Savannah Harbor Expansion Project Impacts to O&M

Background. In evaluating the proposed deepening of the Savannah Harbor, uppermost on the minds of the PDT was the necessity to examine the possible impacts to the District's Operations and Maintenance (O&M) Program. This report is an attempt to quantify the initial (one time) impacts to the O&M program as well as the annual (re-occurring) impacts to the program. The annual impacts include increased dredging costs for the Inner Harbor, Bar Channel, and Mitigation Areas; O&M costs for the fish passage, operating costs for the Oxygen Injection System; long term monitoring; and curation costs for the CSS *Georgia* (removal of the CSS *Georgia* from the project area will be accomplished with construction funds from the SHE project, and the cost will be counted in the project B/C ratio).

Annual Impacts to the O&M program

1. Inner Harbor Advance Maintenance

Current Dredging Market. Past dredging work in Savannah and Brunswick Harbors was performed by as many as 4 different small business contractors; however, current plans advertise this work in the unrestricted category, since the competitive field of dredging contractors capable of dredging Savannah Harbor has been reduced. Currently, we are working near the limit of the small dredges (18 inch cutterhead.) capability due to the depth of the channel, the length of the dredge pipeline to the dredged material containment areas, and the height of containment areas. It is the District's contention that using larger dredges will be more cost effective (22 to 30 inch cutterhead) to perform this work. Starting in FY08 Savannah Harbor maintenance dredging work has been advertised in the unrestricted category.

Current Project Conditions. In order to project shoaling conditions after the Savannah Harbor Expansion project is completed, CESAW-EN conducted an investigation of historical Inner Harbor shoaling rates and dredging volumes per river reach both With and Without the project (harbor deepening and mitigation features) in existence. With authorization and implementation of the Savannah Harbor Expansion Project the Sediment Basin would be filled. The filling of the Sediment Basin is a critical feature in mitigation planning for the Savannah Harbor Expansion Project as it restricts further upstream saltwater incursion.

Mitigation Planning. The selected mitigation plan as depicted in Table 1 includes, among other things, demolition of the Tidegate structure, removal of the northern and southern earthen abutments and construction of a sill across the throat of the Sediment Basin which will permit the Basin to fill with sediment to pre-harbor improvement conditions, thus reducing impacts to wetlands in the Back River by creating a partial barrier to saltwater intrusion up that river. The end result of this mitigation action will be a return of the Inner Harbor shoaling regime to Pre-Tidegate conditions. The deepening of McCoy's Cut and the construction of a diversion channel at the top end of that cut while allowing more freshwater into the area of the Savannah National Wildlife Refuge will also impact O&M in that 70,763

cubic yards of O&M material will have to be dredged from this area every 10-years. It is estimated that the dredging costs for this effort will be $1,415,000 every 10 years ($141,500/year or $7,075,000 for the 50-year life of the project). Also the Fish Passage will need clearing and snagging every 2-3 years to maintain the flow. Say $50,000/year. The only four elements in this table that incur an O&M obligation are (1) the deepening of McCoy's Cut, (2) the Fish Passage at New Savannah Bluff, (3) the Dissolved Oxygen Injection System, and (4) long-term mitigation monitoring.

Table 1: SHEP Mitigation Plan (47-Foot Project Depth)

Mitigation Element	Cost	Contingency	Total Cost
Real Estate	$10,158,500	$2,539,625	$12,698,125
Fish Passage - New Savannah Bluff	$23,661,976	$5,915,494	$29,577,470
CSS Georgia	$11,131,500	$2,782,875	$13,914,375
McCoy's Cut Diversion Channel	$2,324,082	$581,021	$2,905,103
Deepen McCoy's Cut, Upper Middle & Little Back	$7,287,980	$1,821,995	$9,109,975
ROCK Berm at Mouth of Back River	$16,824,049	$4,206,012	$21,030,061
Close Rifle Cut	$663,131	$165,783	$828,914
Removal Tide Gate Pier and Abutments 10	$2,860,514	$715,129	$3,575,643
Embankment at Tide Gate Removal	$14,375,666	$3,593,917	$17,969,583
Close Lower McCoy's Cut Western Arm	$1,137,557	$284,389	$1,421,946
Construct Dissolved Oxygen Injection Sys - On site	$56,643,000	$14,160,750	$70,803,750
Construct Marsh at Disposal Site 1S	$14,075,959	$3,518,990	$17,594,949
Boat Ramp	$499,962	$124,991	$624,953
Broad Berm Basin - Back River	$6,690,000	$1,672,500	$8,362,500
Water Impoundment	$20,150,000	$5,037,500	$25,187,500
Mitigation Costs for Striped Bass	$2,621,000	$655,250	$3,276,250
Mitigation Sub Totals	**$191,104,876**	**$47,776,219**	**$238,881,095**
Pre-construction Monitoring	$2,893,000	$723,250	$3,616,250
During Construction Monitoring	$8,734,000	$2,183,500	$10,917,500
Post Construction Monitoring	$16,828,000	$4,207,000	$21,035,000
Adaptive Management	$16,701,000	$4,175,250	$20,876,250
Monitor After Adaptive Management	$3,000,000	$750,000	$3,750,000
Mitigation Monitoring Sub Totals	$48,156,000	$12,039,000	$60,195,000
Total	**$239,260,876**	**$59,815,219**	**$299,076,095**

Project History. To understand the impact of these mitigation actions the history and purpose of the Sediment Control Works is important. In the early 20th Century, the Corps of Engineers maintained a fleet of hydraulic and mechanical dredges. Several of these dredges were maintained by the Savannah District and were based in the harbor. Historical records indicate that the Middle Harbor, between Stations 40+000 and 70+000 was the highest shoaling area of the harbor and the one to which the Savannah District dedicated the majority of its dredging plant. Hydraulic cutterhead dredges toiled 24/7 to keep this section of channel clear for passing vessels. In the late 1960's, engineering analyses using physical models identified an efficient way to capture the silts and redirect them to other areas outside

the shipping channel where they might be more easily removed at less cost. The result was the Sediment Control works, a three-part system consisting of a 2-mile long sediment basin, a tide gate consisting of 13 massive steel gates across the Back River, and a diversion canal cut through marsh in the upper Back River estuary which connected the Back and Front Rivers. The system was simple, yet effective. The gates closed with the ebb tide and materials in suspension settled out in the basin. The increased velocity caused by the tidal gradient, forced the upstream flow through the upper cut and into the Front River. The increased water volume and velocity flushed silty sediments through the City Front reach to below the Sediment Basin. Through a succession of tidal cycles, these silt materials were ultimately captured in the Sediment Basin and removed from circulation in the channel. In the mid-eighties, volumes as high as five million cubic yards of sediment have been dredged from the Sediment Basin on an annual basis. The system worked as designed and reduced cost to the taxpayer.

