EXHIBIT "I-9"

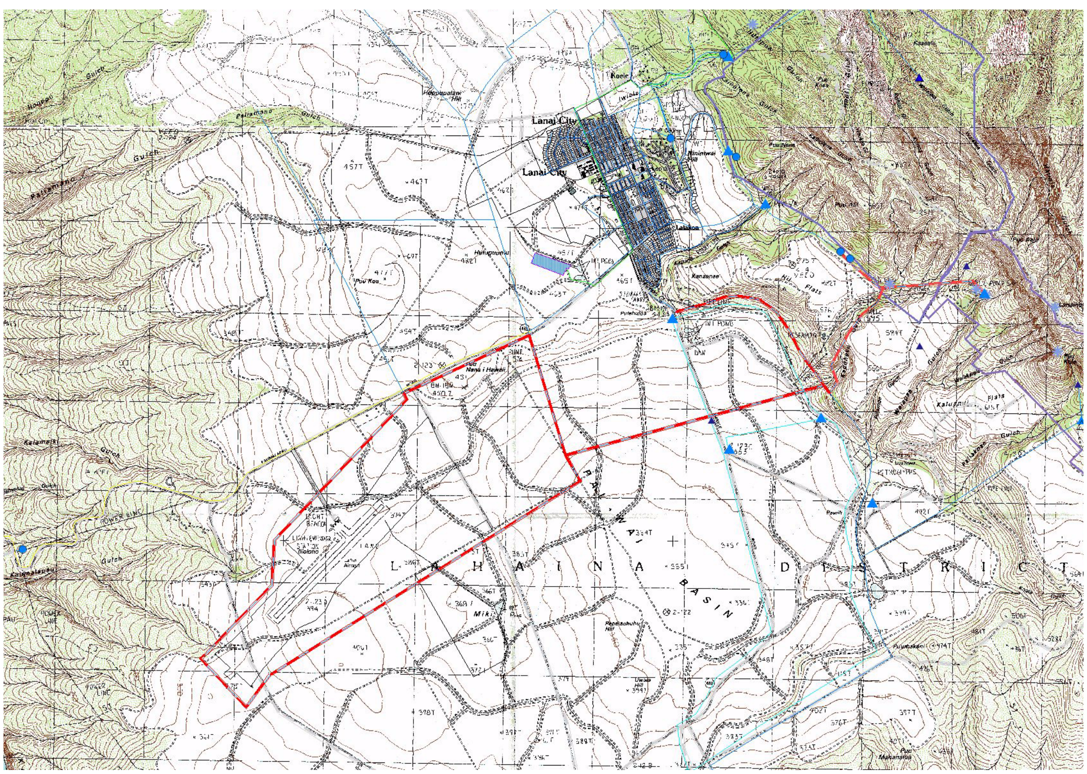
PART J

Pipe Replacement to Reduce System Losses

Unaccounted-for water analysis in the previous chapter led to examination of the source value of pipe replacements in the Palawai Grid. Unaccounted-for water in this area was 44.61% in 2008. To the extent that this represents losses rather than un-metered uses, this represents substantial and expensive operating loss for this service area.

Several options were considered for repairs in this area. For evaluation on a levelized cost basis, the capital cost of this replacement is estimated at about $3.8 million dollars. Water savings are estimated at 202,000 GPD. First year electrical energy savings are $1.49 per thousand gallons. The total thirty-year levelized costs are $2.34 per thousand gallons. This cost is comprised of $4.54 in capital costs, a savings of $.07 in operating and maintenance cost and a savings of $2.14 in electrical energy cost.

FIGURE 5-31. **Palawai Grid Pipe Replacement**



Supply and Demand Side Efficiency Options

FIGURE 5-32. Palawai Grid Pipe Replacement

Capacity (MGD)				
Installed Capacity		0.202		
Max. Day Capacity		0.202		
Effective Sustainable Capacity		0.202		
Facility Capacity Factor		100%		
Average Facility Output		0.202		
Capital Costs ($)	Total	Per MGD		
Exploration/Land/Power	$0	$0		
Refurbish well site	$0	$0		
Development	$0	$0		
Transmission Improvements	$3,200,000	$15,841,584		Per CIP Pipe Replacement Estimate
Storage Improvements	$0	$0		
Design / Engineering	$0	$0		
Contingencies	$640,000	$3,168,317		20%
Total Plant Cost (	$3,840,000	$19,009,901		
Const. Per. Esc. Rate (Nom.)	3.00%			
AFUDC Interest Rate (Nom.)	6.00%			
AFUDC Factor		1.000		
	Total	Per MGD		
Total Capitalized Cost	$3,840,000	$19,009,901		
Fixed Operating Costs ($)	Per Year	Per Y/MGD		
Dedicated Operating Labor		$0		$0.05 per kgal based on estimated Lanai average
Apportioned Operating Labor		$0		
Maintenance Labor		$0		
Fixed Operating Costs				
Electrical Demand	-$3,737	-$18,500		5 Kwh/Kgal/Kft lift efficiency*derived sys demand cost factor*electrical energy cost*installed capacity
Chemicals/Materials		$0		
Maintenance Expenses		$0		
Amort. of Capitalized Rebuild Costs		$0		
Total Fixed Op. Costs	-$3,737	-$18,500		
Variable Operating Costs ($)		Per KGal		
Operating Labor				
Maintenance Labor				
Electrical Energy		-$1.480	HDA calculation	Per Well Production Cost Spreadsheet
Chemicals/Materials		-$0.008	HDA Estimate	150% Maui system average cost
Maintenance Expenses				
Total Variable Op. Costs		-$1.488		
Plant Life (Years)				
Functional Life	20			
Economic/Analysis Life	20			
Book Life	20			
Levelized Production Costs ($)				
Cost of Capital	6.00%			
Discount Rate (Nom.)	6.00%			
Fixed Op.Cost Esc. Rate (Nom.)	3.00%			
Effective Fixed Op.Cost. Disc. Rate	2.91%			
Var. Op.Cost Esc. Rate (Nom.)	4.00%			
Effective Var. Op.Cost. Disc. Rate	1.92%			
		$/kgal		
First Year Cost w/Amortized Capital		**$2.999**		
Amortized Cap. Cost (Book Life)		$4.538		
Fixed Op. Cost		-$0.051		
Varible Op. Cost		-$1.488		
	NPV $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost	**9.782**	**$2.337**		
Capital Cost (20 year Amort.)	19.010	$4.538		
Fixed Op. Cost	-0.277	-$0.066		
Varible Op. Cost	-8.950	-$2.136		
	NPV $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost	**9.782**	**$2.337**		
Capital Cost (Amort. per Econ. Life)	19.010	$4.538		
Fixed Op. Cost	-0.277	-$0.066		
Varible Op. Cost	-8.950	-$2.136		

Covering Open Reservoirs to Reduce Evaporative Losses

Open reservoirs lose water due to evaporation. Estimates for evaporative losses for reservoirs in Hawaii are typically 1/4" per day. Several types of reservoir covers are available. Floating covers are less expensive than structural "roof" covers but require more maintenance and more frequent replacement.

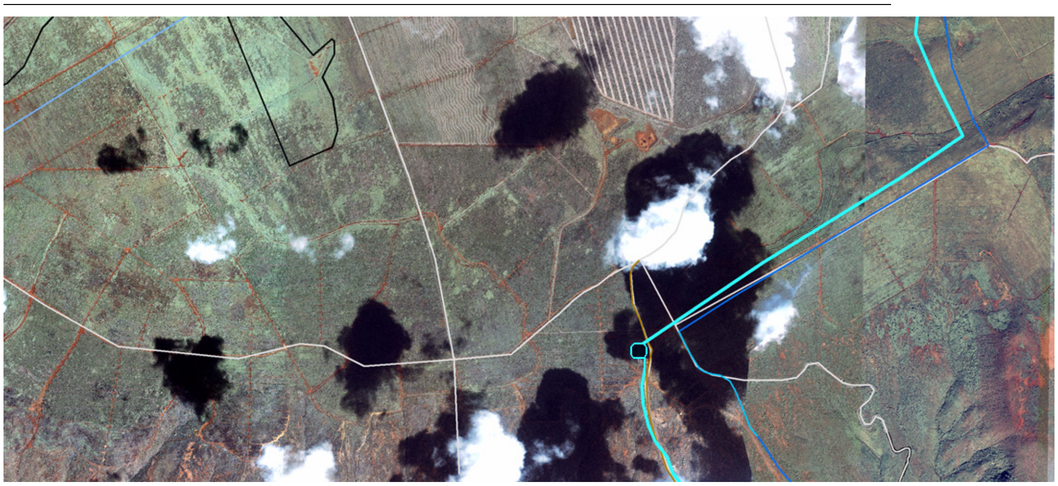
Life cycle costs were estimated for both floating and structural aluminum covers for the 15 MG Manele Reservoir. Cost estimates for installation on Lana'i were obtained from suppliers and Hawaii installers. The Manele Reservoir loses about 17,000 GPDGPD to evaporation. The analysis assumes that covering the reservoir would completely eliminate evaporative losses and would allow precipitation to continue to enter the reservoir.

For a floating reservoir installed costs, including engineering, site and foundation work, materials, installation and contingency, would be about $366,000. The cover is assumed to have a functional life of 10 years. No fixed operating or variable costs are assumed. The total ten-year levelized unit costs would be $10.31 per thousand gallons of reduced losses.

For a structural aluminum roof cover, installed costs, including engineering, site and foundation work, materials, installation and contingency, would be about $4.0 million. The cover is assumed to have a functional life of 30 years. No fixed operating or variable costs are assumed. The total thirty-year levelized unit costs would be $60.67 per thousand gallons of reduced losses.

An additional option evaluated involved the use of Hypalon balls to form a non-structural floating cover. This project was evaluated at roughly $450,000 for materials and an additional $45,000 for contingencies, for a total of $495,000. This cover was somewhat more cost-effective than other cover options. The total lifetime levelized cost of this option would be $13.14 per thousand gallons of reduced losses.

FIGURE 5-33. Hi'i Reservoir Cover



Supply and Demand Side Efficiency Options

FIGURE 5-34. Floating Cover For Hi'i Reservoir

Capacity (MGD)				
Installed Capacity		0.017		Avoided evaporative losses for 10,000 sq.meters @ 1/4"/day
Max. Day Capacity		0.017		
Effective Sustainable Capacity		0.013		80% average reservoir surface area
Facility Capacity Factor		100%		
Average Facility Output		0.013		
Capital Costs ($)	Total	Per MGD		
Design / Engineering	$5,000	$378,788	HDA Estimate	
Cover and anchoring system	$317,308	$24,038,462	Quote from Lemna	Lump sum estimate from manufacturer; 10,000 sq. meters cover adjusted from quote on 13,000 sp. meter cover @
Site Improvements and Installation	$10,000	$757,576	HDA Estimate	
		$0		
		$0		
		$0		
Contingencies	$33,231	$2,517,483	HDA Estimate	10%
Total Plant Cost (	$365,538	$27,692,308		
Const. Per. Esc. Rate (Nom.)	3.00%			
AFUDC Interest Rate (Nom.)	6.00%			
AFUDC Factor		1.000		
	Total	Per MGD		
Total Capitalized Cost	$365,538	$27,692,308		
Fixed Operating Costs ($)	Per Year	Per Y/MGD		
Dedicated Operating Labor		$0		
Apportioned Operating Labor		$0		
Maintenance Labor		$0		
Fixed Operating Costs				
Electrical Demand		$0		
Chemicals/Materials		$0		
Maintenance Expenses		$0		
Amort. of Capitalized Rebuild Costs		$0		
Total Fixed Op. Costs	$0	$0		
Variable Operating Costs ($)		Per KGal		
Operating Labor				
Maintenance Labor				
Electrical Energy				
Chemicals/Materials				
Maintenance Expenses				
Total Variable Op. Costs		$0.000		
Plant Life (Years)				
Functional Life	10			
Economic/Analysis Life	10			
Book Life	10			
Levelized Production Costs ($)				
Cost of Capital	6.00%			
Discount Rate (Nom.)	6.00%			
Fixed Op.Cost Esc. Rate (Nom.)	3.00%			
Effective Fixed Op.Cost. Disc. Rate	2.91%			
Var. Op.Cost Esc. Rate (Nom.)	4.00%			
Effective Var. Op.Cost. Disc. Rate	1.92%			
		$/kgal		
First Year Cost w/Amortized Capital		**$10.301**		
Amortized Cap. Cost (Book Life)		$10.301		
Fixed Op. Cost		$0.000		
Varible Op. Cost		$0.000		
	NPV $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost	**27.692**	**$6.615**		
Capital Cost (20 year Amort.)	27.692	$6.610		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		
	NPV $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost	**27.692**	**$10.308**		
Capital Cost (Amort. per Econ. Life)	27.692	$10.301		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		

