APPENDIX C

Economic Data

SMITH ISLAND DEMOGRAPHIC AND ECONOMIC ANALYSES

Chapter 1
Social and Economic Characteristics

Introduction

Its geographic location in the Chesapeake Bay, 45 minutes by ferry from the Maryland mainland, significantly influences the social and economic setting of Smith Island. Access to and from the island is limited to daily ferryboat trips from Crisfield, Maryland. All consumer goods, from food to building materials to petroleum for the islanders' boats are transported from Crisfield by ferry. Bicycles and golf carts are the primary means of transportation on the island's narrow roads. There are no elected or officially appointed governmental officials on Smith Island. The three island communities of Ewell, Rhodes Point and Tylerton, as well as the island's uninhabited marshlands are within the jurisdiction of Somerset County. In matters of health and safety, the islanders essentially provide necessary services themselves. There are trained medical technicians on the island for medical emergencies, and there is a well-equipped volunteer fire department to address non-medical emergencies. But, there is neither a police force nor an official local taxing authority. Most of the islanders adhere to the de facto authority of the local Methodist Church community. As an illustration, it is the church that assesses an annual fee for trash management and street cleaning activities.

Most islanders are adept at operating waterborne vessels to navigate between the three communities on the island. Nearly all of the 400 residents of Smith Island are dependent on the seafood industry for their livelihood. Seafood is harvested in nearby waters and either processed locally or packed for shipment. Besides providing an indispensable cash commodity to the communities, the harvesting of crabs and oysters provides some of the islanders with a semi-subsistence way of life. There is a crab cooperative located in Tylerton that processes crabmeat for commercial shipment or local consumption by the families participating in the cooperative. While there is no other significant industry on the island, there is a museum, restaurant, and gift shop, which cater to the seasonal tourists disembarking from tour boats from May to October.

The information in the next section characterizes the existing and projected future without a project social and economic aspects for Smith Island. Comparable information is provided at the national, state and Somerset County levels. Demographic information is presented for population, education, housing, income, employment and transportation. The most recently available demographic information from the 1990 census was used as a basis for the analysis. It was augmented by 1998 data provided by the State of Maryland Office of Planning and by data from a 1995 Somerset County Sanitary District survey. The final section addresses the impacts of proposed Corps of Engineers projects on socioeconomic parameters on Smith Island.

Existing and future without a project analysis

Population

Although exact historic population statistics for Smith Island are unavailable, anecdotal information indicates that the population peaked at about 800 residents early in the twentieth century. By 1960, the population had declined to about 650 residents. By 1990, according to the census of that year, the Smith Island population had declined to 459 residents. The 1990 census counted 238 residents in Ewell, 124 residents in Tylerton, and 97 residents in Rhodes Point. The downward spiral in population on Smith Island contrasts with an upturn in the Somerset County population. Between 1980 and 1990 the population of Somerset County increased by 22 percent. In the same timeframe, the state of Maryland population increased by 9.9 percent.

Population estimates from the 1990 Census as well as long term population projections are shown in Table 1 below. State of Maryland projections listed for years 2010 and 2020 were interpolated from census projections for mid-decade years (i.e., 2005, 2015). Long-term state projections to 2050 were projected at the same rate of increase as occurred from 1990 to 2020. Projections for Somerset County through 2020 were obtained from 1996 projections by the Planning Data Services arm of the Maryland Office of Planning, and were also extrapolated from 2020 to 2050 based on the long-term trend. Long-term population projections were not available for Smith Island. However, there has been an average decline of about 10 percent per decade from 1960 to 1990. Projecting this rate of decline over the period of analysis results in the population figures presented in the table for Smith Island. The resulting estimates may be conservative because according to a 1995 survey by the Somerset County Sanitary District, the estimated population on Smith Island was 400 residents, a 12.8 percent decline since the 1990 census. Assuming a continuation of a decline at that recent 5-year rate, total population on the island would likely fall to less than 200 residents by 2030.

Table 1: 1990 Population and Population Projections

	Census	**Population Projections**					
	1990	2000	2010	2020	2030	2040	2050
USA	248,709,873	274,634,000	297,716,000	322,742,000	346,899,000	369,980,000	393,931,000
Maryland	4,797,556	5,275,000	5,665,000	6,068,000	6,500,000	6,962,000	7,674,000
Somerset County	23,440	25,400	26,850	27,250	28,700	30,100	31,600
Smith Island*	459	413	372	335	302	272	245

Source: U.S. Department of Commerce, Census Bureau

*Note: Population estimates are based on continuation of the 1960-1990 average decline of 10% per decade.

Possible explanations for the continuing decline in population may be revealed by a view of study area age and gender population distributions. The distributions of these characteristics on Smith Island differ markedly from national and state level distributions. Table 2 presents the 1990 age distributions at the national, state, county and Smith Island levels. Age distributions on Smith Island are fairly consistent with the state of Maryland

and Somerset County distributions, except in the 0-4 and the 25-64 age ranges. In 1990, there were no children counted in the 0-4 age group on Smith Island. This anomaly probably reflects the trend toward migration of younger residents to the mainland. In the 25-64 age group, the Smith Island population significantly exceeds that for the nation, state, and county.

Gender distribution data reported in the 1990 census of population and housing are shown in Table 3. The Smith Island gender distributions differ considerably from the national, state and county distributions. Fifty eight percent of Smith Islanders in 1990 were male, 9 percent greater than the state and national figures and 5 percent more than in Somerset County. This significant gender disparity is another possible explanatory factor in the overall population decline because there are relatively few women of childbearing age living on the island. In 1990, according to census data, there were 55 females in the expected childbearing age range living on the island, compared with 113 men in the expected paternal age range. This gender disparity was identified as a concern by the attendees at a Corps of Engineers public meeting on the island.

Table 2: Age Distribution

Place	Age (years)	1990 Census Population	%
USA	0 to 4	18,264,096	7%
	5 to 17	45,342,448	18%
	18 to 24	26,234,893	11%
	25 to 64	127,673,161	51%
	over 65	31,195,275	13%
Maryland	0 to 4	368,494	8%
	5 to 17	810,222	17%
	18 to 24	504,543	10%
	25 to 64	2,596,388	54%
	over 65	517,909	11%
Somerset County	0 to 4	1662	5%
	5 to 17	3625	15%
	18 to 24	2711	12%
	25 to 64	11,951	53%
	over 65	3491	15%
Smith Island	0 to 4	0	0%
	5 to 17	73	16%
	18 to 24	51	11%
	25 to 64	278	61%
	over 65	57	12%

Source: U.S. Department of Commerce, Census Bureau

Table 3: Gender Distribution

Place	Gender	1990 Census Population	%
USA	Male	121,172,379	49%
	Female	127,537,494	51%
MD	Male	2,327,097	49%
	Female	2,470,459	51%
Somerset County	Male	12,323	53%
	Female	11,117	47%
Smith Island	Male	265	58%
	Female	194	42%

Source: U.S. Department of Commerce, Census Bureau

Another trend apparent on Smith Island is that people who are not year-round residents of the island are purchasing residential properties to use as vacation housing. If year-round population on the island continues to decline and more housing becomes available, this trend could impact the island's social and economic profile.

Education

There is currently one public elementary school on Smith Island at Ewell. After completing elementary school, Smith Island children commute to Crisfield to attend high school. According to the 1990 census there were 96 Smith Island children enrolled in public schools.

Since 1980, the Chesapeake Bay Foundation has administered an educational program based in Tylerton. Centers of higher education on the Delmarva Peninsula include the University of Maryland Eastern Shore (UMES) and Salisbury State University in Salisbury. Located in the town of Princess Anne, UMES offers undergraduate and graduate programs, including doctoral programs in marine, estuarine, and environmental sciences. Also, Wicomico Community College offers a "college without walls" program on the lower Eastern Shore of the peninsula.