Impacts to Wetlands. As the harbor was improved through the 1980's and 1990's concerns over increased salinity levels were expressed by the US Fish and Wildlife Service (USFWS). Ultimately, the District concluded that the existence of the Tidegate structure prolonged the periods where higher salinity levels existed in the upper estuary's freshwater wetlands. The result was a conversion of freshwater to saltwater marshes which was inconsistent with the mission of the Savannah National Wildlife Refuge. On March 15, 1991, the Tidegate was taken out of service. As a result, the efficiency of the Sediment Basin at trapping sediments was reduced by forty to fifty percent. However,, removal of silts from the basin was more cost effective and less disruptive to shipping than allowing the Basin to completely fill.

Post-Project Channel Conditions. CESAW-EN con ducted a hydraulic analysis of channel conditions expected to occur after the Savannah Harbor Expansion Project is completed. They predict that shoaling will return to pre-Sediment Control Work conditions. Figure 1 below demonstrates this as the green area, which represents the inner harbor shoaling patterns since the decommissioning of the Tidegate has begun to mimic the shoaling pattern depicted in blue which represents the shoaling patterns of the inner harbor prior to constructing the Tidegate. Table 2 below compares historic average annual dredging quantities and costs for the middle harbor (Station 24+000 through Station 70+000) to projected quantities using the same removal costs. The total volume of sediment removed in the inner harbor is not expected to change with a harbor deepening, but the location of the shoaling will be different. Future maintenance costs for the middle harbor, using recent average annual costs will be almost two and a half times greater than existing costs based purely on a different distribution of the sediments. This is a direct result of having to dredge 1,932,000 cubic yards of materials from the channel instead of the Sediment Basin. The difference in cost results from the increased pumping distances to disposal areas and the loss of dredge efficiency due to reduced effective working time caused by passing vessels. There is also a loss of dredge efficiency related to the decreased dredging bank height in the channel (6-8 feet) as compared to 16-20 feet in the Sediment Basin. It should also be noted that if this area experiences periods of above normal precipitation costs could rise considerably.

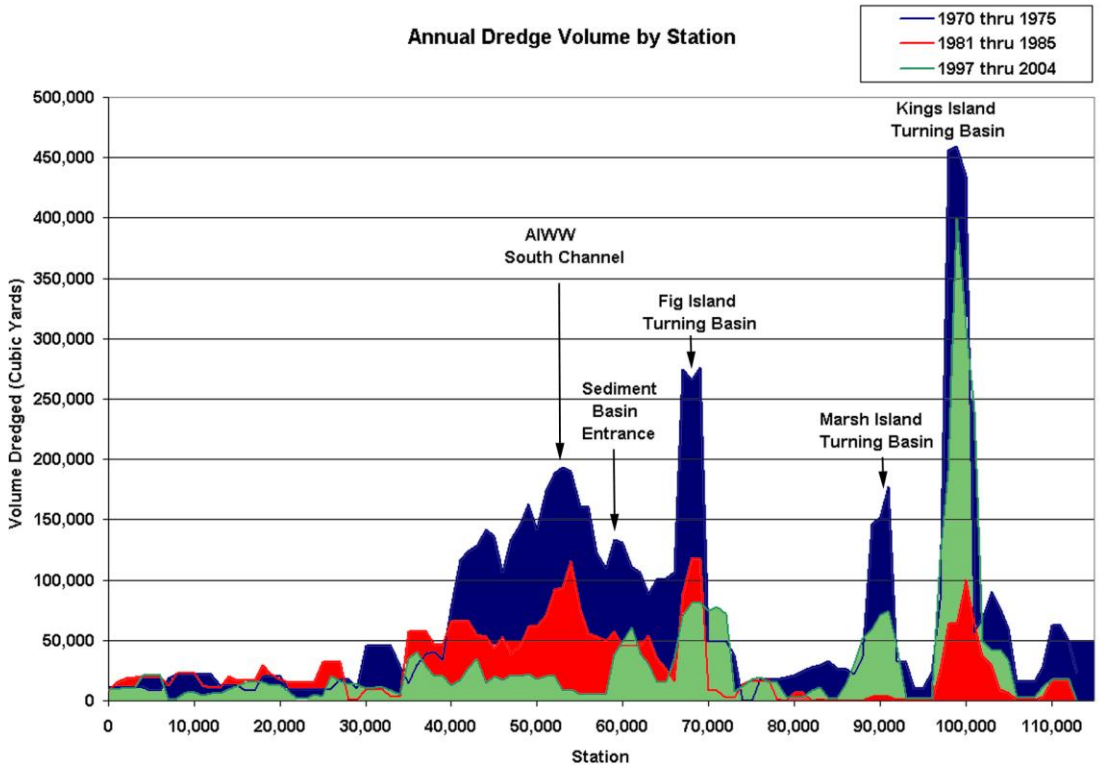


Figure 1

Table 2 – Historic vs. Projected Sediment Volumes and Associated Costs

Stations	Historic Volume w/Sediment Basin	Cost	Projected Volume	Cost
24 to 40+000	328,000	$734,720	364,000	$815,360
40 to 50+000	260,000	$624,000	900,000	$2,160,000
50 to 70+000	820,000	$2,328,800	2,076,000	$5,895,840
Totals	**1,408,000**	**$3,687,520**	**3,340,000**	**$8,871,200**

Present Concerns. The major concerns, as relates to maintenance of the authorized navigation depth in the inner harbor after deepening are the recent low O&M funding levels, the change in shoaling locations anticipated, the availability of dredging plant capable of dredging in the Savannah Harbor, and the available dredging time allotted between environmental windows. The historical solution to all four of these concerns has been the systematic application of what is termed "advanced maintenance" to the O&M of the harbor and concentrating dredging on the middle half of the channel. Since the 1970's, the Savannah District has justified the need to dredge below the congressionally-authorized navigation depth in nearly every reach of the harbor to better maintain the authorized depth for shipping.

