface Water Treatment strategy section of this report, the Waiale and Waihee WTP strategies that assume allocation of sufficient stream base flow to provide reliable source water result in less water available for other offstream irrigation uses than the other strategies.
The strategy on the far right of this chart is the same implementation of the Extensive Conservation and Wastewater Recycling strategy as presented in previous charts except that in this scenario it is assumed that only 1.0 MGD of potable water is displaced by R-1 water. This assumption results in higher study period costs and shows that the economics of this strategy are sensitive to the amount of potable water effectively displaced.

The chart above shows the same strategies as the previous chart except that the “high” energy price scenario is assumed. The relative cost rankings of the strategies is similar in the “low” and “high” energy cost scenarios.

**Figure 44**
Central District Final Candidate Strategies with Alternate Assumptions - “High” Energy Cost Scenario = $125/bbl 2008 Equiv Electrical Energy Costs Escalated at 1% (Real) per Year

The chart above shows the same strategies as the previous chart except that the “high” energy price scenario is assumed. The relative cost rankings of the strategies is similar in the “low” and “high” energy cost scenarios.

**Comparison of the Merits of the Final Candidate Strategies**

The merits of the final candidate strategies can be assessed using the Planning Objective and Attributes Matrix and consideration of the economic analyses described above. The recommendations provided in the following section are based on consideration of the merits of the final candidate strategies with respect to each of the planning objectives identified in the Central District WUDP process.
**Uncertainty and Contingency Planning**

There are substantial uncertainties regarding several factors that are important to consider in determining recommended water resource plans. Some factors, such as future energy prices and the rate of future growth in water demand, are particularly uncertain at this time of pronounced economic upheaval. Some uncertainties have been examined to some extent by testing alternate scenarios in the integrated economic analyses presented in this report. Some remaining uncertainties are addressed by a “contingency planning” approach identifying specific measures to address uncertainties and maintain optimal planning flexibility.

**Uncertainty Regarding the Viability of Strategies**

The viability of several of the final candidate strategies is uncertain to some extent.

- The Na Wai Eha Surface Water Treatment strategies are possibly the most economical options but all are contingent upon pending resolution of long term water availability and price. Both the outcomes of these determinations and the dates that the determinations will be made remain uncertain.

- The Northward Basal Groundwater strategy is uncertain regarding the expected yields of wells in this relatively “unexplored” area. The efficacy of basal wells in this area must be verified before large capital expenditures are committed to develop the necessary water transmission improvements.

- Until verified by further study, the Extensive Conservation and Wastewater Recycling strategy is uncertain regarding the amount of potable water that would be displaced by providing R-1 water transmission to the Wailea area and regarding the capability of the Kihei Wastewater Treatment Plant to provide long term supply of R-1 water without substantial capital expenditures.

The Recommended Central District Plan outlined below discusses and addresses each of these uncertainties.

**Timing of Need for the Next Discretionary Resource**

Because the viability of some of the preferred strategies is uncertain and depends on determinations that will not be known for several years, it is necessary to plan for contingencies. A principal question, for example, is whether or not it is possible to wait for decisions regarding the long term availability and price of Na Wai Eha surface water for treatment for DWS municipal use. Is it possible to wait for the water allocation and pricing decisions that must be made by the CWRM and the Public Utilities Commission? Are other, possibly more expensive contingency options warranted to preserve the option to implement this possible strategy? At what point would it become necessary to abandon this strategy (or other preferred strategies) and opt instead for more expensive options that would preclude this strategy, such as major capital investment in transmission and development of new basal wells in the Haiku aquifer? All of these questions require consideration of the degree of urgency to implement new long term supply resources (beyond those that are committed and expected in the near term) and what immediate measures are necessary to preserve flexibility to implement valuable options and, at the same time, economically maintain reliable water services.

The need date for the next “discretionary” resource addition is calculated by the integrated capacity expansion and production costing model used in the analysis of the final candidate strategies. For the Central District system, assuming timely implementation of the committed and near term supply resource options and assuming the base case projection of future water...
consumption, the next discretionary resource is required in the year 2012. With budgeting and implementation of the basic portfolio of DSM (conservation) programs assumed in each of the final candidate strategies, the next discretionary resource addition would be required in the year 2013. As described below, these need dates incorporate some prudent margins that are appropriate for economic analysis and long range planning purposes but may be somewhat "conservative" in determining dates that resources are absolutely needed for contingency planning purposes.

The modeling analyses of the final candidate strategies incorporate specific assumptions regarding future water demand and the available production capability of the existing Central DWS water system. These assumptions were made carefully to provide a uniform and reasonable basis for economic analysis and long range planning determinations. As described below, the assumptions include some "conservative" margins:

- The capacity expansion criteria used to determine the need dates for new supply resources in order to maintain sufficient reliable capacity are not as rigorous as the State of Hawaii, Water System Standards but are nevertheless somewhat conservative considering the specific characteristics of the Central District system.

- The analyses assume that the existing and planned committed and expected short term resources in the Iao aquifer system will withdraw 16 MGD (12 month moving average) from basal groundwater sources. The DWS is currently permitted to withdraw 18.45 MGD from these sources. An additional 0.613 MGD withdrawal permit for Kehalani (Shaft 33) could also ultimately serve projected water demands for the Central District.

- The analyses assume that 4.0 MGD would be withdrawn from the existing and planned committed wells in the south half of the Waihee aquifer. Only in the Northward Basal Groundwater strategy with transmission to the north side of the Waihee aquifer is additional water withdrawal assumed from the Waihee aquifer. Recently actual withdrawals from the south side of the aquifer have averaged 5.7 MGD (twelve month moving average) without any observable increase in chlorides. The 4 MGD withdrawal assumption is prudent for long range planning purposes but it is reasonable to rely on higher levels of pumping as needed for several years with close monitoring of chlorides.

- The analyses assume production from the Iao Tunnel (which is not included in the Iao aquifer groundwater permitting or sustainable yield limitations) of 1.4 MGD. Sustained production of 2.0 MGD is possible from this existing resource.

- The analyses assume projections of water production requirements that are consistent with the Maui County general plan update demographic projections and the WUDP projections of water demand that are derived from these demographic projections. The WUDP projections of water demand predicted a decrease in water demand in the year 2008 as a result of increases in water prices in conjunction with the DWS inverted block rate structure. Actual water consumption in 2008 decreased substantially more than predicted due, at least in part, to lower average visitor census resulting from national and global economic recession. 2008 consumption was over 1 MGD lower than assumed in the final candidate strategy analyses.