Supply Options

FIGURE 5-35. Aluminum Cover for Hi'i Reservoir

Capacity (MGD)				
Installed Capacity		0.017		Avoided evaporative losses for 10,000 sq.meters @ 1/4"/day
Max. Day Capacity		0.017		
Effective Sustainable Capacity		0.013		80% average reservoir surface area
Facility Capacity Factor		100%		
Average Facility Output		0.013		
Capital Costs ($)	Total	Per MGD		
Lump Sum Project Estimate	$3,657,856	$277,110,303	Quote from Temcor and Hawaii Rep.	Lump sum estimate from manufacturer; 10,000 sq. meters area covered by aluminum low dome structure.
		$0		
		$0		
		$0		
Contingencies	$365,786	$27,711,030	HDA Estimate	10%
Total Plant Cost (	$4,023,642	$304,821,333		
Const. Per. Esc. Rate (Nom.)	3.00%			
AFUDC Interest Rate (Nom.)	6.00%			
AFUDC Factor		1.000		
	Total	Per MGD		
Total Capitalized Cost	$4,023,642	$304,821,333		
Fixed Operating Costs ($)	Per Year	Per Y/MGD		
Dedicated Operating Labor		$0		
Apportioned Operating Labor		$0		
Maintenance Labor		$0		
Fixed Operating Costs				
Electrical Demand		$0		
Chemicals/Materials		$0		
Maintenance Expenses		$0		
Amort. of Capitalized Rebuild Costs		$0		
Total Fixed Op. Costs	$0	$0		
Variable Operating Costs ($)		Per KGal		
Operating Labor				
Maintenance Labor				
Electrical Energy				
Chemicals/Materials				
Maintenance Expenses				
Total Variable Op. Costs		$0.000		
Plant Life (Years)				
Functional Life	30			
Economic/Analysis Life	30			
Book Life	30			
Levelized Production Costs ($)				
Cost of Capital	6.00%			
Discount Rate (Nom.)	6.00%			
Fixed Op.Cost Esc. Rate (Nom.)	3.00%			
Effective Fixed Op.Cost. Disc. Rate	2.91%			
Var. Op.Cost Esc. Rate (Nom.)	4.00%			
Effective Var. Op.Cost. Disc. Rate	1.92%			
		$/kgal		
First Year Cost w/Amortized Capital		**$60.630**		
Amortized Cap. Cost (Book Life)		$60.630		
Fixed Op. Cost		$0.000		
Varible Op. Cost		$0.000		
	NPV $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost	**304.821**	**$72.810**		
Capital Cost (20 year Amort.)	304.821	$72.760		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		
	NPV $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost	**304.821**	**$60.671**		
Capital Cost (Amort. per Econ. Life)	304.821	$60.630		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		

FIGURE 5-36. Hypalon Balls - Cover for Hi'i Reservoir

Capacity (MGD)				
Installed Capacity		0.017		Avoided evaporative losses for 10,000 sq.meters @ 1/4"/day
Max. Day Capacity		0.017		
Effective Sustainable Capacity		0.014		85% reduction in evaporative losses
Facility Capacity Factor		100%		
Average Facility Output		0.014		
Capital Costs ($)	Total	Per MGD		
Lump Sum Project Estimate	$450,000	$32,085,561	Lump Sum Quote	Lump Sum Quote for materials delivered to site per LWCI
		$0		
		$0		
		$0		
Contingencies	$45,000	$3,208,556	HDA Estimate	10%
Total Plant Cost (	$495,000	$35,294,118		
Const. Per. Esc. Rate (Nom.)	3.00%			
AFUDC Interest Rate (Nom.)	6.00%			
AFUDC Factor		1.000		
	Total	Per MGD		
Total Capitalized Cost	$495,000	$35,294,118		
Fixed Operating Costs ($)	Per Year	Per Y/MGD		
Dedicated Operating Labor		$0		
Apportioned Operating Labor		$0		
Maintenance Labor		$0		
Fixed Operating Costs				
Electrical Demand		$0		
Chemicals/Materials		$0		
Maintenance Expenses		$0		
Amort. of Capitalized Rebuild Costs		$0		
Total Fixed Op. Costs	$0	$0		
Variable Operating Costs ($)		Per KGal		
Operating Labor				
Maintenance Labor				
Electrical Energy				
Chemicals/Materials				
Maintenance Expenses				
Total Variable Op. Costs		$0.000		
Plant Life (Years)				
Functional Life	10			
Economic/Analysis Life	10			
Book Life	10			
Levelized Production Costs ($)				
Cost of Capital	6.00%			
Discount Rate (Nom.)	6.00%			
Fixed Op.Cost Esc. Rate (Nom.)	3.00%			
Effective Fixed Op.Cost. Disc. Rate	2.91%			
Var. Op.Cost Esc. Rate (Nom.)	4.00%			
Effective Var. Op.Cost. Disc. Rate	1.92%			
		$/kgal		
First Year Cost w/Amortized Capital		**$13.129**		
Amortized Cap. Cost (Book Life)		$13.129		
Fixed Op. Cost		$0.000		
Varible Op. Cost		$0.000		
	NPV $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost	**35.294**	**$8.430**		
Capital Cost (20 year Amort.)	35.294	$8.425		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		
	NPV $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost	**35.294**	**$13.138**		
Capital Cost (Amort. per Econ. Life)	35.294	$13.129		
Fixed Op. Cost	0.000	$0.000		
Varible Op. Cost	0.000	$0.000		

Reclaimed Water Use

Three options were examined for utilization of "excess" reclaimed water from Lana'i City to offset potable or brackish irrigation use. These were: utilizing reclaimed water for irrigation of the planned Miki Industrial Park; sending "excess" reclaimed water from Lana'i City directly to Manele for irrigation use; and a two-stage project in which reclaimed water is piped to Miki Basin in Phase I and from Miki onward to Manele in Phase II.

Estimated costs for a recycled line to Miki Basin, included transmission and contingency in the amount of $1,536,000 for an assumed use of about 60,000 GPD, and a thirty year functional life. First year energy costs are approximately $0.40 per thousand gallons. For 60,000 GPD of reclaimed water, the total thirty-year levelized cost is $5.77 per thousand gallons. This cost is comprised of $5.09 in capital cost, $0.02 operating and maintenance cost and about $0.66 in energy costs per thousand gallons.

The cost of a recycled water line to Manele was estimated at $16,896,000, comprised of $10,000,000 in treatment plant upgrade, $4.08 million in transmission and $2.82 million in contingencies. The functional life of this project is estimated at thirty years. First year energy costs are estimated at about $0.40 per thousand gallons. For an assumed 500,000 GPD, the total costs per thousand gallons are $7.40, comprised of $6.72 in capital costs, $0.02 in operating and maintenance and about $0.66 in energy costs per thousand gallons.

A Phase I line to Miki Basin, to be followed by connection to Manele is slightly more expensive to install, due to the extra size. The estimated capital costs is $2,304,000 including transmission and contingencies. The amount of production is still assumed to be about 60,000 GPD. The functional life of the project is estimated at thirty years. First year energy costs are estimated at about $0.40 per thousand gallons. For an assumed 60,000 GPD, the total costs per thousand gallons are $8.32, comprised of $7.64 in capital costs, $0.02 in operating and maintenance and about $0.66 in energy costs per thousand gallons.

Phase II of this project, from Miki Basin to Manele would cost an estimated $15,456,000, including $10,000,000 in treatment plant upgrade, $2,880,000 in transmission and $2,576,000 in contingencies. The project is presumed to send 440,000 GPD to Manele, with a functional life of thirty years. First year energy costs are estimated at about $0.40 per thousand gallons. The total costs per thousand gallons is $7.66, comprised of $6.99 in capital costs, $0.02 in operating and maintenance and about $0.66 in energy costs per thousand gallons.

FIGURE 5-37. Reclaimed Water Line from Lana'i City to Miki Basin

Capacity (MGD)					
Installed Capacity			0.060		
Max. Day Capacity			0.060		
Effective Sustainable Capacity			0.060		
Facility Capacity Factor			100%		
Average Facility Output			0.060		
Capital Costs ($2002)		Total	Per MGD		
WWTP R-1 Upgrade		$0	$0		
			$0		
			$0		
Transmission		$1,280,000	$21,333,333	HDA Estimate	16000lf@$80plf for transmission, assumes no marginal distribution cost at Miki Basin (new project area)
			$0		
			$0		
Contingencies		$256,000	$4,266,667	HDA Estimate	20%
Total Plant Cost (		$1,536,000	$25,600,000		
Expenditure Pattern	Year	Nom	Normalized		
	Serv Date	1	100.0%		
	-1	0	0.0%		
	-2	0	0.0%		
	-3	0	0.0%		
	-4	0	0.0%		
	-5	0	0.0%		
	-6	0	0.0%		
	-7	0	0.0%		
	-8	0	0.0%		
Const. Per. Esc. Rate (Nom.)		3.00%			
AFUDC Interest Rate (Nom.)		6.00%			
AFUDC Factor			1.000		
		Total	Per MGD		
Total Capitalized Cost		$1,536,000	$25,600,000		
Fixed Operating Costs ($2002)		Per Year	Per Y/MGD		
Dedicated Operating Labor		$0	$0		
Apportioned Operating Labor			$0		
Maintenance Labor			$0		
Fixed Operating Costs					
Electrical Demand		$248	$4,140		5 Kwh/Kgal/Kft lift efficiency*derived sys demand cost factor*electrical energy cost*installed capacity
Chemicals/Materials			$0		
Maintenance Expenses			$0		
Amort. of Capitalized Rebuild Costs			$0		
Total Fixed Op. Costs		$248	$4,140		
Variable Operating Costs ($2002)			Per KGal		
Operating Labor					
Maintenance Labor					
Electrical Energy			$0.331	HDA per DEM	FY04 Reuse Elec Cost $123,110 for 536,003 Kgal Increased by 45% to reflect $2008 $0.34/KWH de-escalated to $2004
Chemicals/Materials			$0.050	HDA per DEM	FY04 UV Bulbs and Muriatic Acid
Maintenance Expenses			$0.017	HDA per DEM	FY04 Expenses $9,674 for 536,003 Kgal
Total Variable Op. Costs			$0.398		
Plant Life (Years)					
Functional Life		30			
Economic/Analysis Life		30			
Book Life		20			
Levelized Production Costs ($2002)					
Cost of Capital		6.00%			
Discount Rate (Nom.)		6.00%			
Fixed Op.Cost Esc. Rate (Nom.)		3.00%			
Effective Fixed Op.Cost. Disc. Rate		2.91%			
Var. Op.Cost Esc. Rate (Nom.)		4.00%			
Effective Var. Op.Cost. Disc. Rate		1.92%			
			$/kgal		
First Year Cost w/Amortized Capital			**$6.520**		
Amortized Cap. Cost (Book Life)			$6.111		
Fixed Op. Cost			$0.011		
Varible Op. Cost			$0.398		
		NPV2002 $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost		**28.058**	**$6.702**		
Capital Cost (20 year Amort.)		25.600	$6.111		
Fixed Op. Cost		0.062	$0.015		
Varible Op. Cost		2.395	$0.572		
		NPV2002 $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost		**28.974**	**$5.767**		
Capital Cost (Amort. per Econ. Life)		25.600	$5.092		
Fixed Op. Cost		0.082	$0.016		
Varible Op. Cost		3.291	$0.655		

Supply Options

FIGURE 5-38. Reclaimed Water Line to Manele

Capacity (MGD)					
Installed Capacity			0.500		
Max. Day Capacity			0.500		
Effective Sustainable Capacity			0.500		
Facility Capacity Factor			100%		
Average Facility Output			0.500		
Capital Costs ($2002)		Total	Per MGD		
WWTP R-1 Upgrade		$10,000,000	$20,000,000	DEM Rough Estimate	
			$0		
			$0		
Transmission		$4,080,000	$8,160,000	HDA Estimate	34000lf@$120plf for transmission, assumes no marginal distribution cost at Manele (new project area)
			$0		
			$0		
Contingencies		$2,816,000	$5,632,000	HDA Estimate	20%
Total Plant Cost (		$16,896,000	$33,792,000		
Expenditure Pattern	Year	Nom	Normalized		
	Serv Date	1	100.0%		
	-1	0	0.0%		
	-2	0	0.0%		
	-3	0	0.0%		
	-4	0	0.0%		
	-5	0	0.0%		
	-6	0	0.0%		
	-7	0	0.0%		
	-8	0	0.0%		
Const. Per. Esc. Rate (Nom.)		3.00%			
AFUDC Interest Rate (Nom.)		6.00%			
AFUDC Factor			1.000		
		Total	Per MGD		
Total Capitalized Cost		$16,896,000	$33,792,000		
Fixed Operating Costs ($2002)		Per Year	Per Y/MGD		
Dedicated Operating Labor		$0	$0		
Apportioned Operating Labor			$0		
Maintenance Labor			$0		
Fixed Operating Costs					
Electrical Demand		$2,070	$4,140		5 Kwh/Kgal/Kft lift efficiency*derived sys demand cost factor*electrical energy cost*installed capacity
Chemicals/Materials			$0		
Maintenance Expenses			$0		
Amort. of Capitalized Rebuild Costs			$0		
Total Fixed Op. Costs		$2,070	$4,140		
Variable Operating Costs ($2002)			Per KGal		
Operating Labor					
Maintenance Labor					
Electrical Energy			$0.331	HDA per DEM	FY04 Reuse Elec Cost $123,110 for 536,003 Kgal Increased by 45% to reflect $2008 $0.34/KWH de-escalated to $2004
Chemicals/Materials			$0.050	HDA per DEM	FY04 UV Bulbs and Muriatic Acid
Maintenance Expenses			$0.017	HDA per DEM	FY04 Expenses $9,674 for 536,003 Kgal
Total Variable Op. Costs			$0.398		
Plant Life (Years)					
Functional Life		30			
Economic/Analysis Life		30			
Book Life		20			
Levelized Production Costs ($2002)					
Cost of Capital		6.00%			
Discount Rate (Nom.)		6.00%			
Fixed Op.Cost Esc. Rate (Nom.)		3.00%			
Effective Fixed Op.Cost. Disc. Rate		2.91%			
Var. Op.Cost Esc. Rate (Nom.)		4.00%			
Effective Var. Op.Cost. Disc. Rate		1.92%			
			$/kgal		
First Year Cost w/Amortized Capital			**$8.476**		
Amortized Cap. Cost (Book Life)			$8.066		
Fixed Op. Cost			$0.011		
Varible Op. Cost			$0.398		
		NPV2002 $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost		**36.250**	**$8.659**		
Capital Cost (20 year Amort.)		33.792	$8.066		
Fixed Op. Cost		0.062	$0.015		
Varible Op. Cost		2.395	$0.572		
		NPV2002 $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost		**37.166**	**$7.397**		
Capital Cost (Amort. per Econ. Life)		33.792	$6.721		
Fixed Op. Cost		0.082	$0.016		
Varible Op. Cost		3.291	$0.655		

