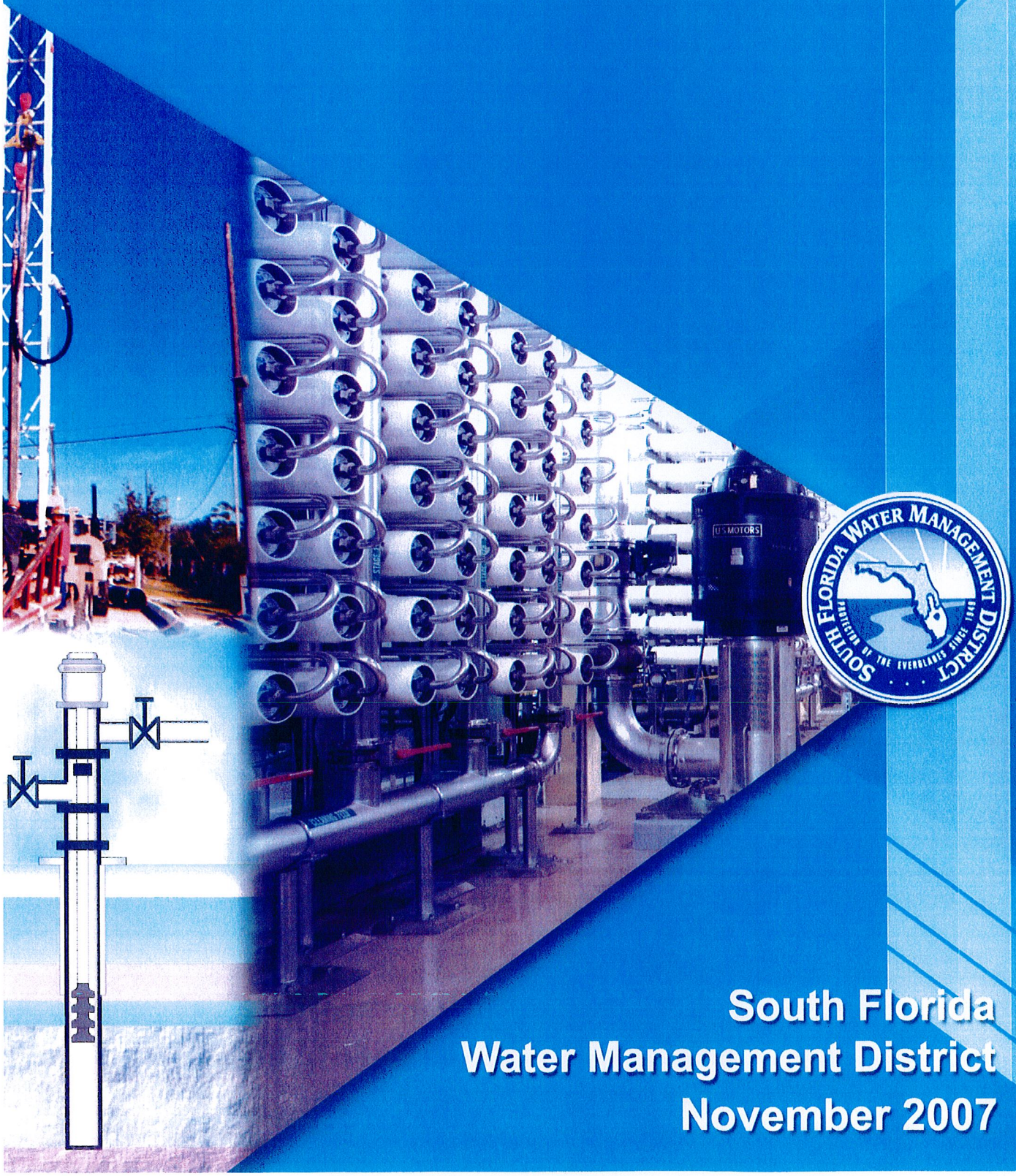
CDM

Water Supply Cost Estimation Study - Phase II Addendum



South Florida Water Management District

November 2007

Contents

Tables

Figures

Introduction

The South Florida Water Management District (SFWMD) develops long-term comprehensive regional water supply plans to provide for current and future water use, while protecting South Florida's water resources. Chapter 373, Florida Statutes (F.S.), requires the SFWMD to prepare water supply plans for regions where projected water demands have the potential to exceed the available supply over the next 20 years during a 10-year drought. The SFWMD has committed to preparing regional water supply plans for all of the basins within its jurisdiction and to updating these plans every five years. As part of this effort, it is necessary to estimate the costs of water supply alternatives. In addition, the SFWMD has an established on-going alternative water supply funding program. Current development costs of alternative water supply options are used to evaluate these proposals.

This report is an Addendum to the February 2007 Water Supply Cost Estimation Report prepared by Camp Dresser & McKee Inc. (CDM). This Addendum estimates the costs for various alternative water supply treatment technologies at lower flows than addressed in the Phase-I Report. Costs are estimated on the same basis as in the Phase-I Report, that is, in terms of capital, operation and maintenance (O&M), and total production costs on a unit cost basis expressed in dollars per 1,000 gallons. In this Addendum, treatment facilities with 1 and 3 mgd capacities were added to the treatment plant capacities of 5 mgd, 10 mgd, 15 mgd, and 20 mgd for selected treatment technologies. With respect to water treatment methods, these capacities refer to the maximum daily flows, whereas for wastewater treatment methods, the capacities represent annual average flows.

Section 1 of this Addendum provides cost estimates for additional capacities of 1 mgd and 3 mgd for the treatment technologies listed below. The cost estimate information is presented in the same manner as in the Phase-I Report. Figures are also presented showing construction costs and total production costs for these technologies. The tables presenting the costs for the following treatment technologies have been modified to include 1 mgd and 3 mgd:

- Nanofiltration;
- Brackish Water Reverse Osmosis (RO);
- Nanofiltration Process Addition;
- Ozone Disinfection; and
- UV Disinfection.

Section 2 estimates the costs for granular filters and chlorine disinfection using onsite generation (OSG) of hypochlorite. Chlorine disinfection is utilized here because of its continued use for wastewater disinfection and for the production of irrigation quality (IQ) water. The cost information is provided in the form of tables and cost curves

similar to those provided in the Phase-I Report for the following production plant capacities: 1, 3, 5, 10, 15, and 20 mgd.

Section 3 provides cost estimates for ballasted flocculation using the Actiflo process. Ballasted flocculation was not addressed in the Phase-I Report. The cost information is provided in the form of tables and cost curves similar to those provided in the Phase-I Report for other treatment technologies for the following plant capacities: 1, 3, 5, 10, 15, and 20 mgd.

Section 1
Estimation of Costs for Water Treatment Plant Capacities of 1 and 3 mgd

This Section of the Addendum provides cost estimates for additional capacities of 1 mgd and 3 mgd for the treatment technologies listed below:

- Nanofiltration;
- Brackish Water Reverse Osmosis (RO);
- Nanofiltration Process Addition;
- Ozone Disinfection; and
- UV Disinfection.

The cost estimate information is presented in the same manner as in the Phase-I Report. The following tables in the report have been modified and are included at the end of this Section:

- 5-3A Opinion of Probable Capital Cost: Nanofiltration.
- 5-3B Opinion of O&M Cost: Nanofiltration.
- 5-3C Opinion of Total Production Cost: Nanofiltration.

- 5-4A Opinion of Probable Capital Cost: Brackish Reverse Osmosis (RO).
- 5-4B Opinion of O&M Cost: Brackish RO.
- 5-4C Opinion of Total Production Cost: RO.

- 5-9A Opinion of Probable Capital Cost: Nanofiltration Process Addition.
- 5-9B Opinion of O&M Cost: Nanofiltration Process Addition.
- 5-9C Opinion of Total Production Cost: Nanofiltration Process Addition.

- 5-14A Opinion of Probable Capital Cost: Ozone Disinfection.

- 5-14B Opinion of O&M Cost: Ozone Disinfection.
- 5-14C Opinion of Total Production Cost: Ozone Disinfection.

- 5-15A Opinion of Probable Capital Cost: Ultraviolet (UV) Disinfection.
- 5-15B Opinion of O&M Cost: UV Disinfection.
- 5-15C Opinion of Total Production Cost: UV Disinfection.

The following graphs have been modified to add 1-mgd and 3-mgd treatment capacities and are included at the end of this Section:

- 5-4 Nanofiltration Construction Cost.
- 5-5 Nanofiltration Production Cost.

- 5-6 Brackish RO Construction Cost.
- 5-7 Brackish RO Production Cost.

- 5-12 Nanofiltration Process Addition Construction Cost.
- 5-13 Nanofiltration Process Addition Production Cost.

- 5-22 Ozone Disinfection Construction Cost.
- 5-23 Ozone Disinfection Production Cost.

- 5-24 UV Disinfection Construction Cost.
- 5-25 UV Disinfection Production Cost.

The assumptions for the development Opinions of Cost for the addition of 1-mgd and 3-mgd plant capacities are the same as those addressed in the Phase-I Report under Section 5.1 "Description of Opinions of Cost and Discussion of Assumptions."

The additional opinions of cost presented in the attached revised tables were prepared based on recently completed projects in that capacity range, with appropriate adjustments for consistency with the assumptions presented in the original study.

From a review of these tables, it is apparent that the capital cost per-gallon per-day of treatment capacity ($/gpd) increases sharply as the plant capacity decreases from 5 mgd to 1 mgd. This is largely due to the fixed capital cost of a deep injection well for concentrate disposal in this capacity range. For example, the opinion of cost for concentrate disposal for a 1-mgd, low pressure reverse osmosis (LPRO) water treatment plant is $5.5 million, which is the same cost as for concentrate disposal for a 20-mgd LPRO plant. This cost becomes a much larger component of the total project cost as the plant capacity decreases.

This trend is consistent with actual experience in the industry. For this reason, unless alternate, less costly means of concentrate disposal are available, many utilities consider these potable water membrane processes not to be cost-effective below the 3- to 5-mgd capacity range.

Another trend worth noting is that the labor component of the total operation and maintenance cost becomes much more significant as the plant capacity decreases from 5 mgd to 1 mgd. This is due to the fact that, due to typical process automation, while large plants can be operated with relatively few operators, smaller plants still must maintain a minimum level of staffing. For example, a 5-mgd plant can be operated with a staffing level very similar to that for a 1-mgd plant.

For the revised cost tables for UV and Ozone, CDM used the same approach as for the original tables, relying on EPA for UV and Ozone direct costs and standard percent mark-ups for design disciplines and overhead/profit (OH&P), consistent with the cost estimates in the Phase-I Report. At lower flows (less than 5 mgd) there are significant diseconomies of scale. This is because some of the major equipment costs do not decrease at lower flows (e.g., UV equipment), as presented in EPA cost tables. These estimates should be considered very conservative since an actual design project would rely on different vendor-supplied equipment suitable for smaller systems.