According to the 1990 census 78 percent of those persons 25 years and older have obtained a high school diploma in the state of Maryland, while in Somerset County and Smith Island the proportions are lower, 61 percent and 24 percent respectively. The 1990 census also reports that among persons 25 years and older, 27 percent have obtained a bachelor's or professional degree in the state of Maryland, while in Somerset County and Smith Island the proportions are lower, 10 percent and 1 percent respectively.

Households, Housing, and Income

The number of households and the number of housing units in Somerset County have been increasing. According to the 1990 census, the number of households in Somerset

County was 7835, an 18.2 percent increase since 1980. Similarly, the number of housing units increased approximately 20.3 percent to 9393 during the same time period. The number of housing units on Smith Island totaled 259 according to 1990 census information, while the number of households on the island totaled 165 in the same census. A 1995 survey conducted by the Somerset County Sanitary District estimated a total of 220 housing units on the island, a 15 percent decrease in housing units over the 5-year period from the 1990 census to the 1995 survey.

Per capita income and poverty data as reported in the 1990 census are presented in Table 4. The table indicates that per capita income in Somerset County and on Smith Island falls below the national average. Per capita income in Somerset County fell 29 percent below the national average and 43 percent below the state level, while 1990 income levels on Smith Island trailed the national level by 26 percent and the state level by 40 percent. Also, the proportion of families below the poverty level in Somerset County exceeds the national average.

According to 1990 census information, there were 98 persons, or 21 percent of the total Smith Island population, identified as having incomes below the poverty level. Of a total of 165 households on Smith Island, 40 reported incomes of less than $10,000 in the 1990 census. Although these monetary income data appear to present a bleak economic picture, the profile they represent is incomplete. Because of the unusual depth and degree of community cohesion and cooperation on Smith Island, and the partial subsistence provided by the consumption of seafood harvested by Smith Island watermen, the quality of life of the island's residents is probably not comparable to that of low-income residents in urban centers, where quality of life tends to be defined more distinctly by the level of monetary income. While Smith Islanders live modestly, they also appear to live comfortably.

Table 4: Per Capita Income

	Income	% Families Below Poverty Level
USA	14,420	10.0%
Maryland	17,730	6.0%
Somerset County	10,232	12.2%
Smith Island	10,698	Data Unavailable

Source: U.S. Department of Commerce, Census Bureau.

Projections of per capita income through 2045 are shown in Table 5. The Bureau of Economic Analysis was the source for national data, while the Maryland Office of Planning provided income data through 2020 for Maryland and Somerset County. Income levels for 2025 and 2045 for Maryland and Somerset County were extrapolated from Maryland Office of Planning data. Income levels in the state of Maryland are expected to exceed the national average over the period of analysis, and income in Somerset County is expected to lag significantly below the national average and the state average.

Although no location specific per capita income projections were available for Smith Island, it is expected to remain parallel to the Somerset County average.

Table 5: Projected Per Capita Income

	Per Capita Income Projections ($1987)					
	2000	2005	2010	2015	2025	2045
USA	$17,718	$18,752	$19,695	$20,517	$22,003	$25,157
Maryland	$20,382	$21,443	$22,403	$23,118	$24,200	$26,400
(percent of national level)	15%	14%	14%	13%	9%	5%
Somerset County	$12,001	$12,762	$13,438	$13,771	$14,355	$15,600
(percent of national level)	-32%	-32%	-32%	-33%	-35%	-38%

Source: U.S. Department of Commerce, Bureau of Economic Analysis

Economy and Employment

According to the 1990 census, the national labor force (persons age 16 and over) has grown by 18 percent since 1980. Labor forces in Maryland and Somerset County have increased by 8 and 2.8 percent, respectively, since 1980. The total 1990 labor force and employment distributions by market sector are shown in Table 6. The 1995 unemployment rate in Somerset County was reported at 9.1 percent according to Maryland Office of Planning data.

As of 1995, there were 377 businesses in Somerset County, 4 of which had 100 or more employees. Crisfield and Princess Anne are the major business and industrial centers in the County. Somerset County is a major seafood producer in the mid-Atlantic region. Crabs processed at the seafood cooperative in Tylerton on Smith Island are shipped to market in Delaware. Agriculture is also an important economic linchpin in the Somerset County economy. Corn and soybeans are the major cash crops produced on County farms. There are no cash crops raised on Smith Island.

Table 6: Employment by Sector

	Population >Age 16	**Agriculture & Mining**	**Construction**	**Manufacturing**	**Transportation &Utilities**	**Wholesale & Retail Trade**	**Personal & Professional Services**	**Gov't**
USA	115,681,202	3,838,795	7,214,763	20,462,087	8,205,062	24,556,692	45,865,735	5,538,077
		3%	**6%**	**18%**	**7%**	**21%**	**40%**	**5%**
MD	3,736,850	25,800	195,500	212,900	118,200	593,100	1,061,000	508,000
		2%	**7%**	**8%**	**4%**	**22%**	**39%**	**19%**
Somerset County	19,200	700	600	800	300	1,600	1,900	2,500
		8%	**7%**	**9%**	**3%**	**17%**	**21%**	**27%**

Source U.S. Department of Commerce, Census Bureau.

Transportation

As noted earlier, access to the mainland from Smith Island is limited to waterborne vessel. Once on the mainland, U.S. Route 13 and Maryland State Highway 413 provide access to major interstate routes. The Norfolk/Hampton Roads metropolitan area is 95 miles south and the highway distance to Baltimore, MD is 119 miles and to Washington, D.C. is 133 miles. There are no aircraft landing facilities on Smith Island.

Existing Conditions Summary

The unique social and economic identity of Smith Island is greatly influenced by two primary factors: its geographic location and its reliance on the harvesting and processing of seafood, especially shellfish. Although within the borders of Somerset County, the island's separation from the mainland has fostered a long tradition of self-government and self-reliance. In addition, the islanders have benefited from a distinct location advantage to develop into an important seafood harvesting and processing center. The commercial watermen of Smith Island form the backbone of the island economy. With the long-term decline of oyster populations and recent, periodic restrictions on the harvesting of crabs in the Chesapeake Bay, the long-term future for communities reliant on crab and oyster harvesting appears uncertain. The exodus of many young people from Smith Island to seek alternate careers on the mainland may be a reflection of the uncertain future faced by Chesapeake Bay watermen.

FUTURE WITH PROJECT CONDITIONS

Although the proposed water resource projects will influence the economic climate of the island in both the short-term and the long-term, they are not likely to significantly alter established economic and demographic trends. The proposed jetty at Rhodes Point will provide the watermen of Rhodes Point and Tylerton a more efficient navigation channel. The jetty is not expected to induce an increase in either the number of active commercial watermen on the island or the productivity of shellfish harvesting. It will, however, enhance economic efficiency. The proposed revetment project in Tylerton will provide protection from erosion and occasional tide induced flooding to existing development in the town. The revetment is not expected to induce development, although it could potentially spur more intensified usage of existing development. The jetty and breakwater projects to protect and create wetlands and seagrasses could boost shellfish populations and provide commercial watermen with a sustainable supply of crabs and oysters in nearby fishing waters.

Based on the demographic information in this study, the future social and economic profile of Smith Island appears uncertain. What does seem certain is that a downsizing of the community has occurred and may continue until a sustainable equilibrium population of watermen has been reached. Property owners who are partial year residents could augment this core community of watermen and their families. Opportunities for the development of a resort and eco-tourism industry on the island could emerge in the future.

