

January 24, 2005

MEMORANDUM

TO: Sarah Lynch, World Wildlife Fund
FROM: Grace M. Johns, Ph.D.
SUBJECT: Estimates of Average and Marginal Costs per Pound of Phosphorus Removed Using RASTAs in the Lake Okeechobee Watershed and Marginal Costs of Water Storage

As you requested, this memorandum presents estimates of the average and marginal costs per pound of phosphorus removed for the reservoir assisted stormwater treatment areas (RASTAs) being planned in the Lake Okeechobee watershed. Also presented are estimates of the marginal costs to store water in the reservoirs of the RASTAs.

Estimated Costs per Pound of Phosphorus Removed. Two sets of estimates are provided based on two data sources: the Lake Okeechobee Watershed Project draft project implementation report dated September 2004 and contracted construction costs for the two stormwater treatment areas being constructed in the Taylor Creek / Nubbin Slough Basin. Almost all of the costs and phosphorus reduction data are planning level estimates and are subject to revision. Once the pilot stormwater treatment areas in the Taylor Creek / Nubbin Slough are built and operating, better information will be available.

The first set of estimates is provided in Table 1 and is based on planning level estimates of construction costs and phosphorus reductions associated with RASTAs in four planning Basins of the Lake Okeechobee Watershed: Lake Istokpoga watershed, Fisheating Creek, Kissimmee River, and Taylor Creek/Nubbin Slough. The costs and phosphorus reductions represent STAs and a nominal level of storage needed to achieve additional phosphorus reduction. These estimates were taken from the CERP, Lake Okeechobee Watershed Project (LOWP), Draft Project Implementation Report, USACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51.¹ This figure provides the lowest cost alternatives in all four planning basins. The horizontal axis is metric tons of phosphorus removed per year and the vertical axis is construction cost in millions of 2003 dollars. It is the magnification of a portion of the graph shown in Figure 4-12. The “best buy” alternative is the one that provides a 134 metric ton phosphorus reduction per year.

The graphs in Figures 4-12 and 4-14 of the report allowed the LOWP team to conclude that designing the RASTAs to achieve a total phosphorus reduction in the range of 125 to 140 metric tons per year is the most cost-effective option for meeting the project goals. The allocation of phosphorus reductions by basin is provided below.

- Lake Istokpoga watershed – 60 metric tons per year
- Fisheating Creek – 50 metric tons per year
- Taylor Creek / Nubbin Slough – 23 metric tons per year
- Kissimmee River – 0-8 metric tons per year
- Total – 133 to 141 metric tons per year

¹ Hazen and Sawyer thanks Anwar Khan of HDR Engineering, Inc. for assistance in interpreting the information provided in this LOWP draft Project Implementation Report.

Because the Kissimmee River basin does not provide any significant phosphorus reduction benefits, its phosphorus reduction is assumed to be zero and its cost is not included in the lowest cost curve of Figure 4-14 that was used to produce the average and marginal costs reported in this memorandum.

Table 1
Summary of Estimated Average and Marginal Costs of Reservoir Assisted Stormwater Treatment Areas in the Lake Okeechobee Watershed to Reduce Phosphorus Loads to the Lake, 2005 dollars (a)

Annual Phosphorus Reduction		Average Cost per Pound of Phosphorus Removed (b)		Marginal Cost per Pound of Phosphorus Removed (b)	
Metric Tons	Pounds	Low	High	Low	High
126.00	277,830	\$106	\$157		
127.50	281,138	\$107	\$158	\$211	\$313
130.00	286,650	\$109	\$161	\$211	\$313
132.50	292,163	\$111	\$164	\$211	\$313
135.00	297,675	\$113	\$167	\$211	\$313
137.50	303,188	\$115	\$170	\$211	\$313
140.00	308,700	\$116	\$172	\$211	\$313
141.00	310,905	\$117	\$173	\$211	\$313

(a) Based on phosphorus reduction and construction cost data found in CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51.

(b) Includes capital cost amortized over 50 years at 5.13% discount rate and annual operations, maintenance, repair, renewal and replacement cost.

