d. Maximum velocity in distribution main (without fire flow) is 6 feet per second.
e. Maximum velocity in distribution main (with fire flow) is 10 feet per second.
f. Maximum static or pumping pressure, whichever is greater, shall not exceed 125 psi.

5. Reservoirs

Reservoirs shall be sized as follows:

a. Meet maximum day consumption. Reservoir full at the beginning of the 24-hour period with no source input to the reservoir.
b. Meet maximum day rate plus fire flow for duration of the fire. Reservoir ¾ full at start of fire, with credit for incoming flow from pumps, one maximum size pump out of service.
c. Standard size of reservoir is 1.0 million gallons (MG) and in increments of 0.5 MG above 1.0 MG.

6. Wells

a. Yield:

For 2 wells drilled, each producing 1,000,000 gallons per day, each well will provide approximately two-thirds the production or 670,000 gallons per day for the project. The total available water for the project will be 1,340,000 gallons per day.

For 1 well drilled, producing 2,000,000 gallons per day, the well will provide approximately half the production or 1,000,000 gallons per day for the project.

b. Contact reservoir:

Provide a contact reservoir for the well equal to the daily production capacity of the well.

7. Service Zone

The majority of the site is within the service zone of the 595-foot Reservoir. The 595-foot Reservoir service zone extends from the 495-foot elevation to the 225-foot elevation. The portion of the site, along the mauka extension of Keanalehu Drive, above the 495-foot elevation has to be serviced from the 935-foot Reservoir, to provide adequate water pressure. Water lines from both reservoir service zones are designed to stub to the project site along Manawale`a Street.

Hawaii Housing Finance and Development Corporation — December 2007
Keahuolu Affordable Housing Master Plan — Prepared by: Belt Collins Hawaii Ltd.

Water - Daily Demands

Single Family Residential =	800	gallons/unit	(see note 1.)
Multi-family Residential =	400	gallons/unit	(see note 2.)
Commercial =	3,000	gallons/acre	per DWS Table 100-18
Schools (550 students) =	60	gallons/student	per DWS Table 100-18
(12 Acre School Site) Use	4,000	gallons/acre	per DHHL Water Master Plan
Parks =	4,000	gallons/acre	per DWS Table 100-18

Development	Units	Daily Demand (gallons/unit)	Average Demand (Gallons)
Concept A - LOW			
Single Family	400	800	320,000
Mult-Family	620	400	248,000
Commercial	9.7	3,000	29,100
Schools	12	4,000	48,000
Parks	25.18	4,000	100,720
Total			745,820

Reservoir Sizing:

1) Meet maximum daily consumption (1.5 x Average Day). Reservoir full at the beginning of the 24-hour period with no source input to the reservoir.

1.5 x 745,820 1,118,730 gallons

2) Meet maximum day rate plus fire flow for duration of fire. Reservoir 3/4 full at start of fire, with credit for incoming flow from pumps, one maximum size pump out of service.

Fire Flow (Worst Case is Schools) = 2000 gpm for 2 hours
240,000 gallons
Max Day Rate 93,228
Storage = 444,303 gallons

Condition 1 governs.
Existing 595' elevation reservoir has approximately 482,095 gallons capacity.
Will need to construct new 1.0 MG reservoir. (1.5 MG > 1.1 MG)

Wells:
Well Site No. 4 estimated yield = 2.0 MGD, Well Site No. 3 estimated yield = 1.0 MGD.
One 2.0 MGD yield well can provide approximately 1,000,000 gallons per day.
One 1.0 MGD yield well can provide approximately 500,000 gallons per day.
Two 1.0 MGD yield wells can provide approximately 1,340,000 gallons per day.
Two wells, one 2.0 MGD and one 1.0 MGD well can provide approximately 2,010,000 gallons per day.
Will need to construct 1 well, with 2 MGD yield. (1.0 MGD > 0.75 MGD)

Notes:

1. Per phone conversation 4/16/07 with Kurt Inaba at the Department of Water Supply, water use varies between 400 gpd (1 unit) to 800 gpd (2 units) based on size of lot. HHFDC anticipates the single family homes to be market units and require 800 gpd (2 units).
2. Per phone conversation 4/16/07 with Kurt Inaba at the Department of Water Supply, water use for the multifamily (affordable) units can be set at 400 gpd (1 unit).