Insert tables and figures

Figure 5-12 Nanofiltration Process Addition Construction Cost

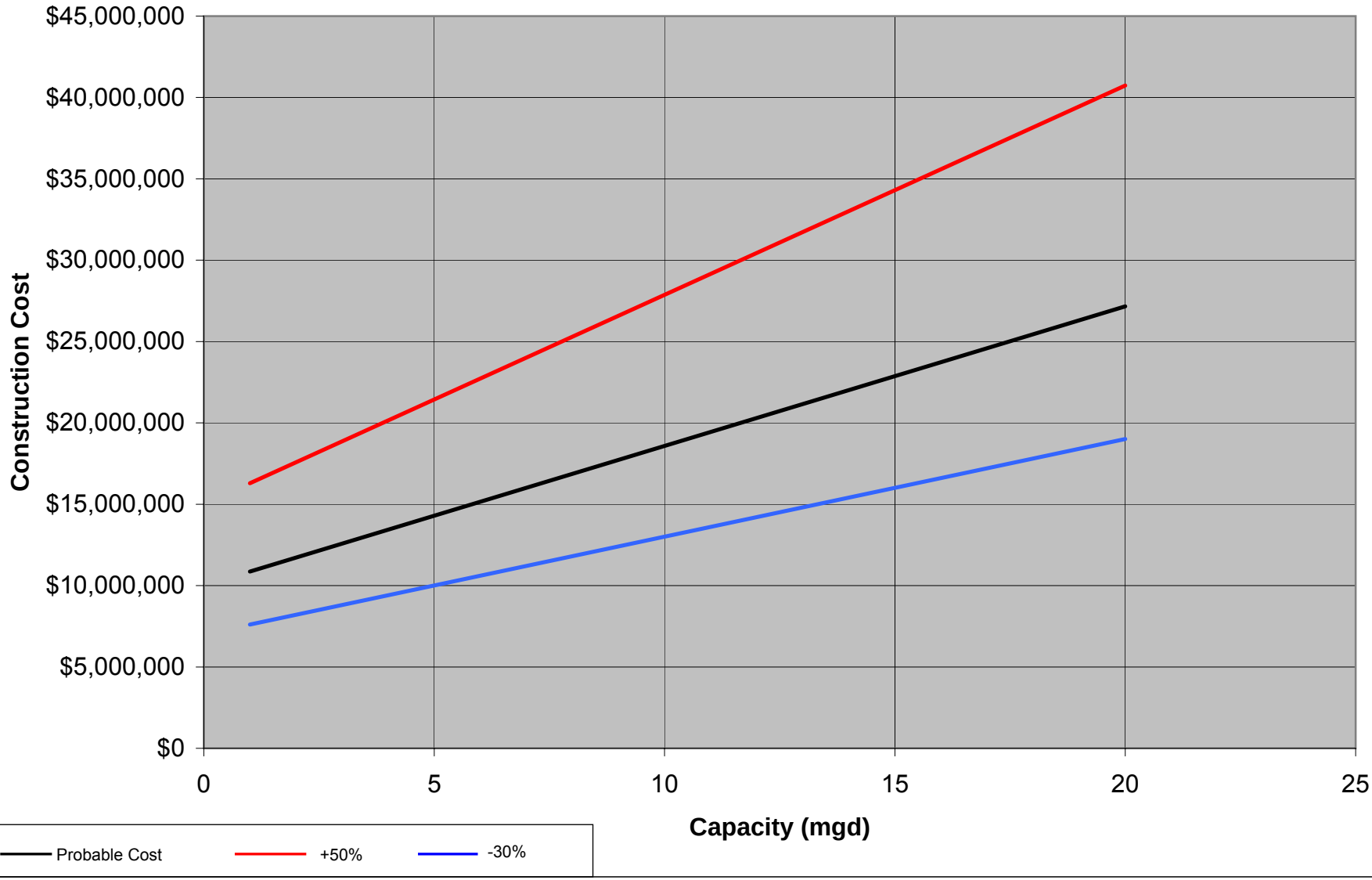


Figure 5-13 Nanofiltration Process Addition Production Cost

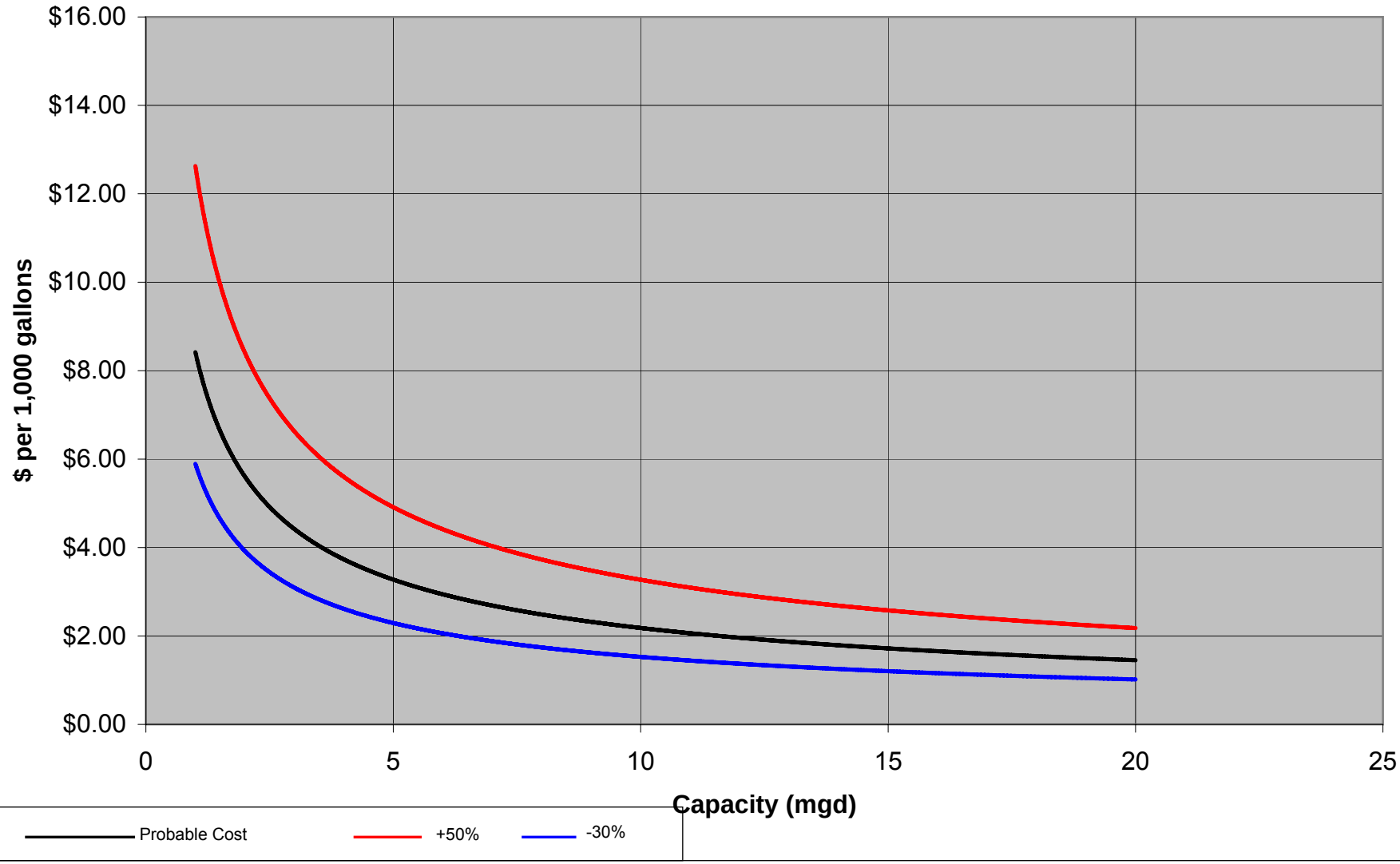


Figure 5-14 Brackish RO Process Addition Construction Cost

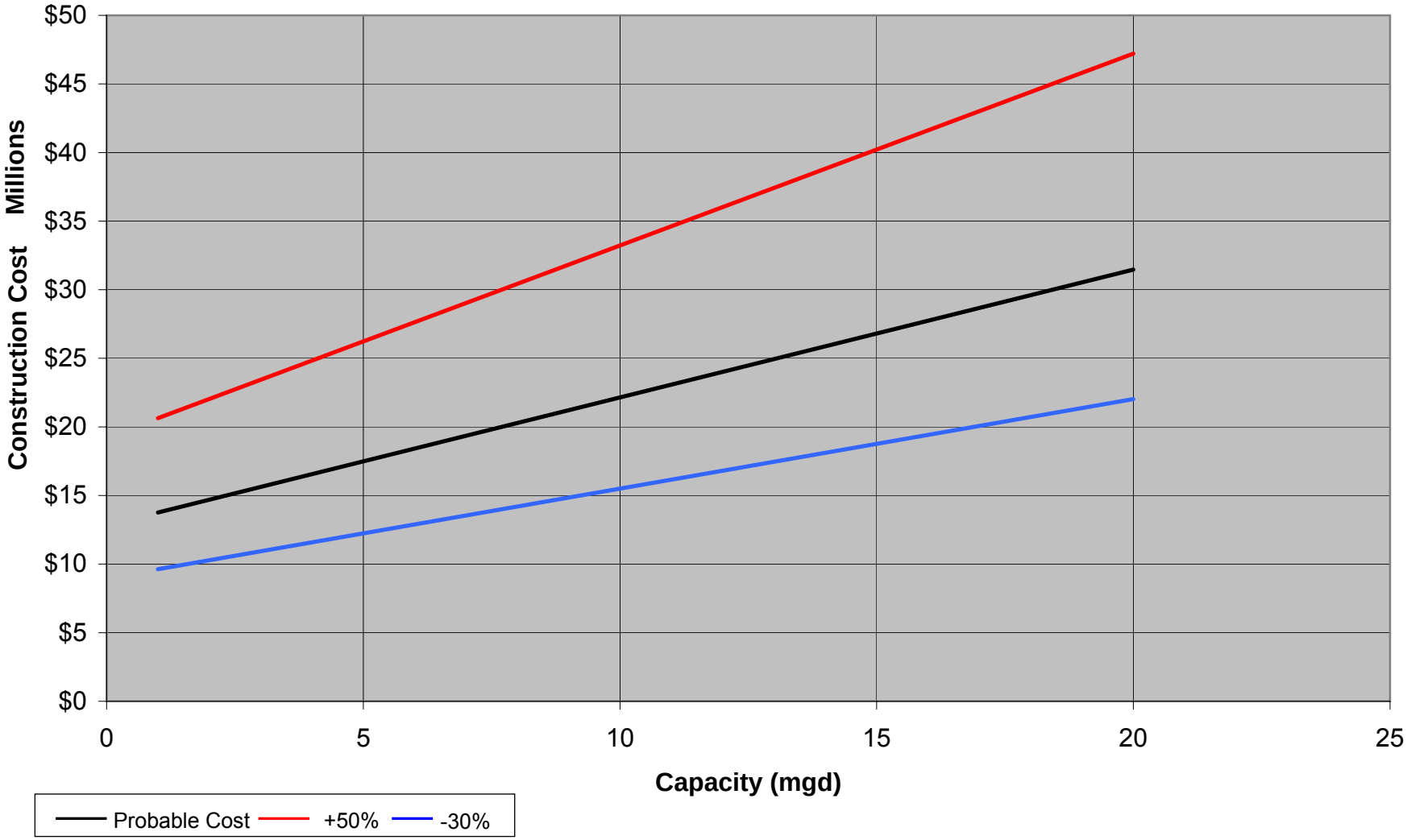


Figure 5-15 Brackish RO Process Addition Production Cost

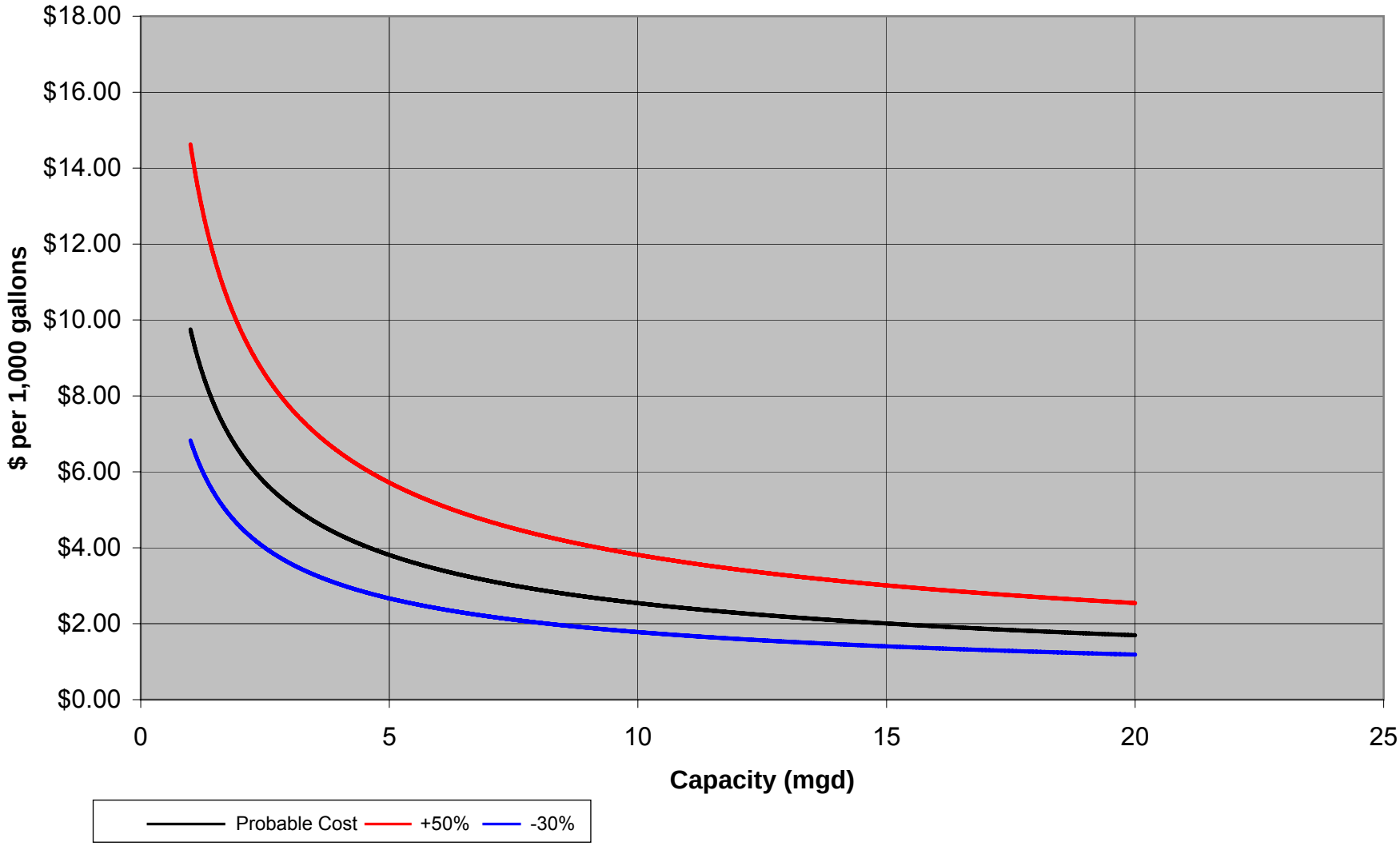


Figure 5-22 Ozone Disinfection Construction Cost

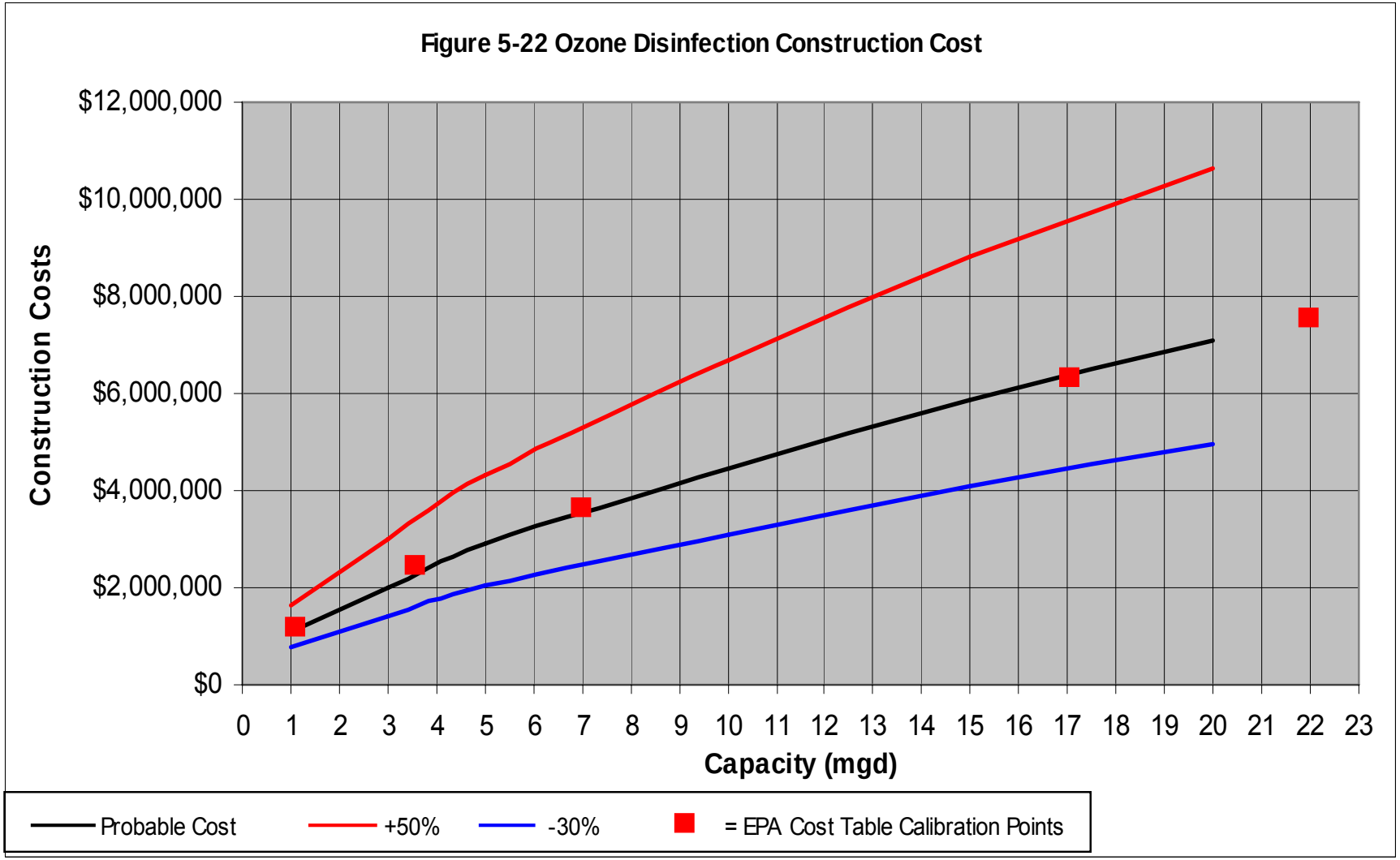


Figure 5-23 OzoneV Disinfection Production Cost

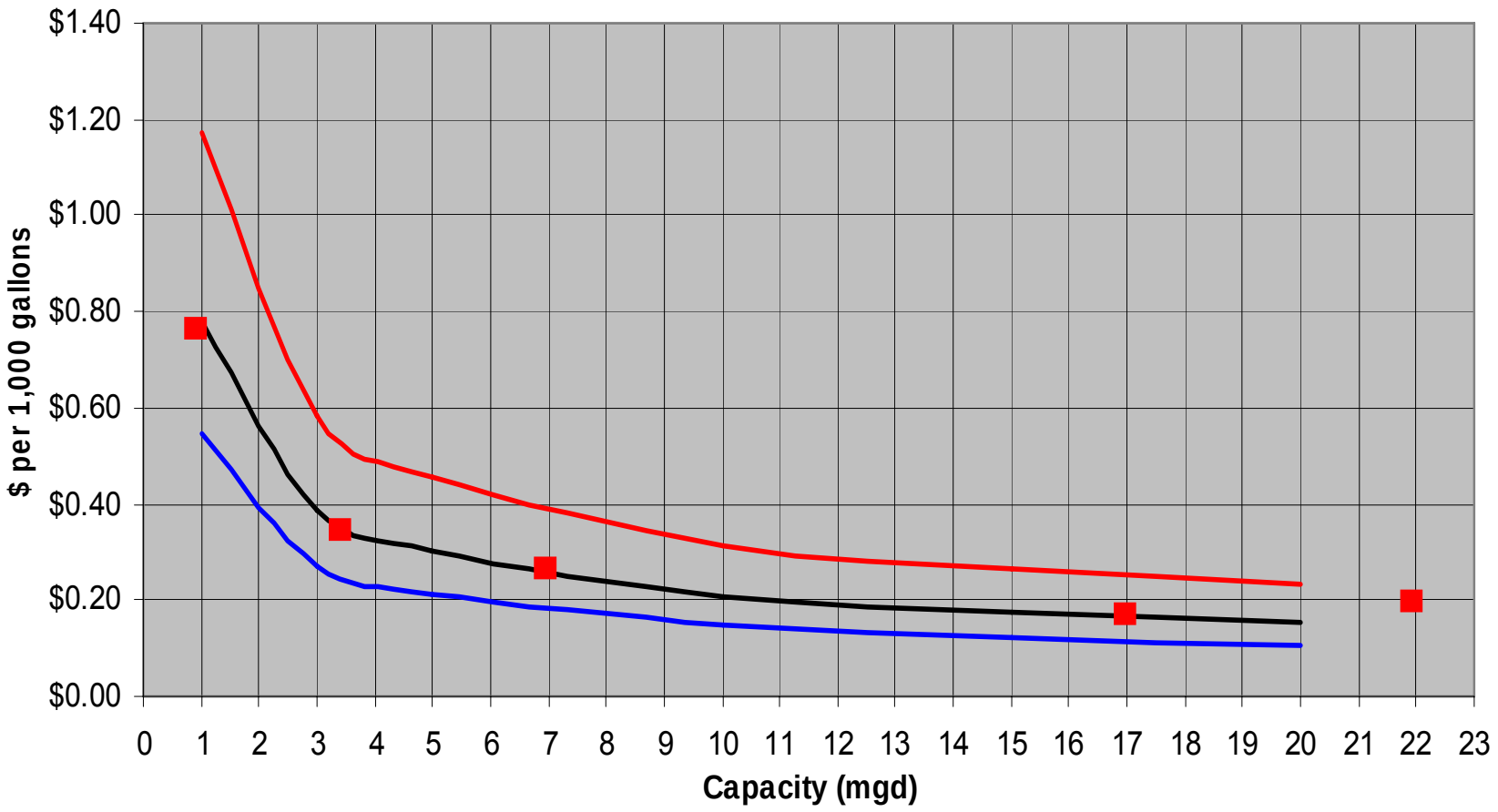


Figure 5-24 UV Disinfection Construction Cost

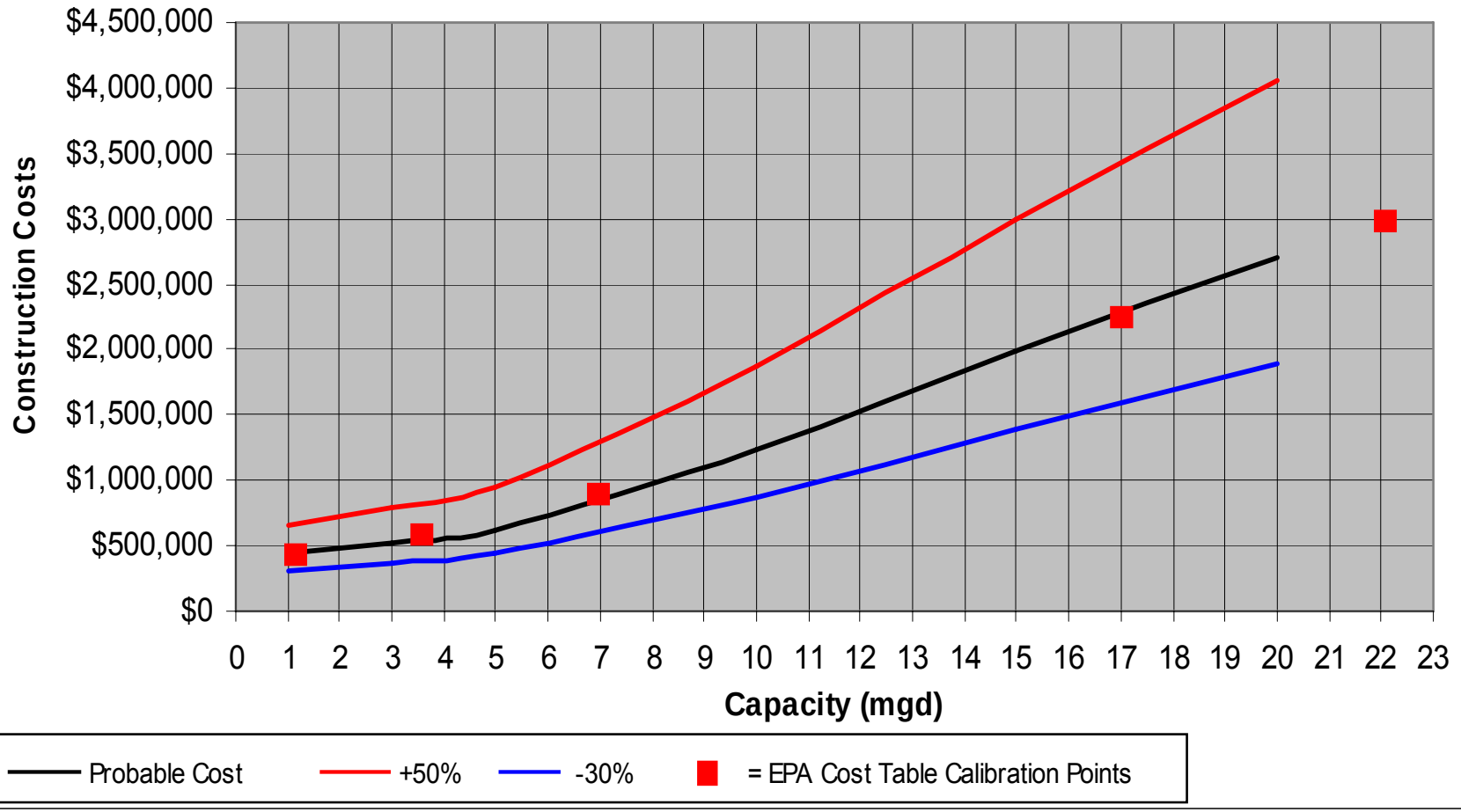


Figure 5-25 UV Disinfection Production Cost

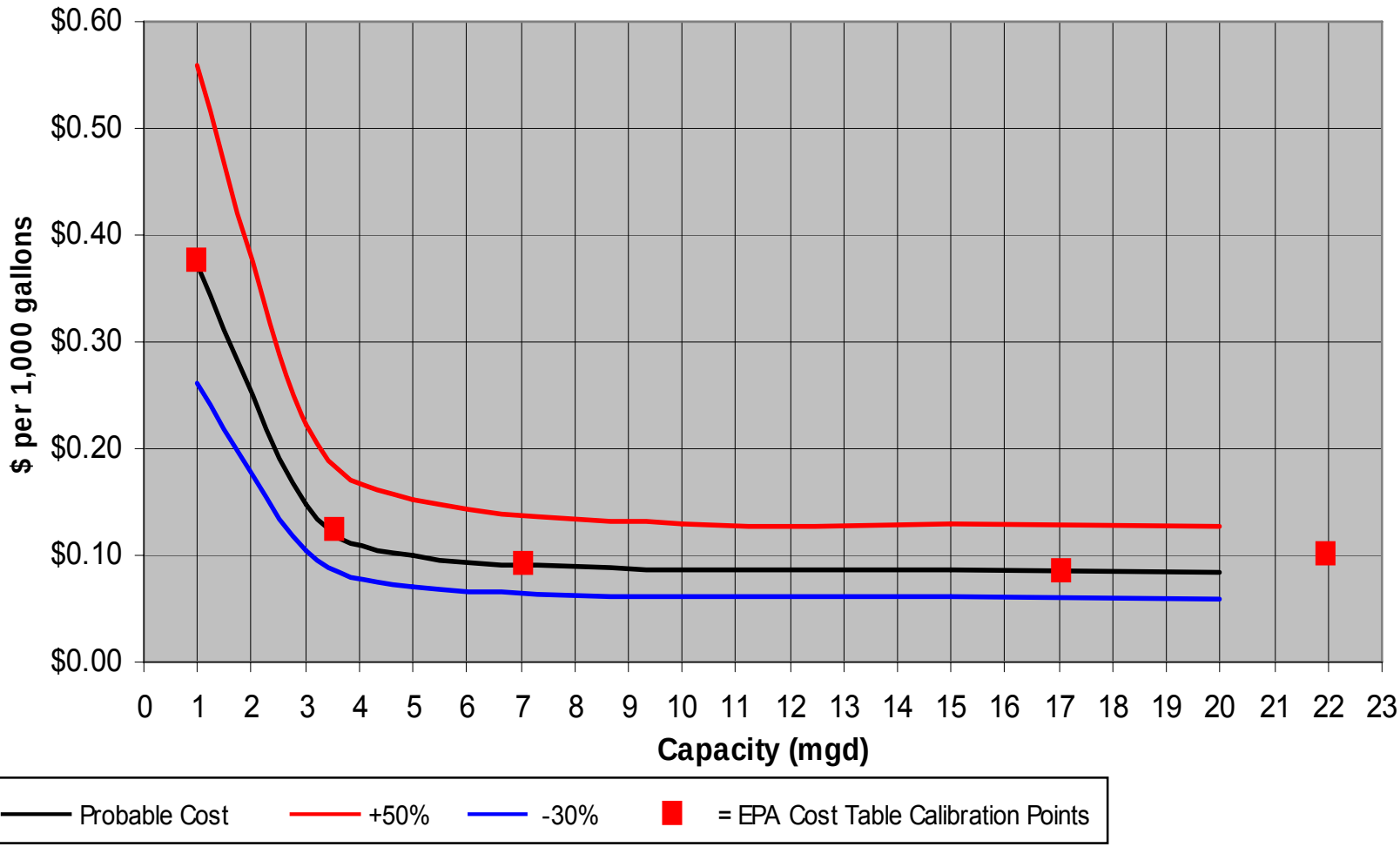


Figure 5-4 Nanofiltration Construction Cost

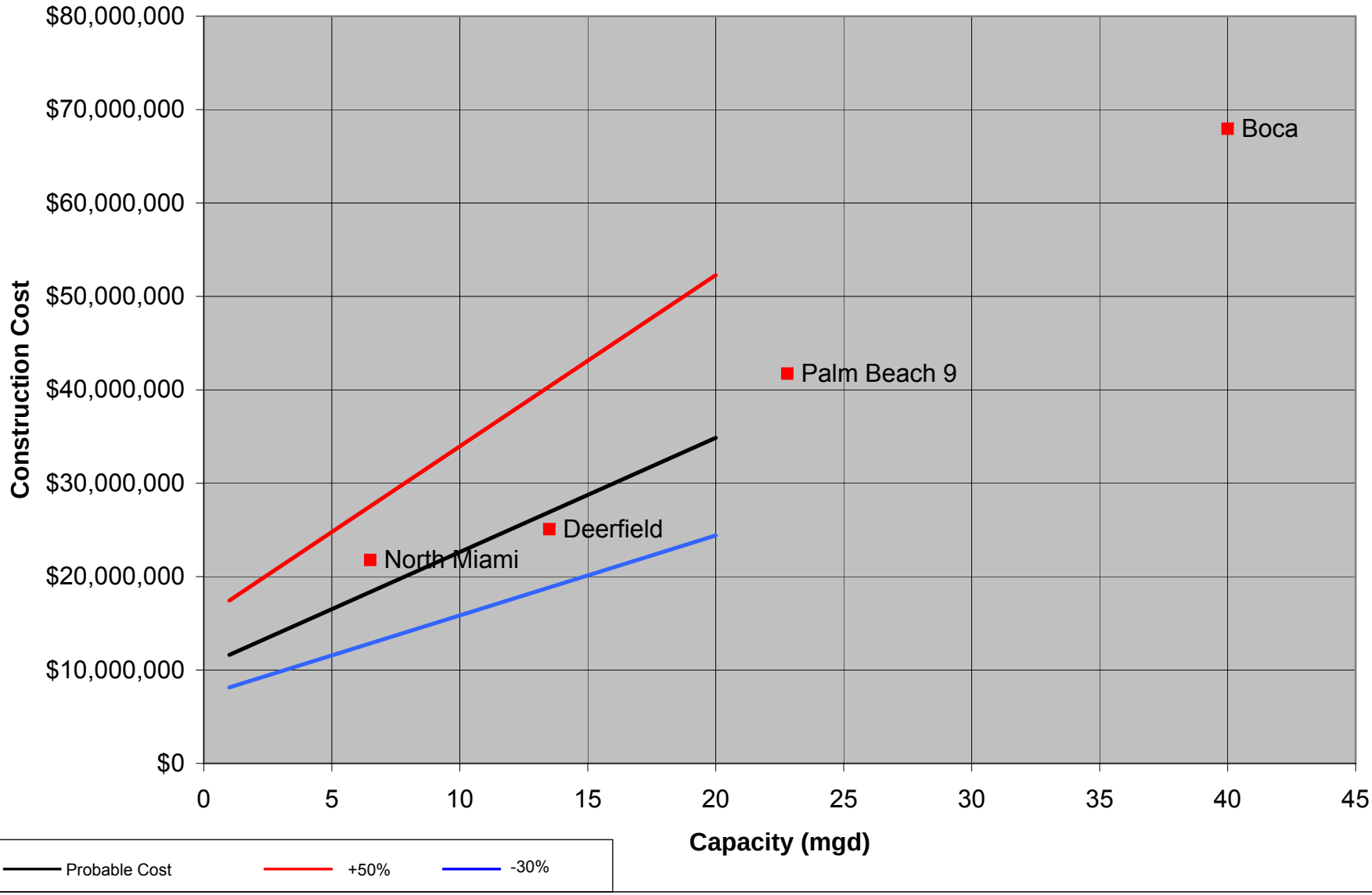


Figure 5-5 Nanofiltration Production Cost

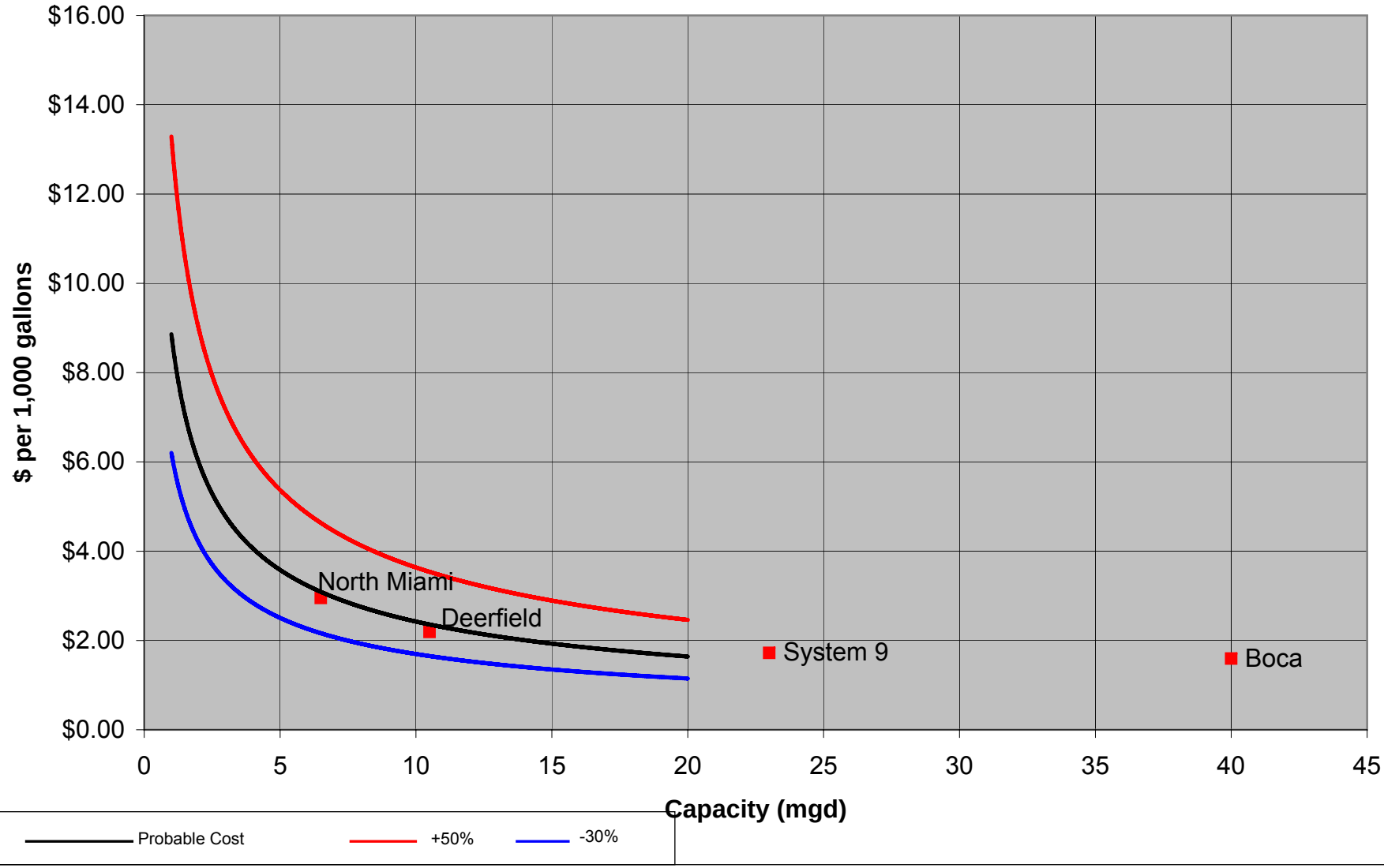


Figure 5-6 Brackish RO Construction Cost

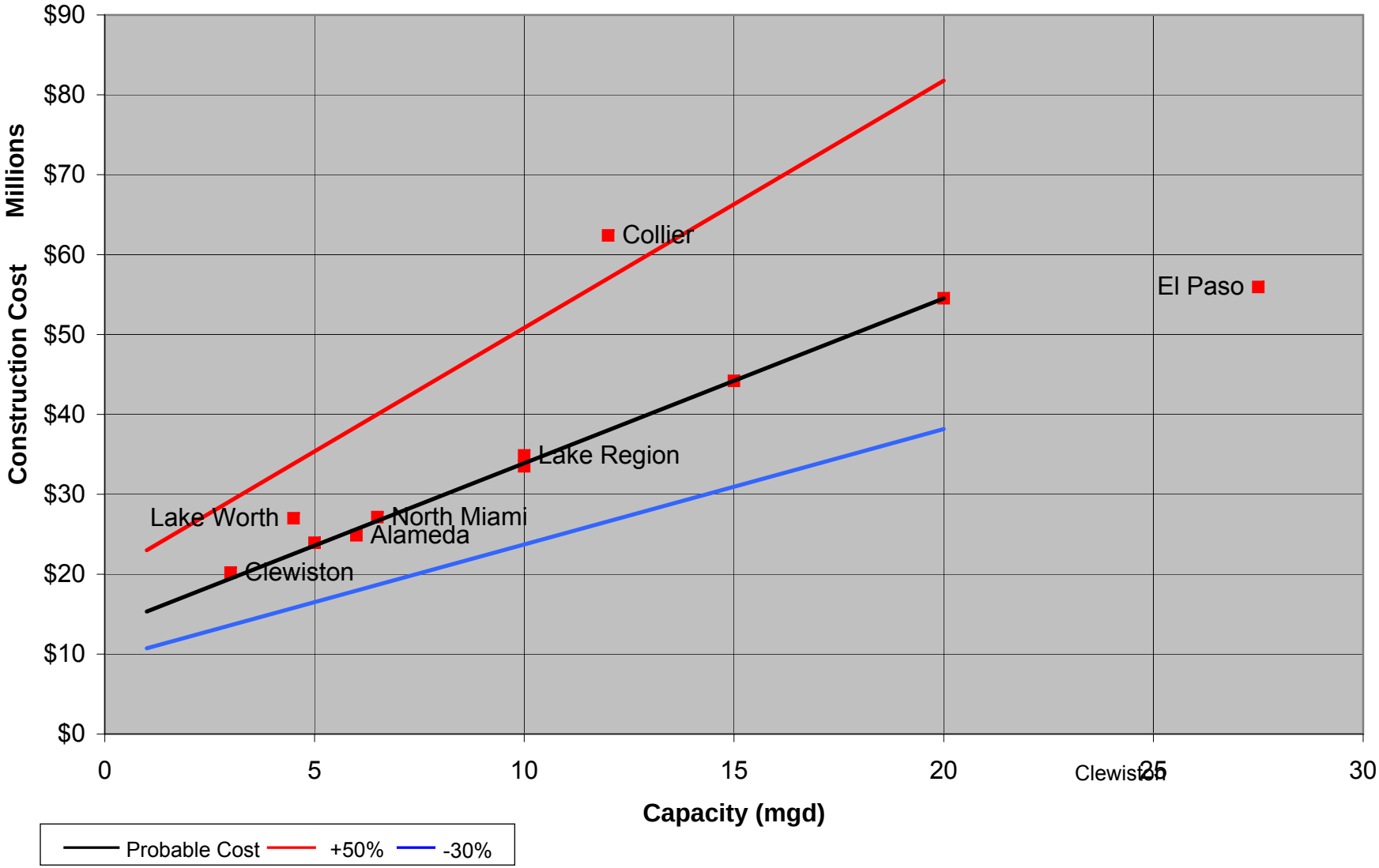


Figure 5-7 Brackish RO Production Cost

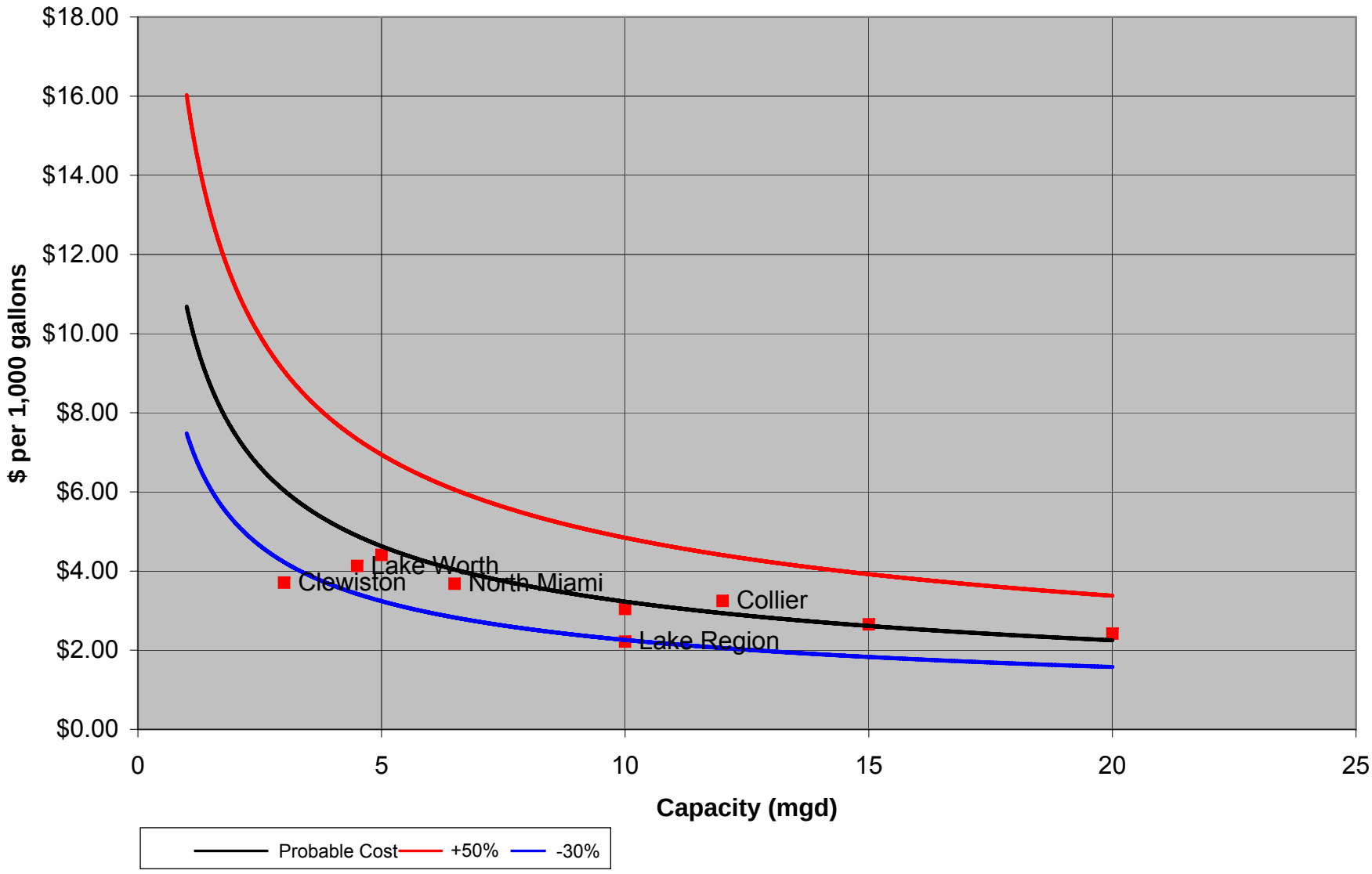


Table 5-3A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Raw water supply		$300,000	$900,000	$1,200,000	$2,400,000	$3,300,000	$4,500,000
2.	Pretreatment		$29,000	$59,000	$87,000	$146,000	$213,000	$268,000
3.	Process equipment		$574,000	$1,308,000	$1,919,000	$3,227,000	$4,396,000	$5,534,000
4.	Post treatment		$74,000	$153,000	$224,000	$377,000	$513,000	$646,000