Advance maintenance is necessary in Savannah because of the high shoaling rate. The District Engineer, through discretionary authority, has authority to "over dredge" in fast

shoaling areas to extend the duration of the authorized navigation template. This allows the channel to provide its authorized depths for a period of time and prevent the need for repeated dredge mobilizations. Through a series of justifications and approvals based on shoaling rates and dredging records, the District demonstrated that advanced maintenance was both an environmentally and economically sound method of extending the duration of the authorized depths.

Recommendations. The District's advance maintenance program covered under the "Existing Project Depth" portion of Table 3 below was recently re-justified (June 2010). For the Recommended Project this table also contains three sections (identified by an asterisk and highlighted in yellow) where additional material would accumulate and advance maintenance could possibly be needed to maintain existing levels of service assuming the same level of dredge plant requirements. These three sections are the same impacted reaches identified in the sedimentation analysis and shown in Table 2. These predicted shoaling changes may require changes to the advance maintenance program. However, since the future shoaling cannot be determined precisely by modeling, the PDT believes that it would be better to allow the harbor to stabilize after the deepening to obtain a better understanding for the shoaling patterns before the District recommends any adjustment to the advanced maintenance program. If adjustments would be helpful, the District will seek approval to implement them through the normal business process, which would include an economic justification and environmental assessment.

Table 3 – Existing and Recommended Project Depths (feet below MLLW)

Station Limits		Existing Project Depths			Recommended Project Depths		
			Advance	Maint.		Advance	Maint.
Lower	Upper	Channel	Maint	Dredging	Channel	Maint	Dredging
97+680B	60+000B		Not applicable		49	0	49
60+000B	14+000B	44	0	44	49	0	49
14+000B	24+000	42	2	44	47	2	49
24+000	35+000	42	4	46	47	4	51
35+000	37+000	42	6	48	47	6	53
37+000	50+500	42	4	46	47	4	51
50+500	52+750	42	4	46	47	4 *	51
52+750	54+000	42	4	46	47	4	51
54+000	60+250	42	4	46	47	4 *	51
60+250	66+750	42	4	46	47	4	51
66+750	70+000	42	4	46	47	4 *	51
70+000	102+000	42	2	44	47	2	49
102+000	103+000	42	0	42	47	0	47
103+500	105+500	36	2	38	36	2	38
105+500	112+500	30	2	32	30	2	32
Kings Island Turning Basin		42	8	50	48	8	56

NOTE: * indicates which reaches may require additional advance maintenance. Savannah District will request additional advance maintenance if post-project monitoring reveals it would be warranted.

2. Bar Channel Maintenance

Current Annual Maintenance Cycle. Maintenance dredging is presently performed on an annual basis. The annual cost of maintenance dredging in the outer bar channel is currently $5.5 million (Table 4). This annual dredging process entails hopper dredges removing the dredged material from the bar channel and placing it in the ocean dredged material disposal site (ODMDS). The SHEP will require the extension of the Bar Channel from Station -60+000B to -97+680B. This will result in an increase in annual maintenance for the Bar Channel of $46,600 (see Table 4, below).

Coastal Zone Management Act (CZM). The proposed project would comply with all elements of the South Carolina and Georgia Coastal Management Programs. The new work sediments associated with dredging the entrance channel will be placed in the ODMDS and an existing upland DMCA.

Due to their cost effectiveness, hopper dredges are expected to be the primary equipment used to maintain depths in the entrance channel. Those dredges would generally deposit maintenance sediments in the ODMDS because the nearshore placement areas are too shallow for direct access to hopper dredges. The Corps could place the maintenance sediments in the nearshore placement areas if a non-Federal interest paid the incremental cost for the additional equipment and time that would be required for such an operation.

Table 4 –Bar Channel Maintenance Costs

Range	Disposal Site	Average Annual O&M Costs	Projected Annual Maintenance Yards	Projected O&M Cost
(-)60+000 to -57+000	**ODMDS**	$4.35	10,000	$43,500
(-)57+000 to -53+500	**ODMDS**	$4.35	3,000	$13,050
(-)53+500 to-40+000	**ODMDS**	$4.35	54,000	$234,900
(-) 40+000 to -30+000	**ODMDS**	$4.35	325,000	$1,413,750
(-)30+000 to -20+000	**ODMDS**	$4.35	281,000	$1,222,350
(-)20+000 to -10+000	**ODMDS**	$4.35	163,000	$709,050
(-) 10+000 to 0+000	**ODMDS**	$4.35	155,000	$674,250
0+000 to +4+000	**ODMDS**	$4.35	76,000	$330,600
			1,067,000	$4,641,450
			Mob & Demob	$690,000
			Multiple Mobs	$40,000
			Total Mob & Demob	$730,000
			PED	$40,000
			S&A	$100,000
	TOTAL COSTS			**$5,511,450**
	Bar Channel Maintenance after Expansion			
Range	**Disposal Site**	**Average Annual O&M Costs**	**Projected Annual Maintenance Yards**	**Projected O&M Cost**
(-)98+600 to -57+000	**ODMDS**	$4.35	21,580	$93,873
(-)57+000 to -53+500	**ODMDS**	$4.35	3,000	$13,050
(-)53+500 to-40+000	**ODMDS**	$4.35	54,000	$234,900
(-) 40+000 to -30+000	**ODMDS**	$4.35	325,000	$1,413,750
(-)30+000 to -20+000	**ODMDS**	$4.35	281,000	$1,222,350
(-)20+000 to -10+000	**ODMDS**	$4.35	163,000	$709,050
(-) 10+000 to 0+000	**ODMDS**	$4.35	155,000	$674,250
0+000 to +4+000	**ODMDS**	$4.35	76,000	$330,600
			1,078,580	**$4,691,823**
			Mob & Demob	$690,000
			Multiple Mobs	$40,000
			Total Mob & Demob	$730,000
			PED	$40,000
			S&A	$100,000
	TOTAL COSTS			**$5,561,823**
	Impacts to O&M			($50,373)