Chapter 2

Smith Island Environmental Restoration Evaluation

Introduction

The Smith Island ecosystem restoration alternatives were formulated to primarily address the impact of shoreline erosion on submerged aquatic vegetation (SAV) and on emergent wetlands. The alternatives were designed to both protect existing SAV and wetlands and provide conditions necessary for restoration lost SAV beds. The benefits and costs of each alternative were evaluated in a cost effectiveness and incremental analysis. For each of the Smith Island shoreline project areas, a separate cost-effectiveness and incremental analysis was conducted. After the recommended alternative from each project area was identified, an overall average cost analysis was conducted to prioritize the projects from an economic perspective.

There are significant SAV beds on Big Thorofare inside the Western Shoreline of the island, inside Fog Point Cove and Back Cove on the northern rim of the island and inside Terrapin Cove on the eastern shore of the island. The gradual, continuous erosion of the shorelines of these areas threatens the existing SAV habitat in these four areas. The rate of shoreline erosion varies at the project sites. The purpose of this chapter is to document the evaluation process used to assess the comparative value of the alternatives formulated to protect emergent wetlands, protect existing SAV beds and provide conditions suitable for restoration of lost SAV.

The analysis begins with a description of the existing conditions at the project areas. The descriptive information will define the project areas and the distribution of their respective habitat types and values. Then the most probable future conditions without a project to reduce or eliminate the shoreline erosion is briefly discussed. Finally, the alternative future with project evaluation is presented. The process involved a separate cost-effectiveness and incremental analysis of each of the project areas to identify the "best buy" alternative for each area. After the identification of the "best buy", an integrated ecosystem restoration project for the entire northern section of the island was formulated and evaluated.

EXISTING CONDITONS

Western Shoreline/Big Thorofare

The Western Shoreline of the Wildlife Refuge extends from approximately Swan Island on the south to Fog Point on the north. This is a linear distance of approximately 9,840 feet. The Western Shoreline provides a buffer from the open waters of the Chesapeake Bay to the interior waters of Big Thorofare. Under existing conditions, the Western Shoreline is eroding at a rate of 2.7 acres of lost wetlands per year. Weak points along the shoreline are susceptible to breaching. Breaching of the shoreline threatens existing SAV beds and the potential for restoration of lost SAV habitat in Big Thorofare. There

are 239 acres of SAV remaining from a 1992 peak of 1,945 acres of SAV in Big Thorofare. There is also 2.1 miles of mud-flat shoreline and 87 acres of quiescent shallow water habit in Big Thorofare protected by the Western Shoreline that could be impacted with continued erosion and breaching of the shoreline.

Fog Point Cove

Fog Point Cove extends from Fog Point at the northwest corner of the island to Bards Point on the east. There are about 1.5 miles of shoreline along Fog Point Cove. Under existing conditions, the shoreline at Fog Point is eroding at a rate of 1.09 acres per year. The erosion has caused a gradual loss of the peninsula at Fog Point, which will expose the cove to increased wave action and sedimentation, damaging SAV beds.

Approximately 29 acres of SAV remain of an historic peak of 114 acres of SAV in the cove. There are also 1.7 miles of mud flats shoreline and 56 acres of quiescent shallow water habitat protected within Fog Point Cove that could be impacted with continued erosion of the shoreline.

Back Cove

Back Cove is comprised of about 6 miles of shoreline extending from Bridge Creek on the west to approximately Otter Creek on the east. The rate of erosion of shoreline at Back Cove is 1.09 acres lost per year. There are 236 remaining acres of an historical peak of 492 acres of SAV habitat protected by the shoreline of Back Cove. In addition there are about 55 acres of emergent wetlands, 1 acre of mudflats and 98 acres of quiescent shallow water habitat along the Back Cove shoreline.

Terrapin Sand Cove

Terrapin Sand Cove extends from Otter Creek on the north to approximately Joes Ridge Creek on the south. Most of the shoreline that forms the cove is already eroded away. There were 46 acres of remaining SAV habitat surveyed in 1998 of an historical peak of 402 acres in the cove. There are also 217 acres of quiescent shallow water habitat in the cove.

Summary of Existing Conditions

The following tables present information about existing conditions for the study areas on Smith Island. Table 1 summarizes the existing conditions SAVdistribution, the historic distribution of SAV and the difference between existing SAV and the mapped historic SAV by project area. The existing conditions SAV represents the mapped 1998 total and the mapped historic SAV extent represents the 1992 total. Overall, Smith Island has lost about 2,450 acres of SAV from the potential represented by the historic extent of SAV.

TABLE 1
Smith Island Submerged Aquatic Vegetation:
Existing and Historic Peak by Study Area
(Outputs in Acres)

Study Area	SAV Habitat (1998)	Peak SAV Habitat (1992)	SAV Loss in Acres (1992-1998)
Western Shoreline	239	1,945	1,706
Fog Point Cove	29	114	85
Back Cove	236	492	256
Terrapin Sand Cove	0	402	402
Smith Island Total	**504 Acres**	**2,953 Acres**	**2,449 Acres**

Table 2 displays the existing conditions distributions of other ecosystem habitat types. The emergent wetlands column represents a projection of the loss of wetlands over a 50-year analysis period given current annual rates of loss in the respective project areas. The mudflats and quiescent shallow water habitat columns represent the distribution by project area with existing conditions. Like emergent wetlands, these habitat types are subject to loss as the shoreline continues to erode.

TABLE 2
Smith Island: Projected Emergent Wetlands Loss, Existing Mudflats and Existing Quiescent Shallow Water Habitat by Study Area

Study Area	Projected Emergent Wetlands Loss over 50 Years (Acres)	Existing Mud Flats (Shoreline Miles)	Quiescent Shallow Water Habitat (Acres)
Western Shoreline	135	2.1	1,905
Fog Point Cove	55	1.7	85
Back Cove	55	1	492
Terrapin Sand Cove	30	0	217
Smith Island Total	**275 Acres**	**4.8 Miles**	**2,699 Acres**

FUTURE WITHOUT PROJECT CONDITIONS

The shoreline of the project areas will continue to erode in the future without project condition. Without a project to address the shoreline erosion and its impact on SAV habitat on the northern section of Smith Island, the combined loss of emergent wetlands for the 4 project areas is projected to be 275 acres over the 50-year period of analysis. As the shoreline continues to erode, the loss of remaining SAV habitat within Big Thorofare and within the cove areas is expected to occur. The restoration of SAV habitat lost is unlikely without a project.

WITH PROJECT EVALUATION: Cost Effectiveness and Incremental Analyses

Western Shoreline Project Effectiveness Evaluation

Table 3 lists the array of preliminary alternatives considered for implementation to address the loss of SAV and loss of wetlands on the Western Shoreline. The table provides a description of each alternative, its length, distance offshore and preliminary cost estimate. Moreover, the column on the far right of the table provides an assessment of the effectiveness of the alternative. This assessment is based on the results of engineering analysis of how the alternative is expected to function in preventing loss of SAV and loss of wetlands. Alternatives with an effectiveness rating of low or very low (shaded in gray) were eliminated from further consideration because the probability is low or very low that they will produce the outputs that the projects were formulated to produce. Projects with a rating of moderate or high were included in the evaluation of expected project outputs and costs.