FIGURE 5-39. Reclaimed Water Line to Miki as Phase I of Project to Manele

Capacity (MGD)					
Installed Capacity			0.060		
Max. Day Capacity			0.060		
Effective Sustainable Capacity			0.060		
Facility Capacity Factor			100%		
Average Facility Output			0.060		
Capital Costs ($2002)		Total	Per MGD		
WWTP R-1 Upgrade		$0	$0		
			$0		
			$0		
Transmission		$1,920,000	$32,000,000	HDA Estimate	16000lf@$120plf for transmission, assumes no marginal distribution cost at Miki Basin (new project area)
			$0		
			$0		
Contingencies		$384,000	$6,400,000	HDA Estimate	20%
Total Plant Cost (		$2,304,000	$38,400,000		
Expenditure Pattern	Year	Nom	Normalized		
	Serv Date	1	100.0%		
	-1	0	0.0%		
	-2	0	0.0%		
	-3	0	0.0%		
	-4	0	0.0%		
	-5	0	0.0%		
	-6	0	0.0%		
	-7	0	0.0%		
	-8	0	0.0%		
Const. Per. Esc. Rate (Nom.)		3.00%			
AFUDC Interest Rate (Nom.)		6.00%			
AFUDC Factor			1.000		
		Total	Per MGD		
Total Capitalized Cost		$2,304,000	$38,400,000		
Fixed Operating Costs ($2002)		Per Year	Per Y/MGD		
Dedicated Operating Labor		$0	$0		
Apportioned Operating Labor			$0		
Maintenance Labor			$0		
Fixed Operating Costs					
Electrical Demand		$248	$4,140		5 Kwh/Kgal/Kft lift efficiency*derived sys demand cost factor*electrical energy cost*installed capacity
Chemicals/Materials			$0		
Maintenance Expenses			$0		
Amort. of Capitalized Rebuild Costs			$0		
Total Fixed Op. Costs		$248	$4,140		
Variable Operating Costs ($2002)			Per KGal		
Operating Labor					
Maintenance Labor					
Electrical Energy			$0.331	HDA per DEM	FY04 Reuse Elec Cost $123,110 for 536,003 Kgal Increased by 45% to reflect $2008 $0.34/KWH de-escalated to $2004
Chemicals/Materials			$0.050	HDA per DEM	FY04 UV Bulbs and Muriatic Acid
Maintenance Expenses			$0.017	HDA per DEM	FY04 Expenses $9,674 for 536,003 Kgal
Total Variable Op. Costs			$0.398		
Plant Life (Years)					
Functional Life		30			
Economic/Analysis Life		30			
Book Life		20			
Levelized Production Costs ($2002)					
Cost of Capital		6.00%			
Discount Rate (Nom.)		6.00%			
Fixed Op.Cost Esc. Rate (Nom.)		3.00%			
Effective Fixed Op.Cost. Disc. Rate		2.91%			
Var. Op.Cost Esc. Rate (Nom.)		4.00%			
Effective Var. Op.Cost. Disc. Rate		1.92%			
			$/kgal		
First Year Cost w/Amortized Capital			**$9.575**		
Amortized Cap. Cost (Book Life)			$9.166		
Fixed Op. Cost			$0.011		
Varible Op. Cost			$0.398		
		NPV2002 $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost		**40.858**	**$9.759**		
Capital Cost (20 year Amort.)		38.400	$9.166		
Fixed Op. Cost		0.062	$0.015		
Varible Op. Cost		2.395	$0.572		
		NPV2002 $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost		**41.774**	**$8.315**		
Capital Cost (Amort. per Econ. Life)		38.400	$7.638		
Fixed Op. Cost		0.082	$0.016		
Varible Op. Cost		3.291	$0.655		

FIGURE 5-40. Reclaimed Water Line as Phase II from Miki to Manele

Capacity (MGD)					
Installed Capacity			0.440		
Max. Day Capacity			0.440		
Effective Sustainable Capacity			0.440		
Facility Capacity Factor			100%		
Average Facility Output			0.440		
Capital Costs ($2002)		Total	Per MGD		
WWTP R-1 Upgrade		$10,000,000	$22,727,273	DEM Rough Estimate	
			$0		
			$0		
Transmission		$2,880,000	$6,545,455	HDA Estimate	24000lf@$120plf for transmission, assumes no marginal distribution cost at Manele (new project area)
			$0		
			$0		
Contingencies		$2,576,000	$5,854,545	HDA Estimate	20%
Total Plant Cost (		$15,456,000	$35,127,273		
Expenditure Pattern	Year	Nom	Normalized		
	Serv Date	1	100.0%		
	-1	0	0.0%		
	-2	0	0.0%		
	-3	0	0.0%		
	-4	0	0.0%		
	-5	0	0.0%		
	-6	0	0.0%		
	-7	0	0.0%		
	-8	0	0.0%		
Const. Per. Esc. Rate (Nom.)		3.00%			
AFUDC Interest Rate (Nom.)		6.00%			
AFUDC Factor			1.000		
		Total	Per MGD		
Total Capitalized Cost		$15,456,000	$35,127,273		
Fixed Operating Costs ($2002)		Per Year	Per Y/MGD		
Dedicated Operating Labor		$0	$0		
Apportioned Operating Labor			$0		
Maintenance Labor			$0		
Fixed Operating Costs					
Electrical Demand		$1,822	$4,140		5 Kwh/Kgal/Kft lift efficiency*derived sys demand cost factor*electrical energy cost*installed capacity
Chemicals/Materials			$0		
Maintenance Expenses			$0		
Amort. of Capitalized Rebuild Costs			$0		
Total Fixed Op. Costs		$1,822	$4,140		
Variable Operating Costs ($2002)			Per KGal		
Operating Labor					
Maintenance Labor					
Electrical Energy			$0.331	HDA per DEM	FY04 Reuse Elec Cost $123,110 for 536,003 Kgal Increased by 45% to reflect $2008 $0.34/KWH de-escalated to $2004
Chemicals/Materials			$0.050	HDA per DEM	FY04 UV Bulbs and Muriatic Acid
Maintenance Expenses			$0.017	HDA per DEM	FY04 Expenses $9,674 for 536,003 Kgal
Total Variable Op. Costs			$0.398		
Plant Life (Years)					
Functional Life		30			
Economic/Analysis Life		30			
Book Life		20			
Levelized Production Costs ($2002)					
Cost of Capital		6.00%			
Discount Rate (Nom.)		6.00%			
Fixed Op.Cost Esc. Rate (Nom.)		3.00%			
Effective Fixed Op.Cost. Disc. Rate		2.91%			
Var. Op.Cost Esc. Rate (Nom.)		4.00%			
Effective Var. Op.Cost. Disc. Rate		1.92%			
			$/kgal		
First Year Cost w/Amortized Capital			**$8.794**		
Amortized Cap. Cost (Book Life)			$8.385		
Fixed Op. Cost			$0.011		
Varible Op. Cost			$0.398		
		NPV2002 $M/MGD	Levelized $/kgal		
Twenty-year Total NPV Cost		**37.585**	**$8.978**		
Capital Cost (20 year Amort.)		35.127	$8.385		
Fixed Op. Cost		0.062	$0.015		
Varible Op. Cost		2.395	$0.572		
		NPV2002 $M/MGD	Levelized $/kgal		
Economic Life Total NPV Cost		**38.501**	**$7.663**		
Capital Cost (Amort. per Econ. Life)		35.127	$6.987		
Fixed Op. Cost		0.082	$0.016		
Varible Op. Cost		3.291	$0.655		

Demand-Side Measures

Demand-Side measures refer to actions taken on the "customer's side of the water meter." These include reducing water use by using more efficient appliances or changing water use patterns.

Many water utilities encourage conservation and water use efficiency by implementing demand-side-management (DSM) programs. These programs use a variety of methods to promote efficiency including incentives to customers, provision of free or low-cost efficient fixtures or appliances, direct installations or conservation rate designs.

Landscape Conservation Measures

Nationwide, estimated outdoor use per-capita is 31.7 GPD. Outdoor use per household varies from 10% to 75% of household consumption. However, even in hot dry areas such as Phoenix, Scottsdale and Tempe Arizona, outdoor use per household is estimated at under 200 GPD on average. A typical 18 hole golf course in Pima County, Arizona uses about 500,000 GPD. (Source: *Water Use and Conservation*, Amy Vickers, WaterPlow Press, Amherst, Massachusetts, 2001).

An area such as Manele is expected to have higher than average water consumption, due to the hot, dry nature of its climate. Residential per unit consumption in Manele is considerably higher than that in high-use communities in South Maui, such as Maui Meadows. This need not be the case. A relatively lush appearance can be attained without creating desert-scapes or replacing foliage with cacti and pebbles. The high level of outdoor consumption on Lana‘i presents an opportunity for demand side savings.

Reduction in water consumption for landscapes can have several benefits. Such reductions can lower system peaking factors, reduce draft from sensitive aquifers, and lower both utility and customer facility costs, to name a few. Even a 10% reduction in irrigation water use could save over 110,000 GPD. Greater savings could quite possibly be attainable.

Landscape conservation begins with a thorough landscape water audit. An inventory should be made delineating the following items as a minimum:

- Irrigated acreage, soils and soil infiltration rates,
- Plant materials,
- Size and irrigation demands of watering zones, weather station or evapotranspiration data (ET data),
- Irrigation equipment and controllers in each zone,
- Watering times, settings, operating pressures and gallons per minute of each zone,
- Condition of equipment, overspray areas, tilted heads, missing heads, etc.,
- Distribution uniformity of equipment,
- Condition of plant materials.

The principles of landscape conservation are well known and will not be iterated in detail here. A draft conservation ordinance, including landscape conservation measures is provided in Appendix E of this plan. Also attached in Appendix I are checklists for landscape conservation, golf courses and hotels. Some general “bullet points” include:

- Turf should be limited to active play or picnic areas.
- Where turf is used, mower blades should be set high.
- Mulching mowers should be used where possible. These return grass clippings to the lawn. Grass clippings contain about 85% water and 5% nitrogen. Leaving them on the lawn helps hold in moisture, reduce evaporation and keep grass cool.
- The majority of landscaped areas should be planted with native species that are adapted to the natural rainfall in the area, or with drought tolerant non-invasive non-native species. In Manele, plant species which are salt tolerant would also be appropriate.
- Thirsty plants should be limited to showcase areas. Plants in these areas can be planted in low areas or small basin-like forms to encourage water to pool.
- Mulches should be used both for decorative value and to reduce evaporative losses, cool soil and control weeds. Mulches can also slow erosion and reduce soil compaction. Plants with similar water requirements should be grouped so that irrigation circuits can be controlled more effectively.
- Irrigation circuits should be designed, timed and operated to prevent overspray or watering of non-planted areas.
- Watering should not occur in the heat of the day, nor during rainfall or other periods when soil moisture may already be adequate.
- Automated irrigation systems should be equipped with controllers capable of multiple programming for different zones, equipped with rain shut-off devices, and smart controllers capable of responding appropriately to either soil moisture or evapotranspiration conditions.
- Maintenance should include frequent leak detection efforts and rapid repairs.
- Distribution uniformities should be at least 85% for drip, 70% for rotors and 60% for spray heads.Discharge limitations for various types of irrigation emitters, as well as other measures, are included in the draft conservation ordinance attached as Appendix E.
- Design planted areas, particularly grassed areas to utilize natural runoff, and position plants in such a way that they receive runoff. A series of swales, basins, berms or microberms to direct flows toward planted areas can help to make use of whatever natural rainfall is present on site. Recessed or concave planting areas receive and retain rainfall better than raised beds.

Nationwide, one of the most effective conservation measures has been the low-tech option of limiting the number of times a week that watering can occur. Conventional wisdom is also that one should prune sparingly, to avoid growth accelerations that can increase water requirements. On Lana‘i, there is an example of a landscape that reduced consumption by allowing a very short bursts of light water spray a few times during the heat of the day to keep plants cool, but reserved deep watering for infrequent evenings. This is not the generally encouraged practice. In fact oscillating sprinklers and other sprinkler heads that produce fine mists or sprays are generally discouraged. However, it may merit further study. It should be noted that this practice was combined with very active pruning, which is also not a generally recommended practice for water conservation as noted above. The intense care taken on the property may mean that the method is not adaptable to those with less intensive maintenance. Nor is it clear how much of the reduced irrigation use came from these techniques versus more intensive monitoring and management of irrigation equipment. The reduction in water use achieved brought overall consumption more in line with that in Maui Meadows, one of Maui's highest per-unit use areas. Although the reduction in consumption achieved was laudable, it is not clear whether these techniques can or ought to be broadly replicated in Manele.

Landscape conservation measures that have been used with some success in South Maui hotels in recent years include:

- Installation of high-end smart controller systems,
- Installation and use of on-site weather stations,
- Replacement of irrigation nozzles,
- Installation of sub-surface drip systems under sod,
- Installation of drip irrigation under shrubs,
- Replacement of decorative plantings with drought tolerant natives, and installation of high-efficiency re-circulating water purification systems in water features.

The Grand Wailea Resort reported a 37% drop in irrigation consumption through the use of such measures.

Hotel Conservation

The hotels on Lana'i are the largest customers of Lana'i's water utility. Much of hotel use is irrigation use, but even leaving irrigation use aside, hotels are large customers. As such, an effort should be made by the water utility to partner with the hotel properties to achieve conservation both in the landscape and throughout hotel facilities.