Based on these factors it is possible that the next discretionary resource may not be required on the Central District system for several years beyond what is determined in the modeling analyses for the Central District. For example, the following assumptions would lead to later discretionary resource need dates:

- Iao aquifer withdrawals with existing and committed resources at 19 MGD (additional 2.16 MGD)
• Waihee aquifer withdrawals (south side) with existing and committed resources at 5.5 MGD (additional 1.5 MGD)
• Iao Tunnel production at 2.0 MGD (additional 0.6 MGD)
• Water consumption at 1.0 MGD less than projected (using 2008 as base year for predicted increases)

These assumptions combined would provide 4.26 MGD more water production capability than assumed in the modeling analyses and 1 MGD less water production requirements. At a base case projected average system growth rate of approximately 0.6 MGD per year, this additional assumed production capability and lower consumption projection would result in a substantial delay in the need date for the next discretionary resource.

It might be reasonable to incorporate some of these less conservative production capability assumptions in the base case assumptions of the resource plans. It would not be prudent, however, to base plans on a conjunction of all of these less conservative assumptions since there is some uncertainty associated with each assumption and because plans do need to incorporate some conservative margins to account for inevitable delays in implementing planned resource additions. The analyses presume, for example, that the committed and planned near term resource options will be implemented as scheduled. Although there is a fairly high degree of confidence in the likelihood these resources will be installed there is nevertheless some uncertainty.43

Uncertainty Regarding Energy Prices

Electrical energy costs are the single largest expense of the DWS. The DWS is the single largest customer of the Maui Electric Company. Future electrical prices are an important determinant in the economic analysis comparing the merits of the final candidate strategies.

The year 2008 has seen the most volatile world energy prices in history. In the first half of the year world oil prices doubled. In the second half of the year they fell to one third of the peak price. This volatility can be seen in the electrical energy price assumptions incorporated in the concurrent WUDP economic analyses. The analyses of the final candidate strategies was revised to incorporate electrical energy prices at approximately their peak and then revised again as prices fell. This report presents a comparative analysis of the final candidate strategies with respect to a range of prices. This range is wide (equivalent to a range of $75 per barrel to $125 per barrel) but certainly does not bound the range of possible future energy prices. Future energy prices remain substantially and inevitably uncertain.

Energy price uncertainty and volatility affects long range planning decisions and DWS finances. From a planning standpoint, uncertainty regarding future energy prices is addressed by considering the results of the economic analyses of the final candidate strategies assuming different future energy price scenarios. The impacts of energy price volatility on DWS finances could be addressed by rate designs that adjust rates according.

Uncertainty Regarding Project Construction Costs

The estimates of project construction costs in the final candidate strategy analyses were derived from several sources. Historical and recent actual and contractual project costs were examined. Estimates were also obtained from a Maui contractor for a range of possible major capital projects. Despite best efforts, however, the estimates of project costs remain substantially uncertain.

43. The specific assumption that two DWS wells will be developed in the near term in the Waikapu aquifer is very uncertain but in conjunction with several other wells in this aquifer that are drilled and in the process of being drilled, it is likely (but still not certain) that the full sustainable yield of this aquifer will be developed to serve municipal needs in the near term.
Construction costs on Maui for the past few years have been particularly high compared to historical costs due, at least in part, to high demand for limited construction industry services. Most recently it is expected that project construction costs could soften as demand for construction industry services wanes with economic recession.

The final candidate strategies were compared under a range of capital cost assumptions to determine the extent to which future construction costs might change the comparative economics of the strategies. Although the magnitude of assumed capital costs changes the costs of the strategies, this factor does not change the comparative outcome of the analyses extensively, primarily due to the fact that all of the strategies incur substantial capital costs.

A more important consideration regarding the uncertainty of project construction costs is maintaining some flexibility in timing major projects to coincide with the availability of lower construction costs. To the extent the DWS can maintain several alternate resource development options and/or stay “ahead” of urgent needs for immediate project implementation, the DWS can potentially minimize capital costs by obtaining more competitive bids from competing contractors.

**Capital Costs and Uncertainty in Future Water Demand**

One specific factor that should be considered is the risk associated with strategies, such as the Eastward Basal Groundwater strategy, that require very large “up front” lump sum capital expenditures that cannot be implemented in phases as demand develops. Some caution is advised regarding commitments to major capital projects at a time of possibly extended economic recession unless the objective (and associated provision of capital funding) is to promote economic stimulus.

In the analyses presented in this report, all of the strategies are evaluated assuming the consistent growth in water demand associated with the trends assumed in the County’s land use planning analyses. It is assumed in the land use planning analyses that planned land development will result in persistent long term growth in water demand. This is not a certain assumption. It is possible that water demand will not increase at projected rates, or indeed at all, in the next several years due to customer response to higher water prices and economic recession. In a worst case perspective, rate increases resulting from large capital projects could further induce reductions in water demand, resulting in further needs for rate increases.

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44. Unlike some of the final candidate resource strategies that can be implemented in phases, the Eastward Basal Groundwater strategy would require a substantial capital investment in water transmission improvements before any water would be produced for the Central system.
Recommended Central District Plan

A recommended Central District plan is outlined below to serve as a starting point for review and discussion for the Central District section of the Maui County Water Use and Development Plan. The general terms of the recommended strategy are described, followed by some specific recommendations consistent with implementation of the strategy.

The recommended strategy attempts to address the planning objectives derived from comments by the Central District Water Advisory Committee. The strategy consists of several components:

- Department of Water Supply actions to provide water needs for its customers
- Conservation programs to reduce water production requirements
- New sources of water supply
- Regulations and rate designs to promote responsible use of water
- Programs to protect the county’s aquifers, watersheds and streams
- Priorities and policies regarding water use and allocation

The recommended Central District Plan is outlined below:

**Short Term Resources**

- **ACQUIRE COMMITTED AND NEAR TERM SUPPLY RESOURCES:** One clear finding from the analyses supporting the examination of the candidate and final candidate strategies is that the committed and near term new supply resources are necessary to install as soon as possible to provide reliable water service for the Central District:
  - Maui Lani Wells
  - Kupaa Well
  - Shaft 33 Replacement Wells (Including Iao Tank and Waikapu Tank wells)
  - Waikapu South Wells 1 and 2

With these resources in place the DWS Central District System will have sufficient capacity and water production capability to meet projected water demands at least through the year 2012.45

- **OPTIMIZE PRODUCTION FROM EXISTING RESOURCES**
  - Optimize pumping distribution for Iao Aquifer wells
  - Pump Waihee aquifer wells at safe rates up to aquifer sustainable yields
  - Optimize Iao Tunnel production within legal constraints

- **CONTINUE AND ACCELERATE LEAK DETECTION AND REPAIR PROGRAM**
  - Provide additional budget, staff and equipment to accelerate leak detection and repair for all DWS systems.