TABLE 3
Western Shoreline Alternative Effectiveness Evaluation

Number	Alternative Description	Length	Distance Offshore	Preliminary Estimated Cost	Project Effectiveness
SI1	No-Action	0	0	$ -	Very Low
SI2	Breach Repair	200 ft	-	**$ -**	Very Low
SI3	Continuous sill	6,540 ft.	30 ft.	$2,185,508	Low
SI4	Continuous sill with wetland creation	6,540 ft.	30 ft.	$2,498,511	Moderate
SI5	Continuous sill	6,540 ft.	100 ft.	$2,665,690	Low
SI6	Continuous sill with wetland creation	6,540 ft.	100 ft.	$3,108,066	Moderate
SI7	Continuous sill	9,840 ft.	30 ft.	$3,550,780	Moderate
SI8	Continuous sill with wetland creation	9,840 ft.	30 ft.	$3,881,601	High
SI9	Continuous sill	9,840 ft.	100 ft.	$4,335,070	Moderate
SI10	Continuous sill with wetland creation	9,840 ft.	100 ft.	$4,880,018	High
SI11	Breakwaters	6,540 ft.	100 ft.	$2,345,000	Very Low
SI12	Breakwaters with wetland creation	6,540 ft.	100 ft.	$2,765,000	Moderate
SI13	Breakwaters	9,840 ft.	100 ft.	$3,123,000	Very Low
SI14	Breakwaters with wetland creation	9,840 ft.	100 ft.	$3,660,000	High
SI15	Breakwaters	6,540 ft.	30 ft.	$1,870,000	Very Low
SI16	Breakwaters with wetland creation	6,540 ft.	30 ft.	$2,190,000	Moderate
SI17	Breakwaters	9,840 ft.	30 ft.	$2,480,000	Low
SI18	Breakwaters with wetland creation	9,840 ft.	30 ft.	$2,805,000	High

Table 4 presents the array of remaining alternatives that were evaluated for protection and restoration on the Western Shoreline. The alternatives are listed in order by output in ascending order starting with the No Action alternative. There were 10 alternatives

evaluated: 4 partial-length alternatives (SI4, SI6, and SI12 an SI16) extending from Swan Island approximately 6,540 feet along the Western Shoreline of the refuge, and 6 full-length alternatives extending from Swan Island approximately 9,840 feet to Fog Point Cove (SI8, SI9, SI10, SI14, SI17, SI18). Each of the alternatives would reduce or eliminate the erosion of the emergent wetlands on the Western Shoreline, and they would protect and restore the SAV beds in Big Thorofare. The wetlands on the Western Shoreline shelter the Big Thorofare SAV beds from the open waters of the Chesapeake Bay.

Based on an expected continuation of the current rate of erosion of the wetlands in the future without a project, the projected wetland loss over a 50-year period of analysis was estimated. Along the entire length of the Western Shore, the expected wetland loss over 50 years is 135 acres. On an annual basis, the loss is 2.7 acres per year. The full-length alternatives provide erosion protection to 135 acres of wetlands over the 50-year analysis period. Because they do not extend the entire length of the Western Shore, the partial-length alternatives provide erosion protection to 95 acres of wetlands over the 50-year analysis period. This amounts to a loss rate of 1.9 acres on an annual basis.

The partial-length alternatives are expected to provide protection to SAV for only the first 10 years of the period of analysis. After 10 years the partial-length projects are not expected to provide protection for SAV due to flanking of the line of protection by the waters of the Chesapeake Bay and subsequent erosion of the shoreline that protects the SAV habitat. The expected SAV protection benefits were discounted to model the projected effectiveness of the alternatives over time. The discounted benefits amount to 118 acres of SAV protected.

The full-length alternatives are expected to protect the existing SAV beds in Big Thorofare over the entire 50-year life of the project because the line of protection extends the entire length of the Western Shoreline and is not expected to be flanked. The expected benefits amount to 239 acres of protected SAV in Big Thorofare.

The alternatives are expected to provide conditions conducive to restoration of SAV beds lost over time in Big Thorofare. There were about 1,945 acres of SAV habitat surveyed in Big Thorofare in 1992. Only 239 acres of SAV remained after the 1998 survey. A significant breach in the shoreline occurred in 1994. Since the 1994 breach, there has been a 45 percent decline in SAV habitat in Big Thorofare. With protection, conditions conducive to SAV restoration are expected to return to Big Thorofare. According to available data, the annual mean SAV habitat in Big Thorofare for the period from1971 to 1998 was 1445 acres. The restoration objective is to return the SAV population to the mean of 1445 acres. To achieve this objective, 1206 acres of SAV would be restored, the difference between the 28-year mean and the current acreage. For the analysis of project outputs and costs, it was assumed that the acreage of Big Thorofare SAV beds would be restored to the mean over a 10-year period with a project to halt the shoreline erosion. This assumption translates to a restoration rate of approximately 120 acres per year of SAV habitat with a shoreline erosion protection project.

The partial-length alternatives are not expected to provide conditions conducive to SAV restoration in Big Thorofare beyond the first 10 years of the 50-year period of analysis due to flanking of the line of protection by waters of the Chesapeake Bay. With a partial-length alternative in place, after year 10 of the analysis period, a gradual decline in SAV in Big Thorofare is expected to occur. To account for the expected decline in restored SAV habitat after the first 10 years, the restored acreage was projected to decline by 20 percent per year starting in year 11 of the analysis until it reaches a point where the restored habitat is lost again. The 20 percent rate is modeled after the average rate of decline in Big Thorofare since the 1994 breach event.

Table 4 also lists the preliminary cost estimate to construct the alternative. These preliminary cost estimates do not include mobilization and demobilization cost, contingencies or escalation. These preliminary costs were used for the cost effectiveness and incremental analyses.

TABLE 4
Western Shoreline Alternatives Sorted by Output in Ascending Order
(Outputs in Acres)

Alternative Description	Project Length	Distance Offshore	Wetlands Protected	Wetlands Created	SAV Protected	SAV Restored	Total Output	Preliminary Cost Est.
No Action				0	0	0	0	$0
Sl4 Partial-length nearshore Sill with wetland creation	6,540 ft.	30 ft.	1.9	5	118	411	535.9	$2,499,000
SI16 Partial-length Breakwaters with wetland creation	6,540 ft.	30 ft.	1.9	5	118	411	535.9	$2,190,000
SI12 Partial-length Breakwaters offshore with wetland creation	6,540 ft.	100 ft.	1.9	14	118	411	544.9	$2,765,000
Sl6 Partial-length offshore Sill with wetland creation	6,540 ft.	100 ft.	1.9	14	118	411	544.9	$3,108,000
SI18 Full-length Breakwaters nearshore with wetland creation	9,840 ft.	30 ft.	2.7	7.5	239	902	1150.4	$2,805,000
Sl7 Full-length Sill nearshore	9,840 ft.	30 ft.	2.7	7.5	239	902	1151.2	$3,551,000
Sl8 Full-length Sill nearshore with wetland creation	9,840 ft.	30 ft.	2.7	7.5	239	902	1151.2	$3,882,000
SI14 Full-length Breakwaters offshore with wetland creation	9,840 ft.	100 ft.	2.7	22	239	902	1165.7	$3,660,000
Sl9 Full-length Sill offshore	9,840 ft.	100 ft.	2.7	22	239	902	1165.7	$4,335,000
Sl10 Full-length Sill offshore with wetland creation	9,840 ft.	100 ft.	2.7	22	239	902	1165.7	$4,880,000

Table 5 displays the cost-effectiveness screening of Western Shoreline project alternatives. The alternatives shaded in gray were screened out because there is at least one alternative that produces greater or the same output for the same or less cost. The four alternatives remaining after the cost-effectiveness screening were the two partial-length breakwaters with wetland creation alternatives (SI2 and SI16) and the two full-

length breakwaters with wetland creation alternatives (SI14 and SI18). These alternatives produce the most wetlands protected, SAV protected and SAV restored at their respective project cost levels. These alternatives were evaluated incrementally. The equivalent annual cost was computed for a 50-year project life using the current FY 2001 interest rate of 6.375 percent.