An axiom in water conservation field is that "you can't save what you don't measure". As with irrigation, conservation at the hotels should begin with a detailed inventory of existing and proposed water uses at the hotels. The inventory should detail fixture units and counts, water uses and water using appliances and equipment in spas, restaurants, guest rooms, landscapes, laundries, cooling and other areas throughout the facility, locations and purposes of controls, sub-meters, water filters or recycling systems, locations and amounts of irrigated acreage, irrigation system elements, controllers, circuits and settings, acreage and volume of pools, filtration equipment, etc.

The hotels could benefit by being registering with the Green Building Certification Institute for LEED credits. The focused attention on conservation that comes with such an effort can result, not only in cost and resource savings, but also in an advertising boost, as "green" design and operation become increasingly marketable. In designing a conservation program, the hotels could aim to obtain 7 out of 10 water efficiency credits as a target. Certainly the future hotels should be designed built and commissioned in a manner that qualifies for a minimum of 7 out of 10 Water Efficiency credits.

Fixture replacements can save on electricity as well as water. A list of WaterSense certified high-efficiency toilets and other fixtures may be found at http://www.epa.gov/WaterSense/pp/index.htm. Fixture retrofits to consider include:

- Retrofit toilets with high efficiency models that use 1.28 gallons per flush or less
- Retrofit urinals with high efficiency models that use 0.5 gallons per flush or less.
- Install showerheads with a flow rate of 2 gpm at 60 psi or less in all units.
- Retrofit bathroom sink faucets with fixtures that do not exceed 1 gpm at 60 psi. (even more efficient models are available)

Cooling / HVAC systems should be reviewed. New systems should be constructed, commissioned and operated in a manner that conserves water as well as energy. Single pass cooling should not be permitted. Recent data indicate that increasing energy efficiency in coolers can also increase water efficiency. Cooling systems should be specified to qualify for LEED certification for energy efficiency and controllability, as well as the specific water conservation measures listed below for multi-pass systems:

- Installation of control systems and sub-metering to monitor and manage water quality and other parameters in make-up water and blow-down.
- Installation of appropriate treatment systems to manage water quality in cooling tower make-up water.
- Operation of cooling towers with greater than 5 cycles of concentration.
- Minimization of drift losses with baffles or drift eliminators.
- Establishment of a proactive cooling system maintenance and monitoring program.

Around the hotel, in kitchens, restaurants, snack shops and other areas, ice making, cooking and washing can be made more efficient with the following measures:

- Ice machines which use water for cooling should be replaced with efficient air-cooled models.
- Refrigeration systems should be air-cooled or closed-system recirculating systems.
- Pre-rinse spray valves on dishwashers shall have a flow rate equal to or less than 1.6 gpm at 60 psi.
- Food steamers should be self-contained "boilerless" or "connectionless" models.
- Wok stoves should be "waterless woks".
- Ware washing units should have flow rates of less than 1 gallon per rack.
- If tunnel washers or multi-load washer extractors are used, they should utilize no more than 2 gallons of water per pound of laundry.
- If regular commercial clothes washers are used, install washers that are *Energy Star* and *WaterSense* certified, or have a water factor (gallons/cubic foot of laundry) of not more than 6.

Guests should be encouraged to conserve. This can be done in a manner that actually enlaces the guest experience. For instance, guided and interpreted, or self-guided “tours” or walks to native plantings, educational materials and displays explaining local resources, even interactive experiences teaching about traditional uses of plants and guiding guests in small projects can create a sense of appreciation for the value and beauty of local resources.

As a minimum, guests should be encouraged to conserve by

- Placing tent cards in rooms to encourage guests to re-use sheets and towels.
- Ensuring adequate towel rack space to enable & encourage guests to hang towels neatly. This will also help encourage them not to require daily washing.
- Placing tent cards in restaurants informing guests that water is available upon request, rather than automatically.

Landscape conservation has been discussed above. In general,

- All irrigated areas shall be equipped with smart controllers capable of self-adjusting to account for moisture conditions, and of multiple programming for separation of turf and non-turf areas.
- Irrigation valves and circuits should be arranged such that plants with different water requirements are watered separately and appropriately (hydrozones).
- Landscaping should be designed and / or renovated so as to qualify for LEED credit WEc1.1 as a minimum.
- To the extent possible in landscaping, select native plant species that are adapted to the natural rainfall and salt conditions in the area. The project is located in Plant Zones 3 and 5. The use of climate-adapted native plants conserves water and protects watersheds from the spread of invasive plant species.

Even water features can be made more efficient. High efficiency filtration systems are available for pools and fountains.

For the new hotels, and in the event that the existing hotels are renovated, wastewater systems should be designed or renovated to qualify for LEED credit WEc2.

Once an inventory of water uses and conservation opportunities has been made, and measures undertaken, it is important to take stock of the actual performance of conserving measures. A useful tool is an annual tally of what has been done, the goal of each measure taken, and how the results panned out. Document the recorded savings or reductions in peak factors, to assist in fine-tuning facility management for conservation as time goes on. An annual inventory of uses, performance, and changes made to fixtures or processes such as treatment, recycling, or other measures to conserve, as well as water use impacts of each, should become a regular practice.

New hotels or expanded facilities should be conditioned upon implementation of such measures. Existing hotels should be encouraged in these directions with incentives such as rebates, as well as pricing signals. Some funds were budgeted to support this in the capital plan discussed in this chapter.

A variety of potential programs were characterized in terms of costs per thousand gallons saved. These included toilet replacement rebate and direct installations, leak detection audits, faucet and fixture giveaway programs, and various outdoor irrigation efficiency and control measures. Several of these programs appear to be cost effective measures in comparison with new source development.

Growth Management

One approach to meeting water demand is to manage the amount of growth and land development by general land use planning procedures. Decisions regarding where growth is allowed to occur and what types of developments are permitted are within the scope of land use planning. However, these decisions are informed by the status of both infrastructure and resources of many sorts, water among them. In the case of water, a unique situation exists, in that the State Water Code HRS §174C-31(a)(2) states that the Water Use and Development plans shall set forth the allocation of water to land use in each county. The Lana‘i Water Advisory Committee discussed allocations at length. These discussions included review of project proposals discussed in the *Demand* chapter of this document, as well as resource issues discussed in the *Existing Resources and Systems* and *Source Water Protection* chapters of this document. The results of these discussions, along with some recommendations, are presented in the *Policy Issues* chapter of this document.

Water Source Protection

Water source protection is an important component of any water system management plan. For the Island of Lana‘i water source protection has been identified as an especially important component because of the importance of vegetation in maintaining the amount of total effective precipitation. The importance and impacts of water source protection measures are discussed the next chapter, on *Source Water Protection*.

Summary of Levelized Costs

Several measures to increase available source have been discussed. Some of these measures include high capital investments up front, but low operating costs. Others include low initial investments, but high operating costs. Some measures create large additional capacity, while other measures create only a little. In order to develop a meaningful comparison of the value of these projects, total costs over the economic life of each project, including inflation and cost of capital where applicable, are derived and levelized to costs per 1,000 gallons of water produced.

In the tables on the following three pages, a summary of costs of new source development, supply side measures and demand side measures are presented in terms of cost per thousand gallons. Figure 5-42 examines new and replacement source options. Figure 5-43 examines loss reduction options, and Figure 5-44 examines demand side management options. In all cases measures are presented in order of least to most expensive on a life time basis.

Some explanation of the column headings may be of use. For the new and replacement source projects and loss reduction projects in Figure 5-42 and 5-43, respectively, installed capacity refers to the capacity of the equipment installed, whereas effective capacity refers to the average day yield anticipated accounting for limitations. Average output is the amount of water assumed in the economic analysis. For the purposes of comparison, this is assumed to be the same thing. The capital cost is the total cost in millions of dollars. The unit cost is millions of dollars per millions of gallons per day, or dollars per gallon per day. Variable costs are principally the costs of electricity and chemicals, or amortized filter costs for treatment plants. These costs are proportional to the amount of production. Economic plant life is assumed to be 30 years for new sources. It is the estimated life of the project before additional major expenditures would be anticipated, recognizing that some portions of projects have longer lives than others. The Unit NPV, or net present value is the capital fixed operating and variable operating cost in terms of $per gallon per day of operating the facility over 30 years expressed in current dollars. The levelized cost is the cost over thirty years in terms of thousands of gallons. Capital, Fixed and Variable operating costs are expressed in terms of levelized dollars per thousand gallons. Capital costs refer to the up-front investment to construct or install a facility. Fixed operating costs refer to expense to operate that are present in the same amount regardless of how much water is being produced, such as labor for metering and maintenance and fixed demand charges for electricity. Variable operating costs are those which increase with increased production such as electrical charges, chemicals or, in the case of treatment, amortized filter costs.

Supply Options

FIGURE 5-41. Summary of New and Replacement Source Options Levelized Costs

Option Name	Plant Capacity Installed	Plant Capacity Effective	Plant Capacity Average Output	Capital Cost Cost	Capital Cost Unit Cost	Fixed Operating Cost	Fixed Operating Unit Cost	Variable Operating Cost	Plant Life Economic	Economic Life Total Discounted Cost: Total Unit NPV	Total Levelized	Capital Levelized	Fixed Op. Levelized	Var. Op. Levelized
	MGD	MGD	MGD	$M	$M/MGD	$/Year	$/Year/MGD	$/kgal	Years	NPV $2007 $M /MGD	**Levelized $ / kgal**	Levelized $ / kgal	Levelized $ / kgal	Levelized $ / kgal
Proposed New Well #2B @ Shaft 3 Site	0.864	0.300	0.300	$1.883	$6.276	$15,415	$51,383	$0.92	30	$14.901	**$2.97**	$1.25	$0.20	$1.51
Proposed New Brackish Well #15	0.864	0.300	0.300	$2.657	$8.856	$19,519	$65,063	$1.30	30	$20.894	**$4.16**	$1.76	$0.26	$2.14
Well - High Level Potable (1) 1mgd near Hi`i Tank	0.864	0.300	0.300	$2.867	$9.556	$20,599	$68,663	$1.41	30	$22.554	**$4.49**	$1.90	$0.27	$2.31
Well - High Level Potable (1) 1MGD near Well #5	0.864	0.300	0.300	$2.957	$9.856	$22,759	$75,863	$1.61	30	$24.650	**$4.91**	$1.96	$0.30	$2.64
Recommission Well#7	0.720	0.300	0.300	$2.678	$8.927	$26,719	$89,062	$2.37	30	$30.266	**$6.02**	$1.78	$0.35	$3.89
Wells - Windward (3)1MGD at Maunalei w/Existing Transmission	3.000	0.750	0.750	$8.001	$10.668	$118,144	$157,525	$2.43	30	$33.860	**$6.74**	$2.12	$0.62	$3.99
Wells - Windward (2) 1 MGD Maunalei w/Existing Transmission	2.000	0.500	0.500	$6.766	$13.531	$78,763	$157,525	$2.43	30	$36.723	**$7.31**	$2.69	$0.62	$3.99
Windward Well at Malau	0.864	0.300	0.300	$6.377	$21.256	$23,839	$79,463	$1.71	30	$36.948	**$7.35**	$4.23	$0.31	$2.81
Windward Well at Kauiki (Incremental)	0.864	0.300	0.300	$4.865	$16.216	$40,334	$134,445	$2.73	30	$41.431	**$8.25**	$3.23	$0.53	$4.49
Recommission Maunalei Shaft/Tunnels	1.000	0.500	0.500	$10.110	$20.220	$48,513	$97,025	$2.43	30	$42.213	**$8.40**	$4.02	$0.38	$3.99
Wells - Windward (3)1MGD at Maunalei w/New Transmission	3.000	0.750	0.750	$14.607	$19.476	$118,144	$157,525	$2.43	30	$42.668	**$8.49**	$3.87	$0.62	$3.99
Windward Well at Kehewai Ridge 2250ft.	0.864	0.300	0.300	$9.275	$30.916	$28,159	$93,863	$2.11	30	$50.200	**$9.99**	$6.15	$0.37	$3.47
Windward Well at Kehewai Ridge 2750ft.	0.864	0.300	0.300	$9.659	$32.196	$32,479	$108,263	$2.51	30	$55.073	**$10.96**	$6.40	$0.43	$4.12
Windward Well at Kauiki	0.864	0.300	0.300	$10.925	$36.416	$40,334	$134,445	$2.73	30	$61.631	**$12.27**	$7.24	$0.53	$4.49
Desalination - Seawater to 400 ppm Chlorides	0.250	0.250	0.250	$3.335	$13.338	$100,348	$401,390	$6.37	30	$73.969	**$14.72**	$2.65	$1.58	$10.48
Desalination - 50% Seawater to 225 ppm Chlorides	0.250	0.250	0.250	$3.272	$13.086	$111,598	$446,390	$9.97	30	$104.372	**$20.77**	$2.60	$1.76	$16.40
Desalination - Seawater to 225 ppm Chlorides	0.250	0.250	0.250	$3.382	$13.527	$121,598	$486,390	$13.17	30	$132.062	**$26.29**	$2.69	$1.92	$21.66

Levelized costs are calculated based on 3.0% inflation, 6.0% cost of capital and 6.0% discount rate. Operating costs are estimates of Haiku Design & Analysis.
Electricity costs included in Variable Operating Costs are $0.40 per KWH (= $125/bbl crude oil price) escalated at 4.0% for levelization.
All engineering assumptions, estimated costs and impacts are planning projections that will need to be verified by specific studies prior to implementation.
NPV = net present value MGD = millions of gallons per day kgal = one thousand gallons $2007 = constant (real) dollars