3. Summary of Annual O&M Dredging Impacts:

Currently, Savannah District annually receives approximately $13M for O&M dredging and maintenance of the upland disposal areas. This does not include funds for dike raising which are described in Table 5 below. With these funds, the District maintains the center two quadrants of the Federal channel. However, under current conditions, with the Sediment Basin operational, if the entire channel prism were to be maintained the cost would be $24,368,190 (Current price levels) an increase of approximately $11.4 million (59%) over the present O&M funding (Table 6). This information is based on a Sedimentation Analysis done on the Savannah Harbor Expansion Project in June 2007. If/when the project is deepened (-42 feet to -47 feet) the sill constructed at the lower end of the Sediment Basin will cause it to fill. This will result in the sediment currently being captured in the Sediment Basin (~1,932,000CY) to instead deposit in the navigation channel mainly in the range from Station 24+000 to 70+000. This will result in a total increase of O&M dredging and maintenance costs to $27,415,490 or an increase attributable to the project of $3,047,773. Of this total $2,997,400 was attributed to the Inner Harbor while $50,373 was attributed to the Bar Channel.

Table 5 – Savannah Harbor Navigation Project (existing)
UPDATE Annual Work Plan FY 2010 – Dike Raising Schedule

Year	Project	Est Cost	Fed$	Non-Fed$
2010	12B/13A Dikes Raising	$3,078,880	$2,001,272	$1,077,608
	Dike Maintenance	$590,000	$560,000	$30,000
	Mosquito Control	$300,000	$300,000	$0
	Bird Island Construction	$900,000	$600,000	$300,000
2011	JOI Dike Raising	$11,950,000	$7,767,500	$4,182,500
	Dike Maintenance	$597,000	$567,000	$30,000
	Mosquito Control	$300,000	$300,000	$0
2012	Dike Maintenance	$615,000	$615,000	$0
	Mosquito Control	$300,000	$300,000	$0
2013	12A Dike Raising	$9,000,000	$5,850,000	$3,150,000
	Dike Maintenance	$633,000	$633,000	$0
	Mosquito Control	$300,000	$300,000	$0
2014	Dike Maintenance	$640,000	$640,000	$0
	Mosquito Control	$300,000	$300,000	$0
2015	Dike Maintenance	$650,000	$650,000	$0
	Mosquito Control	$300,000	$300,000	$0

* The raising of dikes is coordinated with the rotation schedule of the Dredged Material Containment Areas (DMCA) which is included in the DMMP Annual Work Plan.

Table 6 - Current O&M Costs vs. Projected O&M Costs after Deepening

Range	Avg Ann Cost O&M Dredge	Current Ann Maint Yards	Current O&MCosts	Projected Ann Maint Yards	Projected O&M Costs
(-)98+600 to -57+000	$4.35	10,000	$43,500	21,580	$93,873
(-)57+000 to -53+500	$4.35	3,000	$13,050	3,000	$13,050
(-)53+500 to-40+000	$4.35	54,000	$234,900	54,000	$234,900
(-) 40+000 to -30+000	$4.35	325,000	$1,413,750	325,000	$1,413,750
(-)30+000 to -20+000	$4.35	281,000	$1,222,350	281,000	$1,222,350
(-)20+000 to -10+000	$4.35	163,000	$709,050	163,000	$709,050
(-) 10+000 to 0+000	$4.35	155,000	$674,250	155,000	$674,250
0+000 to +4+000	$4.35	76,000	$330,600	76,000	$330,600
Bar Channel (Hopper) Total		**1,067,000**	**$4,641,450**	**1,078,580**	**$4,691,823**
4+000 to 24+000	$5.95	225,000	$1,338,750	225,000	$1,338,750
24+000 to 40+000	$3.25	328,000	$1,066,000	364,000	$1,183,000
40+000 to 50+000	$2.93	260,000	$761,800	900,000	$2,637,000
50+000 to 70+000	$2.80	820,000	$2,296,000	2,076,000	$5,812,800
70+000to 79+000	$2.40	294,000	$705,600	294,000	$705,600
79+000 to 97+750	$4.06	605,000	$2,456,300	605,000	$2,456,300
97+750 to 102+000	$3.67	1,456,000	$5,343,520	1,456,000	$5,343,520
102+000 to 103+000	$3.67	51,000	$187,170	51,000	$187,170
Inner Harbor (Pipeline) Total		**4,039,000**	**$14,155,140**	**5,971,000**	**$19,664,140**
Sediment Basin	$1.30	1,932,000	$2,511,600	0	$0
Project Total without Mob & Demob		**7,038,000**	**$21,308,190**	**7,049,580**	**$24,355,963**
MOB & DEMOB Ocean Bar - One Hopper			$690,000		$690,000
MOB & DEMOB Ocean Bar - Two Pipeline Dredges			$2,200,000		$2,200,000
MULTIPLE MOBS			$40,000		$40,000
MULTIPLE MOBS			$40,000		$40,000
Total MOBS & DEMOBS			$2,970,000		$2,970,000
PED			$40,000		$40,000
S&A			$50,000		$50,000
Projected Total for All Costs			**$24,368,190**		**$27,415,963**
			Impacts to O&M		**$3,047,773**

4. Mitigation – Dissolved Oxygen System

Background. The Savannah District of the United States Army Corps of Engineers (USACE) partnered with the Georgia Ports Authority to evaluate the feasibility of deepening the navigation channel in the Savannah Harbor. This effort is called the Savannah Harbor Expansion (SHE) Project. The project is intended to identify whether deepening the harbor from its presently authorized 42-foot depth, up to a depth of 48-feet is warranted and environmentally acceptable. It will also identify the most appropriate depth within that range.

Hydrodynamic and water quality models were developed and determined to be acceptable in March 2006 by the EPA, United States Fish and Wildlife Service (USFWS), Georgia Department of Natural Resources, Environmental Protection Division (GA DNR-EPD), and South Carolina Department of Health and Environmental Control (SC DHEC) to identify dissolved oxygen levels throughout Savannah Harbor. Studies identified a dissolved oxygen injection system as being the most cost effective method to improve dissolved oxygen levels in the harbor. The Savannah Harbor Expansion Project examined ways to mitigate for potential adverse effects on dissolved oxygen levels resulting from the proposed harbor deepening alternatives. The Savannah Harbor Expansion Project intends to use a dissolved oxygen injection system for that mitigation. To meet these mitigation requirements, designs for a dissolved oxygen injection system were evaluated to size and locate the system components and ensure the dissolved oxygen effectively mixes throughout the portions of the harbor that would have experienced dissolved oxygen impacts.