Water - Daily Demands

Development	Units	Daily Demand (gallons/unit)	Average Demand (Gallons)
Concept B - MED			
Single Family	600	800	480,000
Mult-Family	1240	400	496,000
Commercial	11.32	3,000	33,960
Schools	12	4,000	48,000
Parks	25.18	4,000	100,720
Total			1,158,680

Reservoir Sizing:

1) Meet maximum daily consumption (1.5 x Average Day). Reservoir full at the beginning of the 24-hour period with no source input to the reservoir.

1.5 x 1,158,680 1,738,020 gallons

2) Meet maximum day rate plus fire flow for duration of fire. Reservoir 3/4 full at start of fire, with credit for incoming flow from pumps, one maximum size pump out of service.

Fire Flow (Worst Case is Schools) = 2000 gpm for 2 hours
240,000 gallons
Max Day Rate 144,835
Storage = 513,113 gallons

Condition 1 governs.

Existing 595' elevation reservoir has approximately 482,095 gallons capacity.

Will need to construct new 1.5 MG reservoir. (2.0 MG > 1.7 MG)

Wells:

Well Site No. 4 estimated yield = 2.0 MGD, Well Site No. 3 estimated yield = 1.0 MGD.
One 2.0 MGD yield well can provide approximately 1,000,000 gallons per day.
One 1.0 MGD yield well can provide approximately 500,000 gallons per day.
Two 1.0 MGD yield wells can provide approximately 1,340,000 gallons per day.
Two wells, one 2.0 MGD and one 1.0 MGD well can provide approximately 2,010,000 gallons per day.

Will need to construct 2 wells. (2.01 MGD > 1.16 MGD)

Water - Daily Demands

Development	Units	Daily Demand (gallons/unit)	Average Demand (Gallons)
Concept C - HIGH			
Single Family	0	800	0
Mult-Family	2330	400	932,000
Commercial	11.32	3,000	33,960
Schools	12	4,000	48,000
Parks	25.18	4,000	100,720
Total			1,114,680

Reservoir Sizing:

1) Meet maximum daily consumption (1.5 x Average Day). Reservoir full at the beginning of the 24-hour period with no source input to the reservoir.

1.5 x 1,114,680 1,672,020 gallons

2) Meet maximum day rate plus fire flow for duration of fire. Reservoir 3/4 full at start of fire, with credit for incoming flow from pumps, one maximum size pump out of service.

Fire Flow (Worst Case is Schools) = 2000 gpm for 2 hours
240,000 gallons
Max Day Rate 139,335
Storage = 505,780 gallons

Condition 1 governs.

Existing 595' elevation reservoir has approximately 482,095 gallons capacity.

Will need to construct new 1.5 MG reservoir. (2.0 MG > 1.67 MG)

Wells:

Well Site No. 4 estimated yield = 2.0 MGD, Well Site No. 3 estimated yield = 1.0 MGD.
One 2.0 MGD yield well can provide approximately 1,000,000 gallons per day.
One 1.0 MGD yield well can provide approximately 500,000 gallons per day.
Two 1.0 MGD yield wells can provide approximately 1,340,000 gallons per day.
Two wells, one 2.0 MGD and one 1.0 MGD well can provide approximately 2,010,000 gallons per day.

Will need to construct 2 wells. (2.01 MGD > 1.11 MGD)