FIGURE 5-42. Summary of Loss Reduction Options - Levelized Costs

Option Name	Plant Capacity Installed	Plant Capacity Effective	Plant Capacity Average Output	Capital Cost	Capital Unit Cost	Fixed Operating Cost	Fixed Operating Unit Cost	Variable Operating Cost	Plant Life Economic	Economic Life Total Discounted Cost: Total Unit NPV	Total Levelized	Capital Levelized	Fixed Op. Levelized	Var. Op. Levelized
	MGD	MGD	MGD	$M	$M/MGD	$/Year	$/Year/MGD	$/kgal	Years	NPV $2007 $M /MGD	**Levelized $ / kgal**	Levelized $ / kgal	Levelized $ / kgal	Levelized $ / kgal
Pipe Replacement / Loss Reduction IGGP	0.202	0.202	0.202	$3.840	$19.010	-$3,737	-$18,500	-$1.49	20	$9.782	**$2.34**	$4.54	-$0.07	-$2.14
Recycled Water Line to Miki Basin Industrial Prk	0.060	0.060	0.060	$1.536	$25.600	$248	$4,140	$0.40	30	$28.974	**$5.77**	$5.09	$0.02	$0.65
Recycled Water Line to Manele (2030)	0.500	0.500	0.500	$16.896	$33.792	$2,070	$4,140	$0.40	30	$37.166	**$7.40**	$6.72	$0.02	$0.65
Phase II Recycled Water Line Miki Basin to Manele	0.440	0.440	0.440	$15.456	$35.127	$1,822	$4,140	$0.40	30	$38.501	**$7.66**	$6.99	$0.02	$0.65
Phase I Recycled Water Line to Miki Basin Industrial Park	0.060	0.060	0.060	$2.304	$38.400	$248	$4,140	$0.40	30	$41.774	**$8.31**	$7.64	$0.02	$0.65
Floating Cover on 15 MG Reservoir	0.017	0.013	0.013	$0.366	$27.692	$0	$0	$0.00	10	$27.692	**$10.31**	$10.30	$0.00	$0.00
Hypalon Balls on 15 MG Reservoir	0.017	0.014	0.014	$0.495	$35.294	$0	$0	$0.00	10	$35.294	**$13.14**	$13.13	$0.00	$0.00
Aluminum cover on 15 MG Reservoir	0.017	0.013	0.013	$4.024	$304.821	$0	$0	$0.00	30	$304.821	**$60.67**	$60.63	$0.00	$0.00

Notes: Levelized costs are calculated based on 3.0% inflation, 6.0% cost of capital and 6.0% discount rate. Operating costs are HDA estimates.
Electricity costs included in Variable Operating Costs are $0.40 per KWH (= $125/bbl crude oil price) escalated at 4.0% for levelization.
All engineering assumptions, estimated costs and impacts are planning projections that will need to be verified by specific studies prior to implementatic

Abbreviations: NPV = net present value MGD = millions of gallons per day kgal = one thousand gallons $2007 = constant (real) dollars

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FIGURE 5-43. Summary of Demand Side Management Options - Levelized Costs

Candidate DSM Program Characterization

Program Name	Delivery Mechanism	Measure Cost: Equip Cost	Measure Cost: Instal Cost	Measure Cost: Total per unit	Utility Cost: Rebate per unit	Utility Cost: Admin per unit	Utility Cost: Total per unit	Program Cost: Participant per unit	Program Cost: Utility per unit	Program Cost: TRC per unit	Savings Efficacy gpdpf	Measure Life Years	Levelized Unit Cost: Participant $ / kgal	Levelized Unit Cost: Utility $ / kgal	Levelized Unit Cost: TRC $ / kgal
Toilet Flapper Install	Per SPU CPA	$8	$0	$8	$8	$12	$20	$0	$20	$20	9.25	10	$0.000	$0.804	**$0.804**
Toilet Targeted Retro	Direct installation of fixtures in targeted buildings with existing 5-7 gpf fixtures	$80	$100	$180	$180	$75	$255	$0	$255	$255	50.00	15	$0.000	$1.438	**$1.438**
Urinal Retro Rebate	Rebate Application similar to Honolulu toile rebate program	$250	$100	$350	$150	$50	$200	$200	$200	$400	55.55	15	$1.015	$1.015	**$2.031**
Toilet Retro Rebate	Bounty for old fixtures brought to depo (dumpster) and destroyed.	$80	$100	$180	$100	$50	$150	$80	$150	$230	30.00	15	$0.752	$1.410	**$2.162**
Toilet Retro Rebate	Rebate Application based on Honolulu program	$80	$100	$180	$100	$50	$150	$80	$150	$230	30.00	15	$0.752	$1.410	**$2.162**
Shwrhd Direct Install	Showerheads installed by trained technicians				$0	$30	$30	$0	$30	$30	7.29	10	$0.000	$1.531	**$1.531**
Shwrhd Canvass	Showerheads distributed by door to doo canvase with choice of type				$0	$20	$20	$0	$20	$20	4.86	10	$0.000	$1.531	**$1.531**
Showerhead Giveaway	Showerheads distributed at public events or by request				$0	$10	$10	$0	$10	$10	1.62	10	$0.000	$2.296	**$2.296**
Shwrhd Mass Mail	Showerheads mailed to all customers				$0	$15	$15	$0	$15	$15	1.62	10	$0.000	$3.444	**$3.444**
Water Eff Clothes Wash	Rebate Application with purchase documentation	$350	$0	$350	$150	$70	$220	$200	$220	$420	16.91	10	$4.400	$4.840	**$9.240**
Water Eff Dish Washer	Rebate Application with purchase documentation	$50	$0	$50	$50	$70	$120	$0	$120	$120	1.00	10	$0.000	$44.640	**$44.640**
Improve Irr. Scheduling	Per SPU CPA - Improve irrigation efficiency by better scheduling	$25	$0	$25	$25	$9	$34	$0	$34	$34	23.77	10	$0.000	$0.534	**$0.534**
Low Water Use Plantings	Per SPU CPA - Replace 300sq.ft. lawn with low water req. plants	$25	$0	$25	$25	$9	$34	$0	$34	$34	10.31	10	$0.000	$1.231	**$1.231**
Xeriscaping	HDA per SPU CPA - Replace irrigated landscaping with zeriscape	$500	$1,000	$1,500	$500	$300	$800	$1,000	$800	$1,800	500.00	10	$0.744	$0.595	**$1.339**
Soil Moisture Sensor	Per SPU CPA - Install soil moisture sensors on automatic irrigation systems	$150	$0	$150	$150	$9	$159	$0	$159	$159	34.11	10	$0.000	$1.735	**$1.735**
Improve Perf. of Irr. Sys.	Per SPU CPA - repair, replacement, adjustmen of in-ground irr. system	$188	$0	$188	$188	$9	$197	$0	$197	$197	38.03	10	$0.000	$1.923	**$1.923**
Auto Rain Shut Off	Per SPU CPA - Install automatic rain shut-off on automatic irrigation systems	$50	$0	$50	$50	$9	$59	$0	$59	$59	10.66	10	$0.000	$2.063	**$2.063**
Rain Barrel Catchment	Per SPU CPA - Install 50 gallon barrels to gutte downspouts for irrigation	$50	$0	$50	$50	$9	$59	$0	$59	$59	1.99	10	$0.000	$11.050	**$11.050**
Greywater for Irrigation	Per SPU CPA - Install grey water collect/dist. system -new and remod. with sand filtratior	$2,000	$0	$2,000	$2,000	$9	$2,009	$0	$2,009	$2,009	16.11	15	$0.000	$35.169	**$35.169**

Notes:
Shaded cells are data entry cells; other numerical cells are calculated
SPU CPA = Seattle Public Utilities Conservation Potential Assessment Final Project Report, May 1998. Delivery mechanisms were not explicitly identified for several programs
Documentation, calculations of estimates and sources are identified on a more detailed source spreadsheet
Levelized costs are calculated according to the identified measure life assuming a 3.0% inflation rate, 6.0% cost of capital, 6.0% discount rate.
All estimates and calculated costs and savings impacts should be considered rough approximations for purposes of intial measure and program assessment.

Abbreviations: gpd = gallons per day; gpdpf = gallons per day per fixture; kgal = thousand gallons; TRC = Total Resource Cost Test HDA = Haiku Design & Analysis (Carl Freedman)

Existing Near Term Source Plans

Existing near term source plans include the replacement of Well 3, replacement of Well 2 and Shaft 3 with Wells 2-A and 2-B, recommissioning of Well 7 and installation of Well 15.

Based upon system standards, as shown on Figure 5-21, these wells would be adequate to firm the system and handle redundancy requirements for natural growth, as forecast in the Base Case SMS Forecast. However, they could not all be used at design capacity without exceeding the sustainable yield of the Leeward aquifer. For more optimal distributions of withdrawals, as well as more use from new or replacement sources, it would be advisable to seek windward aquifer sources within the planning period. One good option cost-wise might be the installation of a well in the Windward aquifer at Malau.

On a levelized basis, the most cost-effective measure to improve source availability turns out to be replacement of the pipes in the Palawai Grid, as discussed in the next section. Although this was not part of the near term source plan, it is now recommended, along with some other measures to be discussed in the proposed plan section.

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FIGURE 5-44. Base Case Forecast Installed Capacity Requirements and Plans

Installed Capacity Less Largest Pump Requirements for Base Case - Elasticity = 1

Year	Wells 6 & 8	Wells 2 & 4	Wells 1, 9 & 14	Total
Now Less Lrgst Pump	792,000	1,296,000	864,000	2,952,000
2009	1,357,441	1,008,550	2,044,160	4,410,151
2010	1,378,325	1,024,067	2,075,609	4,478,002
2011	1,401,321	1,041,152	2,110,238	4,552,711
2012	1,424,316	1,058,237	2,144,866	4,627,419
2013	1,447,311	1,075,322	2,179,495	4,702,128
2014	1,470,306	1,092,407	2,214,123	4,776,836
2015	1,493,302	1,109,492	2,248,751	4,851,545
2016	1,512,631	1,123,853	2,277,859	4,914,343
2017	1,531,960	1,138,215	2,306,967	4,977,142
2018	1,551,290	1,152,576	2,336,075	5,039,940
2019	1,570,619	1,166,937	2,365,183	5,102,739
2020	1,589,948	1,181,298	2,394,291	5,165,537
2021	1,611,333	1,197,187	2,426,493	5,235,013
2022	1,632,717	1,213,075	2,458,696	5,304,488
2023	1,654,102	1,228,963	2,490,899	5,373,963
2024	1,675,486	1,244,851	2,523,101	5,443,439
2025	1,696,870	1,260,739	2,555,304	5,512,914
2026	1,719,255	1,277,371	2,589,012	5,585,638
2027	1,741,639	1,294,002	2,622,721	5,658,361
2028	1,764,023	1,310,633	2,656,429	5,731,085
2029	1,786,407	1,327,264	2,690,137	5,803,808
2030	1,808,792	1,343,895	2,723,845	5,876,532

Additional Capacity Required to Meet System Standards

Year	Wells 6 & 8	Wells 2 & 4	Wells 1, 9 & 14	Total
Now Less Lrgst Pump	792,000	1,296,000	864,000	2,952,000
Additional Capacity Required to Meet Standard Redundancies				
2009	565,441	-287,450	1,180,160	1,458,151
2010	586,325	-271,933	1,211,609	1,526,002
2011	609,321	-254,848	1,246,238	1,600,711
2012	632,316	-237,763	1,280,866	1,675,419
2013	655,311	-220,678	1,315,495	1,750,128
2014	678,306	-203,593	1,350,123	1,824,836
2015	701,302	-186,508	1,384,751	1,899,545
2016	720,631	-172,147	1,413,859	1,962,343
2017	739,960	-157,785	1,442,967	2,025,142
2018	759,290	-143,424	1,472,075	2,087,940
2019	778,619	-129,063	1,501,183	2,150,739
2020	797,948	-114,702	1,530,291	2,213,537
2021	819,333	-98,813	1,562,493	2,283,013
2022	840,717	-82,925	1,594,696	2,352,488
2023	862,102	-67,037	1,626,899	2,421,963
2024	883,486	-51,149	1,659,101	2,491,439
2025	904,870	-35,261	1,691,304	2,560,914
2026	927,255	-18,629	1,725,012	2,633,638
2027	949,639	-1,998	1,758,721	2,706,361
2028	972,023	14,633	1,792,429	2,779,085
2029	994,407	31,264	1,826,137	2,851,808
2030	1,016,792	47,895	1,859,845	2,924,532

Anticipated Capacity Additions

Source Option	Wells 6 & 8	Wells 2 & 4	Wells 1, 9 & 14	Total
Well 3	432,000	432,000		864,000
Well 2-A		864,000		864,000
Well 2-B		864,000		864,000
Well 15			576,000	576,000
Recommission Well 7	864,000			576,000
NEAR TERM ADDITIONS	1,296,000	2,160,000	576,000	3,744,000
Deficit			1,283,845	
Base Case WW Addition			387,723	
Remaining Deficit	None	None	896,122	None
Resulting Installed Less Largest Pump	2,088,000	3,456,000	1,440,000	4,320,000
For Brackish System Only - Standards Don't Apply - Checking Requirements vs. Source				
Forecast Source Requirement	803,907	597,287	1,210,598	2,611,792
* *Shown for all systems for information, though this exercise applies only to brackish systems.*				
Capacity over Avg Day Forecasted Requirement			229,402	

System Maintenance and Replacement Needs

Any twenty year plan must consider system replacement needs as well as new source, in order to determine feasibility and costs.

Anticipated costs of system replacement needs can be estimated in a number of ways. One way is to schedule replacements based on installation dates of system elements. The estimated useful life of a facility depends upon size, material and location, but if these factors are known, a replacement schedule can be derived.

Another accepted way to schedule capital improvements is based upon inspection and condition assessment of actual facilities. For example, such flaws as rust or caving tank roofs are clearly visible upon inspection. Similarly, frequent breaks, pressure or water quality complaints, or high unaccounted-for water can also help to target problem pipes for replacement. In this method, items are budgeted based on condition and performance. This method generally applies to near-term budgeting.