Dissolved Oxygen Injection System. Deepening the navigation channel would adversely impact dissolved oxygen levels in the harbor if no mitigation is included. Since this is a critical resource in the harbor, the Corps has included a feature in the mitigation plan for each depth alternative that minimizes that adverse effect.

The Corps' studies indicate that oxygen injection is the most cost-effective method for raising D.O. levels in the harbor. Due to site-specific requirements, the Corps believes that a land-based injection system would be the most effective solution. It identified the use of Speece cones as the specific technique to inject oxygen into the water, although another land-based technique could be found to be more cost-effective. A different injection technique could be substituted at the time of construction without further NEPA coordination if impacts to wetlands, water quality or fisheries remain the same as with the Speece cones. The hydrodynamic and water quality modeling indicate that a system of injection locations would be needed, as summarized in Table 7. These systems would remove the incremental effects of the channel deepening alternatives.

Table 7: Number of Injection Locations based on Project Depth

Depth Alternative	Number of Injection Locations	Capacity to Increase D.O. (lb/day)
44-foot	3	36,000
45-foot	3	32,000
46-foot	3	36,000
47-foot	3	40,000
48-foot	3	44,000

The locations identified for these systems are shown in Figure 2. All three locations (near Georgia Pacific, Hutchinson Island – west, Hutchinson Island –east) would be needed for each channel depth alternative. The systems would be land-based, with water being withdrawn from the river through pipes, then super-saturated with oxygen and returned to the river. The water intake structure would include screens to reduce the intake of trash and other suspended solids. The screens would be sized to keep flow velocities from exceeding 0.5 foot per second to minimize entrainment of fish larvae. The intake and discharge would be located along the side of the river and not extend out into the authorized navigation channel. Figure 3 shows a typical layout for the oxygen injection facility. The systems would be operated at full capacity during the months of July/August/September. The Corps would begin to operate the systems on 15 June to allow the dissolved oxygen to be fully distributed throughout the estuary by 1 July.

With all oxygen injection designs, dissolved oxygen levels are higher near the injection site and taper off to lower levels as distance from the site increases. Removing the incremental project effect at a great distance from injection site requires substantially greater amounts of oxygen. A tradeoff results between the amount of oxygen required and the distance from the injection site. This becomes a tradeoff between the amount of oxygen required (operating expense) and the number of injection locations (capital expense). As the number of injection locations increases, the complexity of maintaining numerous systems also increases. The overall D.O. system configuration is designed to remove the incremental effect of a deeper channel in 95 percent of the cells in the hydrodynamic model. The minor impact that would remain at a distance away from the injection location is balanced by the higher dissolved oxygen levels that would occur close to where the oxygen is added. The District and the natural resource agencies believe the 95 percent level of performance recognizes both the higher D.O. levels close to the injection sites and the limitations of the model at distinguishing small differences between different run conditions.