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45. Currently the DWS Central District system has sufficient water production capability to provide water for existing needs but is deficient with respect to its system design criteria (State of Hawaii, Water System Standards, 2002). Applying the modified system design criteria used in the WUDP analyses, the installation of the committed and near term resources identified here would provide sufficient capacity and water production capability to make the Central District system sufficient until 2012 at the rate of growth in consumption forecast in the WUDP base case projections. The need dates for new resources cited in this Recommended Central District Plan are consistent with the results of the supporting system modeling analyses and include several conservative assumptions to provide planning margins appropriate for economic analysis and long range planning purposes. This is discussed in detail in the preceding section titled “Uncertainties and Contingency Planning”
EXPLORE DEMAND RESPONSE OPTIONS  
Demand response options are measures that can be implemented quickly during periods of restricted water availability or in response to water supply system disruptions. In order for these options to be effective, protocols and authorities need to be established in advance of the need for demand response measures.

- Landscape irrigation scheduling restrictions
- Monitoring and enforcement of waste prohibitions
- End-use restrictions (on pavement cleaning / watering, automobile washing, dust control with potable water and other discretionary uses of water)

Long Term Resource Acquisition

In previous sections of this report several final resource strategies were examined that posed alternative approaches to providing new water supply for the DWS. The recommended strategy recognizes that there is substantial uncertainty regarding the feasibility, costs and timing of the availability of some of the final resource strategies.

Discussion:

- The use of Na Wai Eha stream water for treatment to serve DWS municipal needs is possibly the most cost effective strategy but there are uncertainties regarding the feasibility and timing of availability of this strategy.
  - There is currently no long term assurance of available source water for a treatment plant. Any assured source of water will have to wait for the outcome of several allocation proceedings by the CWRM and possible court challenges.
  - The price of the source water is uncertain. The price currently proposed by Wailuku Water Company (WWC) would make this strategy more expensive than several alternative strategies. Water pricing will depend on the outcome of a Certificate of Public Convenience and Necessity proceeding for WWC currently underway before the Public Utilities Commission.

- The costs and efficacy of developing new basal groundwater wells to the north of the existing extent of the Central District system (into the north half of the Waihee aquifer and the Kahakuloa aquifer) are uncertain.
  - Hydrology and expected well production output need to be verified before expensive transmission system costs are incurred.
  - Transmission system construction cost estimates are currently particularly high but may decrease in the next several years as the demand for construction services is expected to decrease.

- Developing water transmission lines to the Haiku aquifer would be more expensive than other options. Developing transmission to the Honopou or Waikamo aquifers would be prohibitively expensive.

- Desalination of brackish water would be more expensive than other options. As desalination technologies continue to develop, costs may decrease.

- Water conservation programs would be economical and could delay the date by which new water supply resources are needed. The basic water conservation programs included in the final resource strategy analyses would cost approximately $4.3 million over a five year period and would reduce capital and operating costs by about $9.4 million.46 If started in 2010, the basic conservation programs could defer the need for new supply resources (beyond the committed and near term resources identified above) from 2012 to 2013.47 More intensive implementation of conservation pro-
grams could defer the need for new supply resources by an additional one or two years. Customer response to higher water prices may also delay the need for new resources.

- Providing transmission for R-1 recycled water from the Kihei Wastewater Treatment Plant to the Wailea area could displace enough potable water use to further delay the need for the next new supply resource to the year 2018 or 2019.\footnote{48}

**Recommendations:**

Based on these considerations the following plan components are recommended regarding acquisition of new potable water supply sources for the Central District:

- **MONITOR NA WAI EHA SURFACE WATER PROCEEDINGS:** Monitor the progress of proceedings regarding water from the Na Wai Eha streams.
  - CWRM actions regarding amending interim instream flow standards for the Na Wai Eha streams - allocating water between instream and kuleana uses versus offstream uses
  - CWRM actions regarding the designation of the Na Wai Eha surface water management area and allocations of water between all water users
  - PUC actions regarding the terms of a CPCN for WWC and associated tariffs specifying the price of water sold by WWC to users
  - County of Maui actions regarding condemnation of WWC diversion structure appurtenances by powers of eminent domain

- **DEFER BUT BE PREPARED TO CONTINUE WAIALE WTP NEGOTIATIONS:** In consideration of and contingent upon the progress and results of the proceedings listed above, be prepared to continue negotiations regarding a WTP near the Waiale reservoir site. Negotiations would need to determine:
  - Construction of a WTP financed by A&B or by the DWS or by a partnering agreement
  - Assurance of a long term reliable base flow supply of water for the WTP
    - including obtaining allocations from the CWRM and
    - obtaining contractual or other means of legal assurance of uncontested use of source water for the WTP
  - Resolution of policies and details regarding property instruments created in any source developer contracts
    - Terms of ownership and denomination of source credits
    - Entitlements to water, water meters or land development approvals

- **CONSIDER ALTERNATE WTP SITE**
  - Review existing studies and conduct further siting feasibility investigations and negotiations with WWC regarding locating a WTP on gradient with the Waihee Ditch upstream of the Wailuku-Kahului urbanized area to potentially reduce long

\footnote{46. The basic conservation programs included in each of the final candidate strategies are budgeted at approximately $1 million per year for a period of five years. The net present value (npv) of these costs is $4.3 million. As a result of the impacts of the programs DWS capital costs would be reduced by $4.2 million (npv) and the operating costs would be reduced by $5.2 million (assuming the low energy price scenario).

\footnote{47. See footnote prior to preceding footnote.

\footnote{48. See preceding footnote.}
term operating costs and reduce exposure of source water to urban non-point source (surface water runoff) pollution. The factors listed above regarding Waiale WTP negotiations should be taken into consideration.

- **WATER CONSERVATION MEASURES**
  - Immediately take steps to begin implementation of water conservation programs designed to attain at least 15% of the technical conservation potential for the Central District within five years.
    - Budget for initial implementation of programs in FY2010.
    - Provide additional DWS staff positions and train existing DWS staff in indoor and outdoor conservation audit procedures, DSM contract management and program tracking and evaluation procedures.
    - Retain expert assistance to assist the DWS to determine optimal DSM program designs, solicit and procure DSM program implementation contracts, conduct necessary market research and publicity outreach, establish a portfolio of conservation programs for the DWS systems and implement accountable program tracking and evaluation procedures.
    - Establish and facilitate an agricultural water user group and a building facilities manager group to discuss and promote water efficiency measures.
  - Based on experience with program implementation and based on continuing needs to defer the need for new supply resources consider more aggressive DSM programs.