TABLE 5
Cost Effectiveness Screening of Western Shore Alternatives
(Outputs in Acres)

Alternative Description	Length	Distance Offshore	Total Output	Project Cost	Annual Cost
No Action			0	$0	
SI4 Partial-length nearshore Sill with wetland creation	6,540 ft.	30 ft.	535.9	$2,499,000	$167,000
SI16 Partial-length Breakwaters with wetland creation	6,540 ft.	30 ft.	535.9	$2,190,000	$146,000
SI12 Partial-length Breakwaters offshore with wetland creation	6,540 ft.	100 ft.	544.9	$2,765,000	$185,000
SI6 Partial-length offshore Sill with wetland creation	6,540 ft.	100 ft.	544.9	$3,108,000	$208,000
SI18 Full-length Breakwaters nearshore with wetland creation	9,840 ft.	30 ft.	1151.2	$2,805,000	$187,000
SI7 Full-length Sill nearshore	9,840 ft.	30 ft.	1151.2	$3,551,000	$237,000
SI8 Full-length Sill nearshore with wetland creation	9,840 ft.	30 ft.	1151.2	$3,882,000	$259,000
SI14 Full-length Breakwaters offshore with wetland creation	9,840 ft.	100 ft.	1165.7	$3,660,000	$244,000
SI9 Full-length Sill offshore	9,840 ft.	100 ft.	1165.7	$4,335,000	$290,000
SI0 Full-length Sill offshore with wetland creation	9,840 ft.	100 ft.	1165.7	$4,880,000	$326,000

In Table 6, an incremental analysis was performed for the four remaining cost-effective Western Shore restoration alternatives. Alternative SI16 was evaluated incrementally against the no-action alternative, and alternative SI12 was evaluated incrementally against alternative SI16. Alternative SI18 was evaluated incrementally against alternative SI12, and alternative SI14 was evaluated incrementally against alternative SI18.

Alternative SI16 produces an incremental output of 535.9 total acres of output in relation to the no-action alternative. The incremental annual cost per acre of output is $272.

Alternative SI12 produces an incremental output of 9 total acres of output in relation to alternative SI16. The incremental annual cost per acre of output is $4,333.

Alternative SI18 produces an incremental output of 606.3 total acres of output in relation to alternative SI12. The incremental annual cost per acre of output is $3.29.

Alternative SI14 produces an incremental output of 14.5 total acres of output in relation to alternative SI18. The incremental annual cost per acre of output is $3,931.

TABLE 6
Incremental Values for Each Successive Cost Effective Western Shore Alternative
(Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	0	$0	$0	NA	NA	NA
SI16 Partial-length Breakwaters with wetland creation	535.9	$2,190,000	$146,000	$146,000	535.9	$272
SI12 Partial-length Breakwaters offshore with wetland creation	544.9	$2,765,000	$185,000	$39,000	9	$4,333
SI18 Full-length Breakwaters nearshore with wetland creation	1151.2	$2,805,000	$187,000	$2,000	606.3	$3.29
SI14 Full-length Breakwaters offshore with wetland creation	1165.7	$3,660,000	$244,000	$57,000	14.5	$3,931

Table 7 evaluates the incremental cost of implementing each of the remaining plans compared to the no-action plan for the Western Shoreline.

Alternative SI16 produces an incremental output of 535.9 acres of output in relation to the no-action alternative. The incremental annual cost per acre of output is $272.

Alternative SI12 produces an incremental output of 544.9 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $340.

Alternative SI18 produces an incremental output of 1151.2 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $162.

Alternative SI14 produces an incremental output of 1165.7 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $209.

TABLE 7
Incremental Cost of Implementing Each Remaining Plan Instead of No Action
(Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	0	$0	$0	NA	NA	NA
SI16 Partial-length Breakwaters with wetland creation	535.9	$2,190,000	$146,000	$146,000	535.9	$272
SI12 Partial-length Breakwaters offshore with wetland creation	544.9	$2,765,000	$185,000	$185,000	544.9	$340
SI18 Full-length Breakwaters nearshore with wetland creation	1151.2	$2,805,000	$187,000	$187,000	1151.2	$162
SI14 Full-length Breakwaters offshore with wetland creation	1165.7	$3,660,000	$244,000	$244,000	1165.7	$209

Western Shoreline "Best Buy" Alternative

The results of the cost-effectiveness and incremental analyses indicate that alternative SI18, the full-length breakwaters 30-feet offshore with wetland creation alternative, is the

most productive alternative. In comparison to the two other alternatives with an identical output of 1151.2 acres, the annual cost is $50,000 less than the next least costly alternative. In incremental comparison to alternative SI12, alternative SI18 produces an increment of 606.3 annual acres of output at an annual cost per acre of just $3.29. When compared with alternative SI14, SI18 produces just 14.5 acres less output and the incremental cost of alternative SI14 is in excess of $3,900 per acre.

In comparison to the no-action alternative, alternative SI18 produces an additional 1151.2 annual acres of output at an annual cost of $162 per acre. This cost is $47 per acre less than the annual cost per acre of alternative SI14 compared to the no-action alternative. Based on these cost-effectiveness and incremental analysis data, SI18 is identified as the "best buy" for the Western Shore.

Fog Point Cove Cost Effectiveness Evaluation

Table 8 lists the array of preliminary alternatives considered for implementation to address the loss of SAV habitat in Fog Point Cove. The table provides a description of each alternative, its length, and preliminary cost estimate. Moreover, the column on the far right of the table provides an assessment of the effectiveness of the alternative. This assessment is based on the results of engineering analysis of how the alternative is expected to function in preventing loss of SAV habitat. Alternatives with an effectiveness rating of low or very low (shaded in gray) were eliminated from further evaluation because the probability is low or very low that they will produce the outputs that the alternatives were formulated to produce. Projects with a rating of moderate or high were included in the evaluation of expected project outputs and costs.

A 1998 SAV survey indicated there were 29 acres of remaining SAV within Fog Point Cove. According to available historic data, the peak SAV acreage measured in the cove since 1971 was 98 acres in 1992, and the annual mean SAV acreage in Fog Point Cove from 1971 to 1998 was 75 acres. The difference between the historic annual mean and the remaining acreage in the cove is 46 acres. The restoration objective was defined as a return to the annual mean of 75 acres.

The eastern shoreline alternatives (FP4, FP5, FP6) were formulated to provide conditions conducive to restoration of lost SAV beds within Fog Point Cove due to erosion of the shoreline. However, even with construction of the eastern shoreline alternatives, the cove would still be exposed to forces hostile to SAV propagation from the open waters of the Chesapeake Bay. Thus, an eastern shoreline alternative would not be effective in restoring lost SAV unless built in conjunction with an extension on the western shoreline. As a stand-alone project, the eastern shoreline alternatives would not produce SAV restoration outputs. Based on the known physical realities governing alternative effectiveness, the eastern shoreline extension alternatives were eliminated from consideration as stand-alone project alternatives and these alternatives were not subjected to cost effectiveness or incremental analysis.

The western shoreline extension alternatives (FP2 and FP3) are expected to protect the 29 acres of existing SAV threatened by erosion of the shoreline, and they are expected to provide conditions conducive to restoration of 4 acres of SAV beds lost over time in Fog Point Cove. The 1998 SAV survey indicated that the 29 acres of remaining SAV within Fog Point Cove are located within the arc of the western shoreline. The number of acres of SAV within the cove is expected to diminish if erosion of the western shoreline continues unabated. In addition, alternative FP3, which includes placement of material behind the line of protection, and planting of wetland plants, would produce 1.3 acres of created wetlands.