MODELED LOCATIONS
FOR DISSOLVED OXYGEN INJECTION SYSTEMS

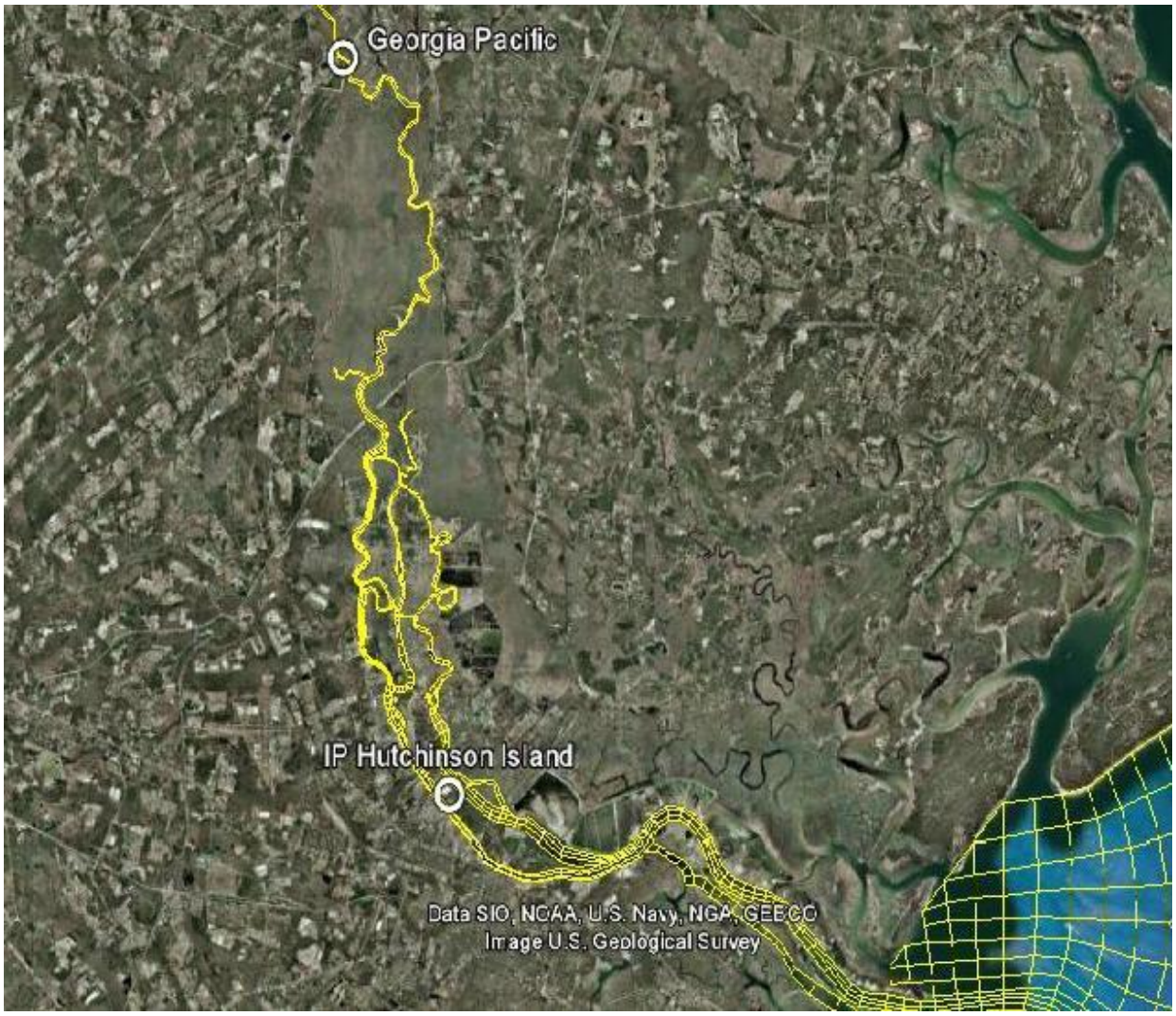
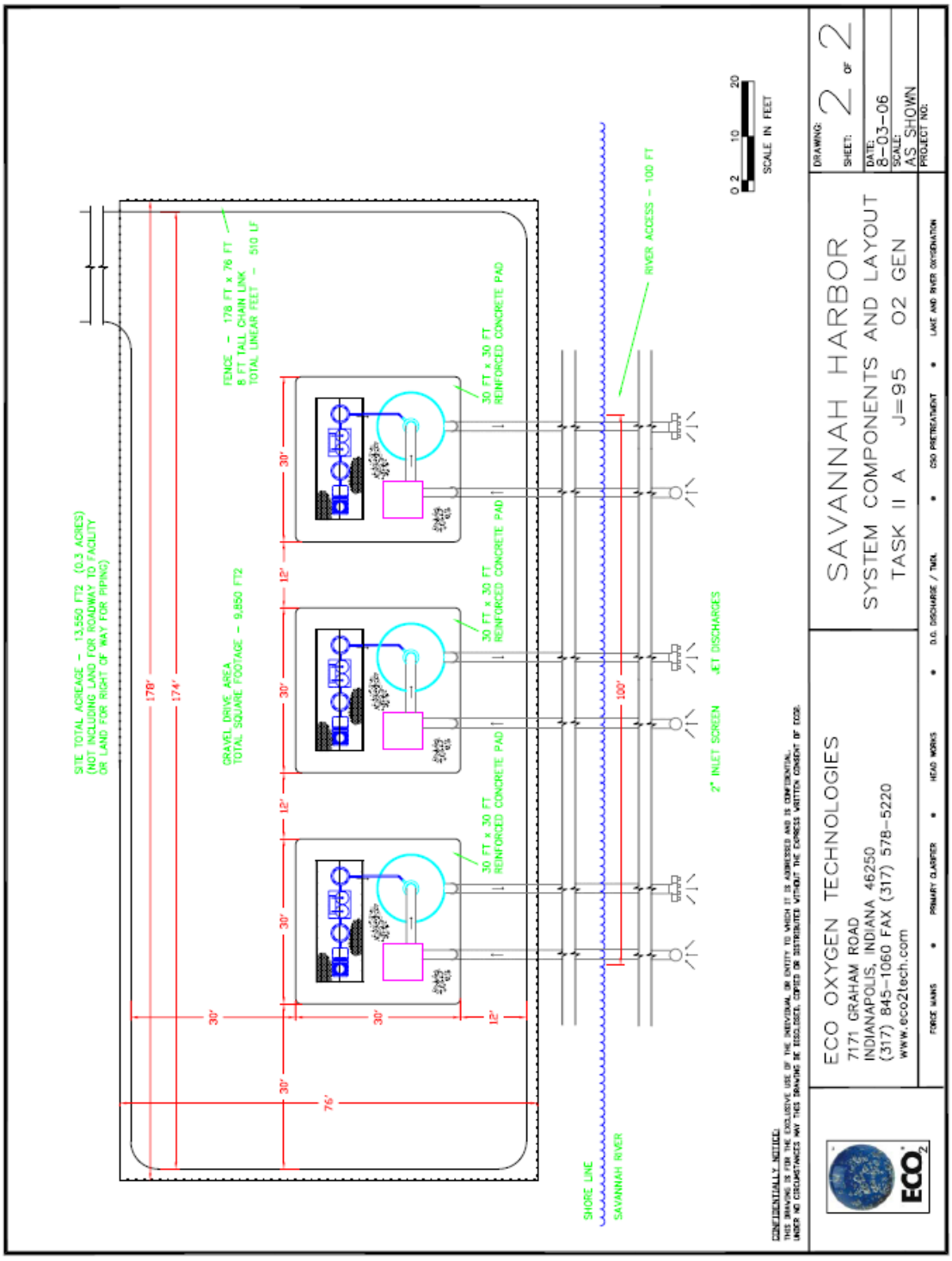


Figure 2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FENCE - 178 FT x 76 FT 6 FT TALL CHAIN LINK TOTAL LINEAR FEET - 510 LF
GRAVEL DRIVE AREA TOTAL SQUARE FOOTAGE - 9,850 FT2
SITE TOTAL ACREAGE - 13,550 FT2 (0.3 ACRES) (NOT INCLUDING LAND FOR ROADWAY TO FACILITY OR LAND FOR RIGHT OF WAY FOR PIPING)
178'
174'
76'
100'
CONFIDENTIALITY NOTICE:

Figure 3

Since dissolved oxygen levels would be higher near the injection site and taper off away from the site, the Corps analyzed the model outputs and found that the systems would increase dissolved oxygen levels above their present levels over much of the harbor. Such improvements are a secondary benefit of a system that is designed to remove the incremental effect of a deeper channel in 95 percent of the bottom cells. The following information shows the extent of the improvements that would occur:

Table 8: Percent of Cells with Improvement in D.O. Levels Over Existing Conditions With the D.O. Improvement Systems

	DEPTH ALTERNATIVE				
Vertical Layer	**44-foot**	**45-foot**	**46-foot**	**47-foot**	**48-foot**
Surface	99.3	98	98	98.4	99.2
Mid-Depth	94	94.5	94.5	96.2	95.1
Bottom	96.9	93.9	92.3	95.1	96.4
Water Column	98	99.9	99.8	99.8	99.7

The proposed system designs provide the best balance of system spacing, size and effectiveness, when the issues of operating complexity, existing land uses, and over-compensation of impacts are considered. The systems are also scalable so that it could be expanded in the future if desired to produce net improvements in harbor D.O. levels.