5.	Intermediate storage (clearwell)		$45,000	$75,000	$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$46,000	$85,000	$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$660,000	$1,020,000	$1,371,000	$2,306,000	$3,142,000	$3,955,000
8.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$7,228,000	$9,100,000	$10,516,000	$14,324,000	$17,563,000	$21,051,000
9.	Yard piping	7%	$506,000	$637,000	$736,000	$1,003,000	$1,229,000	$1,474,000
10.	Electrical(1)	10%	$173,000	$360,000	$502,000	$882,000	$1,206,000	$1,555,000
11.	Instrumentation and controls(1)	7%	$121,000	$252,000	$351,000	$618,000	$844,000	$1,089,000
12.	Site work	5%	$361,000	$455,000	$526,000	$716,000	$878,000	$1,053,000
Subtotal:			$8,389,000	$10,804,000	$12,631,000	$17,543,000	$21,720,000	$26,222,000
13.	General Requirements	2%	$168,000	$216,000	$253,000	$351,000	$434,000	$524,000
14.	Contractor overhead and profit	15%	$1,258,000	$1,621,000	$1,895,000	$2,631,000	$3,258,000	$3,933,000
15.	Construction contingency	15%	$1,258,000	$1,621,000	$1,895,000	$2,631,000	$3,258,000	$3,933,000
Opinion of Probable Construction Cost:			**$11,073,000**	**$14,262,000**	**$16,674,000**	**$23,156,000**	**$28,670,000**	**$34,612,000**
16.	Technical Services	25%	$2,768,000	$3,566,000	$4,169,000	$5,789,000	$7,168,000	$8,653,000
17.	Owner administration and legal	5%	$554,000	$713,000	$834,000	$1,158,000	$1,434,000	$1,731,000
18.	Project contingency	15%	$1,661,000	$2,139,000	$2,501,000	$3,473,000	$4,301,000	$5,192,000