A third method is to estimate an average annual requirement and budget for that. For example, on Lana‘i, with just under 80 miles of active pipeline, and an average useful life of fifty years - roughly 1.6 miles of pipe should be replaced per year. This is a valid method for a long term budget approximation. Depending upon the segments to be replaced, this will be more in some years and less in others, but it reflects the average pace of replacement necessary to maintain a system the size of Lana‘i’s. Similar calculations can be done for other system facilities.

Usually, replacement schedules are drafted based upon a combination of these two methods, as is the case with the plan presented here.

Once projects have been identified, it must be determined whether and how they can be funded.

Typically, new or expanded source is funded by new meter fees. These may be called “Water System Development Fees”, “Facilities Capacity Charges”, “Tap-In Charges”, or simply “New Meter Fees”, but they refer to the charge paid to add a new meter to the system. This philosophy is sometimes encapsulated in the phrase “growth pays for growth”.

Replacement, renovation or repair of existing facilities is typically funded by rates and monthly or bi-monthly charges.

In preparing this plan, funding had to be distributed between Lana‘i Water Company, Inc. (LWCI) and Lana‘i Holdings, LLC. (LHI). LWCI purchases source delivery from it’s parent company, LHI. Part of this arrangement is that LHI develops and drills new or expanded capacity. According to utility personnel, once source projects have been developed, LWCI must budget cost recovery for LHI to maintain, repair or replace them. Under the current structure, some costs are recovered by the utility, while others are borne by the company. Costs of projects in this plan have been assigned to either LHI or LWCI based upon discussions with utility personnel.

Once system needs are identified, and recovery needs determined, a rate and fee structure is designed to accommodate them.

Projects necessary for system maintenance have been identified and are classed in the following broad categories:

- Source
- Supply and Demand Side Efficiency
- Storage
- Pipeline and Valves
- Pumps
- SCADA Telemetry and Monitoring Needs

Source

The following projects, although source related, are anticipated to be funded through LWCI rates and fees because they involve replacement or renovation of existing source.

Well 3 Replacement Well 3 is out of service and in need of replacement. This source once delivered half a million gallons per day, but toward the end of its life pumpage was closer to 100,000 gallons per day. Well 3 had one particularly useful feature, which was that it could effectively serve either the Koele and Lana'i City systems, Kaumalapau or supplement the service areas of Wells 2 & 4. The Well 3 Replacement will be located in the same area as the existing Well 3. It is expected to have an installed capacity of 864,000 GPD, with an average day capacity of 384,000 gallons and an average water delivery of 300,000 GPD. Installation costs provided by utility personnel total $1.7 million. Well 3 Replacement is expected to be on-line in the third quarter of 2010.

Well 2 Renovation Well 2-Shaft 3, although technically on line, is rarely used due to issues of both safety and facility condition. Well 2-Shaft 3 was once the island's main source of irrigation water. Based upon water levels, Well 2-Shaft 3 should be the most economical source to operate. The Well 2 renovation involves replacement of the Well 2 portion of Well 2-Shaft 3. This project involves moving the pump facilities, controls and telemetry to the surface and renovating the well and pump facility. Anticipated capacity is 864,000 GPD installed, with an average day capacity of 384,000 gallons and an average water delivery of 300,000 GPD. Estimated costs provided by utility personnel are $900,000. Well 2 Renovation is expected to be on-line in 2012. Because of the project listed below, this Well 2 Renovation is also referred to as Well 2-A.

Well 2-B Well 2-B involves replacing the old Shaft 3 with a well drilled to tap into the old Shaft 3 source. Based on the behavior of water levels at Well 2 and Shaft 3, LWCI personnel believe that Well 2 and Shaft 3 tap separate dike compartments, and can be operated as two separate sources. Anticipated costs are $2,382,880. Anticipated capacity is 864,000 installed, with an average day capacity of 384,000 gallons and an average water delivery of 300,000 GPD. Well 2-B is expected to be on-line in the fourth quarter of 2014.

Well 1 Replacement or Renovation Well 1 was drilled in 1945. By 2030 it will be an 85 year old well. The pump and shaft were last replaced in 2005. Water levels in Well 1 are declining, as they are in Wells 9 & 14. Part of the purpose of Well 15 is to distribute withdrawals in the hopes that water levels in these wells can stabilize, as well as for additional redundancy.

Well 4 Replacement or Renovation Well 4 is the island's most productive well at present. Although Well 4 appears to be in working order, replacement or renovation remains on the fringes of LWCI's plans, because by the year 2030 it will be an 80 year old well. It was drilled in 1950. The pump motor was last replaced in 2006. Project costs are estimated only roughly, at $1.75 million. The existing pump is 900 GPM, or 1,296,000 GPD installed capacity. The size of the replacement pump would be determined based upon water levels at the time it is replaced.

The following projects would be funded by LHI as expansion source.

Well 15 Water levels in all three pumping brackish wells, Wells 1, 9 & 14, are declining. An additional well is required to distribute withdrawals, as well as to provide redundancy for the brackish system. Costs are estimated at $2,656,800. Anticipated installed capacity is 864,000, with an average day capacity of 384,000 gallons. No additional source availability is assumed to result from this project.

Recommission Well 7 Well 7 could provide both reliability and improved distribution of withdrawals on the north end of the Leeward aquifer. Well 7 has the advantage of being situated such that, with transmission improvements, it could serve either Lana'i City or the Irrigation Grid. Estimated costs to renovate Well 7 and construct transmission to the Lana'i City system are $2,678,210.

Well 5 Replacement Well 5 was drilled in 1950. By the late 1980s, water deliveries from this well were declining, and the well was used mainly for backup. When it was in use, it had to be used with caution, and given time to allow water to recharge. Although Well 5 has been out of use since 1994, it was seen as a possible re-instated future source for years. More recently, general thinking has been that it would be more likely to replace this source than to revitalize the old well. Costs are estimated at $2,956,800. The costs of this project would be borne by LHI.

In addition to these three quasi -replacement sources, new source projects identified and described earlier in this chapter would be funded by LHI.

- High Level Potable Well Near Hi'i Tank (between Hi'i Tank and Well 3)
- Windward Well at Malau
- Windward Well at Maunalei
- Windward Well at Kehewai Ridge - 2,250'
- Windward Well at Kehewai Ridge - 2,750'
- Windward Well at Kauiki
- Windward Wells at Kauiki (Incremental)

Supply and Demand Side Efficiency

Indoor Conservation Technical domestic savings potential was evaluated in the *Demand Analysis* chapter of this WUDP. The theoretical potential water savings from indoor conservation was estimated at 175,192 GPD. $1,480,419 is included in the designed rate structure for a “Direct Install” program to replace all existing, non-conserving toilets, showerheads and faucet aerators and clothes washers on the island. Replacement of clothes washers could be traded for an equivalent savings opportunity in the commercial or other sectors, such as tunnel washers, pre-rinse spray valves, efficiency improvements in cooling, or other efficiency measures. Estimated costs included funds for contracting the installation out and associated internal administration. Since residential dishwashers are not addressed in this program, their estimated savings potential is subtracted from the total estimated technical savings potential, resulting in a theoretical savings from this plan of 174,040 GPD.

It is never possible to achieve full theoretical technical potential with a conservation program. Assumptions in program design assume that only a portion of technical potential is achieved. Assuming that roughly 100,000 GPD in savings were actually attained (about 57% of technical potential), an estimated $2,337,600 in savings would result from this investment of roughly $1.5 million. This savings is comprised of $212,000 in pumping costs, and the avoided installation of roughly 1/3 of a well, using the Well at Malau as a median priced example. Although net present value cost estimates were not calculated, the savings promise to be substantial enough that the measure is anticipated to be cost-effective.

<u>Incentives for Landscape or Hotel Conservation</u> Landscape is the largest use of water on the island, estimated at over 1.1 MGD. Hotels are the largest customers, with over 0.27 MGD in metered uses on the meters specifically classed as hotel alone. Roughly half of that is thought to be used outdoors for irrigation of hotel properties, water features, and the like. Both represent major opportunities for efficiency savings.

Measures for landscape efficiency have been discussed in general terms above. In addition, the pricing structure designed to support necessary expenditures over the next 20 years should have the effect of flattening at least the more excessive landscape or other uses. One means to mitigate and avert potential rate shock is to assist those most affected with incentives and assistance to conserve. $225,000 has been included for this purpose. $25,000 would be spent to hire an expert conservation consultant to identify the most critical measures, with the bulk of the funds going to actual efficiency incentives or rebates for these sectors.

<u>Leak Detection Equipment</u> Unaccounted-for water analysis in the *Demand Analysis* chapter of this document documented high losses in the Palawai Irrigation Grid. However, long before that, the Lana‘i Water Advisory Committee discussed high pressures, frequent water service interruptions due to pipe breaks at the MECO plant in the Miki Basin area. LWCI personnel described “walking the lines” to find visible leaks. A leak in a buried pipe that has become visible at the surface has usually been growing for some time. All of the circumstances listed are indications of severely leaky pipes. Moreover, high pressures reported in the Grid would put additional burden on pipes in poor condition. An unfortunate finding of the unaccounted-for water analysis was that even with recent repairs and replacements, unaccounted-for water remained high in the Palawai Irrigation Grid as of the first 6 billing periods in 2009. Leaks can go on for a long time without detection, if not actively sought. In highly permeable or sandy soils, even severe leaks can go undetected indefinitely.

One way to minimize such losses is a regular system audit with leak detection equipment. In the proposed capital plan, $150,000 is included for leak detection equipment. This should be enough to obtain a digital correlator, some correlating loggers, a pipe locator, a leak detector and some leak loggers.

Water losses are costly in terms of energy consumption, wear on pumps and facilities, service interruptions, lost revenues and lost opportunities to do useful things with the water. These costs can be insidious. A standard Water Audit Worksheet from the American Water Works Association was used to examine the leaks indited on Wells 2 & 4, with the result that annual economic losses from these leaks were roughly $300,000.

Storage

Replace Hi'i Tank and Hi'i Reservoir with New 2 MG Tank The 0.5 MG Hi'i Tank is old and in need of replacement. The tank is in poor condition, with rust on the roof and near the base of the tank. A portion of the base appears to be missing or cracked. These deficiencies were mentioned in the Sanitary Survey of the Manele System. The Hi'i Reservoir is also about fifty years old, has a concrete lining and a cover. A concrete reservoir of this age could also be one source of unaccounted-for water, if cracks have begun to develop in the concrete.

Hypalon Balls To Reduce Evaporative Losses at 15 MG Brackish Reservoir Lana'i Water Advisory Committee members frequently expressed concern about unaccounted-for water at or around the 15 MG brackish water reservoir in Palawai Irrigation Grid. Unaccounted-for water in the brackish system is about 19%. Three options to reduce evaporative losses were evaluated. An aluminum cover, a floating cover and hypalon balls. The most cost effective appeared to be the floating cover. In discussions with utility personnel, there was concern that the floating cover might not be as easy to work with logistically as the hypalon balls. Floating covers can be difficult to remove when they start to disintegrate. Hypalon was selected for inclusion in the capital proposal. Anticipated savings are 14,000 GPD.

Pipeline Replacement

Nine pipeline projects totalling roughly $11,946,921 were identified and reviewed. Of these, eight were included in the capital proposal.

Replace Broken and Leaking Pipe In the Central Palawai Irrigation Grid As noted above, unaccounted-for water on this portion of the system is 44.61%. Due to the high pressures, frequent breaks and visible leaks discussed above, it is believed that the lion's share of this unaccounted-for water actually is lost to leakage. Even a reduction in losses, leaving 15% unaccounted-for water would result in over 200,000 GPD in savings from Wells 2 and 4. The costs of these losses to the utility are over $200,000 per year. By offsetting electrical costs for 200,000 GPD of pumpage, while at the same time adding 200,000 gallons of source availability, this option, pencils out as the most economical of all the source options, on a levelized cost basis.

The project also includes segments upstream of the Palawai Irrigation Grid, from Well 3 to Well 2, from Well 4 to Well 2, and from Wells 2 and 4 to the Hi'i Reservoir. Portions of these upstream segments do not meet system standards.

Both fire protection and potable water for the planned industrial park are required in the area as well, meaning that at least some portions of these replacements may receive developer funding. For instance, 12" line from Hi'i Tank to Miki Basin could be developer funded, while the rest of the project would be funded by the utility. An alternate option would be to make a dual connection, running a potable 8" line to the Kaumalapau system, and an 8" line from Hi'i to the Miki Basin.

Apart from Miki Basin, most of the uses in the Palawai Irrigation Grid could be served by irrigation grade rather than potable grade lines. Meters requiring potable service could be relocated to the Kaumalapau line for potable water. Mapping the actual locations of meters served by these lines within the grid led to this option. This could reduce the cost of the replacement.

On-site storage poses some questions. In discussion with utility personnel, it appeared that the currently favored option might be to provide on site storage with pumping capability for fire protection. Gravity flow is generally preferred, and might be a better option. Since some storage is likely to be required as a condition of the proposed industrial park development, it may be possible to combine the required tank with the replacement of the Hi'i Tank and reservoir. The developer could cover all or part of that replacement, up to whatever would be necessary to serve the Industrial Park without detriment to Manele, according to standards. This option would require a 12" transmission line, but would provide better fire flow to the site. It is important to note in this regard that the project as priced involves an 8" line, which is adequate combined with other projects here to meet the needs of current uses. Never the less, a 12" line may be the better choice.

The estimated cost used in the plan is $3,740,920. This includes potable grade ductile iron lines the same sizes as existing lines upstream of the reservoir, and 8" irrigation grade line downstream of the reservoir.

If ductile iron lines suitable for potable use are selected, or if the line is upgraded to 12", whether potable or irrigation grade, to provide fire protection, the cost could go up. But in these cases it may also be that all or a portion of these project upgrades could be developer-funded. It would be advisable to consult with developers and make these decisions before the upgraded line is installed.