The costs for operating the dissolved oxygen injection system are based on their continued operation for a period of 180 days per year. Adjustments should be made to those operating costs if the sytems would be operated for shorter or longer durations. Once the Oxygen Injection systems are installed, they will be the responsibility of the Federal Navigation Project to operate and maintain. Since the Corps considers mitigation features as "General Navigation Features", the Federal Government would be responsible for the costs to operate and maintain them.

Impacts to O&M. The annual impacts to O&M by the Dissolved Oxygen Injection System are for upkeep of the landside facilities to house the system and for the operating costs to produce the oxygen. These costs are shown by project depth in Table 9. Also included in the annual O&M costs are the replacement costs for the Speece cone and intake and discharge lines at 40-year intervals; and replacement of the oxygen flow control, oxygen generator and side stream pump at 20 year intervals.

Table 9: Dissolved Oxygen Injection System Annual Impact to O&M

Project Depth	Annual O&M Costs
44-foot	$1,110,000
45-foot	$908,500
46-foot	$1,110.000
47-foot	$1,210,400
48-foot	$1,311,000

5. Project Impacts to O&M

Annual Savannah Harbor Expansion Project impacts to O&M are shown in Table 10, while Table 11 contains the annual impacts to O&M for the NED Plan (47-ft) and the annual O&M project costs after expansion. Cost sharing is 100-percent Federal above 45 feet and 50/50 Federal/non-Federal below 45 feet.

Table 10: Expansion Project Annual Impacts to O&M by Depth			
	44-ft Project		
Description	**Cost**	**Federal Cost**	**Non-Federal Cost**
Oxygen Injection System	$1,110,000.00	$1,110,000.00	$0.00
Inner Harbor O&M Dredging	$2,672,080.00	$2,672,080.00	$0.00
Channel Extension	$46,589.00	$46,589.00	$0.00
Mitigation Features Dredging	$114,000.00	$114,000.00	$0.00
CSS Georgia Curation	$20,000.00	$20,000.00	$0.00
Fish Passage O&M	$50,000.00	$50,000.00	$0.00
Long Term Monitoring	$428,400.00	$428,400.00	$0.00
Total	**$4,441,069.00**	**$4,441,069.00**	**$0.00**
	45-ft Project		
Oxygen Injection System	$908,500.00	$908,500.00	$0.00
Inner Harbor O&M Dredging	$2,672,080.00	$2,672,080.00	$0.00
Channel Extension	$48,155.00	$48,155.00	$0.00
Mitigation Features Dredging	$114,000.00	$114,000.00	$0.00
CSS Georgia Curation	$20,000.00	$20,000.00	$0.00
Fish Passage O&M	$50,000.00	$50,000.00	$0.00
Long Term Monitoring	$428,400.00	$428,400.00	$0.00
Total	**$4,241,135.00**	**$4,241,135.00**	**$0.00**
	46-ft Project		
Oxygen Injection System	$1,110,000.00	$1,009,250.00	$100,750.00
Inner Harbor O&M Dredging	$2,672,080.00	$2,672,080.00	$0.00
Channel Extension	$48,938.00	$48,546.50	$391.50
Mitigation Features Dredging	$114,000.00	$114,000.00	$0.00
CSS Georgia Curation	$20,000.00	$20,000.00	$0.00
Fish Passage O&M	$50,000.00	$50,000.00	$0.00
Long Term Monitoring	$428,400.00	$428,400.00	$0.00
Total	**$4,443,418.00**	**$4,342,276.50**	**$101,141.50**
	47-ft Project		
Oxygen Injection System	$1,210,400.00	$1,059,450.00	$150,950.00
Inner Harbor O&M Dredging	$2,672,080.00	$2,672,080.00	$0.00
Channel Extension	$49,199.00	$48,677.00	$522.00
Mitigation Features Dredging	$114,000.00	$114,000.00	$0.00
CSS Georgia Curation	$20,000.00	$20,000.00	$0.00
Fish Passage O&M	$50,000.00	$50,000.00	$0.00

Long Term Monitoring	$428,400.00	$428,400.00	$0.00
Total	**$4,544,079.00**	**$4,392,607.00**	**$151,472.00**
	48-ft Project		
Oxygen Injection System	$1,311,000.00	$1,109,750.00	$201,250.00
Inner Harbor O&M Dredging	$2,672,080.00	$2,672,080.00	$0.00
Channel Extension	$50,373.00	$49,264.00	$1,109.00
Mitigation Features Dredging	$114,000.00	$114,000.00	$0.00
CSS Georgia Curation	$20,000.00	$20,000.00	$0.00
Fish Passage O&M	$50,000.00	$50,000.00	$0.00
Long Term Monitoring	$428,400.00	$428,400.00	$0.00
Total	**$4,645,853.00**	**$4,443,494.00**	**$202,359.00**

For Tables 11 - 13 cost indexing was accomplished using EM 1110-2-1304 (31 March 2000) Civil Works Construction Cost Index System (CWCCIS) (CWBS Code = 12 – Navigation Ports & Harbors).