Opinion of Probable Capital Cost:			**$16,056,000**	**$20,680,000**	**$24,178,000**	**$33,576,000**	**$41,573,000**	**$50,188,000**
Opinion of Equivalent Annual Capital Cost:			**$1,515,573**	**$1,952,046**	**$2,282,232**	**$3,169,337**	**$3,924,197**	**$4,737,392**
Plant service life =		20 years						
Annual interest rate =		7%						
Unit Probable Construction Cost ($/gpd)			$11.07	$4.75	$3.33	$2.32	$1.91	$1.73
Unit Probable Total Capital Cost ($/gpd)			$16.06	$6.89	$4.84	$3.36	$2.77	$2.51

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

Table 5-3B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Variable Costs						
1.	Power	$144,000	$383,000	$477,000	$954,000	$1,431,000	$1,908,000
2.	Chemicals	$49,000	$148,000	$293,000	$492,000	$667,000	$828,000
3.	Replacement parts and materials	$153,000	$257,000	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$18,500	$55,000	$110,000	$185,000	$250,000	$311,000
	Fixed						
4.	Operation and maintenance labor	$283,000	$393,000	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$108,000	$186,000	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$756,000**	**$1,422,000**	**$2,083,000**	**$3,447,000**	**$4,682,000**	**$5,846,000**
	Unit Cost at Rated Capacity, $/kgal	$2.07	$1.30	$1.14	$0.94	$0.86	$0.80
	Annual Production at Avg Day Demand, (mgy)	243	730	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD	**$634,000**	**$1,141,000**	**$1,646,000**	**$2,836,000**	**$3,913,000**	**$4,992,000**
	Unit Cost at ADD, $/kgal	$2.61	$1.56	$1.35	$1.05	$0.93	$0.85