- **RECYCLING R-1 WASTEWATER PLANT EFFLUENT**
  - Initiate a verification study, followed as appropriate with preliminary engineering design, regarding extension of transmission of R-1 recycled water from the Kihei WWTP to the Wailea area and to displace potable water currently used for landscape irrigation. In conjunction with the conservation programs recommended above, this option could defer the need for other new supply resources until 2018 or 2019 should these resources fail to become economically available in the next few years. The study should:
    - Verify the amount of potable water in the Wailea area that could be displaced with R-1 water.
    - Verify total project costs and Kihei WWTP R-1 long term production capability.
    - Investigate costs and feasibility of alternative strategies to deliver treated wastewater to the Wailea area to displace potable use.

- **MONITOR FEASIBILITY AND PRESERVE OTHER LONG TERM OPTIONS:** Continue to monitor costs and feasibility of other resource strategy options.
  - Verify the hydrology of the North Waiheeaquifer to determine the feasibility of the Northward Basal Groundwater strategy by supporting further study or drilling one or more test wells north of Makamaka'ole Gultch.
  - Monitor construction costs for water transmission and storage reservoir projects to determine the ongoing economic feasibility of the Northward and Eastward Basal Groundwater strategies.
Regulatory Mechanisms

- **MAINTAIN AND/OR EXTEND INVERTED BLOCK AND PROGRESSIVE RATE DESIGNS:** The existing DWS inverted block rate design is progressive in the respect that it provides aggressive price signals in the higher consumption blocks that encourage conservation and also provides lifeline rates for low volume consumers.
  - Consider increasing the rate block price differential and/or providing an additional higher cost block.
  - Ensure that all costs necessary to provide water services are included in rates.

- **REVIEW SYSTEM EXPANSION FINANCING POLICIES AND/OR ESTABLISH SUFFICIENT SYSTEM DEVELOPMENT FEES**
  - The County should establish sufficient and appropriate System Development Fees that are consistent with the fiscal purposes and policies of the DWS. The source and transmission components of the current fees are not sufficient to pay for commensurate new source and transmission improvements. As an alternative the County should consider revising its system development financing policies to provide debt financing for system expansion improvements where necessary.

- **ESTABLISH WATER SOURCE DEVELOPMENT CONTRACT STANDARDS:** The Maui County Code provides that approvals of new subdivisions require prior verification by the Water Director of a long term reliable source of water. In areas where the DWS does not currently have sufficient water capacity or production capability, potential land developers have a strong incentive to develop new potable water sources in order to obtain required verification. Few developers want to operate water sources or commit to providing perpetual water services. In most cases developers prefer to transfer ownership of a new water source to the DWS in trade for verification of water availability, entitlements to obtain water meters and/or source credits towards payment of DWS System Development Fees.

From the perspective of potential source developers as well as for the interests of the County there is a need for clear policies and standards regarding water source contracts. Clear standards would provide fairness, encourage reasonable financial investments in new sources and ensure that new sources are safe, properly sited and contribute to the system planning and operation objectives of the DWS.

  - Establish clear and uniform standards for determining source credits
    - Source credits should be denominated in dollars towards the cost of system development fees at the time the source credits are redeemed (rather than in terms of capacity or meter equivalents).
    - Terms and transferability of source credits should be clearly established.

  - Establish standards for well (or other source) location requiring consideration of:
    - Source / Wellhead protection to ensure long term water quality
    - Source elevation and impacts on water system operation costs
    - Proximity to existing water system transmission lines
    - Need to boost water to elevation of land developments
- Establish standards for integration of new sources with the DWS system
  - Need and role of new source in DWS long range system plans
  - Functional / operational role of the new water source
  - Variable and fixed operation costs
  - Storage and disinfection contact requirements
  - Design of new sources to DWS construction / engineering standards

- ESTABLISH CLEAR, MEANINGFUL CRITERIA FOR DETERMINING AVAILABILITY OF WATER AND NEED FOR NEW SYSTEM SUPPLY RESOURCES: The DWS needs to have a clear method to determine whether there are sufficient water resources and sufficient infrastructure to supply new water demands. This is necessary for several reasons including (1) the need to determine verifications of sufficient water source for new subdivisions, (2) the timing of need for new source development and capital improvements in order to maintain reliable water service and (3) implementing water allocation policies.

- Commission a study/project to develop reasonable and useful system reliability standards, system capacity expansion criteria and methods to determine and express the status of water availability for new water services.

**Resource Protection and Restoration**

Actions, programs and measures to protect and restore cultural, watershed and groundwater resources are essential components of Maui's WUDP.

**Watershed protection and restoration**

Healthy forests and soil in our watershed areas are essential to maintain the healthy streams and ground water aquifers that are the source of our water supplies. These resources need protection and, in some places, substantial restoration. Healthy forests invite and capture precipitation, retain water to replenish aquifers, maintain base flow in streams, prevent soil erosion and flooding and maintain stream water quality.

- SUPPORT WATERSHED PARTNERSHIP AGREEMENTS
- SUPPORT REFORESTATION PROGRAMS

**Wellhead protection**

- IMPLEMENT A WELLHEAD / AQUIFER PROTECTION ORDINANCE FOR EACH ISLAND

**Stream restoration**

Healthy streams are essential to support Hawai‘i's unique stream fauna and provide sufficient cool water necessary for growing taro.

- SUPPORT CWRM AMENDMENT OF INTERIM AND OR PERMANENT INSTREAM FLOW STANDARDS
- SUPPORT PROGRAMS TO PROTECT AND RESTORE STREAMS
- CONSIDER IMPACTS ON RELIANCE ON WATER FROM STREAMS IN COUNTY LAND USE DETERMINATIONS

**Protection of Cultural Resources**

- SUPPORT STREAM RESTORATION MEASURES
- CONSULT WITH BURIAL COUNCIL AND LOCAL KULEANA REPRESENTATIVES REGARDING DWS ACTIONS
Energy Efficiency and Energy Production

Energy costs are the single largest expense of the DWS. The DWS is the largest aggregate customer of Maui Electric Company (MECO). Opportunities to use energy more efficiently, manage the timing of electrical loads with MECO and to generate electrical energy can all benefit the County and DWS customers.

Efficient use of energy by the DWS will reduce costs to the County and DWS customers and reduce the impacts associated with electrical power production. Cost effective energy efficiency measures are consistent with all of the WUDP planning objectives.

Managing the timing of electrical energy use (load management) can be a valuable resource to MECO. The DWS can benefit by existing MECO load management incentives and by negotiating benefits resulting from future power management protocols with MECO.