The calculations for the low end and high end cost estimates are provided in the attached Tables A-1 and A-2, respectively. The construction costs in 2003 dollars provided in the LOWP Implementation Plan report included estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, permitting, finance, administration, legal, operation and maintenance. The high end estimate of costs provided in Table 1 uses these costs and the low end estimate of costs used 90 percent of the reported construction costs. This is because the LOWP Planning Team believes that the costs reported in the LOWP Implementation Report, while sound for the purposes of initial project optimization, may be a bit on the high side since all four projects still need to be optimized together to achieve efficiencies and synergy. The construction costs were converted to 2005 dollars by increasing the 2003 construction costs by three percent.

The other direct costs for planning, engineering design, project management, construction management, permitting, finance, administration and legal were estimated at 15 percent of the construction cost as recommended by the LOWP Planning Team. The sum of the construction, land and other direct costs is the capital cost of the RASTAs.

The capital cost was then amortized over the 50 year life of the project at 5.13 percent discount rate to obtain an annualized value. This discount rate is currently used by the U.S. Army Corps of Engineers for project planning and is recommended by the US Bureau of Reclamation for evaluating Bureau of Reclamation projects (<http://www.publicdebt.treas.gov/opd/opdirbr.htm>).

To this was added the annual operations, maintenance, repair, renewal and replacement cost (OMRR&R cost). This cost was estimated as 3.2 percent of the capital cost for the high end cost estimate and 1.0 percent of the capital cost for the low end cost estimate. This range of values was based on information from SFWMD's STA projects operating in the Everglades Agricultural Area

and the SFWMD report prepared by Hazen and Sawyer titled "Natural Resource Analysis of Lake Okeechobee Phosphorus Management Strategies, Phase II, Documentation Report, December 2003, pages 10-9 to 10-15 (based on U.S. Army Corps of Engineers' data as of July 2001).

The annualized cost is the amortized capital cost plus the annual OMRR&R cost. It was divided by the annual expected phosphorus reduction in pounds to obtain the average cost per pound of phosphorus removed. The average cost ranges from \$106 to \$157 per pound of phosphorus removed when the total pounds removed is 278,000 pounds or 126 metric tons per year. When phosphorus removal is 311,000 pounds or 141 metric tons per year, the average cost is \$117 to \$173 per pound of phosphorus removed.

The marginal cost is the difference between the costs at two levels of phosphorus removal divided by the difference in the pounds of phosphorus removed. For example, the additional cost per pound removed when increasing phosphorus removal from 126 tons to 127.5 tons per year ranges from \$211 to \$313 per pound removed. This marginal cost is constant at this level over the range of 126 tons and 141 tons of phosphorus removed per year.

An estimate of the average stormwater treatment area (STA) cost per pound of phosphorus removed was obtained using the contracted construction costs and estimated phosphorus reduction of the two stormwater treatment areas currently being built in the Taylor Creek / Nubbin Slough Basin. The calculations and results are provided in Table 2. The table provides a description of how the values were estimated. Unlike Table 1, the values in Table 2 do not include any phosphorus reduction benefits or costs associated with a storage reservoir.

Table 2
Average Cost Per Pound of Phosphorus Removed Using Two Pilot Stormwater Treatment Areas in the Taylor Creek / Nubbin Slough (a)

Item	Taylor Creek STA (780 acres)	Nubbin Slough STA (193 acres)	Total
COSTS			
Capital			
Construction Cost	\$3,447,356	\$10,636,523	\$14,083,879
Land Cost (Purchase prices as of 1997)	\$280,500	\$1,133,627	\$1,414,127
Other Direct Costs (b)	\$559,178	\$1,765,522	\$2,324,701
Total Capital Cost	\$4,287,035	\$13,535,672	\$17,822,707
Annualized Capital Cost (c)	\$239,562	\$756,382	\$995,945
Annual Operations and Maintenance Cost (d)	\$137,185	\$433,142	\$570,327
Total annual capital and O&M Cost	\$376,747	\$1,189,524	\$1,566,271
PHOSPHORUS REDUCTION			
Pounds per Year (e)	6,890	24,800	31,690
AVERAGE COST PER POUND OF PHOSPHORUS REMOVED			
Cost per pound	\$55	\$48	\$49

(a) Construction and land costs from Lisa Kreiger, South Florida Water Management District, Okeechobee Service Center, January 20, 2005. Construction cost based on contracted amount plus 20% contingency. Land cost is actual cost.