<u>Replace Asbestos-Concrete Pipe Segments in Lana'i City, including PRV on 10" Asbestos Line</u> To the northeast of Lana'i City, some of the old transmission lines are asbestos. These are at an age where repairs become necessary from time to time, especially at the joints. Working with asbestos creates safety hazards for field crews, as well as inefficiencies and inconveniences on the job due to the need for special precautions. The estimated cost of the project is $972,041.

<u>Upgrade Kaumalapau Line</u> The line to Kaumalapau is old and undersized to provide fire protection to the Kaumalapau Harbor and residences. Portions of this line are in poor repair. The estimated costs to upgrade this line is $3,958,217.

<u>Potable Line Connecting Miki Basin to the Kaumalapau Waterline</u> This project could be a requirement of the proposed Miki Industrial Park. However, the existing MECO facility in Miki Basin has substandard service and would also benefit.

Potable Line Connecting Well 7 to Upper End of Lana'i City Service Area   Well 7 has the advantage of flexibility, in that it could serve either the city or the west end of the Palawai Irrigation Grid service area. There is also an advantage in the fact that the well has been drilled for some time, which should afford some cost savings. This project would be paid for by LHI.

Replace Old Steel Pipe Segments in Lana'i City   About 1.62 miles of pipe in Lana'i City are old wound steel pipes. These are due for replacement. Estimated project costs are $1,202,755.

Connect Well 7 To West End Grid This is part of a phased project. Connecting Well 7 to the West end of the Palawai Irrigation Grid would enable services on that side to be served by Well 7. Although these services do not use much, this would provide some relief to Wells 2 & 4. Leaks on this end of the Palawai Irrigation Grid are not believed to be as severe as they are in the Miki Basin, where pressures were extremely high for a long time. Never the less, the line is of the same general vintage and will be well past due for replacement within the planning period.

Re-route Brackish Line to Save Electrical Costs This project is not included in the capital plan. It was evaluated for inclusion, as it was determined that roughly $29,250 in electrical costs per year could be saved if two hills along the transmission route could be avoided. The benefits of the re-alignment were not sufficient to warrant replacing the entire line. The benefits of replacing portions of the line, to attain part of the possible savings, were also examined.   None of the options examined warranted line replacement or retrofit. However, it is suggested that when the brackish line does become due for replacement, it be re-routed as shown in Figure 5-48.

Pumps

Rolling Pump Replacement   At present there are six or seven operating source pumps, depending upon whether Well 2 is counted, with four or five likely to commence or resume operations in the near future, those being Well 3 (relocated), Well 2-A and 2-B, Well 15, and possibly Well 7. A total of twelve operating source pumps with an assumed lifetime of fifteen years per pump leads to a replacement rate of about 0.8 pumps per year, or 4 pumps every 5 years. Since some of these will be new, not all are deemed to require replacement within the planning period. An estimated twelve pump replacements over the twenty year period were included in the capital plan, at a cost of $2,400,000.

Motor Control and Electrical Center Upgrades   Regular maintenance, assessment and replacement of parts such as motors, electrical controls, impellers or other elements as needed can help to extend the operating life of pumps. An annual allowance of $50,000 is included within the capital plan, for a total of $1,000,000.

SCADA, Telemetry and Other Monitoring Equipment

Monitoring Replacements and Upgrades An annual allowance of $25,000 is included to allow for regular replacement and upgrade of telemetry, SCADA, controls, flow meters or other monitoring equipment, for a total over the planning period of $500,000.

FIGURE 5-45. Pipeline Projects

PRIORITY	DESCRIPTION	DISTRICT	INSTALL DATE	MATERIAL	DIAM	REPLACE ONLINE DATE	LENGTH MILES	LENGTH FEET	REPLACEMENT DIAMETER	ANTICIPATED COSTS	COMMENT
Replace Broken & Leaking Pipe in Central Palawai Irrigation Grid											
1	IGGP '4th' Leg - St A to St S -5401 to 5229	IGGP	1960	Concrete	12	0	1.850	9,769.849	6	$146,547.74	
1	IGGP '4th' Leg - Stations Y, S, J, P and rain gague	IGGP	1960		0	0	0.870	4,595.615	6	$68,934.23	
1	IGGP Loop Line along Kaumalapau Rd	IGGP	0		0	0	0.958	5,057.262	6	$75,858.93	
1	Manele Trans - Well 3 to Well 2 by fields 5401-02	MNPD	1968	Concrete Cylinder	16	0	1.415	7,473.349	12	$1,233,102.59	Near city but to Manele. One map says this leg is 8" transite.
1	Revised Mid-East Alignment Per John	IGGP	0		0	0	0.206	1,088.763	6	$16,331.45	
1	Revised West End Alignment Per John	IGGP	0		0	0	3.146	16,610.208	6	$249,153.12	
1	Second Leg - 5513-14 and 5507-08	IGGP	1951	Cement Mortar Lined	0	0	2.536	13,392.114	6	$200,881.71	
1a	Pipeline from Well 2 / Shaft 3 to Trnamission Main	MNPD	1955		0	0	0.875	4,617.825	12	$761,941.13	
1a	Pipeline from Well 4 to Well 2	MNPD	1952		0	0	0.721	3,807.123	12	$628,175.30	
1a	Pipeline from Wells 2 and 4 to Hii	LCTY	0		0	0	0.413	2,181.779	12	$359,993.54	
							12.990	68,593.887		3,740,920	
Replace Asbestos-Concrete Pipe Segments in Lana`i City											
2	6th Street Waterline - From Queens St. to Alapa St	LCTY	0	Asbestos	10	0	0.031	162.213	10	$25,143.02	
2	Line fr Cavendish Mtr Line to Koele	LCTY	0	Asbestos	12	0	0.114	601.841	12	$99,303.77	
2	Line fr Old Lanai Tank down to Line that Enters Qu	LCTY	0	Asbestos	10	0	0.270	1,427.991	10	$221,338.61	
2	Part of 12" Main Above Alapa to N. End Queens	LCTY	0	Asbestos	12	0	0.185	977.430	12	$161,275.95	
2	Queens Avenue	LCTY	0	Asbestos	12	0	0.158	833.334	12	$137,500.11	
2	Queens St to Lanai Ave Waterline - btwn 8th and 9t	LCTY	0	Asbestos	10	0	0.120	631.275	10	$97,847.63	
2	Waterline Connecting 6th Street Line to Queens St	LCTY	0	Asbestos	10	0	0.033	174.356	10	$27,025.18	
2	Waterline from Maunalei Line to Top of 6th Street	LCTY	0	Asbestos	12	0	0.233	1,227.921	12	$202,606.97	
							1.144	6,036.361		972,041	
Upgrade Line to Kaumalapau to Meet System Standards											
3a	KPAU Trans 3rd Leg - below WWTP to Top of Runway	KPAU	1952			0	1.757	4,707.121	8	$663,704.06	
3	KPAU Trans - top of runway to Airport Road	KPAU				0	0.865	4,568.984	8	$644,226.74	
3	Airport Road to Kaumalapau Tank Waterline	KPAU				0	2.656	14,024.948	8	$1,977,517.67	
3	Kaumalapau Tank to Kaumalapau Harbor Waterline	KPAU				0	0.904	4,771.408	8	$672,768.53	
										$3,958,217.00	
Connect Potable Kaumalapau Waterline to Miki Basin											
4	Waterline from Kaumalapau Line to Miki Basin	IGGP	0		0	0	1.179	6,227.393	8	$878,062.41	
										$878,062.41	
Commission Well 7 and Connect to System											
5	Connect Well 7 to City fr. In by Koele to 2MG tk	LCTY	0	Ductile Iron	12	0	0.604	3,190.322	8	$449,835.40	
5	Connect Well 7 to City (portion to line by Koele)	LCTY	0	Ductile Iron	12	0	0.333	1,758.911	8	$248,006.45	
							0.937	4,949.233		697,842	

System Maintenance and Replacement Needs

FIGURE 5-45. Pipeline Projects - Continued

Replace Old Steel Pipe Segments in Lana`i City										
6	N of Lanai Avenue Waterline - fr Koele line to 3rd	LCTY	0	Steel	8	0	0.199	1,051.637	8	$148,280.82
6	Ninth Street Waterline - Lanai Avenue to Fraser Av	LCTY	0	Steel	10	0	0.190	1,001.682	8	$141,237.16
6	Ninth Street Waterline - Puulani Place to Lanai Av	LCTY	0	Steel	10	0	0.120	632.279	8	$89,151.34
6	Olapa Street Waterline - 9th to Kaumalapau Hwy	LCTY	0	Steel	8	0	0.332	1,752.642	8	$247,122.52
6	Palawai Lane Waterline	LCTY	0	Steel	8	0	0.335	1,767.013	8	$249,148.83
6	Potable Line North of City from Fraser to Lana`i	LCTY	0	Steel	0	0	0.186	981.787	8	$138,431.97
6	Potable Line North of City fr Lana`i Ave to Koel	LCTY	0	Steel	0	0	0.254	1,343.137	8	$189,382.32
							----------	----------		----------
							1.616	8,530.177		1,202,755
Connect Well 7 to West End Grid										
7	Connection for Well 7 to West End Grid (Re-aligned	IGGP	0		0	0	1.935	10,215.809	6	$153,237.14
							----------	----------		----------
							4.658	24,590.565		153,237
Replace Old Pipe In West End of Palawai Irrigation Grid		**Estimated Cost: $6.17 Million**								
8	IGGP '4th' Leg - St P to N - crosses 5325 & 5313	IGGP	1960		0	0	1.252	6,613.055	6	$99,195.83
8	IGGP '4th' Leg- Stns Y,S,J,P, rain gauge 5311-5223	IGGP	1960		0	0	0.841	4,440.507	6	$66,607.61
8	Revised West End Alignment Per John	IGGP	0		0	0	1.350	7,125.360	6	$106,880.40
8	West North West End of Grid	IGGP	0		0	0	0.887	4,684.214	6	$70,263.21
							----------	----------		----------
							23.390	118,928.184		342,947
										11,946,021

FIGURE 5-46. **Pipeline Projects**

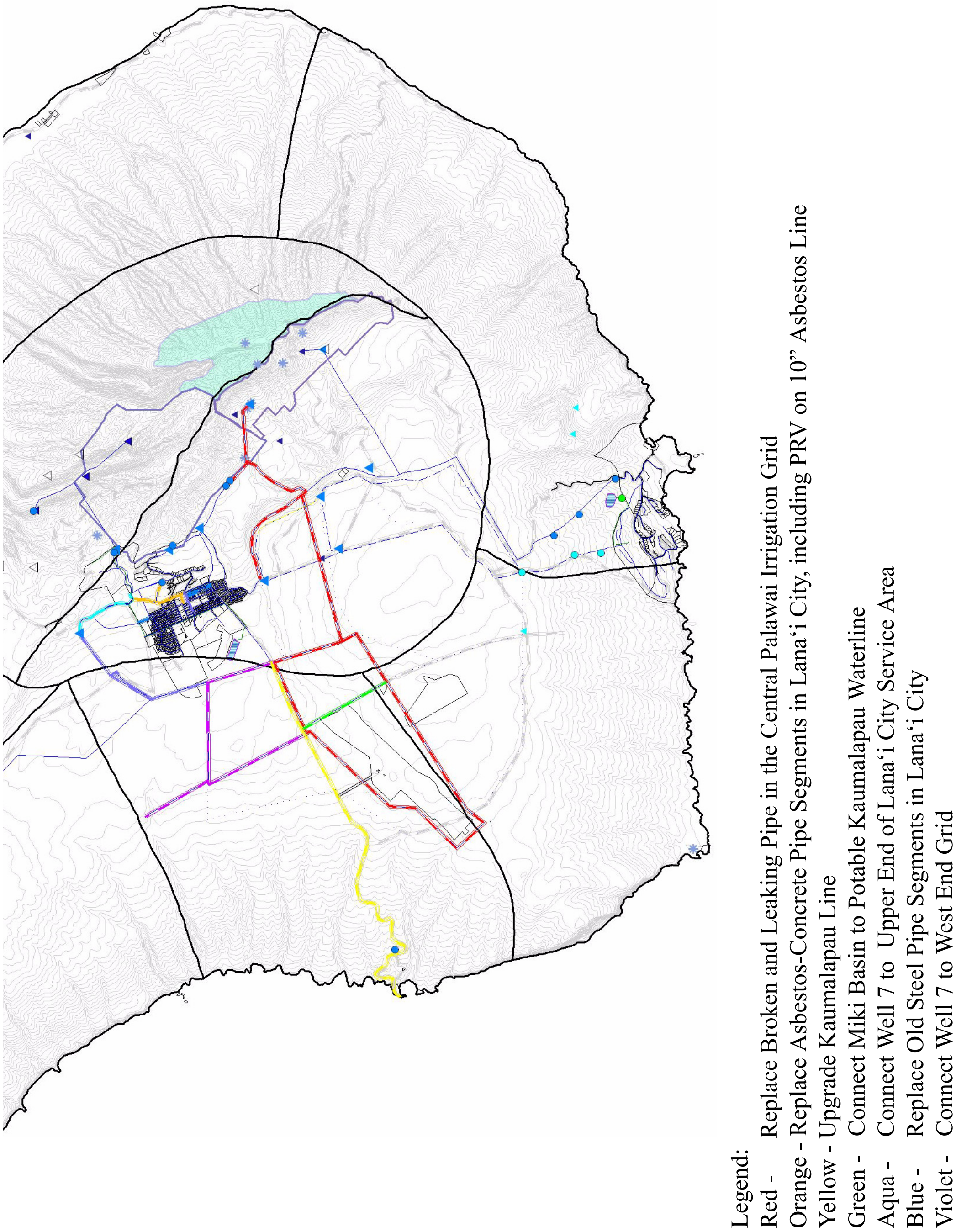
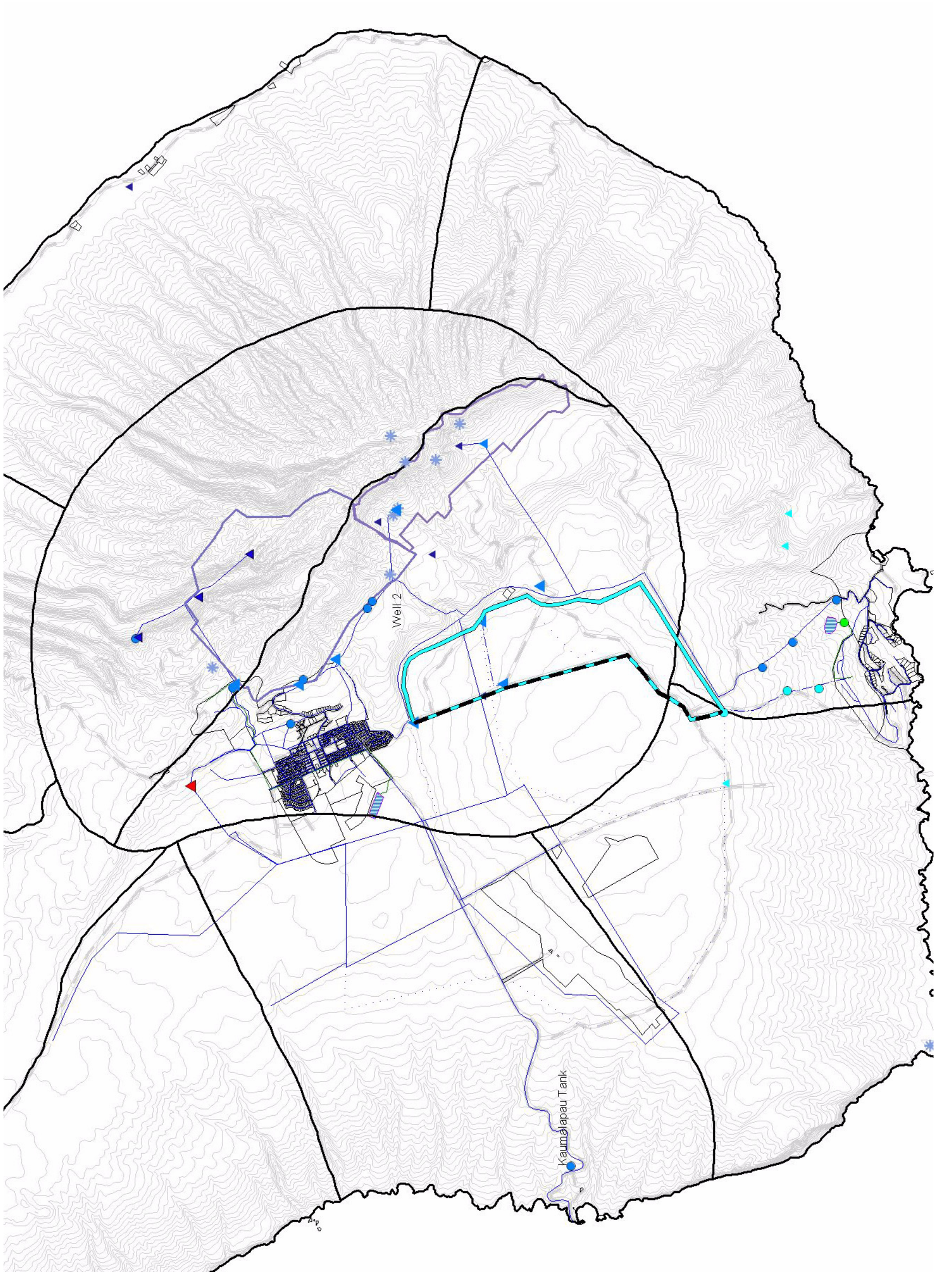