HHFDC Keahuolu Lands
Off-Site Water System Costs

OFF-SITE WATER SYSTEM

Item No.	Estimated Quantity	Description		Unit Price		Total
12-inch Water Line in Kealakaa Street						
1- 1	1,040	Cu. Yds., Unclassified Trench Excavation	$	130.00	$	135,200
1- 2	3,200	Lin. Ft., 12-inch Water Line	$	85.00	$	272,000
1- 3	330	Lin. Ft., 6-inch Water Line	$	60.00	$	19,800
1- 4	7,000	Lbs, Fittings	$	8.00	$	56,000
1- 5	30	Each, Concrete Reaction Blocks	$	500.00	$	15,000
1- 6	11	Fire Hydrant	$	4,000.00	$	44,000
1- 7	6	12" Butterfly Valve and Box	$	3,070.00	$	18,420
1- 8	11	6" Gate Valve and Box	$	1,800.00	$	19,800
1- 9	2	1" Air Relief Valve and Manhole	$	3,100.00	$	6,200
1- 10	2	Each, Connect to existing water line	$	3,000.00	$	6,000
1- 11	1	Lump Sum, Water line testing	$	10,000.00	$	10,000
1- 12	1	Lump Sum, Traffic Control	$	30,000.00	$	30,000
		Subtotal for 12-inch Water Line in Kealakaa Street			$	632,420
		Contingency (20%)			$	126,484
		Construction Total			$	758,904
		Design and Construction Services (15%)			$	113,836
		Total			$	872,740
		SAY			**$**	**873,000**
12-inch Water Line in Manawale'a Street						
2- 1	270	Cu. Yds., Unclassified Trench Excavation	$	130.00	$	35,100
2- 2	800	Lin. Ft., 12-inch Water Line	$	85.00	$	68,000
2- 3	100	Lin. Ft., 6-inch Water Line	$	60.00	$	6,000
2- 4	3,000	Lbs, Fittings	$	8.00	$	24,000
2- 5	12	Each, Concrete Reaction Blocks	$	500.00	$	6,000
2- 6	3	Fire Hydrant	$	4,000.00	$	12,000
2- 7	4	12" Butterfly Valve and Box	$	3,070.00	$	12,280
2- 8	3	6" Gate Valve and Box	$	1,800.00	$	5,400
2- 9	1	1" Air Relief Valve and Manhole	$	3,100.00	$	3,100
2- 10	2	Each, Connect to existing water line	$	3,000.00	$	6,000
2- 11	1	Lump Sum, Water line testing	$	10,000.00	$	10,000
2- 12	1	Lump Sum, Traffic Control	$	20,000.00	$	20,000
		Subtotal for 12-inch Water Line in Manawale'a Street			$	207,880
		Contingency (20%)			$	41,576
		Construction Total			$	249,456
		Design and Construction Services (15%)			$	37,418
		Total			$	286,874
		SAY			**$**	**287,000**

HHFDC Keahuolu Lands
Off-Site Water System Costs

Item No.	Estimated Quantity	Description		Unit Price		Total
12-inch Water Line in Ane Keohokalole Highway						
3- 1	910	Cu. Yds., Unclassified Trench Excavation	$	130.00	$	118,300
3- 2	2,820	Lin. Ft., 12-inch Water Line	$	85.00	$	239,700
3- 3	280	Lin. Ft., 6-inch Water Line	$	60.00	$	16,800
3- 4	7,000	Lbs, Fittings	$	8.00	$	56,000
3- 5	29	Each, Concrete Reaction Blocks	$	500.00	$	14,500
3- 6	10	Fire Hydrant	$	4,000.00	$	40,000
3- 7	7	12" Butterfly Valve and Box	$	3,070.00	$	21,490
3- 8	10	6" Gate Valve and Box	$	1,800.00	$	18,000
3- 9	2	2" Cleanout and Manhole	$	2,000.00	$	4,000
3- 10	3	1" Air Relief Valve and Manhole	$	3,100.00	$	9,300
3- 11	1	Each, Connect to existing water line	$	5,000.00	$	5,000
3- 12	1	Lump Sum, Water line testing	$	15,000.00	$	15,000
3- 13	1	Lump Sum, Traffic Control	$	20,000.00	$	20,000
		Subtotal for 12-inch Water Line in Ane Keohokalole Highway			$	578,090
		Contingency (20%)			$	115,618
		Construction Total			$	693,708
		Design and Construction Services (15%)			$	104,056
		Total			$	797,764
		SAY			**$**	**798,000**