(b) These costs were estimated and include Planning, Design, Construction Mgmt, Project Mgmt, Permitting, Finance, Administration and Legal (15% of construction and land cost)

(c) Amortized over 50 years at 5.13% annual discount rate.

(d) Estimate is 3.2 percent of capital cost. To be determined during operation of these STAs.

(e) Estimated by Stanley Consultants based on specific assumptions regarding flow rates and other factors. To be determined during operation of these STAs.

Estimated Marginal Cost of Storage. The LOWP Implementation Report cited above also identified the cost effective storage sizes for each basin RASTA. The benefits of the additional storage contemplated here are beyond that needed to achieve phosphorus reduction. The lowest cost alternatives for each Basin are provided in Figures 4-15 through 4-18 of the draft LOWP Implementation Report on pages 53 through 56. The horizontal axis is in 1,000s of acre-feet of storage and the vertical axis is construction cost of the RASTA for that one Basin only in millions of dollars where the STA is designed to achieve the metric ton phosphorus reduction goal listed above in this memorandum. These cost curves were used to estimate the marginal cost of additional reservoir storage and the results are provided in Table 3.

The high estimate of marginal cost is taken directly from the construction cost estimates in 2003 dollars provided Figures 4-15 through 4-18 of the LOWP Implementation Report. These values were then converted to 2005 dollars by increasing the 2003 construction costs by three percent. This value was then increased by 15 percent to include the costs of planning, design, construction management, permitting, finance, administration and legal. The result is the capital cost at each level of storage capacity. The capital costs were amortized over 50 years at 5.13 percent discount rate to obtain an annual capital cost. Because annual OMR&R costs associated with just the storage component of the RASTA are not known but are expected to be relatively small, they are not included in the marginal cost of storage. The low end estimate of marginal cost is 90 percent of the high end estimate.

The marginal cost of storage is the difference between the costs at two levels of storage divided by the difference in storage. The calculations for the high marginal cost estimates for each basin are provided in the attached Tables A-3 through A-6. For example, the additional cost per acre-foot of storage when increasing storage from 25,000 acre-feet to 40,000 acre-feet ranges from \$71 to \$79 per acre-foot (Table A-3). This marginal cost is constant at this level over the range of 25,000 acre-foot and 125,000 acre feet of storage and this is presented in the first row of Table 3.

The marginal cost varies by Basin as shown in Table 3. The estimated marginal cost of storage in Fisheating Creek ranges from \$71 to \$79 per acre-foot. In the Istokpoga basin, the estimated marginal cost ranges from \$77 to \$86 per acre-foot. In the Kissimmee and Taylor Creek / Nubbin Slough basins, the estimated marginal cost ranges from \$93 to \$103 and from \$113 to \$126, respectively.

Table 3
Estimated Marginal Storage Costs Associated with LOWP RASTAs, 2005 Dollars (a)

Basin	Range of Storage Capacity in Acre Feet		Marginal Cost per Acre-Foot of Additional Storage	
	From	To	Low	High
Fisheating Creek	25,000	125,000	\$71	\$79
Istokpoga	25,000	225,000	\$77	\$86
Kissimmee	24,000	120,000	\$93	\$103
Taylor Creek / Nubbin Slough	25,000	135,000	\$113	\$126

(a) Source: CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figures 4-15 through 4-18, pages 53 to 56. Includes capital costs only, not annual OMR&R costs. High estimate is taken directly from report cited above. Low estimate is 90% of the high estimate to take into account efficiencies and synergies which are expected to be achieved when the RASTAs in the four basins are optimized together.