The alternatives with extensions from both the eastern and western shorelines (FP7, FP8, and FP9) provide a synergistic effect in relation to restoration of SAV beds. Together, the shoreline extensions would halt erosion of the cove's shorelines and shelter it from the high-energy climate in the Bay. The resulting effect would be to provide conditions conducive to restoration of the 46 acres of SAV lost due to erosion from the level of the historic mean. In addition, alternative FP9, which includes placement of material behind the line of protection, and planting of wetland plants, would produce 3.8 acres of created wetlands.

The rate of restoration used to compute the restoration over time was 10 percent of the restoration objective of 46 acres per year. A 10 percent restoration rate translates to a recovery of approximately 4.6 acres per year of SAV habitat annually with an effective shoreline erosion protection alternative. Because the restoration SAV acreage is expected to take place gradually over a 10-year period, the expected benefits in each year were discounted to the project base year. The discounted annual restoration equivalent is 34 acres.

TABLE 8
Fog Point Alternatives Effectiveness Evaluation

Number	Alternative Description	Shoreline Protected	Length of Protection	Preliminary Estimated Cost	Effectiveness
FP1	no action	none	0	$ 0 -	Very Low
FP2	sill	western	600 ft.	$ 375,527	Moderate
FP3	sill/backfill	western	600 ft.	$ 789,159	Moderate
FP4	sill	eastern	1,200 ft	$ 709,203	Low
FP5	sill/backfill	eastern	1,200 ft	$1,047,957	Low
FP6	breakwaters	eastern	1,200 ft.	$ 336,200	Low
FP7	sill	both shorelines	1,800 ft.	$1,498,362	Moderate
FP8	sill/breakwaters	both shorelines	1,800 ft.	$ 711,727	High
FP9	sill/breakwaters--with backfill	both shorelines	1,800 ft.	$1,125,359	Very High

Table 9 presents the five Fog Point Cove alternatives that were evaluated using cost effectiveness and incremental analysis criteria. Three of these alternatives (FP7, FP8, and FP9) include improvements to both the western and eastern shorelines of the cove. The remaining two are western shoreline alternatives (FP2 and FP3). The table also displays the preliminary cost estimate to construct the alternative and the expected output

with implementation of the alternative. The preliminary cost estimates do not include mobilization and demobilization cost, contingencies or escalation. These preliminary costs were used for the cost effectiveness and incremental analysis evaluation.

TABLE 9
Fog Point Cove Alternatives Sorted by Output in Ascending Order
(Outputs in Acres)

Alternative Description	Length	Shoreline Protected	Wetlands Created	SAV Protected	SAV Restored	Total Output	Preliminary Cost Est.
No Action	NA	NA	0	0	0	0	$0
FP2 Sill from western shore	600 ft.	western	0	29	4	33	$376,000
FP3 Sill with wetland creation	600 ft.	western	1.3	29	4	34.3	$789,000
FP7 Sill from both shorelines	1,800 ft.	western & eastern	0	29	34	63	$1,498,000
FP8 Sill from western shoreline; breakwaters from eastern shoreline	1,800 ft.	western & eastern	0	29	34	63	$712,000
FP9 FP8 + wetland creation	1,800 ft.	western & eastern	3.8	29	34	66.8	$1,125,000

Table 10 displays the cost-effectiveness screening of Fog Point Cove project alternatives. The alternatives shaded in gray were screened out because there is at least one alternative that produces the same or greater output for the same or less cost. The equivalent annual cost was computed for a 50-year project life using the current FY 2001 interest rate of 6.375 percent.

TABLE 10
Cost Effectiveness Screening of Fog Point Cove Alternatives
(Outputs in Acres)

Alternative Description	Length	Shoreline Protected	Total Output	Project Cost	Annual Cost
No Action	NA	NA	0	$0	$0
FP2 Sill from western shore	600 ft.	western	33	$376,000	$25,000
FP3 Sill with wetland creation	600 ft.	western	34.3	$789,000	$53,000
FP7 Sill from both shorelines	1,800 ft.	western & eastern	63	$1,498,000	$100,000
FP8 Sill from western shoreline; breakwaters from eastern shoreline	1,800 ft.	western & eastern	63	$712,000	$48,000
FP9 FP8 + wetland creation	1,800 ft.	western & eastern	66.8	$1,125,000	$75,000

In Table 11, an incremental analysis was performed for the three remaining cost-effective Fog Point Cove restoration alternatives. Alternative FP2 was evaluated incrementally against the no-action alternative, and alternative FP8 was evaluated incrementally against alternative FP2. Alternative FP8 was evaluated incrementally against alternative FP9.

Alternative FP2 produces an incremental output of 33 total acres of output in relation to the no action alternative. The incremental annual cost per acre of output is $758.

Alternative FP8 produces an incremental output of 30 total acres of output in relation to alternative FP2. The incremental annual cost per acre of output is $767.

Alternative FP9 produces an incremental output of 3.8 total acres of output in relation to alternative FP8. The incremental annual cost per acre of output is $7,105.

TABLE 11
Incremental Values for Each Successive Cost Effective Fog Point Cove Alternative (Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	0	$0	$0	NA	NA	NA
FP2 Sill from western shoreline	33	$376,000	$25,000	$25,000	33	$758
FP8 Sill from western shoreline; breakwaters from eastern shoreline	63	$712,000	$48,000	$23,000	30	$767
FP9 FP8 + wetland creation	66.8	$1,125,000	$75,000	$27,000	3.8	$7,105

Table 12 evaluates the incremental cost of implementing each of the remaining plans compared to the no-action plan for Fog Point Cove.

Alternative FP2 produces an incremental output of 33 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $758.

Alternative FP8 produces an incremental output of 63 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $762.

Alternative FP9 produces an incremental output of 66.8 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $1,123.

TABLE 12
Incremental Cost of Implementing Each Remaining Plan Instead of No Action (Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	0	$0	$0	NA	NA	NA
FP2 Sill from western shoreline	33	$376,000	$25,000	$25,000	33	$758
FP8 Sill from western shoreline; breakwaters from eastern shoreline	63	$712,000	$48,000	$48,000	63	$762
FP9 FP8 + wetland creation	66.8	$1,125,000	$75,000	$75,000	66.8	$1,123

Fog Point Cove "Best Buy" Alternative

The results of the cost-effectiveness and incremental analyses indicate that FP2, the sill from the western shoreline alternative, is marginally more productive than the other alternatives that were evaluated. FP2 produces 33 acres of output at an incremental cost of $758 compared to the no action alternative. FP8 produces 63 acres of output at a cost of $762 compared to the no action alternative. The incremental cost per acre to produce

an additional 30 acres with FP8 is $767 per acre when compared to FP2. The incremental cost to implement FP2 as opposed to No Action would be $758 per acre. Alternative FP9 produces an increment of 3.8 acres of created wetlands compared to FP8 for an incremental cost per acre in excess of $7,000.

Back Cove

There were a total of 14 alternatives identified and formulated for shoreline protection at the Back Cove section of the island. There were 7 alternatives formulated for protection and restoration along the northwest shoreline of Back Cove, and 7 alternatives formulated for protection and restoration of the southeast shoreline of Back Cove. A separate cost-effectiveness and incremental analysis was performed for the northwest shoreline alternatives and for the southeast shoreline alternatives because implementation of an alternative in either project area does not impact outputs or costs in the other project area.