HHFDC Keahuolu Lands
Off-Site Water System Costs

Item No.	Estimated Quantity	Description	Unit Price	Total
Wells				
4- 1	1	Well Site No. 4		
		Construction		
		Clearing, Grading and Access Road	$ 706,000.00	$ 706,000
		Well and Facilities	$ 607,000.00	$ 607,000
		2.0 MG Reservoir	$ 2,588,000.00	$ 2,588,000
		Reservoir Grading	$ 20,000.00	$ 20,000
		Reservoir Excavation	$ 1,376,000.00	$ 1,376,000
		Control Building	$ 656,000.00	$ 656,000
		Water Lines and Valve Stations		
		16" Water Line (1,330 LF)	$ 222,110.00	$ 222,110
		12" Water Line (550 LF)	$ 70,950.00	$ 70,950
		Valve Station	$ 66,000.00	$ 66,000
		Site Electrical	$ 146,000.00	$ 146,000
		Off-Site 16" Water Line (7,000 LF)	$ 1,726,200.00	$ 1,726,200
		Construction Subtotal		$ 8,184,260
		Contingency (20%)		$ 1,636,852
		Construction Total		$ 9,821,112
		Planning and Design (15%)		$ 1,474,000
		Total		$ 11,295,112
		SAY		**$ 11,296,000**
4- 2	1	Well Site No. 3		
		Construction		
		Clearing, Grading and Access Road	$ 700,000.00	$ 700,000
		Well and Facilities	$ 900,000.00	$ 900,000
		1.0 MG Reservoir	$ 2,070,000.00	$ 2,070,000
		Reservoir Grading	$ 8,000.00	$ 8,000
		Reservoir Excavation	$ 421,400.00	$ 421,400
		Control Building	$ 656,000.00	$ 656,000
		Water Lines and Valve Stations		
		16" Water Line (1,000 LF)	$ 167,000.00	$ 167,000
		12" Water Line (500 LF)	$ 64,500.00	$ 64,500
		Valve Station	$ 66,000.00	$ 66,000
		Site Electrical	$ 146,000.00	$ 146,000
		Construction Subtotal		$ 5,198,900
		Contingency (20%)		$ 1,039,780
		Construction Total		$ 6,238,680
		Planning and Design (15%)		$ 936,000
		Total		$ 7,174,680
		SAY		**$ 7,175,000**

Note: Cost for Well Site No. 3 does not include land acquisition cost for reservoir site.

HHFDC Keahuolu Lands
Off-Site Water System Costs

Item No.	Estimated Quantity	Description	Unit Price	Total
595' OF Elevation Reservoir on DHHL Keahuolu Property				
5- 1		1.0 MG Reservoir		
	1	Reservoir Construction	$ 2,070,000.00	$ 2,070,000
	39,000	Cu. Yds, Earthwork	$ 43.00	$ 1,677,000
	1.7	Acres, Grading	$ 8,000.00	$ 13,600
	100	Lin. Ft., Reservoir 16" Water Line	$ 167.00	$ 16,700
	2	Valve Stations	$ 66,000.00	$ 132,000
	1,770	Lin. Ft., Chain Link Fencing, PVC Coated	$ 40.00	$ 70,800
	5,500	Sq. Ft., AC Pavement	$ 8.00	$ 44,000
	14,400	Sq. Ft., Access Road Pavement	$ 8.00	$ 115,200
	22,000	Cu. Yds, Access Road Earthwork	$ 36.00	$ 792,000
	4	Acres, Access Road Grading	$ 8,000.00	$ 32,000
	2,400	Lin. Ft., Access Road 16" Water Line	$ 167.00	$ 400,800
		Subtotal		$ 5,364,100
		Contingency (20%)		$ 1,072,820
		Construction Total		$ 6,436,920
		Planning and Design (15%)		$ 966,000
		Total		$ 7,402,920
		SAY		**$ 7,403,000**
5- 2		1.5 MG Reservoir		
	1	Reservoir Construction	$ 2,300,000.00	$ 2,300,000
	50,000	Cu. Yds, Earthwork	$ 43.00	$ 2,150,000
	2.0	Acres, Grading	$ 8,000.00	$ 16,000
	100	Lin. Ft., Reservoir 16" Water Line	$ 167.00	$ 16,700
	2	Valve Stations	$ 66,000.00	$ 132,000
	1,770	Lin. Ft., Chain Link Fencing, PVC Coated	$ 40.00	$ 70,800
	6,200	Sq. Ft., AC Pavement	$ 8.00	$ 49,600
	14,400	Sq. Ft., Access Road Pavement	$ 8.00	$ 115,200
	22,000	Cu. Yds, Access Road Earthwork	$ 36.00	$ 792,000
	4	Acres, Access Road Grading	$ 8,000.00	$ 32,000
	2,400	Lin. Ft., Access Road 16" Water Line	$ 167.00	$ 400,800
		Subtotal		$ 6,075,100
		Contingency (20%)		$ 1,215,020
		Construction Total		$ 7,290,120
		Planning and Design (15%)		$ 1,094,000
		Total		$ 8,384,120
		SAY		**$ 8,385,000**

Notes: 1) Reservoir construction costs are based on estimates from DYK Inc. and adjusted (1.15) as a subcontractor to a general site contractor.

2) Reservoir construction costs do not include land acquisition from DHHL.