c: File No. 40265

**Table A-1
Calculation of Estimated Average and Marginal Costs of LOWP RASTAs - Low End Estimate in 2005 Dollars**

Annual P Reduction (metric tons) (a)	Construction Cost, 2003 \$ (a)	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMRR&R	Total Annual Cost	Annual P Reduction (pounds)	Average Cost per Pound Removed	Marginal Cost per Pound Removed (c)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = (5)x.01	(8)=(6)+(7)	(9)=(1)x2205	(10)=(8)/(9)	(11)
126.0	\$378,000,000	\$387,749,079	\$58,162,362	\$445,911,441	\$24,898,834	\$4,459,114	\$29,357,948	277,830	\$106	
127.5	\$387,000,000	\$396,981,200	\$59,547,180	\$456,528,380	\$25,491,663	\$4,565,284	\$30,056,947	281,138	\$107	\$211
130.0	\$402,000,000	\$412,368,068	\$61,855,210	\$474,223,278	\$26,479,712	\$4,742,233	\$31,221,945	286,650	\$109	\$211
132.5	\$417,000,000	\$427,754,936	\$64,163,240	\$491,918,177	\$27,467,761	\$4,919,182	\$32,386,943	292,163	\$111	\$211
135.0	\$432,000,000	\$443,141,804	\$66,471,271	\$509,613,075	\$28,455,810	\$5,096,131	\$33,551,941	297,675	\$113	\$211
137.5	\$447,000,000	\$458,528,673	\$68,779,301	\$527,307,974	\$29,443,859	\$5,273,080	\$34,716,939	303,188	\$115	\$211
140.0	\$462,000,000	\$473,915,541	\$71,087,331	\$545,002,872	\$30,431,908	\$5,450,029	\$35,881,937	308,700	\$116	\$211
141.0	\$468,000,000	\$480,070,288	\$72,010,543	\$552,080,831	\$30,827,128	\$5,520,808	\$36,347,936	310,905	\$117	\$211

(a) Source: 90 percent of estimated planning level cost from CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Marginal cost is equal to the difference in annual cost divided by the difference in phosphorus reduction (Columns (8) and (9)).

Table A-2
Calculation of Estimated Average and Marginal Costs of LOWP RASTAs – High End Estimate in 2005 Dollars

Annual P Reduction (metric tons) (a)	Construction Cost, 2003 \$ (a)	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMRR&R	Total Annual Cost	Annual P Reduction (pounds)	Average Cost per Pound Removed	Marginal Cost per Pound Removed (c)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = (5)x.032	(8)=(6)+(7)	(9)=(1)x2205	(10)=(8)/(9)	(11)
126.0	\$420,000,000	\$430,832,310	\$64,624,846	\$495,457,156	\$27,665,371	\$15,854,629	\$43,520,000	277,830	\$157	
127.5	\$430,000,000	\$441,090,222	\$66,163,533	\$507,253,755	\$28,324,070	\$16,232,120	\$44,556,190	281,138	\$158	\$313
130.0	\$446,666,667	\$458,186,742	\$68,728,011	\$526,914,754	\$29,421,902	\$16,861,272	\$46,283,175	286,650	\$161	\$313
132.5	\$463,333,333	\$475,283,262	\$71,292,489	\$546,575,752	\$30,519,735	\$17,490,424	\$48,010,159	292,163	\$164	\$313
135.0	\$480,000,000	\$492,379,783	\$73,856,967	\$566,236,750	\$31,617,567	\$18,119,576	\$49,737,143	297,675	\$167	\$313
137.5	\$496,666,667	\$509,476,303	\$76,421,445	\$585,897,748	\$32,715,399	\$18,748,728	\$51,464,127	303,188	\$170	\$313
140.0	\$513,333,333	\$526,572,823	\$78,985,923	\$605,558,747	\$33,813,231	\$19,377,880	\$53,191,111	308,700	\$172	\$313
141.0	\$520,000,000	\$533,411,431	\$80,011,715	\$613,423,146	\$34,252,364	\$19,629,541	\$53,881,905	310,905	\$173	\$313

(a) Source: From CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-14, page 51. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Marginal cost is equal to the difference in annual cost divided by the difference in phosphorus reduction (Columns (8) and (9)).

Table A-3

Calculation of Estimated Marginal Costs of Water Storage at the LOWP RASTAs – High End Estimate for Fisheating Creek Basin with RASTA Designed for 50 Metric Tons per Year of Phosphorus Removal In 2005 Dollars (a)