Table 5-3C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Nanofiltration
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Production Costs at Rated Capacity						
1.	Equivalent annual capital cost	$1,516,000	$1,952,000	$2,282,000	$3,169,000	$3,924,000	$4,737,000
2.	Annual O&M Cost - Variable	$364,500	$843,000	$1,312,000	$2,357,000	$3,332,000	$4,268,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$152,000	$195,000	$228,000	$317,000	$392,000	$474,000
	Total Annual Cost:	$2,424,000	$3,569,000	$4,593,000	$6,933,000	$8,998,000	$11,057,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$6.64**	**$3.26**	**$2.52**	**$1.90**	**$1.64**	**$1.51**
	Production Costs at Average Day Demand (ADD)						
	MDD/AADD factor(2):	1.50	1.50	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,516,000	$1,952,000	$2,282,000	$3,169,000	$3,924,000	$4,737,000
2.	Annual O&M Cost - Variable	$243,000	$562,000	$875,000	$1,746,000	$2,563,000	$3,414,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$152,000	$195,000	$228,000	$317,000	$392,000	$474,000
	Total Annual Cost:	$2,302,000	$3,288,000	$4,156,000	$6,322,000	$8,229,000	$10,203,000
	Annual finished water production rate (mgy)(3):	243	730	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$9.46**	**$4.50**	**$3.42**	**$2.34**	**$1.95**	**$1.75**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Table 5-4A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Raw water supply		$850,000	$2,550,000	$3,400,000	$6,800,000	$10,200,000	$13,600,000
2.	Pretreatment		$62,000	$102,000	$128,000	$175,000	$237,000	$293,000
3.	Process equipment		$1,076,000	$1,764,000	$2,219,000	$3,032,000	$4,109,000	$5,099,000
4.	Post treatment		$856,000	$1,403,000	$1,765,000	$2,411,000	$3,269,000	$4,056,000
5.	Intermediate storage (clearwell)		$45,000	$75,000	$110,000	$208,000	$305,000	$400,000
6.	Transfer pumping		$46,000	$85,000	$105,000	$160,000	$194,000	$248,000
7.	Plant infrastructure		$750,000	$1,230,000	$1,548,000	$2,114,000	$2,866,000	$3,556,000
8.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$9,185,000	$12,709,000	$14,775,000	$20,400,000	$26,680,000	$32,752,000
9.	Yard piping	7%	$643,000	$890,000	$1,034,000	$1,428,000	$1,868,000	$2,293,000
10.	Electrical(1)	10%	$369,000	$721,000	$928,000	$1,490,000	$2,118,000	$2,725,000
11.	Instrumentation and controls(1)	7%	$258,000	$505,000	$649,000	$1,043,000	$1,483,000	$1,908,000
12.	Site work	5%	$459,000	$635,000	$739,000	$1,020,000	$1,334,000	$1,638,000
Subtotal:			$10,914,000	$15,460,000	$18,125,000	$25,381,000	$33,483,000	$41,316,000
13.	General Requirements	2%	$218,000	$309,000	$363,000	$508,000	$670,000	$826,000
14.	Contractor overhead and profit	15%	$1,637,000	$2,319,000	$2,719,000	$3,807,000	$5,022,000	$6,197,000
15.	Construction contingency	15%	$1,637,000	$2,319,000	$2,719,000	$3,807,000	$5,022,000	$6,197,000
Opinion of Probable Construction Cost::			**$14,406,000**	**$20,407,000**	**$23,926,000**	**$33,503,000**	**$44,197,000**	**$54,536,000**
16.	Technical Services	25%	$3,602,000	$5,102,000	$5,982,000	$8,376,000	$11,049,000	$13,634,000
17.	Owner administration and legal	5%	$720,000	$1,020,000	$1,196,000	$1,675,000	$2,210,000	$2,727,000
18.	Project contingency	15%	$2,161,000	$3,061,000	$3,589,000	$5,025,000	$6,630,000	$8,180,000
Opinion of Probable Capital Cost:			**$20,889,000**	**$29,590,000**	**$34,693,000**	**$48,579,000**	**$64,086,000**	**$79,077,000**
Opinion of Equivalent Annual Capital Cost:			**$1,971,774**	**$2,793,087**	**$3,274,774**	**$4,585,514**	**$6,049,265**	**$7,464,309**
Plant service life =		20 years						
Annual interest rate =		7%						
Unit Probable Construction Cost ($/gpd)			$14.41	$6.80	$4.79	$3.35	$2.95	$2.73
Unit Probable Total Capital Cost ($/gpd)			$20.89	$9.86	$6.94	$4.86	$4.27	$3.95

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

Table 5-4B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Variable Costs						
1.	Power	$142,000	$426,000	$710,000	$1,420,000	$2,130,000	$2,839,000
2.	Chemicals	$49,000	$148,000	$246,000	$492,000	$738,000	$985,000
3.	Replacement parts and materials	$86,000	$259,000	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$18,000	$55,000	$92,000	$185,000	$277,000	$370,000
	Fixed						
4.	Operation and maintenance labor	$283,000	$393,000	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$108,000	$186,000	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$686,000**	**$1,467,000**	**$2,251,000**	**$3,913,000**	**$5,479,000**	**$6,993,000**
	Unit Cost at Rated Capacity, $/kgal	$1.88	$1.34	$1.23	$1.07	$1.00	$0.96
	Annual Production at Avg Day Demand, (mgy)	243	730	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD	**$588,000**	**$1,171,000**	**$1,758,000**	**$3,181,000**	**$4,526,000**	**$5,910,000**
	Unit Cost at ADD, $/kgal	$2.42	$1.60	$1.44	$1.18	$1.07	$1.01

Table 5-4C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Brackish Reverse Osmosis
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Production Costs at Rated Capacity						
1.	Equivalent annual capital cost	$1,972,000	$2,793,000	$3,275,000	$4,586,000	$6,049,000	$7,464,000
2.	Annual O&M Cost - Variable	$295,000	$888,000	$1,480,000	$2,823,000	$4,129,000	$5,415,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$197,000	$279,000	$328,000	$459,000	$605,000	$746,000
	Total Annual Cost:	$2,855,000	$4,539,000	$5,854,000	$8,958,000	$12,133,000	$15,203,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$7.82**	**$4.15**	**$3.21**	**$2.45**	**$2.22**	**$2.08**
	Production Costs at Average Day Demand (ADD)						
	MDD/AADD factor(2):	1.50	1.50	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,972,000	$2,793,000	$3,275,000	$4,586,000	$6,049,000	$7,464,000
2.	Annual O&M Cost - Variable	$197,000	$592,000	$987,000	$2,091,000	$3,176,000	$4,332,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$197,000	$279,000	$328,000	$459,000	$605,000	$746,000
	Total Annual Cost:	$2,757,000	$4,243,000	$5,361,000	$8,226,000	$11,180,000	$14,120,000
	Annual finished water production rate (mgy)(3):	243	730	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$11.33**	**$5.81**	**$4.41**	**$3.04**	**$2.65**	**$2.42**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Table 5-9A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Pretreatment		$29,000	$59,000	$87,000	$146,000	$213,000	$268,000
2.	Process equipment		$574,000	$1,308,000	$1,793,000	$3,015,000	$4,396,000	$5,534,000
3.	Post treatment		$74,000	$153,000	$209,000	$352,000	$513,000	$646,000
4.	Intermediate storage (clearwell)		$45,000	$75,000	$110,000	$208,000	$305,000	$400,000
5.	Transfer pumping		$46,000	$85,000	$105,000	$160,000	$194,000	$248,000
6.	Plant infrastructure		$660,000	$1,020,000	$1,371,000	$2,306,000	$3,142,000	$3,955,000
7.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$6,928,000	$8,200,000	$9,175,000	$11,687,000	$14,263,000	$16,551,000
8.	Yard piping	7%	$485,000	$574,000	$642,000	$818,000	$998,000	$1,159,000
9.	Electrical(1)	10%	$143,000	$270,000	$368,000	$619,000	$876,000	$1,105,000
10.	Instrumentation and controls(1)	7%	$100,000	$189,000	$257,000	$433,000	$613,000	$774,000
11.	Site work	5%	$346,000	$410,000	$459,000	$584,000	$713,000	$828,000
Subtotal:			$8,002,000	$9,643,000	$10,901,000	$14,141,000	$17,463,000	$20,417,000
12.	General Requirements	2%	$160,000	$193,000	$218,000	$283,000	$349,000	$408,000
13.	Contractor overhead and profit	15%	$1,200,000	$1,446,000	$1,635,000	$2,121,000	$2,619,000	$3,063,000
14.	Construction contingency	15%	$1,200,000	$1,446,000	$1,635,000	$2,121,000	$2,619,000	$3,063,000
Opinion of Probable Construction Cost:			**$10,562,000**	**$12,728,000**	**$14,389,000**	**$18,666,000**	**$23,050,000**	**$26,951,000**
15.	Technical Services	25%	$2,641,000	$3,182,000	$3,597,000	$4,667,000	$5,763,000	$6,738,000
16.	Owner administration and legal	5%	$528,000	$636,000	$719,000	$933,000	$1,153,000	$1,348,000
17.	Project contingency	15%	$1,584,000	$1,909,000	$2,158,000	$2,800,000	$3,458,000	$4,043,000
Opinion of Probable Capital Cost:			**$15,315,000**	**$18,455,000**	**$20,863,000**	**$27,066,000**	**$33,424,000**	**$39,080,000**
Opinion of Equivalent Annual Capital Cost:			**$1,445,628**	**$1,742,021**	**$1,969,320**	**$2,554,839**	**$3,154,989**	**$3,688,876**
Plant service life =		20 years						
Annual interest rate =		7%						
Unit Probable Construction Cost ($/gpd)			$10.56	$4.24	$2.88	$1.87	$1.54	$1.35
Unit Probable Total Capital Cost ($/gpd)			$15.32	$6.15	$4.17	$2.71	$2.23	$1.95

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

Table 5-9B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Variable Costs						
1.	Power	$116,000	$300,000	$477,000	$954,000	$1,431,000	$1,908,000
2.	Chemicals	$49,000	$148,000	$293,000	$492,000	$667,000	$828,000
3.	Replacement parts and materials	$153,000	$257,000	$432,000	$726,000	$984,000	$1,221,000
	a. Replacement membranes:	$18,500	$55,000	$110,000	$185,000	$250,000	$311,000
	Fixed						
4.	Operation and maintenance labor	$283,000	$393,000	$459,000	$565,000	$638,000	$695,000
5.	Administration/regulatory compliance	$108,000	$186,000	$312,000	$525,000	$712,000	$883,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$728,000**	**$1,339,000**	**$2,083,000**	**$3,447,000**	**$4,682,000**	**$5,846,000**
	Unit Cost at Rated Capacity, $/kgal	$1.99	$1.22	$1.14	$0.94	$0.86	$0.80
	Annual Production at Avg Day Demand, (mgy)	243	730	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD	**$615,000**	**$1,086,000**	**$1,646,000**	**$2,836,000**	**$3,913,000**	**$4,992,000**
	Unit Cost at ADD, $/kgal	$2.53	$1.49	$1.35	$1.05	$0.93	$0.85

Table 5-9C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Nanofiltration - Process Addition
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Production Costs at Rated Capacity						
1.	Equivalent annual capital cost	$1,446,000	$1,742,000	$1,969,000	$2,555,000	$3,155,000	$3,689,000
2.	Annual O&M Cost - Variable	$336,500	$760,000	$1,312,000	$2,357,000	$3,332,000	$4,268,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$145,000	$174,000	$197,000	$256,000	$316,000	$369,000
	Total Annual Cost:	$2,319,000	$3,255,000	$4,249,000	$6,258,000	$8,153,000	$9,904,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$6.35**	**$2.97**	**$2.33**	**$1.71**	**$1.49**	**$1.36**
	Production Costs at Average Day Demand (ADD)						
	MDD/AADD factor(2):	1.50	1.50	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,446,000	$1,742,000	$1,969,000	$2,555,000	$3,155,000	$3,689,000
2.	Annual O&M Cost - Variable	$224,000	$507,000	$875,000	$1,746,000	$2,563,000	$3,414,000
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$771,000	$1,090,000	$1,350,000	$1,578,000
4.	Annual R&R fund deposit(1):	$145,000	$174,000	$197,000	$256,000	$316,000	$369,000
	Total Annual Cost:	$2,206,000	$3,002,000	$3,812,000	$5,647,000	$7,384,000	$9,050,000
	Annual finished water production rate (mgy)(3):	243	730	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$9.07**	**$4.11**	**$3.13**	**$2.09**	**$1.75**	**$1.55**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Table 5-10A

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Pretreatment		$62,000	$102,000	$128,000	$175,000	$237,000	$293,000
2.	Process equipment		$1,076,000	$1,764,000	$2,219,000	$3,032,000	$4,109,000	$5,099,000
3.	Post treatment		$856,000	$1,403,000	$1,765,000	$2,411,000	$3,269,000	$4,056,000
4.	Intermediate storage (clearwell)		$45,000	$75,000	$110,000	$208,000	$305,000	$400,000
5.	Transfer pumping		$46,000	$85,000	$105,000	$160,000	$194,000	$248,000
6.	Plant infrastructure		$750,000	$1,230,000	$1,548,000	$2,114,000	$2,866,000	$3,556,000
7.	Concentrate disposal		$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000	$5,500,000
Subtotal:			$8,335,000	$10,159,000	$11,375,000	$13,600,000	$16,480,000	$19,152,000
8.	Yard piping	7%	$583,000	$711,000	$796,000	$952,000	$1,154,000	$1,341,000
9.	Electrical(1)	10%	$284,000	$466,000	$588,000	$810,000	$1,098,000	$1,365,000
10.	Instrumentation and controls(1)	7%	$198,000	$326,000	$411,000	$567,000	$769,000	$956,000
11.	Site work	5%	$417,000	$508,000	$569,000	$680,000	$824,000	$958,000
Subtotal:			$9,817,000	$12,170,000	$13,739,000	$16,609,000	$20,325,000	$23,772,000
12.	General Requirements	2%	$196,000	$243,000	$275,000	$332,000	$407,000	$475,000
13.	Contractor overhead and profit	15%	$1,473,000	$1,826,000	$2,061,000	$2,491,000	$3,049,000	$3,566,000
14.	Construction contingency	15%	$1,473,000	$1,826,000	$2,061,000	$2,491,000	$3,049,000	$3,566,000
Opinion of Probable Construction Cost::			**$12,959,000**	**$16,065,000**	**$18,136,000**	**$21,923,000**	**$26,830,000**	**$31,379,000**
15.	Technical Services	25%	$3,240,000	$4,016,000	$4,534,000	$5,481,000	$6,708,000	$7,845,000
16.	Owner administration and legal	5%	$648,000	$803,000	$907,000	$1,096,000	$1,342,000	$1,569,000
17.	Project contingency	15%	$1,944,000	$2,410,000	$2,720,000	$3,288,000	$4,025,000	$4,707,000
Opinion of Probable Capital Cost:			**$18,791,000**	**$23,294,000**	**$26,297,000**	**$31,788,000**	**$38,905,000**	**$45,500,000**
Opinion of Equivalent Annual Capital Cost:			**$1,773,737**	**$2,198,789**	**$2,482,251**	**$3,000,562**	**$3,672,357**	**$4,294,878**
Plant service life =		20 years						
Annual interest rate =		7%						
Unit Probable Construction Cost ($/gpd)			$12.96	$5.36	$3.63	$2.19	$1.79	$1.57
Unit Probable Total Capital Cost ($/gpd)			$18.79	$7.76	$5.26	$3.18	$2.59	$2.28

Notes:

(1) "Electrical" and "Instrumentation and controls" cost items are estimated as 10% and 7%, respectively, of the subtotal of the preceding cost components minus the cost for concentrate disposal. This is due to the fact that a concentrate disposal deep injection well (DIW) has negligible electrical and instrumentation and controls costs relative to other plant components, while the construction cost for a DIW is typically a substantial portion of the total facility cost.