Northwest Shoreline Project Effectiveness Evaluation

Table 13 lists the array of preliminary alternatives formulated for implementation to address the loss of SAV habitat and loss of wetlands in Back Cove on the northwest shoreline. The table provides a description of each alternative, its length, and preliminary cost estimate. Moreover, the column on the far right of the table provides an assessment of the effectiveness of the alternative. This assessment is based on the results of engineering analysis of how the alternative is expected to function in preventing loss of SAV habitat and loss of wetlands. Alternatives with an effectiveness rating of low or very low (shaded in gray) were eliminated from further evaluation because the probability is low or very low that they will produce the outputs that the alternatives were formulated to produce. Projects with a rating of moderate or high were included in the evaluation of expected project outputs and costs.

TABLE 13
Back Cove Northwest Shoreline Alternative Effectiveness Evaluation

Number	Alternative Description	Shoreline	Length of Protection	Preliminary Estimated Cost	Project Effectiveness
BC1	no-action	Northwest	0	$ 0	Very Low
BC2	sill	Northwest	5,200 ft	$2,556,632	Moderate
BC3	sill/backfill	Northwest	5,200 ft	$2,860,962	High
BC4	sill/extension	Northwest	5,950 ft	$2,917,778	Moderate
BC5	sill/extension--backfill	Northwest	5,950 ft	$3,236,077	High
BC6	breakwaters	Northwest	5,200 ft.	$1,568,700	Low
BC7	breakwaters/extension	Northwest	5,950 ft	$2,042,800	Low
BC8	breakwaters/extension--backfill	Northwest	5,950 ft	$2,342,800	High

Table 14 presents the array of five remaining alternatives evaluated for protection and restoration on the northwest shoreline of Back Cove. The alternatives are listed in order by output in ascending order starting with the No Action alternative.

The wetlands on the northwest peninsula shelter the Back Cove SAV beds from the open waters of the Chesapeake Bay. Based on an expected continuation of the current rate of erosion of the wetlands in the future without a project, the projected wetland loss over a 50-year period of analysis was estimated. The northwest shoreline of Back Cove is expected to lose 54.6 acres of wetlands over 50 years. On an annual basis, the loss is 1.1 acres per year. Each of the alternatives will reduce or eliminate the erosion of the emergent wetlands on the northwest shoreline of Back Cove, and they will protect and restore SAV beds in the cove. The alternatives with an extension from the peninsula into the cove will provide greater stability and an increased expanse of SAV habitat protection and restoration.

The alternatives without an extension from the northwest peninsula (BC2 and BC3) are expected to provide protection to approximately 2/3 of the existing SAV beds on the northwest shoreline of Back Cove and create conditions conducive to restoration of approximately 2/3 of the annual average SAV habitat surveyed on the shoreline from 1971-1998. The expected SAV protection benefits attributable to the alternatives without an extension from the peninsula is 121 acres, and the annual SAV restoration benefit is 62.4 acres.

The alternatives with an extension from the peninsula (BC4, BC5, and BC8) are expected to protect 100 percent of the existing SAV beds in the northwest section of Back Cove over the entire 50-year life of the project because the line of protection extends from the northwest peninsula into the cove. The expected benefits amount to 181 acres of protected SAV in Back Cove.

The alternatives with an extension from the peninsula (BC4, BC5, and BC8) are expected to provide conditions conducive to restoration of SAV beds lost over time behind the northwest shoreline of Back Cove. The average number of acres of SAV habitat surveyed in the northwest shoreline of Back Cove on an annual basis from 1971-1998 was 306 acres. Only 181 acres of SAV remained after the 1998 survey. The SAV restoration objective on the northwest shoreline is 125 acres, the difference between the long-term average and the 1998 survey. For the purposes of formulation, a 10 percent annual rate of restoration of the 125 acre difference between existing conditions and the long-term average was assumed until the entire amount is restored in project year 10. The annual equivalent value of this restoration is 94 acres for alternatives with an extension from the northwest peninsula.

The alternatives with placement of material behind the line of protection and planting of wetland plants (BC3, BC5 and BC8) would provide created wetland acreage in the cove. BC3 would create 4.8 acres of created wetlands. BC5 and BC8 would create 5.5 acres of created wetlands.

TABLE 14
Back Cove Northwest Shoreline Alternatives Sorted by Output in Ascending Order
(Outputs in Acres)

Alternative Description	Length of Protection	Wetlands Protected	Wetlands Created	SAV Protected	SAV Restored	Total Output	Project Cost
No Action	NA	0	0	0	0	0	$0
BC2 Sill	5,200 ft.	1.1	0	121	62.4	189.3	$2,557,000
BC3 Sill with wetland creation	5,200 ft.	1.1	4.8	121	62.4	194.1	$2,861,000
BC4 Sill with extension	5,950 ft.	1.1	0	181	93.7	275.8	$2,918,000
BC5 Sill with extension + wetland creation	5,950 ft.	1.1	5.5	181	93.7	281.3	$3,236,000
BC8 Breakwaters with extension + wetland creation	5,950 ft.	1.1	5.5	181	93.7	281.3	$2,343,000

Table 15 displays the cost-effectiveness screening of Back Cove northwest shoreline project alternatives. The alternatives shaded in gray were screened out because there is at least one alternative that produces greater output for the same cost or the same output for less cost. There was only one alternative remaining after the cost-effectiveness screening. Alternative BC8 produces either a greater output for the same or less cost or the same or greater output for less cost than each of the other alternatives. BC8 produces more output than BC2, BC3, and BC4 at a lesser cost than those alternatives. BC8 would produce the same output as BC5 at an annual cost $60,000 less than the cost of BC5. The equivalent annual cost was computed for a 50-year project life using the current FY 2001 interest rate of 6.375 percent.

TABLE 15
Back Cove Northwest Shoreline Cost Effectiveness Screening
(Outputs in Acres)

Alternative Description	Length	Total Output	Project Cost	Annual Cost
No Action	NA	NA	NA	NA
BC2 Sill	5,200 ft.	189.3	$2,557,000	$171,000
BC3 Sill with wetland creation	5,200 ft.	194.1	$2,861,000	$191,000
BC4 Sill with extension	5,950 ft.	275.8	$2,918,000	$195,000
BC5 Sill with extension + wetland creation	5,950 ft.	281.3	$3,236,000	$216,000
BC8 Breakwaters with extension + wetland creation	5,950 ft.	281.3	$2,343,000	$156,000

Back Cove Northwest Shoreline "Best Buy" Alternative

The results of the cost-effectiveness and analysis clearly indicate that the breakwaters with an extension from the peninsula with backfill and planting alternative (BC8) is the most productive alternative. In comparison to BC5, the other alternative with an identical output of 281.3 acres, the annual cost of BC8 is $60,000 less. In comparison to alternative BC4, BC8 produces 5.5 acres of output more for $39,000 less annual cost.

In comparison to the no-action alternative, alternative BC8 produces an additional 281.3 annual acres of protected and restored habitat at an annual cost of $555 per acre of output gained. Based on these cost-effectiveness analysis data, BC8 is identified as the "best buy" for the northwest shoreline of Back Cove.

Southeast Shoreline Project Effectiveness Evaluation

Table 16 lists the array of preliminary alternatives considered for implementation to address the loss of SAV habitat in Back Cove on the southeast shoreline. The table provides a description of each alternative, its length, and preliminary cost estimate. Moreover, the column on the far right of the table provides an assessment of the effectiveness of the alternative. This assessment is based on the results of engineering analysis of how the alternative is expected to function in preventing loss of SAV habitat. Alternatives with an effectiveness rating of low or very low (shaded in gray) were eliminated from further evaluation because the probability is low or very low that they will produce the outputs that the alternatives were formulated to produce. Projects with a rating of moderate or high were included in the evaluation of expected project outputs and costs.