Table 11: Impacts to O&M for NED Plan and O&M Program (47-Foot Project)

ANNUAL O&M INCREASE COST DUE TO EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$2,672,080	$2,709,489	$2,752,841	$2,799,639	$2,847,233	$2,895,636	$2,944,862	$2,994,925	$3,045,838	$3,097,618
Bar Channel O&M Dredging	$49,199	$49,888	$50,686	$51,548	$52,424	$53,315	$54,222	$55,143	$56,081	$57,034
Oxygen Injection System	$1,210,400	$1,227,346	$1,246,983	$1,268,182	$1,289,741	$1,311,667	$1,333,965	$1,356,642	$1,379,705	$1,403,160
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
	$4,544,079	$4,607,696	$4,681,419	$4,761,003	$4,841,940	$4,924,253	$5,007,966	$5,093,101	$5,179,684	$5,267,738

ANNUAL O&M PROJECT COST AFTER EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$21,487,100	$21,787,919	$22,136,526	$22,512,847	$22,895,565	$23,284,790	$23,680,631	$24,083,202	$24,492,617	$24,908,991
Bar Channel O&M Dredging	$3,416,423	$3,464,253	$3,519,681	$3,579,516	$3,640,367	$3,702,254	$3,765,192	$3,829,200	$3,894,297	$3,960,500
Oxygen Injection System	$1,210,400	$1,227,346	$1,246,983	$1,268,182	$1,289,741	$1,311,667	$1,333,965	$1,356,642	$1,379,705	$1,403,160
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
Estimated $ to Fully Maintain	$26,726,323	$27,100,492	$27,534,099	$28,002,179	$28,478,216	$28,962,346	$29,454,706	$29,955,436	$30,464,678	$30,982,578
Current Funding Appropriation	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000
Additional Need to Fully Maintain	$13,726,323	$14,100,492	$14,534,099	$15,002,179	$15,478,216	$15,962,346	$16,454,706	$16,955,436	$17,464,678	$17,982,578

* All costs are totals assuming a 47-foot project. No breakout of Federal vs. Sponsor cost has been applied.
(100% Fed to 45', 50/50 Fed/Non-Fed from 45' to NED).

Table 12: Impacts to O&M for NED Plan and O&M Program (46-Foot Project)

ANNUAL O&M INCREASE COST DUE TO EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$2,672,080	$2,709,489	$2,752,841	$2,799,639	$2,847,233	$2,895,636	$2,944,862	$2,994,925	$3,045,838	$3,097,618
Bar Channel O&M Dredging	$48,938	$49,623	$50,417	$51,274	$52,146	$53,032	$53,934	$54,851	$55,783	$56,732
Oxygen Injection System	$1,110,000	$1,125,540	$1,143,549	$1,162,989	$1,182,760	$1,202,867	$1,223,315	$1,244,112	$1,265,262	$1,286,771
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
	$4,443,418	$4,505,626	$4,577,716	$4,655,537	$4,734,681	$4,815,171	$4,897,029	$4,980,278	$5,064,943	$5,151,047

ANNUAL O&M PROJECT COST AFTER EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$21,487,100	$21,787,919	$22,136,526	$22,512,847	$22,895,565	$23,284,790	$23,680,631	$24,083,202	$24,492,617	$24,908,991
Bar Channel O&M Dredging	$3,416,423	$3,464,253	$3,519,681	$3,579,516	$3,640,367	$3,702,254	$3,765,192	$3,829,200	$3,894,297	$3,960,500
Oxygen Injection System	$1,110,000	$1,125,540	$1,143,549	$1,162,989	$1,182,760	$1,202,867	$1,223,315	$1,244,112	$1,265,262	$1,286,771
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
Estimated $ to Fully Maintain	$26,625,923	$26,998,686	$27,430,665	$27,896,986	$28,371,235	$28,853,546	$29,344,056	$29,842,905	$30,350,235	$30,866,189
Current Funding Appropriation	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000
Additional Need to Fully Maintain	$13,625,923	$13,998,686	$14,430,665	$14,896,986	$15,371,235	$15,853,546	$16,344,056	$16,842,905	$17,350,235	$17,866,189

* All costs are totals assuming a 46-foot project. No breakout of Federal vs. Sponsor cost has been applied.
(100% Fed to 45', 50/50 Fed/Non-Fed from 45' to NED).

Table 13: Impacts to O&M for NED Plan and O&M Program (48-Foot Project)

ANNUAL O&M INCREASE COST DUE TO EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$2,672,080	$2,709,489	$2,752,841	$2,799,639	$2,847,233	$2,895,636	$2,944,862	$2,994,925	$3,045,838	$3,097,618
Bar Channel O&M Dredging	$50,373	$51,078	$51,895	$52,778	$53,675	$54,587	$55,515	$56,459	$57,419	$58,395
Oxygen Injection System	$1,311,000	$1,329,354	$1,350,624	$1,373,584	$1,396,935	$1,420,683	$1,444,835	$1,469,397	$1,494,377	$1,519,781
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
	$4,645,853	$4,710,895	$4,786,269	$4,867,636	$4,950,386	$5,034,542	$5,120,129	$5,207,172	$5,295,694	$5,385,720

ANNUAL O&M PROJECT COST AFTER EXPANSION

	Year									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Inner Harbor O&M Dredging	$21,487,100	$21,787,919	$22,136,526	$22,512,847	$22,895,565	$23,284,790	$23,680,631	$24,083,202	$24,492,617	$24,908,991
Bar Channel O&M Dredging	$3,416,423	$3,464,253	$3,519,681	$3,579,516	$3,640,367	$3,702,254	$3,765,192	$3,829,200	$3,894,297	$3,960,500
Oxygen Injection System	$1,311,000	$1,329,354	$1,350,624	$1,373,584	$1,396,935	$1,420,683	$1,444,835	$1,469,397	$1,494,377	$1,519,781
Mitigation Features O&M Dredging	$114,000	$115,596	$117,446	$119,442	$121,473	$123,538	$125,638	$127,774	$129,946	$132,155
Fish Passage O&M	$50,000	$50,700	$51,511	$52,387	$53,277	$54,183	$55,104	$56,041	$56,994	$57,963
CSS Georgia Curation	$20,000	$20,280	$20,604	$20,955	$21,311	$21,673	$22,042	$22,416	$22,798	$23,185
Long Term Monitoring	$428,400	$434,398	$441,348	$448,851	$456,481	$464,242	$472,134	$480,160	$488,323	$496,624
Estimated $ to Fully Maintain	$26,826,923	$27,202,500	$27,637,740	$28,107,581	$28,585,410	$29,071,362	$29,565,576	$30,068,190	$30,579,350	$31,099,198
Current Funding Appropriation	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000	$13,000,000
Additional Need to Fully Maintain	$13,826,923	$14,202,500	$14,637,740	$15,107,581	$15,585,410	$16,071,362	$16,565,576	$17,068,190	$17,579,350	$18,099,198

* All costs are totals assuming a 48-foot project. No breakout of Federal vs. Sponsor cost has been applied.
(100% Fed to 45', 50/50 Fed/Non-Fed from 45' to NED).