The DWS has several opportunities to produce renewable energy for its own use that would reduce system costs. Renewable energy production opportunities are site specific due to the nature and availability of renewable energy sources and proximity to the DWS system electrical loads. Several specific opportunities for potential wind and hydroelectric generation have been identified for the Upcountry District. Opportunities for the Central District will depend on the location of future resource development.

- **ESTABLISH DWS ENERGY RESOURCE COORDINATOR POSITION**
  - Establish a full time staff position to monitor, investigate and implement energy efficiency programs, load management measures and energy generation opportunities

- **IDENTIFY AND IMPLEMENT ENERGY EFFICIENCY OPPORTUNITIES**
  - Participate in existing MECO energy efficiency programs
    - Prescriptive programs - Lighting in DWS buildings
    - Customized Rebate Programs - HVAC in DWS buildings and motor and pump efficiency investments
  - Participate in upcoming Public Benefit Fund Administrator energy efficiency programs
  - Invest in high efficiency equipment wherever cost effective
  - Monitor and optimize energy consumption of motor loads
    - Establish and monitor baseline efficiency metrics for pumping loads
    - Measure and monitor actual operational motor loads for energy diagnostics and optimization of equipment replacement
  - Establish system operation protocols that consider energy efficiency
    - Tabulate marginal operation costs for all system resources
    - Determine operational protocols to minimize energy costs without compromising system functionality
  - Optimize power factor correction on all large motor loads
    - Monitor balance of electrical service three phase legs
    - Determine and install optimum power factor correction capacitance for each large motor load
**IDENTIFY AND IMPLEMENT LOAD MANAGEMENT OPPORTUNITIES**
- Review and, as appropriate, amend MECO rate rider contracts
  - Balance MECO rate incentives versus system operation functionality
- Monitor and negotiate load management opportunities, especially electrical system transient management services
  - Monitor MECO system needs and proposed measures to incorporate increased wind generation on the Maui electrical grid
  - Develop DWS load management protocols that are valuable to the MECO system.
  - Negotiate for shared system and economic benefits for load management services provided by DWS to MECO

**IDENTIFY AND IMPLEMENT ENERGY GENERATION OPPORTUNITIES**
- Monitor ongoing opportunities for cost effective energy generation to serve DWS electrical loads

**Water Allocation Policies**

This section of this report is currently drafted to provide an expository discussion of possible water allocation policies. As this matter is discussed in various public forums more concrete recommendations may be offered.

The State Water Code (Code) clearly provides that each county shall adopt a WUDP by ordinance “... setting forth the allocation of water to land use in that county...”49 Apart from this unequivocal directive, however, the Code is silent and provides no further guidance regarding water allocations in the county WUDP’s. The Code does not identify how the allocations should be made or what purposes they are intended to serve. The Code does not identify any context or venue in which the allocations should be applied nor does it explicitly provide any authority to implement or enforce water allocations.50

There have been discussions in several venues regarding allocations of water in the WUDP but there is no consensus regarding how the allocations should be expressed or how they should be applied. There are diverse opinions on this matter.

In order to provide a starting point for further detailed discussion regarding the “allocation of water to land use” in the WUDP, several clarifications and approaches are outlined below.

**Venues and Purposes for Allocations**

Water allocation in the WUDP can serve several purposes, either as guidelines or as rules.
- Water allocation policies established in the WUDP can serve as **guidelines:**
  - To the CWRM regarding amendments to interim instream flow standards (IIFS) and establishing instream flow standards (IFS)

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49. HRS 174C-31(a)(2)

50. The County certainly may have authority to allocate water provided by the DWS to DWS customers but this authority does not derive from the Code's language regarding the Hawaii Water Plan or the County Water Use and Development Plans. There is a distinction between “users” in the context of the Code and DWS customers. In the context of the Code the DWS is a “user” but the DWS customers are not users. The DWS serves many customers
- These CWRM standards determine allocation of water to in-stream versus off-stream uses

○ To the CWRM regarding allocation of water to competing uses and users in water management areas.  
  - Permits for water use issued by the CWRM in surface water management areas explicitly allocate water between instream uses and offstream uses as well as between competing off-stream users.
  - Permits for water use issued by the CWRM in ground water management areas explicitly allocate water, within aquifer sustainable yields, to competing ground water uses and users.

○ To the DWS in making decisions within its discretionary authority

○ To state and county agencies, including the Maui County Council, in determining rules, ordinances, policies and plans, including the General, Island and Community Plans.

- Water allocation policies in the WUDP can potentially serve as rules regarding determinations within the authority of the Maui County Council:

  ○ Rules regarding actions by the DWS including
    - Issuance of water meters
    - Issuance of reservations for water meters
    - Certification by DWS Director of availability of reliable source of water supply necessary for subdivision approvals
    - Approval of contracts with water source developers
    - Development of DWS supply and transmission resources
    - Restrictions on certain water uses during drought or temporary system deviance

  ○ Rules regarding actions by County agencies including
    - Planning Commission
    - Department of Public Works
    - Planning Department permitting and/or subdivision approvals
    - Board of Variance and Appeals actions

  ○ Rules with respect to the actions listed above regarding set asides or reservations for specific priority uses, possibly including
    - Affordable housing projects
    - Kuleana or public trust domestic uses
    - Hospitals or other municipal emergency or public service uses
    - Department of Hawaiian Homelands (DHHL) projects
    - General or specific agricultural uses

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51. In the context of allocation of water by the CWRM, the DWS is a “user” but individual DWS customers are not “users” by way of receiving water from the DWS. These allocations are made in accordance with the provisions of the State Water Code, HRS Chapter 174C. Allocations of water between existing and potential DWS customers are determined by the County in accordance with DWS policies and county ordinances and rules.
Hierarchy of Priorities

A general hierarchy could be outlined to establish water use priorities. Outlined below is one example of a hierarchy of priorities of water use derived from existing law and practical considerations:

- Public Emergency Uses (Temporary)
  - Fire control
- Public Trust Uses
  - Instream uses
  - Kuleana kalo, subsistence agriculture and domestic uses
- Reasonable / Beneficial Uses
  - Essential municipal public service uses (hospitals)
  - DHHL domestic uses
  - Domestic uses
  - DHHL agricultural uses
  - Agricultural uses
  - Government uses (offices)
  - Hotel / Commercial / Industrial uses
  - Non-essential municipal public service uses (parks)
  - Landscape Irrigation uses
- Non-Reasonable / Non-Beneficial Uses
  - Excessive or Purposeless Commercial uses
  - Wasteful or Excessive Landscape irrigation uses
  - Waste

Set-Asides

Amounts of water could be set aside for specific users or uses. For example, it could be determined that a specific amount of water or a percentage of available water would be set aside for DHHL projects, for affordable housing, for agriculture, or other projects determined by the Council. Implementation of a set-aside policy requires quantification of the total amount of water available and the amounts already committed to existing and “entitled” uses. This approach requires several determinations and presents several challenges. It would be necessary to:

- Determine what categories of water users or uses would have water set aside
- Determine what amounts of water would be set aside for each beneficiary category of users or uses
- Determine whether the set-asides would be applied to the County as a whole, to each island or to specific areas, districts or systems.
- Establish a clear and concise method of determining, on an ongoing basis, how much total water is available to be allocated. It would have to be determined whether the set-asides would allocate portions of
  - potential sources (aquifer sustainable yields or stream flows),
  - existing developed infrastructure (existing wells, treatment plants, transmission and storage), or
- planned infrastructure.