FIGURE 5-47. Alternate Route for Future Brackish Line



Aqua colored line is existing brackish line.
Dashed aqua and black colored line is proposed re-route upon replacement.

Supply Options

FIGURE 5-48. Initial Twenty Year Project List

Year	Project	Phase	Project Description	Budget	Antic Capacity GPM	24 Hrs	16 Hrs	Avg Day Capacity	Effective Assumed Source Pumping In Addition	1996 Model	Comment
								See also Storage & Line Replacement projects, as these also have options that increase source availability.			
2008	Well 3 Replacement	Drill	Drill replacement for Well 3	1,000,000							
2009	Well 3 Replacement	Pump	Install pump	200,000							
2010	Well 3 Replacement	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	500,000	600	864,000	576,000	384,000	**0**	Yes	GPD Reliability for existing capacity.
2010	Well 15	Design & Exploratory Drilling		1,155,000							
2011	Well 2 A - Renovation	Move pump & controls to surface		400,000							
2011	Well 2-B	Study	Determine interconnectivity between well 2 and shaft 3	500,000							
2011	Well 15	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	1,501,800	400	576,000	384,000	256,000	**0**	No	Distribution of withdrawals to address declining water levels in Wells 1, 9 & 14.
2012	Well 2 A - Renovation	Equip and Develop		500,000	600	864,000	576,000	384,000	**0**	Yes	Renovation of existing well to firm non-firm capcity.
2013	Well 2-B	Design & Exploratory Drilling	Drill Well 2-B at site of existing Shaft 3	623,880							
2014	Well 2-B	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	1,259,000	600	864,000	576,000	384,000	**300,000**	Yes	Although this is also "firming non-firm" capacity, LWCI hopes to gain effective capacity if water levels prove independent.
In Plan But Not Really Scheduled											
2016	Well 7 Renovation	Design, Pump Replacement, Site Renovation		575,000							
2017	Well 7 Renovation (see Trans in pipelines	Develop & Equip	Equip with Control Tank, Telemetery, MCC, Site Pipine Etc., and Connect to Lana`i City Upper Level	1,405,368	600	864,000	576,000	384,000	**300,000**	Yes	Although levelized cost estimates assume 500,000 GPD, it should be noted that water levels in wells on this side of the system are dropping with lower pumping rates than this, Could be only 300,000 GPD.
2018	Well 4 Replacement or Renovation	Design & Exploratory Drilling	Drill replacement for Well 3	750,000							
2020	Well 4 Replacement	Develop & Equip	Install motors, controls, telemetry, site	1,000,000	900	1,296,000	864,000	576,000	**0**	Yes	Tentative budget to replace or renovate existing old well.
2022	Well 1 Replacement or Renovation	Design & Exploratory Drilling	Drill replacement for Well 3	750,000							
2024	Well 1 Replacement	Develop & Equip	Install motors, controls, telemetry, site	1,000,000	300	432,000	288,000	192,000	**0**	Yes	Tentative budget to replace or renovate existing old well.
	Well 5 Replacement	Design & Exploratory Drilling	Drill replacement for Well 5 or Other	1,155,000							
	Well 5 Replacement	Develop & Equip	piping & appurtenances	1,801,800	600	864,000	576,000	384,000	**300,000**	Yes	Assuming Wells 2-B and 7 increase effective capacity as hoped, at this point, development of additional wells in the Leeward aquifer will be for distribution of withdrawals. If a 600,000 gallon (10% of total sustainable yield) resource reserve is maintained, with 300,000 GPD of that from each aquifer, the added yield of this well would be only 113,310 GPD.
Reclaimed Water Use											
	Reclaimed Line to Miki	Transmission	Provide irrigation source for Miki Basin	1,536,000				60,000	**60,000**		Costs for all options are presented, but the chosen one within the planning period is the line from Lana`i City to Miki Basin to offset potable water use for irrigation in that area, particularly at the new Industrial Park & Airport.
	Reclaimed Line to Manele	Transmission	Provide irrigation source for Manele	16,896,000				500,000	**500,000**		
	Reclaimed Line to Miki as Phase I	Transmission	Iirrigation source for Miki Basin & Manele	2,304,000				60,000	**60,000**		
	II	Transmission	Iirrigation source for Miki Basin & Manele	15,456,000				440,000	**440,000**		
New Source Alternatives - Unscheduled											
	High Level Potable Well Near Hi`i Tank	Design & Exploratory Drilling	Drill well between Hi`i Tank and Well 3.	1,080,000							Well for distribution of withdrawals in Leeward aquifer. Pumpage from the Leeward aquifer is already > 1.9 MGD. By this point, sustainable yield would have been reached, without resource reserve.
	High Level Potable Well Near Hi`i Tank	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	1,636,800	600	864,000	576,000	384,000	**186,690**	No	
	Windward Well at Malau	Design & Exploratory Drilling	Drill well in windward aquifer at Malau near Keomoku Road.	905,000							
	Windward Well at Malau	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	1,971,800							
	Windward Well at Malau	Transmission	Install roughly 15,0000' of pipeline to connect Malau Well to system.	3,600,000	600	864,000	576,000	384,000	**300,000**	No	
	Windward Wells at Maunalei	Design & Exploratory Drilling	Recommission or drill new wells in Windward aquifer near Maunalei sources.	1,270,000							
	Windward Wells at Maunalei	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	5,481,000							
	Windward Wells at Maunalei	Transmission	Install or repair existing transmission as necessary.	1,250,000	1,800	2,592,000	1,728,000	1,152,000	**750,000**	Partially	Assumes 3 wells in Maunalei, with use of existing transmission lines, but with repairs, improvements & connection to that line. Costs vary depending upon whether or not existing transmission lines can be utilized. IF completely new transmission is required, then Wells at Kehewai Ridge are cheaper, as is reclaimed water line from Lana`i City to Manele. Reclaimed line would not be cost-effective until the proposed

FIGURE 5-48. Initial Twenty Year Project List - Continued

Year	Project	Phase	Project Description	Budget	Antic Capacity GPM	24 Hrs	16 Hrs	Avg Day Capacity	Effective Source Addition	Assumed Pumping In '96 Model	Comment
	Windward Well at Malau	Design & Exploratory Drilling	Drill well in windward aquifer at Malau near Keomoku Road.	905,000							
	Windward Well at Malau	Develop & Equip	Install motors, controls, telemetry, site piping &	1,971,800							
	Windward Well at Malau	Transmission	Install roughly 15,0000' of pipeline to connect Malau Well to system.	3,600,000	600	864,000	576,000	384,000	**300,000**	No	
	Windward Wells at Maunalei	Design & Exploratory Drilling	wells in Windward aquifer near Maunalei sources.	1,270,000							Assumes 3 wells in Maunalei, with use of existing transmission lines, but with repairs, improvements & connection to that line. Costs vary depending upon whether or not existing transmission lines can be utilized. IF completely new transmission is required, then Wells at Kehewai Ridge are cheaper, as is reclaimed water line from Lana`i City to Manele. Reclaimed line would not be cost-effective until the proposed build-out scenario was reached in Lana`i City & Koele.
	Windward Wells at Maunalei	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	5,481,000							
	Windward Wells at Maunalei	Transmission	Install or repair existing transmission as necessary.	1,250,000	1,800	2,592,000	1,728,000	1,152,000	**750,000**	Partially	
	Windward Well at Kehewai Ridge - 2,250' Elevation	Design & Exploratory Drilling	Drill well in windward aquifer at	1,370,000							Although the transmission route may appear strange for this option, the project has been designed to avoid damage to the core remaining intact native habitat on Lana`i.
		Develop & Equip	telemetry, site piping &	1,954,800							
	Windward Well at Kehewai Ridge - 2,250' Elevation	Transmission	Install roughly 15,0000' of pipeline to connect well to	5,950,000	600	864,000	576,000	384,000	**300,000**	No	
	Windward Well at Kehewai Ridge - 2,750' Elevation	Design & Exploratory Drilling	Drill well in windward aquifer at Kehewai Ridge.	1,370,000							Although the transmission route may appear strange for this option, the project has been designed to avoid damage to the core remaining intact native habitat on Lana`i.
	Windward Well at Kehewai Ridge - 2,750' Elevation	Develop & Equip	Install motors, controls, telemetry, site piping &	2,018,800							
	Windward Well at Kehewai Ridge - 2,750' Elevation	Transmission	Install roughly 15,0000' of pipeline to connect well to	5,950,000	600	864,000	576,000	384,000	**300,000**	No	
	Windward Wells at Kauiki	Design &	Drill well in windward aquifer at	1,570,000							Costs shown include replacement of Maunalei Transmission. If this is not necessary, or for subsequent incremental wells, costs are reduced considerably. Costs without Maunalei transmission would be $4,864,800 per new well, vs. $10,924,800 as shown. Even if existing Maunalei transmission can be used, at some point it may need to be up-sized.
	Windward Wells at Kauiki	Develop & Equip	Install motors, controls, telemetry, site piping & appurtenances	1,929,800							
	Windward Wells at Kauiki	Transmission	Install roughly 15,0000' of pipeline to connect well to system.	7,425,000	600	864,000	576,000	384,000	**300,000**	No	
	Windward Wells at Kauiki - Incremental	Design & Exploratory Drilling	Drill well in windward aquifer at Kauiki.	1,545,000							As noted above, costs of incremental wells become lower. However, with a resource reserve, at this point all available source within the Windward aquifer as well as the Leeward aquifer would essentially have been developed.
	Windward Wells at Kauiki - Incremental	Develop & Equip	Install motors, controls, telemetry, site piping &	1,559,000							
	Windward Wells at Kauiki - Incremental	Transmission	Install roughly 15,0000' of pipeline to connect well to	1,760,800	600	864,000	576,000	384,000	**300,000**	No	
	Windward Wells at Kauiki - Incremental	Design & Exploratory Drilling	Drill well in windward aquifer at Kauiki.	1,545,000							As noted above, costs of incremental wells become lower. However, at this point all 3 MGD within the Windward aquifer as well as the
	Windward Wells at Kauiki - Incremental	Develop & Equip	Install motors, controls, telemetry, site piping &	1,559,000							