Storage in Acre-Foot	Construction Cost, 2003 \$	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMR&R	Total Annual Cost	Average Cost per Acre-Foot of Storage (c)	Marginal Cost per Acre-Foot of Storage (d)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = \$0	(8)=(6)+(7)	(9)=(8)/(1)	(10)
25,000	\$180,000,000	\$184,642,419	\$27,696,363	\$212,338,781	\$11,856,588	\$0	\$11,856,588	\$474	
40,000	\$198,000,000	\$203,106,660	\$30,465,999	\$233,572,659	\$13,042,246	\$0	\$13,042,246	\$326	\$79
55,000	\$216,000,000	\$221,570,902	\$33,235,635	\$254,806,538	\$14,227,905	\$0	\$14,227,905	\$259	\$79
70,000	\$234,000,000	\$240,035,144	\$36,005,272	\$276,040,416	\$15,413,564	\$0	\$15,413,564	\$220	\$79
85,000	\$252,000,000	\$258,499,386	\$38,774,908	\$297,274,294	\$16,599,223	\$0	\$16,599,223	\$195	\$79
100,000	\$270,000,000	\$276,963,628	\$41,544,544	\$318,508,172	\$17,784,881	\$0	\$17,784,881	\$178	\$79
115,000	\$288,000,000	\$295,427,870	\$44,314,180	\$339,742,050	\$18,970,540	\$0	\$18,970,540	\$165	\$79
125,000	\$300,000,000	\$307,737,364	\$46,160,605	\$353,897,969	\$19,760,979	\$0	\$19,760,979	\$158	\$79

(a) Includes the cost of the STA and the storage. Source: From CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-15, page 53. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Includes the cost of the STA and the storage.

(d) Marginal cost is equal to the difference in annual cost divided by the difference in storage (Columns (8) and (1)).

Table A-4

Calculation of Estimated Marginal Costs of Water Storage at the LOWP RASTAs – High End Estimate for Istokpoga Basin with RASTA Designed for 60 Metric Tons per Year of Phosphorus Removal In 2005 Dollars (a)

Storage in Acre-Foot	Construction Cost, 2003 \$	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMRR&R	Total Annual Cost	Average Cost per Acre-Foot of Storage (c)	Marginal Cost per Acre-Foot of Storage (d)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = \$0	(8)=(6)+(7)	(9)=(8)/(1)	(10)
25,000	\$180,000,000	\$184,642,419	\$27,696,363	\$212,338,781	\$11,856,588	\$0	\$11,856,588	\$474	
53,571	\$217,142,857	\$222,743,235	\$33,411,485	\$256,154,720	\$14,303,185	\$0	\$14,303,185	\$267	\$86
82,143	\$254,285,714	\$260,844,052	\$39,126,608	\$299,970,659	\$16,749,782	\$0	\$16,749,782	\$204	\$86
110,714	\$291,428,571	\$298,944,868	\$44,841,730	\$343,786,598	\$19,196,380	\$0	\$19,196,380	\$173	\$86
139,286	\$328,571,429	\$337,045,685	\$50,556,853	\$387,602,537	\$21,642,977	\$0	\$21,642,977	\$155	\$86
167,857	\$365,714,286	\$375,146,501	\$56,271,975	\$431,418,476	\$24,089,575	\$0	\$24,089,575	\$144	\$86
196,429	\$402,857,143	\$413,247,318	\$61,987,098	\$475,234,415	\$26,536,172	\$0	\$26,536,172	\$135	\$86
225,000	\$440,000,000	\$451,348,134	\$67,702,220	\$519,050,354	\$28,982,770	\$0	\$28,982,770	\$129	\$86

(a) Includes the cost of the STA and the storage. Source: From CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-16, page 54. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Includes the cost of the STA and the storage.

(d) Marginal cost is equal to the difference in annual cost divided by the difference in storage (Columns (8) and (1)).

Table A-5

Calculation of Estimated Marginal Costs of Water Storage at the LOWP RASTAs – High End Estimate for Kissimmee Basin with RASTA Designed for 0 Metric Tons per Year of Phosphorus Removal In 2005 Dollars (a)