○ If set-asides are made against planned infrastructure it would have to be determined what threshold would determine whether water would be considered “available”
  - source construction contract?
  - feasibility study?
  - inclusion in the CIP?
  - inclusion in the WUDP?

○ Establish a clear and concise method of determining, on an ongoing basis, how much of the total available water is already committed. This could include any of several categories of use:
  - use by existing customers with meters
  - average historical consumption basis?
  - expected continued increase in use per meter (as lots with meters are improved and “built out”).
  - anticipated use by projects and subdivisions that have some level of implicit or explicit entitlement or reservation
  - verification of long term water source by the DWS director
  - water meter reservation
  - land use approvals
  - water promised or committed by source development contracts
  - water promised or committed by contract with DWS (letters or memoranda of understanding)

○ Determine at what stage of which process the set aside allocations would be determined and at what stage the determinations of net availability would be applied:
  - in General, Island or Community Plan land use designation process?
  - in the WUDP?
  - as a set aside allocation ordinance?
  - at time of subdivision verification of water source availability by DWS director?
  - at time of reservation or issuance of water meter?

Allocations of Specific Water Sources to Land Use

Specific water sources could be allocated to specific land uses or categories of land uses. For example, the output of a specific well or production tunnel could be allocated to municipal potable use. Raw water from a specific diversion or reservoir could be allocated to agricultural uses in a specific area. Specific allocations of water for instream uses could be identified.

52. It is recognized that the County may not have explicit authority to directly allocate water from some specific sources. In these cases the allocations would serve as policy statements.
Statements of Allocation Policies

The County could express its allocation of water to land use by stating policies that should apply generally or to specific circumstances. Some examples are provided, including statements of policy that have been suggested in the WUDP public process:

- Maintain mauka to makai flow in Maui’s streams
- Return all water to the streams
- Give priority to riparian, kuleana and instream uses
- Give priority to DHHL uses
- Use ground water for potable uses and surface water for non-potable uses
- Provide for the needs of existing users before allowing new uses (land development)
- Give priority to residents’ needs over visitor industry needs
Appendix A - Analysis of Demand Side Management (Conservation) Program Portfolios

Demand Side Management (Conservation) Programs

“Demand side management" (DSM) is a utility industry term of art that describes actions that can be taken by a utility to affect how the utility’s commodity is used by its customers. Originally applied to the electric utilities and applied now also to gas and water utilities, DSM options have proven to be valuable “resources” to meet utility planning objectives.

DSM resource options are usually programs undertaken by a utility to encourage the use of efficient appliances or practices by its customers or to encourage customers shift their time of use. DSM programs often use incentives such as monetary rebates to encourage purchase of efficient appliances. More intensive DSM programs include direct installation of new efficient fixtures by the utility (or a contractor paid by the utility) at customers’ premises.

DSM programs are evaluated based on a comparison of the costs of implementing the programs with the costs the utility and its customers would otherwise incur to develop and operate new supply resources.

DSM programs are included in all of the final candidate strategies.

The analysis of DSM programs for the Central District strategies was conducted in several steps:

- Characterization and Evaluation of Individual DSM Measures
- Preliminary Analysis of Candidate DSM Programs
- Characterization of Water End Uses by District
- Estimate of DSM Technical Potential
- Estimate and Analysis of DSM Economic Potential
- Analysis of Magnitude and Pacing of DSM Programs
- Independent Expert Review of DSM Analysis and Program Design
- Specific DSM Program Design and Contracting

Each of these steps is described below:

Characterization and Evaluation of Individual DSM Measures

Analysis of an inclusive list of possible DSM measures is presented in the Resource Options Chapter. In this analysis, each DSM measure was characterized in terms of the fixture costs, installation costs, program administration costs and average expected water savings. The costs and benefits of each measure were characterized in terms of the levelized life cycle costs per thousand gallons of water saved. This analysis does not explicitly consider the operational benefits of the DSM measures in the specific context of the water system or possible future resource strategies.

Preliminary Analysis of Candidate DSM Programs

Analysis of several candidate DSM programs was presented in the Candidate Strategies Chapter. The purpose of these analyses was to determine, generally, whether DSM programs could be an effective and cost effective means to meet Central District water needs. In these analyses several example portfolios of DSM programs were examined in the specific context of the Central District system using the integrated capacity expansion and production cost analysis model for each of several candidate resource strategies.
The candidate DSM portfolios in these analyses include a toilet retrofit rebate program, a commercial urinal retrofit program, an irrigation efficiency program and a xeriscaping program. Labor assumed in characterizing the portfolio of programs includes four full time staff. The annual budget for the portfolio of programs includes $261,000 of rebates, $240,000 incremental administration costs and presumes $150,000 of costs born by program participants. The portfolio impacts are estimated to reduce metered consumption by 88,000 gallons per day for each year of program implementation. The life of the measures is assumed to be fifteen years.

For purposes of sensitivity analysis several other portfolios were examined including a portfolio with twice the assumed penetration and a portfolio with higher administrative costs.

As documented in the Candidate Resource Strategies Chapter, the DSM programs examined in this analysis proved to be effective and cost effective in the context of the candidate strategies. Based on these results more detailed characterization and analyses were conducted.

**Characterization of Water End-Uses by District**

The analyses described above characterize the economic benefits of several DSM programs but do not determine the amount of water savings that would ultimately be possible. The magnitude of potential water savings was determined in three progressive steps: end-use analysis, estimation of technical potential and estimation of economic potential.

End-use analysis determines how much water is used for different ultimate purposes. For the Central district the amount of water use was determined for each class of customers. For domestic uses the amount of water use was estimated for each of several end use categories. A summary of the results of this analysis is portrayed in the tables below.