Table 5-10B

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Variable Costs						
1.	Power	$121,000	$362,000	$709,848	$1,419,695	$2,129,543	$2,839,390
2.	Chemicals	$49,000	$148,000	$246,161	$492,322	$738,483	$984,644
3.	Replacement parts and materials	$86,000	$259,000	$431,550	$725,778	$983,721	$1,220,608
	a. Replacement membranes:	$18,000	$55,000	$92,400	$184,800	$277,200	$369,600
	Fixed						
4.	Operation and maintenance labor	$283,000	$393,000	$458,544	$564,534	$637,554	$695,022
5.	Administration/regulatory compliance	$108,000	$186,000	$312,167	$525,000	$711,587	$882,941
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$665,000**	**$1,403,000**	**$2,251,000**	**$3,912,000**	**$5,478,000**	**$6,992,000**
	Unit Cost at Rated Capacity, $/kgal	$1.82	$1.28	$1.23	$1.07	$1.00	$0.96
	Annual Production at Avg Day Demand, (mgy)	243	730	1,217	2,704	4,212	5,840
	Annual O&M Cost at ADD	**$574,000**	**$1,128,000**	**$1,757,000**	**$3,180,000**	**$4,525,000**	**$5,909,000**
	Unit Cost at ADD, $/kgal	$2.36	$1.55	$1.44	$1.18	$1.07	$1.01

Table 5-10C

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology : Brackish Reverse Osmosis Process Addition
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Production Costs at Rated Capacity						
1.	Equivalent annual capital cost	$1,773,737	$2,198,789	$2,482,251	$3,000,562	$3,672,357	$4,294,878
2.	Annual O&M Cost - Variable	$274,000	$824,000	$1,479,959	$2,822,595	$4,128,947	$5,414,242
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$770,711	$1,089,534	$1,349,141	$1,577,964
4.	Annual R&R fund deposit(1):	$177,000	$220,000	$248,000	$300,000	$367,000	$429,000
	Total Annual Cost:	$2,616,000	$3,822,000	$4,981,000	$7,213,000	$9,517,000	$11,716,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual Production Cost at Rated Cap. ($/kgal):	**$7.17**	**$3.49**	**$2.73**	**$1.98**	**$1.74**	**$1.60**
	Production Costs at Average Day Demand (ADD)						
	MDD/AADD factor(2):	1.50	1.50	1.50	1.35	1.30	1.25
1.	Equivalent annual capital cost	$1,773,737	$2,198,789	$2,482,251	$3,000,562	$3,672,357	$4,294,878
2.	Annual O&M Cost - Variable	$183,000	$549,000	$986,639	$2,090,811	$3,176,113	$4,331,393
3.	Annual O&M Cost - Fixed	$391,000	$579,000	$770,711	$1,089,534	$1,349,141	$1,577,964
4.	Annual R&R fund deposit(1):	$177,000	$220,000	$248,000	$300,000	$367,000	$429,000
	Total Annual Cost:	$2,525,000	$3,547,000	$4,488,000	$6,481,000	$8,565,000	$10,633,000
	Annual finished water production rate (mgy)(3):	243	730	1,217	2,704	4,212	5,840
	Annual Production Cost at ADD ($/kgal):	**$10.38**	**$4.86**	**$3.69**	**$2.40**	**$2.03**	**$1.82**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Maximum day demand (MDD, equal to the plant capacity rating) divided by the annual average daily demand (AADD). This factor is used to calculate the AADD to be used in the calculation of the annual production cost.
(3) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Table 5-14A
South Florida Management District Water Supply Cost Estimation Study
Opinion of Probable Capital Cost
Treatment Technology: Ozone Disinfection
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd)					
			1	3	5	10	15	20
1	Ozone Generation System		178,000	298,000	418,000	586,000	731,000	843,000
2	Ozone Contactor		93000	188000	283,000	452,000	603,000	741,000
3	OffGas Destruction		26000	43000	61,000	87,000	108,000	124,000
4	Stainless Steel Piping, Valves and Ductwork		75000	133000	192,000	285,000	365,000	433,000
5	LOX Storage Pad		0	2000	3,000	5,000	7,000	9,000
6	Ozone Generator Building		17000	50000	83,000	184,000	296,000	400,000
	Subtotal:		389,000	714,000	1,040,000	1,599,000	2,110,000	2,550,000
10	Yard Piping	8%	31,000	57,000	83,000	128,000	169,000	204,000
11	Mechanical	10%	-2	-1	0	0	0	0
12	Electrical	14%	54,000	100,000	146,000	224,000	295,000	357,000
13	Instrumentation and Controls	8%	31,000	57,000	83,000	128,000	169,000	204,000
14	Site Work	8%	31,000	57,000	83,000	128,000	169,000	204,000
	Subtotal:		535,998	984,999	1,435,000	2,207,000	2,912,000	3,519,000
15	General Requirements	9%	48,000	89,000	129,000	199,000	262,000	317,000
16	Contractor Overhead and Profit	15%	80,000	148,000	215,000	331,000	437,000	528,000
17	Construction Contingency	15%	80,000	148,000	215,000	331,000	437,000	528,000
	Opinion of Probable Construction Cost:		743,998	1,369,999	1,994,000	3,068,000	4,048,000	4,892,000
18	Technical Services	25%	186,000	342,000	499,000	767,000	1,012,000	1,223,000
19	Owner Adminstration and Legal	5%	37,000	68,000	100,000	153,000	202,000	245,000
20	Project Contingency	15%	112,000	205,000	299,000	460,000	607,000	734,000
	Opinion of Probable Capital Cost:		1,078,998	1,984,999	2,892,000	4,448,000	5,869,000	7,094,000
	Opinion of Equivalent Annual Capital Cost		$102,000	$187,000	$273,000	$420,000	$554,000	$670,000
	Plant Service Life=	20		years				
	Annual Interest Rate=	7%						

Table 5-14B
South Florida Management District Water Supply Cost Estimation Study
Opinion of Annual Operation and Maintenance Cost
Treatment Technology: Ozone Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd)					
		1	3	5	10	15	20
1	Liquid Oxygen	$2,000	$6,100	$10,100	$22,500	$35,100	$48,700
2	Electricity	$2,600	$7,900	$13,200	$29,300	$45,700	$63,300
3	Operation and Maintenance Labor	$37,400	$37,400	$37,400	$37,400	$37,400	$37,400
4	Replacement Parts and Materials	$8,800	$8,800	$8,800	$12,400	$15,500	$17,900
	Opinion of Annual O&M Cost:	50,800	60,200	69,500	101,600	133,700	167,300

Table 5-14C
South Florida Management District Water Supply Cost Estimation Study
Opinion of Total Production Cost
Treatment Technology: Ozone Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd)					
		1	3	5	10	15	20
1	Equivalent Annual Capital Cost	$102,000	$187,000	$273,000	$420,000	$554,000	$670,000
2	Annual Operation and Maintenance Cost	$50,800	$60,200	$69,500	$101,600	$133,700	$167,300
3	Annual R&R Fund Deposit	$10,200	$18,700	$27,300	$42,000	$55,400	$67,000
	Total Annual Cost:	$163,000	$265,900	$369,800	$563,600	$743,100	$904,300
	MDD/AADD Factor (2):	1.75	1.60	1.50	1.35	1.30	1.25
	Annual Finished Water Production Rate (mgy)(3):	209	684	1,217	2,704	4,212	5,840
	Annual Production Cost ($k/gal):	$0.78	$0.39	$0.30	$0.21	$0.18	$0.15

Table 5-15A
South Florida Management District Water Supply Cost Estimation Study
Opinion of Probable Capital Cost
Treatment Technology: UV Disinfection
August 2006 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd)					
			1	3	5	10	15	20
1	UV Equipment		177,000	176,000	214,000	423,000	686,000	949,000
2	UV Building		28,000	28,000	28,000	64,000	124,000	164,000
3	Pipes and Valves		24,000	54,000	84,000	161,000	231,000	294,000
	Subtotal:		229,000	258,000	326,000	648,000	1,041,000	1,407,000
4	Yard Piping	8%	18,000	21,000	26,000	52,000	83,000	113,000
5	Mechanical	10%	-2	-1	0	0	0	0
6	Electrical	14%	32,000	36,000	46,000	91,000	146,000	197,000
7	Instrumentation and Controls	8%	18,000	21,000	26,000	52,000	83,000	113,000
8	Site Work	8%	18,000	21,000	26,000	52,000	83,000	113,000
	Subtotal:		314,998	356,999	450,000	895,000	1,436,000	1,943,000
9	General Requirements	9%	28,000	32,000	41,000	81,000	129,000	175,000
10	Contractor Overhead and Profit	15%	47,000	54,000	68,000	134,000	215,000	291,000
11	Construction Contingency	15%	47,000	54,000	68,000	134,000	215,000	291,000
	Opinion of Probable Construction Cost:		436,998	496,999	627,000	1,244,000	1,995,000	2,700,000
12	Technical Services	25%	109,000	124,000	157,000	311,000	499,000	675,000
13	Owner Administration and Legal	5%	22,000	25,000	31,000	62,000	100,000	135,000
14	Project Contingency	15%	66,000	75,000	94,000	187,000	299,000	405,000
	Opinion of Probable Capital Cost:		633,998	720,999	909,000	1,804,000	2,893,000	3,915,000
	Opinion of Equivalent Annual Capital Cost		$60,000	$68,000	$86,000	$170,000	$273,000	$370,000

Plant Service Life= 20 years
Annual Interest Rate= 7%

Table 5-15B
South Florida Management District Water Supply Cost Estimation Study
Opinion of Annual Operation and Maintenance Cost
Treatment Technology: UV Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd)					
		1	3	5	10	15	20
1	Electricity	$2,400	$7,300	$12,200	$27,000	$42,100	$58,400
2	Replacement Parts and Materials (lamps, sleeves, ballasts, sensors	$7,800	$10,500	$11,400	$12,200	$13,000	$14,800
3	Operation and Maintenance Labor	$1,600	$3,400	$4,600	$7,500	$10,300	$13,100
	Opinion of Annual O&M Cost:	11,800	21,200	28,200	46,700	65,400	86,300

Table 5-15C
South Florida Management District Water Supply Cost Estimation Study
Opinion of Total Production Cost
Treatment Technology: UV Disinfection
August 2006 Dollars

Item No.	Description	Plant Capacity (mgd)					
		1	3	5	10	15	20
1	Equivalent Annual Capital Cost	$60,000	$68,000	$86,000	$170,000	$273,000	$370,000
2	Annual Operation and Maintenance Cost	$11,800	$21,200	$28,200	$46,700	$65,400	$86,300
3	Annual R&R Fund Deposit	$6,000	$6,800	$8,600	$17,000	$27,300	$37,000
	Total Annual Cost:	$77,800	$96,000	$122,800	$233,700	$365,700	$493,300
	MDD/AADD Factor (2):	1.75	1.60	1.50	1.35	1.30	1.25
	Annual Finished Water Production Rate (mgy)(3):	209	684	1,217	2,704	4,212	5,840
	Annual Production Cost ($k/gal):	$0.37	$0.14	$0.10	$0.09	$0.09	$0.08

Section 2
Estimation of Costs for Granular Filters and Chlorine Disinfection

This Section of the Addendum estimates costs for granular filters and chlorine disinfection using onsite generation (OSG) of hypochlorite. These costs were developed by taking the costs for granular media filters in the Phase-I Report and adding the cost of OSG of hypochlorite. To achieve these costs, the onsite generation sodium hypochlorite disinfection system costs (Table 5-13) were combined with the costs of granular media filtration components (Table 6-12) and opinions of cost for 1-mgd and 3-mgd capacity increments were added. The cost information is provided in the form of tables and cost curves similar to those provided in the Phase-I Report for the following production plant capacities: 1, 3, 5, 10, 15, and 20 mgd. The tables and figures are as follows and are included at the end of this Section:

- 6-15 Opinion of Probable Capital Cost: Granular Media Filters & OSG Hypochlorite Disinfection.
- 6-16 Opinion of Annual O&M Cost: Granular Media Filters & OSG Hypochlorite Disinfection.
- 6-17 Opinion of Total Production Cost: Granular Media Filters & OSG Hypochlorite Disinfection.

- 6-14 Granular Media Filters & OSG Hypochlorite Disinfection Construction Cost.
- 6-15 Granular Media Filters & OSG Hypochlorite Disinfection Production Cost.

Insert tables and figures

Figure 6-14 GMF/OSG Hypochlorite Disinfection Construction Cost

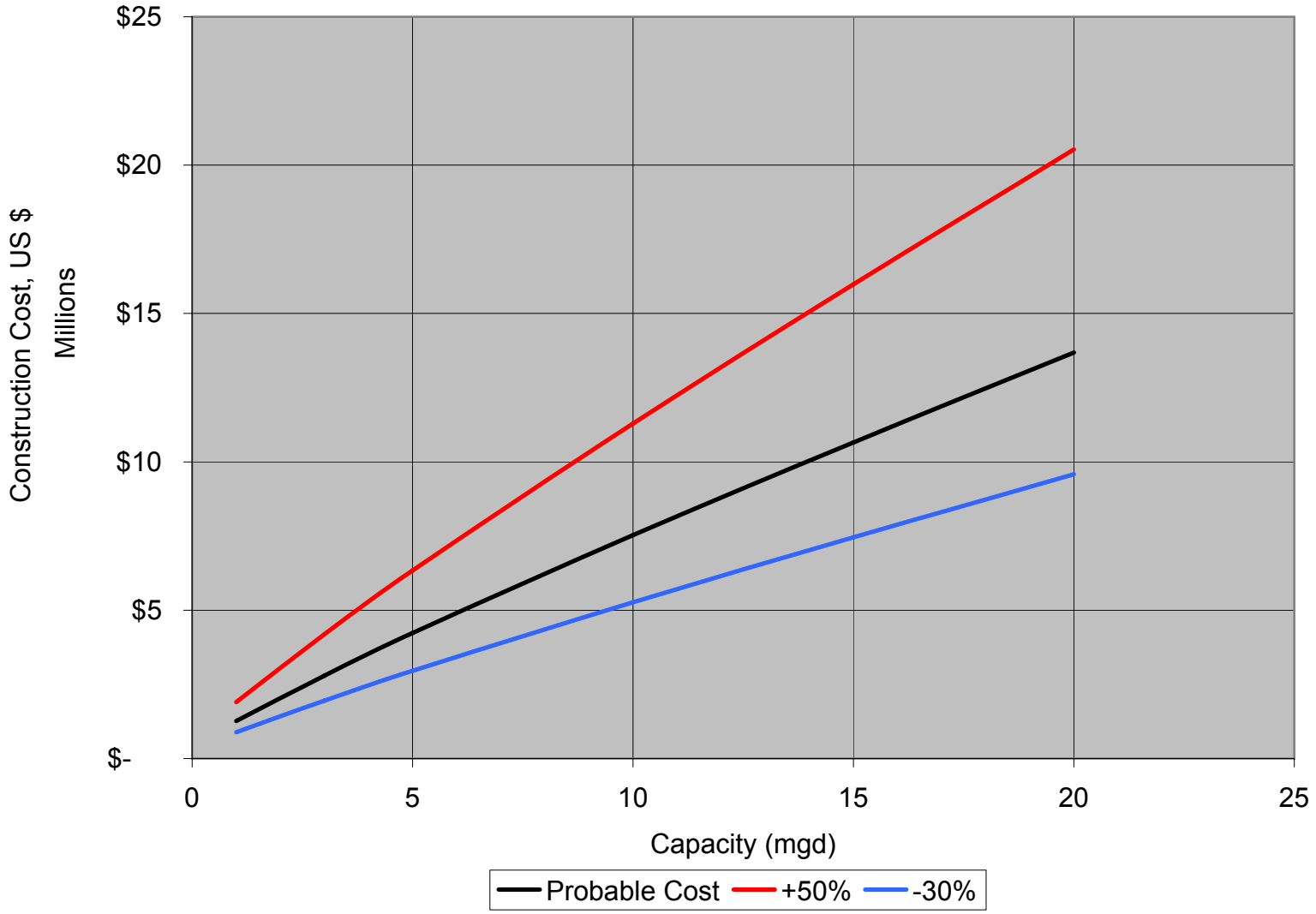


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Figure 6-15 GMF/OSG Hypochlorite Disinfection Production Cost