Storage in Acre-Feet	Construction Cost, 2003 \$	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMR&R	Total Annual Cost	Average Cost per Acre-Foot of Storage (c)	Marginal Cost per Acre-Foot of Storage (d)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = \$0	(8)=(6)+(7)	(9)=(8)/(1)	(10)
24,000	\$180,000,000	\$184,642,419	\$27,696,363	\$212,338,781	\$11,856,588	\$0	\$11,856,588	\$494	
37,714	\$201,428,571	\$206,623,659	\$30,993,549	\$237,617,208	\$13,268,086	\$0	\$13,268,086	\$352	\$103
51,429	\$222,857,143	\$228,604,899	\$34,290,735	\$262,895,634	\$14,679,585	\$0	\$14,679,585	\$285	\$103
65,143	\$244,285,714	\$250,586,139	\$37,587,921	\$288,174,060	\$16,091,083	\$0	\$16,091,083	\$247	\$103
78,857	\$265,714,286	\$272,567,380	\$40,885,107	\$313,452,487	\$17,502,582	\$0	\$17,502,582	\$222	\$103
92,571	\$287,142,857	\$294,548,620	\$44,182,293	\$338,730,913	\$18,914,080	\$0	\$18,914,080	\$204	\$103
106,286	\$308,571,429	\$316,529,860	\$47,479,479	\$364,009,339	\$20,325,579	\$0	\$20,325,579	\$191	\$103
120,000	\$330,000,000	\$338,511,101	\$50,776,665	\$389,287,766	\$21,737,077	\$0	\$21,737,077	\$181	\$103

(a) Includes the cost of the STA and the storage. Source: From CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-17, page 55. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Includes the cost of the STA and the storage.

(d) Marginal cost is equal to the difference in annual cost divided by the difference in storage (Columns (8) and (1)).

**Table A-6
Calculation of Estimated Marginal Costs of Water Storage at the LOWP RASTAs – High End Estimate for Taylor Creek / Nubbin Slough Basin with RASTA Designed for 23 Metric Tons per Year of Phosphorus Removal In 2005 Dollars (a)**

Storage in Acre-Feet	Construction Cost, 2003 \$	Construction Cost, 2005 \$	Other Direct Costs (b)	Capital Cost	Amortized Capital Cost	Annual OMR&R	Total Annual Cost	Average Cost per Acre-Foot of Storage (c)	Marginal Cost per Acre-Foot of Storage (d)
(1)	(2)	(3)=(2)x1.03	(4)=(3)x0.15	(5) = (3) + (4)	(6) = (5) at 50 years, 5.13%	(7) = \$0	(8)=(6)+(7)	(9)=(8)/(1)	(10)
25,000	\$180,000,000	\$184,642,419	\$27,696,363	\$212,338,781	\$11,856,588	\$0	\$11,856,588	\$474	
40,714	\$210,000,000	\$215,416,155	\$32,312,423	\$247,728,578	\$13,832,685	\$0	\$13,832,685	\$340	\$126
56,429	\$240,000,000	\$246,189,891	\$36,928,484	\$283,118,375	\$15,808,783	\$0	\$15,808,783	\$280	\$126
72,143	\$270,000,000	\$276,963,628	\$41,544,544	\$318,508,172	\$17,784,881	\$0	\$17,784,881	\$247	\$126
87,857	\$300,000,000	\$307,737,364	\$46,160,605	\$353,897,969	\$19,760,979	\$0	\$19,760,979	\$225	\$126
103,571	\$330,000,000	\$338,511,101	\$50,776,665	\$389,287,766	\$21,737,077	\$0	\$21,737,077	\$210	\$126
119,286	\$360,000,000	\$369,284,837	\$55,392,726	\$424,677,563	\$23,713,175	\$0	\$23,713,175	\$199	\$126
135,000	\$390,000,000	\$400,058,573	\$60,008,786	\$460,067,359	\$25,689,273	\$0	\$25,689,273	\$190	\$126

(a) Includes the cost of the STA and the storage. Source: From CERP, Lake Okeechobee Watershed Project, Section 4.0 Development of Alternative Plans, 4.1 Formulation of Alternative Plans for the Okeechobee Watershed, Draft Project Implementation Report, US ACE, SFWMD and HDR Engineering, Inc., September 2004, Figure 4-18, page 56. Construction costs include estimates for construction and land acquisition only. They do not include allowances for additional planning, engineering design, project management, construction management, finance, administration, operation and maintenance.

(b) Other direct costs include Planning, Engineering Design, Construction Management, Administration, Permitting, Finance and Legal (15% of construction cost).

(c) Includes the cost of the STA and the storage.

(d) Marginal cost is equal to the difference in annual cost divided by the difference in storage (Columns (8) and (1)).