<table>
<thead>
<tr>
<th>DWS CY2006 Consumption (MGD)</th>
<th>Wailuku Kahului CPD</th>
<th>Kihei Makena CPD</th>
<th>Central District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>0.1</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Commercial</td>
<td>1.4</td>
<td>0.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Industrial</td>
<td>0.7</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Domestic Indoor</td>
<td>3.8</td>
<td>3.4</td>
<td>7.2</td>
</tr>
<tr>
<td>Outdoor (Non-Ag)</td>
<td>3.3</td>
<td>7.5</td>
<td>10.8</td>
</tr>
<tr>
<td>Total</td>
<td>9.3</td>
<td>12.5</td>
<td>21.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CY2006 Domestic Indoor Consumption (MGD)</th>
<th>Wailuku Kahului CPD</th>
<th>Kihei Makena CPD</th>
<th>Central District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>0.9</td>
<td>0.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Showers</td>
<td>0.8</td>
<td>0.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Baths</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
</tr>
<tr>
<td>Faucets</td>
<td>1.0</td>
<td>0.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Dishwashers</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Clothes Washers</td>
<td>0.7</td>
<td>0.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>3.9</td>
<td>3.5</td>
<td>7.2</td>
</tr>
</tbody>
</table>
Estimate of DSM Technical Potential

The DSM technical potential is the amount of water that could be saved using efficient fixtures and practices. For the purposes of this analysis the technical potential is defined as the amount of water that would be saved if all fixtures in the District were converted to fixtures meeting the current effective code efficiency standards. The results of the quantification of the technical potential for various domestic end uses for the Central District is presented in the table below.

<table>
<thead>
<tr>
<th>DSM Technical Potential (MGD)</th>
<th>Wailuku</th>
<th>Kahului</th>
<th>Kihei</th>
<th>Makena</th>
<th>CPD</th>
<th>Central District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toilets</td>
<td>0.6</td>
<td>0.5</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Showers</td>
<td>0.4</td>
<td>0.2</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baths</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faucets</td>
<td>0.3</td>
<td>0.2</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dishwashers</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clothes Washers</td>
<td>0.3</td>
<td>0.3</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Indoor</td>
<td>1.6</td>
<td>1.2</td>
<td>2.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor Irrigation</td>
<td>1.1</td>
<td>2.6</td>
<td>3.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.7</td>
<td>3.9</td>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The estimate of technical potential includes an assessment of the vintage of existing water fixtures determined from Maui County Tax Division records. The consumption of existing fixtures was estimated from fixture vintage based on the date of the last building permit for each TMK.

If all fixtures in the Central District were upgraded to the efficiency standards in current codes indoor water use would be reduced by approximately 2.9 MGD. This equals about 40% of indoor domestic consumption and equals about 13% of total Central District DWS system 2006 metered consumption.

Domestic outdoor use is primarily irrigation of plants. The technical potential estimate is based on an estimate of 35% reduction of outdoor irrigation use that would result from eliminating all over-watering of plants and eliminating waste due to poorly designed and/or maintained irrigation systems. This estimate is based on industry literature and discussion with local irrigation system industry personnel. 35% of 2006 estimated domestic outdoor irrigation use equals 3.8 MGD.

The total technical potential of indoor and outdoor measures is estimated to be 6.7 MGD which equals about 30% of Central District 2006 total metered consumption. For practical purposes it is important to note that the estimates of technical potential assume upgrading ALL fixtures to current code standards and improving ALL irrigation to optimum practices. Assessments of realizable “economic” potential are determined by further analysis as described below.

Estimate and Analysis of DSM Economic Potential

Estimates and characterization of the practical, economic potential of implementing DSM programs was made in several stages. Initially, the economics of several DSM programs was examined in the analysis of the candidate strategies as described above. Based on the end-use analyses and the estimates of technical potential the economics of a portfolio of more refined...
and specific DSM programs was examined to explore the optimum magnitude and pacing of program implementation. This is described in the section below. After these analyses were conducted, a nationally recognized water conservation program expert was retained to visit Maui, review the assumptions, programs and analysis methods used and to recommend a specific portfolio of DSM programs for Maui's water systems.

**Analysis of Magnitude and Pacing of DSM Programs**

DSM programs can be implemented with differing degrees of intensity. Modest rebate programs can be expected to result in modest amounts program participation and modest reductions in water use. With additional expenditures on DSM programs, providing higher incentives or direct installation of fixtures, higher amounts of program participation and water savings can be expected... but at a higher cost per unit of savings. Depending upon the circumstances and needs of the water system, higher expenditures on DSM programs may be more effective and more cost effective... but only to a point of diminishing returns.

In order to determine the optimum magnitude and pacing of DSM programs several analyses were conducted using the integrated capacity expansion and production cost model for the Central District. A portfolio of DSM programs was characterized and applied in differing degrees of magnitude and pacing to compare the resulting effectiveness and cost effectiveness in the context of each of several final candidate strategies. The results of several analyses are provided below.

The portfolio of programs used in this analysis includes both indoor and outdoor measures. The indoor measures include direct installation of efficient toilets, showerheads and sink fixture flow restrictors for domestic units. The outdoor measures include direct installation of evapo-transpiration (ET) weather manager controls on automated irrigation systems and repair, replacement and adjustment of in-ground irrigation systems. The assumed program costs include the costs of installing and maintaining several weather stations to provide data to the ET controllers via automated telephone communication.

The differing intensities of program magnitude and pacing were analyzed based on an initial base program portfolio designed to attain 15% of the DSM technical potential in a period of five years. Differing intensities of DSM program implementation were analyzed as multiples of the base program with corresponding associated costs and impacts.

The base indoor program portfolio, including direct retrofit of domestic toilets, showerheads and sink faucet restrictors results in a reduction of water use of 89,000 gallons per day for each year of program implementation at a total cost (customer and utility cost) of $458,000 per year. The outdoor program portfolio, including installation of ET controls and associated weather stations and repair and adjustment of existing irrigation systems would reduce water consumption by 111,000 gallons per day for each year of program implementation at a total cost of $507,000 per year. Combined, the indoor and outdoor portfolios would result in attaining 15% of the DSM technical potential after five years of implementation. This means that the programs would result in 15% of the possible saving that would result if ALL fixtures were upgraded to current code standards and ALL domestic irrigation equipment and practices were optimum.

The basic indoor program, for example, would reduce water consumption by 89,000 gallons per day for each year of program implementation. This would result in a reduction of water con-

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54. Note that, although the estimate reduction in water use for this indoor program (89,000 gpd/yr) is close to the reduction estimated for the combined indoor and outdoor program portfolio in a previous stage of analysis reported above (88,000 gpd/yr), these are separate programs with different components and different underlying assumptions.
The basic outdoor program would reduce water consumption by 111,000 gallons per day for each year of program implementation. This would result in a reduction of water consumption of 555,000 gallons per day after five years of program implementation. This is equal to 15% of the estimated 3.8 MGD domestic outdoor irrigation technical potential for the Central District.