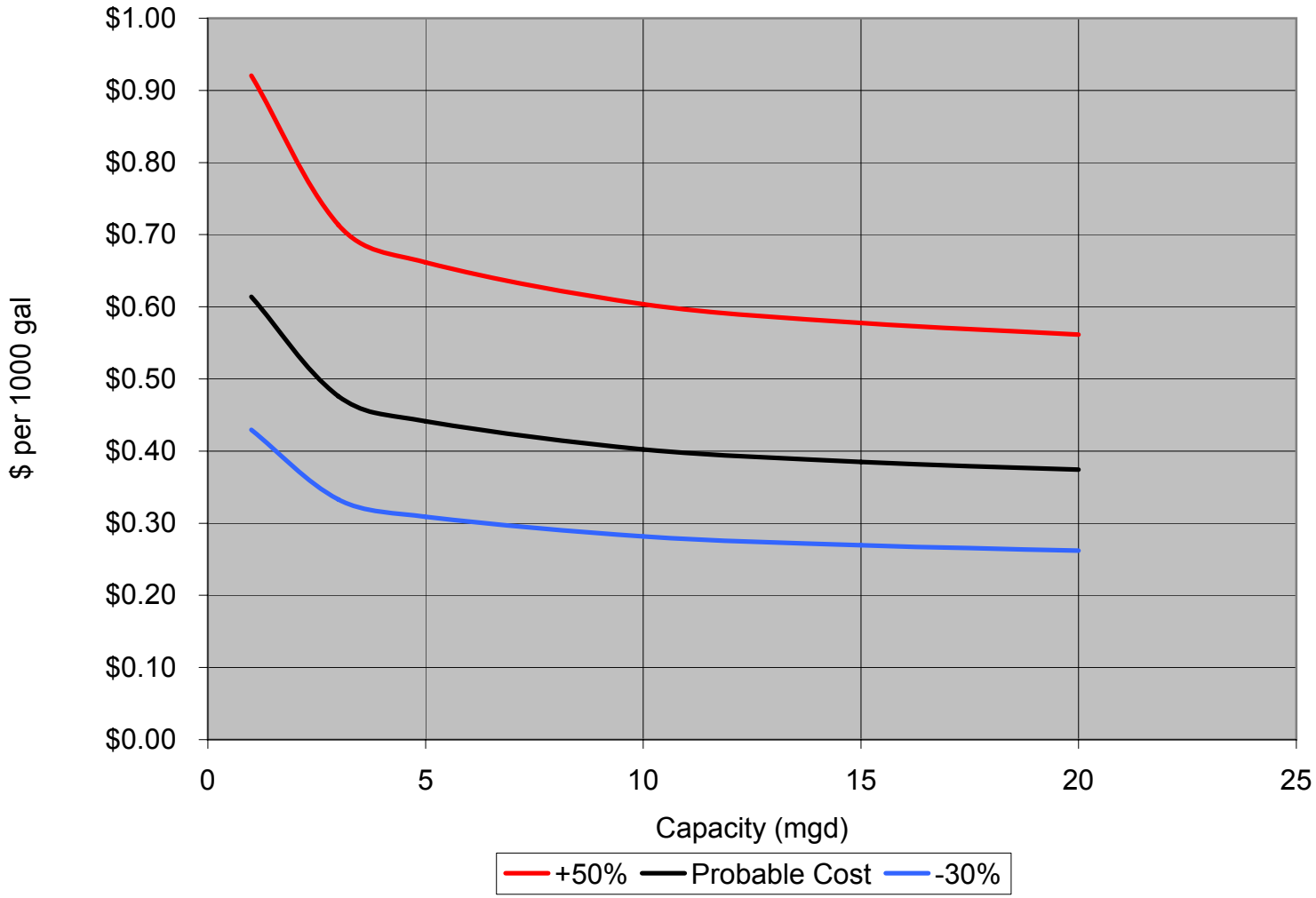

Table 6-15
South Florida Water Management District Cost Estimation Study
Opinion of Probable Capital Cost

Treatment Technology : Granular Media Filters & OSG Hypochlorite Disinfection

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Deep Bed Filters		$325,000	$696,000	$892,000	$1,600,000	$2,377,000	$3,166,000
2.	OSG hypochlorite system		$106,000	$267,000	$529,000	$890,000	$1,206,000	$1,497,000
3.	Plant Infrastructure		$43,100	$96,300	$194,000	$377,000	$562,000	$713,000
4.	Chlorine Contact Basin		$152,000	$322,000	$479,000	$860,000	$1,131,000	$1,400,000
Subtotal:			$626,000	$1,381,000	$2,094,000	$3,727,000	$5,276,000	$6,776,000
6.	Yard piping	10%	$63,000	$138,000	$209,000	$373,000	$528,000	$678,000
6.	Mechanical	10%	$63,000	$138,000	$209,000	$373,000	$528,000	$678,000
7.	Electrical	15%	$94,000	$207,000	$314,000	$559,000	$791,000	$1,016,000
8.	Instrumentation and controls	8%	$50,000	$110,000	$168,000	$298,000	$422,000	$542,000
9.	Site work	10%	$63,000	$138,000	$209,000	$373,000	$528,000	$678,000
Subtotal:			$959,000	$2,112,000	$3,203,000	$5,703,000	$8,073,000	$10,368,000
10.	General Requirements	2%	$19,000	$42,000	$64,000	$114,000	$161,000	$207,000
11.	Contractor overhead and profit	15%	$144,000	$317,000	$480,000	$855,000	$1,211,000	$1,555,000
12.	Construction contingency	15%	$144,000	$317,000	$480,000	$855,000	$1,211,000	$1,555,000
Opinion of Probable Construction Cost::			**$1,266,000**	**$2,788,000**	**$4,227,000**	**$7,527,000**	**$10,656,000**	**$13,685,000**
13.	Technical Services	25%	$317,000	$697,000	$1,057,000	$1,882,000	$2,664,000	$3,421,000
14.	Owner administration and legal	5%	$63,000	$139,000	$211,000	$376,000	$533,000	$684,000
15.	Project contingency	15%	$190,000	$418,000	$634,000	$1,129,000	$1,598,000	$2,053,000
Opinion of Probable Capital Cost:			**$1,836,000**	**$4,042,000**	**$6,129,000**	**$10,914,000**	**$15,451,000**	**$19,843,000**
Opinion of Equivalent Annual Capital Cost:			**$173,000**	**$382,000**	**$579,000**	**$1,030,000**	**$1,458,000**	**$1,873,000**
Plant service life =		20 years						
Annual interest rate =		7%						

Table 6-16
South Florida Water Management District Cost Estimation Study
Opinion of Annual Operation and Maintenance Cost
Treatment Technology : Granular Media Filters & OSG Hypochlorite Disinfection

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Deep Bed Filters	$30,000	$90,000	$150,000	$300,000	$450,000	$600,000
2.	OSG hypochlorite system	$3,600	$10,800	$18,000	$36,000	$54,000	$72,000
Opinion of Annual O&M Cost:		**$34,000**	**$101,000**	**$168,000**	**$336,000**	**$504,000**	**$672,000**

Table 6-17
South Florida Water Management District Cost Estimation Study
Opinion of Total Production Cost
Treatment Technology : Granular Media Filters & OSG Hypochlorite Disinfection

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Equivalent annual capital cost	$173,000	$382,000	$579,000	$1,030,000	$1,458,000	$1,873,000
2.	Annual operation and maintenance cost	$34,000	$101,000	$168,000	$336,000	$504,000	$672,000
3.	Annual R&R fund deposit(1):	$17,000	$38,000	$58,000	$103,000	$146,000	$187,000
Total Annual Cost:		$224,000	$521,000	$805,000	$1,469,000	$2,108,000	$2,732,000
Annual finished water reuse production rate (mgy) (2):		365	1,095	1,825	3,650	5,475	7,300
Annual Production Cost ($/kgal):		**$0.61**	**$0.48**	**$0.44**	**$0.40**	**$0.39**	**$0.37**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.
(2) Annual finished water production rate in million gallons per year (mgy) is equal to the AADD (mgd) times 365 days.

Section 3
Estimation of Costs for Ballasted Flocculation Treatment (ActiFlo)

3.1 Ballasted Flocculation Treatment Process (ActiFlo)

CDM has developed opinions of probable capital, operation and maintenance (O&M), and production costs for ballasted flocculation treatment technologies. Cost tables and curves were developed for this Cost Estimation Study to accomplish advanced wastewater treatment (AWT) with ballasted flocculation from existing secondary treatment plants.

For the purpose of this study, it was assumed that the ballasted flocculation treatment process will be used for the removal of phosphorus to achieve an effluent limit of 0.12 mg/l Total Phosphorus (TP) on an annual average basis.

3.2 Approach for Developing Probable Costs

Costs include capital and O&M costs for design plant capacities of 1 mgd, 3 mgd, 5 mgd, 10 mgd, 15 mgd, and 20 mgd. For this study, an order-of-magnitude approach was used to develop probable capital and operating costs. Probable costs are based on cost-capacity curves, scale factors, bid prices, budgetary quotes from equipment suppliers, technical literature, and costs from other studies.

This approach is appropriate for planning where detailed engineering data has not yet been developed. This type of estimate cannot be substituted for carefully prepared estimates of cost based on sound, thorough engineering evaluation and a complete set of construction drawings and specifications.

The following is a more specific approach used in the development of this cost estimating effort. Construction costs for the Ballasted Flocculation process were obtained from unit costs derived from vendor equipment budgetary quotes and bid prices.

Percentage allowances were included in the construction cost table presented below for mechanical piping, electrical, instrumentation and controls, and site work. It is envisioned that the system would be located on the wastewater treatment plant property; therefore, land purchase costs are not included. It is assumed that the basin structures will be above grade to facilitate the estimate at this planning phase; therefore, earthwork quantities are not included. Costs include only the ballasted flocculation system components and the immediate structure. Other components outside of the footprint of the structure, such as yard piping and pumping costs associated with transferring the flow to the system and away from the system after treatment, are not included in this cost.

The construction costs were adjusted to the September 2007 ENR Index (CCI 8049.65). General requirements, contractor overhead and profit, contingency, technical services, and administration and legal mark-ups were included to develop the opinion of probable capital cost.

The O&M costs were developed from standard unit costs, estimates from existing plants, and vendor information. The O&M costs include labor, chemicals, sand usage, maintenance, and power. The annual operation costs were developed for 6 months and 12 months of plant operation.

The annual production cost was calculated based on the total annual cost (i.e., equivalent annual capital, plus annual O&M cost, plus annual R&R fund deposit) divided by the average finished water production rate in million gallons per year (mgy). The equivalent annual capital cost was calculated using a typical service life of 20 years for the Ballasted Flocculation Treatment (ActiFlo) option, a discount rate of 7 percent, and constant dollars (i.e., no allowance for inflation).

3.2.1 Cost Tables

Tables 6-18, **6-19**, and **6-20** summarize capital, O&M, and total production costs (6 months and 12 months of plant operation) for the AWT option.

3.2.2 Cost Curves

Figures 6-16, **6-17**, and **6-18** illustrate construction and total production costs for the ballasted flocculation system. A +50 percent of base cost and -30 percent of base cost are also included in the graphs to show an envelope of potential costs. Actual bidding construction costs for several projects were included in the curves. The costs were adjusted from the bid date to the September 2007 ENR Index. Most of the plants are within the range of size investigated in this study; however, most of these systems are used for combined sewer overflow and sanitary sewer overflow (CSO/SSO) applications. The only plant listed in the curves that is used to produce high quality reuse water is the East Central Regional Wastewater Treatment Facility (ECR WTF) at the City of West Palm Beach.

Insert tables and figures

Figure 6-16 Ballasted Flocculation Construction Cost

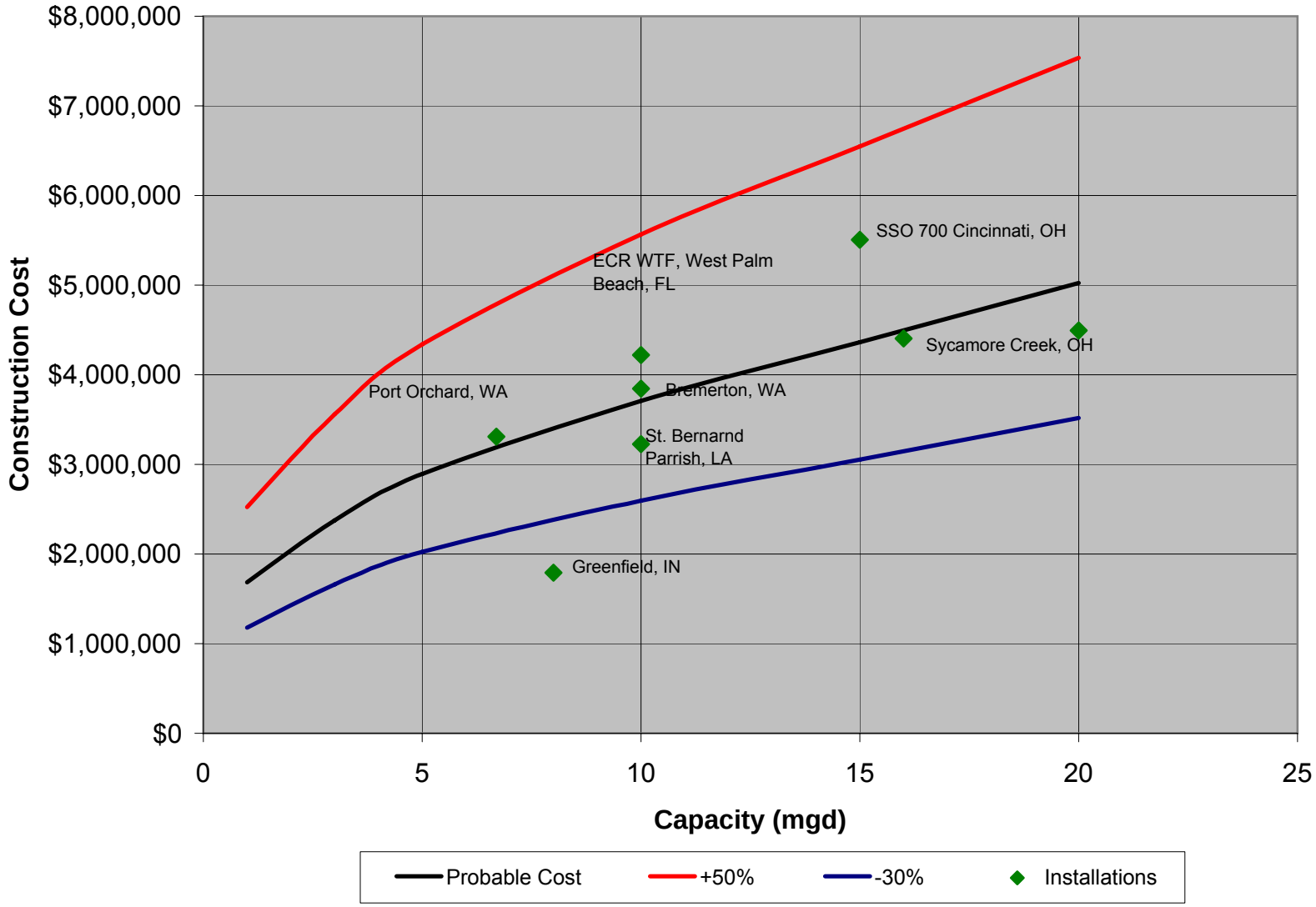

Figure 6-17 Ballasted Flocculation Production Cost (6-Month)