Together, the basic indoor and outdoor program portfolio would reduce water consumption by 200,000 gallons per day for each year of program implementation resulting in 1 MGD of reduction after five years of program implementation. This equals 15% of the 6.7 MGD total domestic DSM technical potential for the Central District.

Alternate magnitudes and pacing of DSM program implementation were analyzed assuming program intensities that would attain 30%, 45%, 60% and 75% of technical potential. Increasing the intensity of program implementation would require higher costs per unit of savings due to the need to use higher incentives, more expenditure on publicity and advertising and increasingly expensive measures in the portfolio of DSM programs. For example, to attain higher percentages of the technical potential it would be necessary to include substantial installation of more expensive measures such as high efficiency clothes washers and dishwashers.

Central District Reference Strategy with Alternate Levels of Indoor DSM Program Penetration with Progressively Extended Program Duration

Analysis of alternate levels of indoor DSM program penetration with progressively extended program duration.
The table above shows the DSM costs and resulting planning period cost impacts of implementing an indoor DSM program with increasing duration and an increasing portfolio of measures. The base program attains 15% of the DSM technical potential in five years. Alternate levels of implementation attain 30%, 45%, 60% and 75% of the DSM technical potential in seven, ten, twelve and fifteen years respectively. The longer duration programs include progressively higher levels of incentives, more expensive delivery mechanisms and more expensive measures in later years to achieve higher levels of program participation.

This analysis demonstrates that increasing the duration and intensity of program implementation yields diminishing returns. This is expected since it is necessary to employ more expensive program delivery mechanisms and to target more expensive water saving measures in order to achieve higher proportions of DSM technical potential. In this analysis a ten year program to attain 45% DSM technical potential is cost effective but a twelve year program to attain 60% DSM technical potential is not.

Several other analyses were performed using alternate assumptions and using different candidate strategies as the reference plan.

Central District Reference Strategy with Alternate Levels of Indoor DSM Program Penetration Using Accelerated Program Pacing to Attain Water Savings Within Five Years

Analysis of alternate levels of indoor DSM program penetration using accelerated program pacing to attain water savings within five years.
The chart above shows the DSM costs and resulting planning period cost impacts of implementing an indoor DSM program with increasing “pacing” and an increasing portfolio of measures. The base program attains 15% of the DSM technical potential in five years and is identical to the base program in the analysis presented on the previous page. Alternate levels of program implementation attain 30%, 45%, 60% and 75% of the DSM technical potential in five years using progressively higher levels of incentives and more expensive measures to achieve a higher rate of program implementation.

As shown with the analysis presented on the previous page, increasing the intensity of program implementation yields diminishing returns. Increasing the pace of program implementation as shown here is a more expensive way to achieve higher portions of DSM technical potential than by increasing program duration. This is because more expensive program delivery mechanisms are necessary in order to increase the pace of the programs. It is also less feasible to optimize program cost effectiveness by capturing as much of the less expensive program opportunities in the early years of program implementation. In this analysis it is not cost effective to achieve more than 30% of the DSM technical potential in a five year period. Depending upon the specific characteristics and immediate needs of the water system it may be more cost effective to accelerate the pacing of DSM programs in some circumstances.

Several analyses were performed to test the cost effectiveness of several DSM program portfolios under alternate assumptions. The indoor and outdoor programs were tested and shown to be cost-effective individually and conjunctively. The DSM programs were also tested in conjunction with all of the final candidate strategies. In all cases the basic DSM program portfolio of indoor and outdoor programs designed to attain 15% of technical potential was cost-effective.

The analyses shown above reflect electrical energy costs associated with world oil prices at approximately $75 per barrel consistent with the “low” energy price scenarios presented in the final candidate strategies report. During the year 2008 in which the final candidate strategies were examined, energy prices increased dramatically to over $140 per barrel and, by the end of the year fell again to under $40 per barrel. Several analyses of the DSM programs were performed assuming a range of energy prices. In the “high” energy price scenarios (equivalent to $125 per barrel crude oil price), the DSM programs, as expected, were determined to be more cost effective than in the lower price scenarios.

Independent Expert Review of DSM Analysis and Program Design

In order to verify the reasonableness of the characterization and analysis of DSM programs a nationally renowned expert was retained. Amy Vickers, the author of an authoritative text on water conservation, Water Use and Conservation, was retained to visit Maui and provide a critical review of the DSM program analyses and provide a recommended portfolio of DSM programs appropriate for Maui’s systems. The review included a spectrum of site visits to agricultural, commercial and domestic properties across the island, a technical review of the methods used in the analyses described above, meetings with DWS staff and a Powerpoint presentation of findings to the County Council Water Resources Committee.

Ms. Vickers approved of the analytical methods used but recommended some different DSM program designs and delivery mechanisms than were assumed in the analyses. After careful review it was determined that the programs used in the analyses are sufficient to conservatively demonstrate the value and cost effectiveness of a portfolio of DSM programs but that a different portfolio of programs should be considered for implementation for Maui’s systems. In particular, Ms. Vickers recommended against basing the outdoor DSM programs primarily upon the

55. The DSM program portfolio recommended by Ms. Vickers was determined to cost less and result in at least as much reduction in water usage as the program portfolio included in the prior analyses. The findings of the prior analyses, that the portfolio of DSM programs would be cost-effective, is therefore likely to be “conservative.”
installation of ET irrigation system controls. Ms. Vickers recommended the following portfolio of DSM programs:

- Residential / Commercial Audit and Direct Installation Program for Indoor and Landscape Irrigation Users
- Education and publicity program to encourage water conservation and promote program participation
- Direct installation of efficient fixtures at customer premises including toilet, shower-head and sink faucet flow restrictors
- Audit of existing irrigation system equipment and practices and specific resulting recommendations to customer to improve efficiency
- Direct Installation of Targeted “High Payback” Fixtures in Commercial Premises
- High Efficiency Fixture Rebates
- High efficiency washing machines
- High efficiency toilets and waterless urinals
- Hotel Awards Program
- Building Manager User Group and Services
- Agricultural User Group and Services

**Specific DSM Program Design and Contracting**

The analyses described above conclude that a portfolio of DSM programs would be beneficial and cost-effective for the Central District system. As recommended in the Central District Final Candidate Strategies Report, the next step towards implementing a DSM program for the DWS would be to obtain proposals and bids from companies that implement water utility DSM programs. This will provide more specific cost and impact estimates that can be used in further economic analysis.