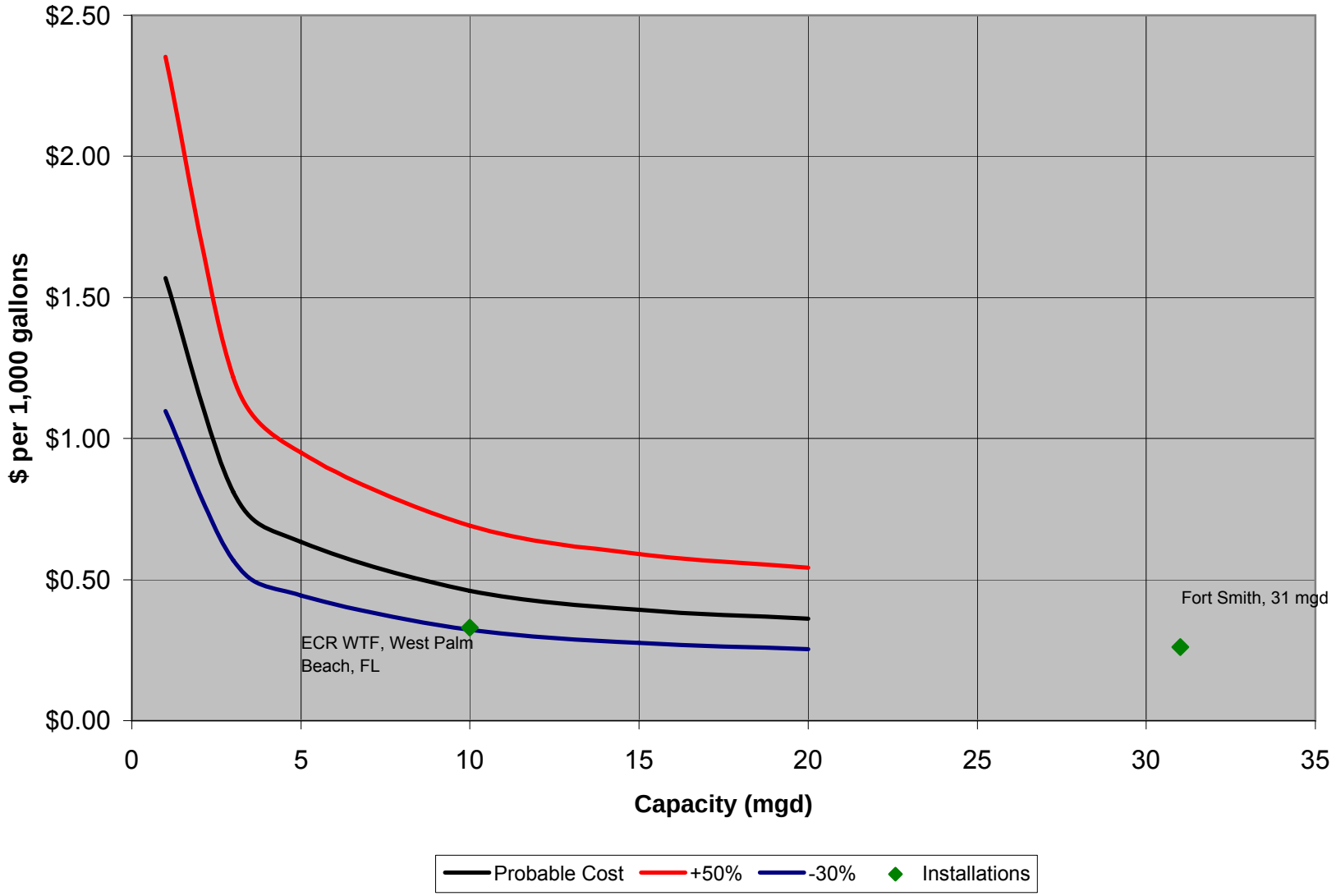

Figure 6-18 Ballasted Flocculation Production Cost (12-Month)

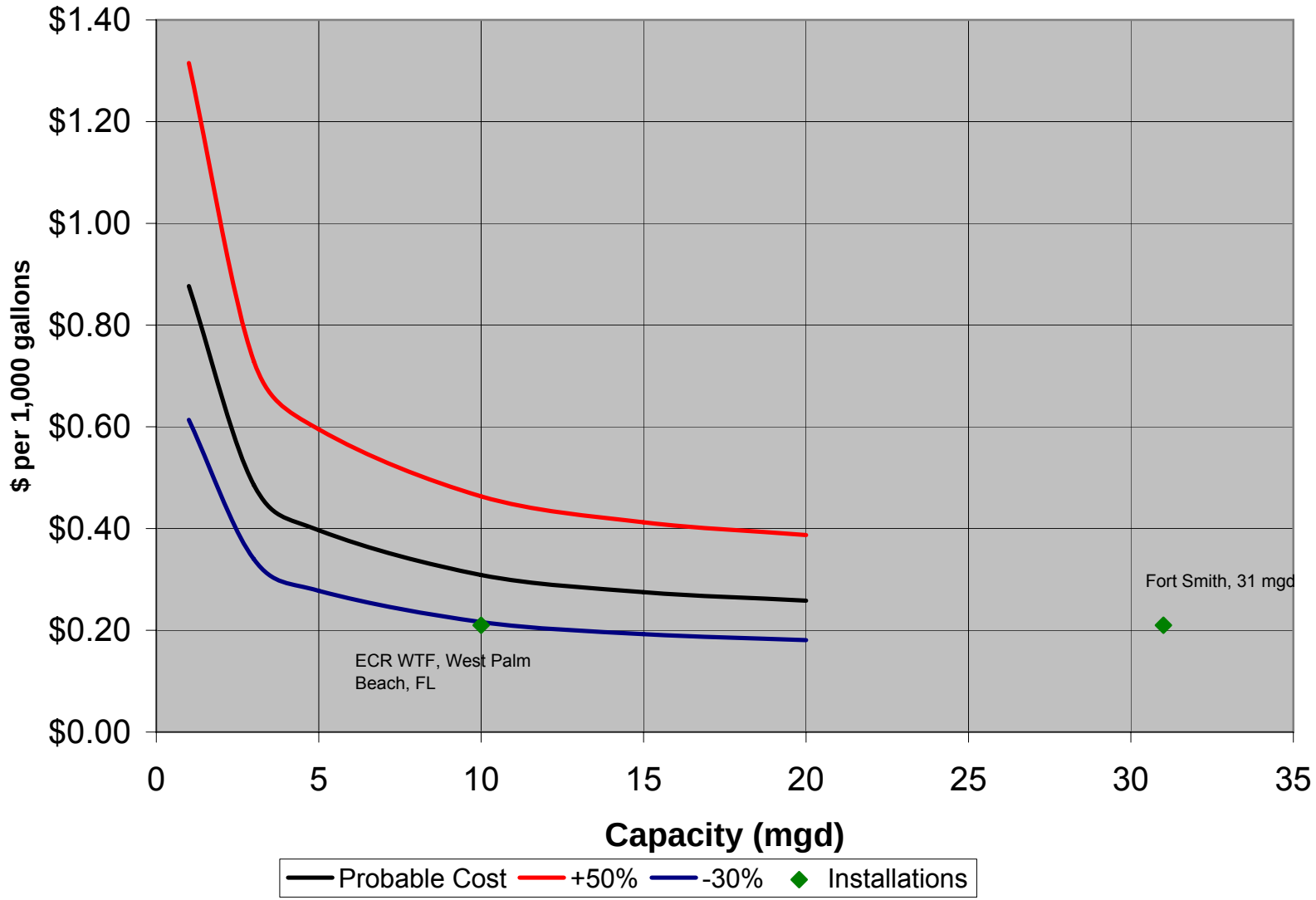

Table 6-18

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Probable Capital Cost
Treatment Technology: Ballasted Flocculation
September 2007 Dollars

Item No.	Description	Allowance Factor	Plant Capacity (mgd) 1	3	5	10	15	20
1.	Actiflo Process Equipment		$938,000	$1,323,000	$1,611,000	$2,065,000	$2,431,000	$2,798,000
Subtotal:			$938,000	$1,323,000	$1,611,000	$2,065,000	$2,431,000	$2,798,000
2.	Electrical [1]	15%	$141,000	$198,000	$242,000	$310,000	$365,000	$420,000
3.	Painting [2]	1%	$9,000	$13,000	$16,000	$21,000	$24,000	$28,000
4.	Instrumentation and Controls [3]	10%	$94,000	$132,000	$161,000	$207,000	$243,000	$280,000
5.	Miscellaneous Piping [4]	7%	$66,000	$93,000	$113,000	$145,000	$170,000	$196,000
Subtotal:			$1,248,000	$1,759,000	$2,143,000	$2,748,000	$3,233,000	$3,722,000
6.	General Requirements	5%	$62,000	$88,000	$107,000	$137,000	$162,000	$186,000
7.	Contractor overhead and profit	15%	$187,000	$264,000	$321,000	$412,000	$485,000	$558,000
8.	Construction contingency	15%	$187,000	$264,000	$321,000	$412,000	$485,000	$558,000
Opinion of Probable Construction Cost:			**$1,684,000**	**$2,375,000**	**$2,892,000**	**$3,709,000**	**$4,365,000**	**$5,024,000**
9.	Technical Services	25%	$421,000	$594,000	$723,000	$927,000	$1,091,000	$1,256,000
10.	Owner administration and legal	5%	$84,000	$119,000	$145,000	$185,000	$218,000	$251,000
11.	Project contingency	15%	$253,000	$356,000	$434,000	$556,000	$655,000	$754,000
Opinion of Probable Capital Cost:			**$2,442,000**	**$3,444,000**	**$4,194,000**	**$5,377,000**	**$6,329,000**	**$7,285,000**
Opinion of Equivalent Annual Capital Cost:			**$230,508**	**$325,089**	**$395,884**	**$507,551**	**$597,413**	**$687,652**
Plant service life =		20 years						
Annual interest rate =		7%						
Unit Probable Construction Cost ($/gpd)			$1.68	$0.79	$0.58	$0.37	$0.29	$0.25
Unit Probable Total Capital Cost ($/gpd)			$2.44	$1.15	$0.84	$0.54	$0.42	$0.36

Notes:

(1) "Electrical" cost item is estimated as 15% of the subtotal of the preceding cost components.
(2) "Painting" cost item is estimated as 1% of the subtotal of the preceding cost components.
(3) "Instrumentation and Controls" cost item is estimated as 10% of the subtotal of the preceding cost components.
(4) "Miscellaneous Piping" cost item is estimated as 7% of the subtotal of the preceding cost components.

Assumptions

(1) No rock excavation is required, no dewatering is needed and no consideration for contaminated solids or hazardous materials is included.
(2) Tank costs assume foundation is on-grade, no earthwork is included.

Table 6-19

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Annual Operation and Maintenance Cost
Treatment Technology: Ballasted Flocculation
September 2007 Dollars

Assumptions
Unit power cost = $0.10 per kW-hr

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Variable Costs						
1.	Power	$7,000	$10,000	$15,000	$27,000	$39,000	$51,000
2.	Chemicals	$26,000	$77,000	$129,000	$257,000	$385,000	$513,000
	Fixed						
3.	Operation and maintenance labor	$25,000	$65,000	$108,000	$213,000	$318,000	$423,000
4.	Administration/regulatory compliance	$8,000	$22,000	$36,000	$71,000	$106,000	$141,000
	Annual Production at Rated Capacity, (mgy)	365	1,095	1,825	3,650	5,475	7,300
	Annual O&M Cost at Rated Capacity	**$66,000**	**$174,000**	**$288,000**	**$568,000**	**$848,000**	**$1,128,000**
	Unit Cost at Rated Capacity, $/kgal	$0.18	$0.16	$0.16	$0.16	$0.15	$0.15

Table 6-20

South Florida Water Management District Water Supply Cost Estimation Study

Opinion of Total Production Cost
Treatment Technology: Ballasted Flocculation
September 2007 Dollars

Item No.	Description	Plant Capacity (mgd) 1	3	5	10	15	20
	Production Costs - 1 year in Operation						
1.	Equivalent annual capital cost	$231,000	$325,000	$396,000	$508,000	$597,000	$688,000
2.	Annual O&M Cost - Variable	$33,000	$87,000	$144,000	$284,000	$424,000	$564,000
3.	Annual O&M Cost - Fixed	$33,000	$87,000	$144,000	$284,000	$424,000	$564,000
4.	Annual R&R fund deposit [1]	$23,100	$32,500	$39,600	$50,800	$59,700	$68,800
	Total Annual Cost:	$320,000	$532,000	$724,000	$1,127,000	$1,505,000	$1,885,000
	Annual Production at Rated Capacity, (mgy)[2]:	365	1,095	1,825	3,650	5,475	7,300
	Annual (12-month) Production Cost ($/kgal):	**$0.88**	**$0.49**	**$0.40**	**$0.31**	**$0.27**	**$0.26**
	Production Costs - 6 Months in Operation						
1.	Equivalent annual capital cost	$231,000	$325,000	$396,000	$508,000	$597,000	$688,000
2.	Annual O&M Cost - Variable	$16,500	$43,500	$72,000	$142,000	$212,000	$282,000
3.	Annual O&M Cost - Fixed	$16,500	$43,500	$72,000	$142,000	$212,000	$282,000
4.	Annual R&R fund deposit [1]	$23,100	$32,500	$39,600	$50,800	$59,700	$68,800
	Total Annual Cost:	$287,000	$445,000	$580,000	$843,000	$1,081,000	$1,321,000
	Annual finished water production rate (mgy)[2]:	183	549	915	1,830	2,745	3,660
	Annual (6-month) Production Cost ($/kgal):	**$1.57**	**$0.81**	**$0.63**	**$0.46**	**$0.39**	**$0.36**

Notes:

(1) Annual deposit to a renewal and replacement (R&R) fund is equal to 10% of the equivalent annual capital cost.

(2) Annual finished water production rate in million gallons per year (mgy) is equal to the capacity (mgd) times 365 days for 12-month operation and 183 days for 6-month operation.