TABLE 16
Back Cove Southeast Shoreline Alternatives Effectiveness Evaluation

Number	Alternative Description	Shoreline	Length of Protection	Preliminary Estimated Cost	Project Effectiveness
BC9	no-action	Southeast	0	$ 0	Very Low
BC10	sill	Southeast	1,950 ft	$1,045,440	Moderate
BC10a	sill with extension	Southeast	2,950 ft	$3,305,800	Moderate
BC11	sill--backfill	Southeast	1,950 ft	$1,414,958	High
BC11a	sill/extension --backfill	Southeast	2,950 ft	$4,055,800	High
BC12	breakwaters	Southeast	1,950 ft	$ 784,400	Low
BC12a	breakwaters/extension	Southeast	2,950 ft	$1,008,500	Low
BC13	breakwaters--backfill	Southeast	1,950 ft	$1,144,000	High
BC13a	breakwaters/extension--backfill	Southeast	2,950 ft	$1,758,500	High

Table 17 presents the array of alternatives evaluated for protection and restoration of habitat on the southeast shoreline of Back Cove. The alternatives are listed in order by output in ascending order starting with the No Action alternative. Alternatives BC10, BC11 and BC13 were formulated to conform to the existing southeast shoreline. Alternatives BC10a, BC11a, and BC13a include an extension to restore a portion of the lost peninsula. The alternatives with an extension provide an expanded area for habitat protection and restoration.

Based on an expected continuation of the current rate of erosion of the wetlands in the future without a project, the projected wetland loss over a 50-year period of analysis was estimated. The southeast shoreline of Back Cove is expected to lose 24 acres of wetlands over 50 years. On an annual basis, the projected loss of wetlands is.5 acre per year. Each

of the alternatives will reduce or eliminate the erosion of the existing emergent wetlands on the southeast shoreline of Back Cove.

In addition, the alternatives with an extension from the peninsula into the cove will protect the remaining 55 acres of SAV habitat in the cove, and provide conditions conducive to restoration of lost SAV habitat. The average number of acres of SAV habitat surveyed in the southeast shoreline of Back Cove on an annual basis from 1971-1998 was 157 acres. Only 55 acres of SAV remained after the 1998 survey. The potential restoration of SAV on the southeast shoreline is 102 acres, the difference between the long-term average and the 1998 survey. For the purposes of formulation, a 10 percent annual rate of restoration of the 102 acre difference between existing conditions and the long-term average was assumed until the entire amount is restored in project year 10. The annual value of this restoration is 77 acres for alternatives with an extension from the southeast peninsula.

The alternatives that provide for placement of backfill material and planting of wetland plants will provide additional created wetlands output. The alternatives with wetland creation and without an extension are expected to create 4.4 acres of wetland. The alternatives with wetland creation and with an extension from the peninsula are expected to produce 6.7 acres of created wetlands.

TABLE 17
Back Cove Southeast Shoreline Alternatives Sorted by Output in Ascending Order
(Outputs in Acres)

Alternative Description	Length of Protection	Wetlands Protected	Wetlands Created	SAV Protected	SAV Restored	Total Output	Project Cost
No Action	NA	0	0	0	0	0	$0
BC10 Sill	1,950 ft.	0.5	0	0	0	0.5	$1,045,000
BC11 Sill + wetland creation	1,950 ft.	0.5	4.4	0	0	4.5	$1,415,000
BC13 Breakwaters + wetland creation	1,950 ft.	0.5	4.4	0	0	4.9	$1,144,000
BC10a Sill with extension	2,950 ft.	0.5	0	55	76.7	132.2	$3,306,000
BC11a Sill with extension + wetland creation	2,950 ft.	0.5	6.7	55	76.7	138.9	$4,056,000
BC13a Breakwaters with extension + wetland creation	2,950 ft.	0.5	6.7	55	76.7	138.9	$1,759,000

Table 18 displays the cost-effectiveness screening of Back Cove southeast shoreline project alternatives. The alternatives shaded in gray were screened out because there is at least one alternative that produces greater output for the same cost or the same output for less cost. There were three alternatives (BC10, BC13 and BC13a) remaining after the cost-effectiveness screening. The equivalent annual cost was computed for a 50-year project life using the current FY 2001 interest rate of 6.375 percent.

TABLE 18
Back Cove Southeast Shoreline Cost Effectiveness Screening
(Outputs in Acres)

Alternative Description	Length of Protection	Total Output	Project Cost	Annual Cost
No Action	NA	NA	NA	NA
BC10 Sill	1,950 ft.	0.5	$1,045,000	$70,000
BC11 Sill + wetland creation	1,950 ft.	4.5	$1,415,000	$95,000
BC13 Breakwaters + wetland creation	1,950 ft.	4.9	$1,144,000	$76,000
BC10a Sill with extension	2,950 ft.	132.2	$3,306,000	$221,000
BC11a Sill with extension + wetland creation	2,950 ft.	138.9	$4,056,000	$271,000
BC13a Breakwaters with extension + wetland creation	2,950 ft.	138.9	$1,759,000	$117,000

Table 19 displays the results of the incremental analysis of the three remaining cost-effective Back Cove southeast shoreline restoration alternatives. Alternative BC10 was evaluated incrementally against the no-action alternative, and alternative BC13 was evaluated incrementally against alternative BC10. Alternative BC13s was then evaluated incrementally against alternative BC13.

Alternative BC10 produces an incremental output of .5 total acres of output in relation to the no-action alternative. The incremental annual cost per acre of output is $140,000.

Alternative BC13 produces an incremental output of 4.4 total acres of output in relation to alternative BC10. The incremental annual cost per acre of output is $1,364.

Alternative BC13a produces an incremental output of 134 total acres of output in relation to alternative BC13. The incremental annual cost per acre of output is $306.

TABLE 19
Incremental Values for Each Successive Cost Effective Back Cove Southeast Shoreline Alternative (Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	NA	NA	NA	NA	NA	NA
BC10 Sill	0.5	$1,045,000	$70,000	$70,000	0.5	$140,000
BC13 Breakwaters + wetland creation	4.9	$1,144,000	$76,000	$6,000	4.4	$1,364
BC13a Breakwaters with extension + wetland creation	138.9	$1,759,000	$117,000	$41,000	134	$306

Table 20 evaluates the incremental cost of implementing each of the remaining plans compared to the no-action plan for the Back Cove southeast shoreline restoration.

Alternative BC10 produces an incremental output of .5 acre of output in relation to the no-action alternative. The incremental annual cost per acre of output is $140,000.

Alternative BC13 produces an incremental output of 4.9 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $15,510.

Alternative BC13a produces an incremental output of 138.9 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $842.

TABLE 20
Incremental Cost of Implementing Each Remaining Plan Instead of No Action
(Outputs in Acres)

Alternative Description	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Output
No Action	NA	NA	NA	NA	NA	NA
BC10 Sill	0.5	$1,045,000	$70,000	$70,000	0.5	$140,000
BC13 Breakwaters + wetland creation	4.9	$1,144,000	$76,000	$76,000	4.9	$15,510
BC13a Breakwaters with extension + wetland creation	138.9	$1,759,000	$117,000	$117,000	138.9	$842

Back Cove Southeast Shoreline "Best Buy" Alternative

The results of the cost-effectiveness and incremental analyses indicate that alternative BC13a, the breakwaters with an extension from the peninsula with placement of backfill and planting of wetlands plants is the most productive alternative. In comparison to the other alternative with an identical output of 138.9 acres, the annual cost of the breakwaters with an extension from the peninsula alternative is $154,000 less. In comparison to alternative BC13, alternative BC13a produces an increment of 134 annual acres of protected and restored habitat at an annual cost of $306 per acre of habitat output gained.

In comparison to the no-action alternative, the breakwaters with an extension from the peninsula alternative produces an additional 138.9 annual acres of protected and restored habitat at an annual cost of $842 per acre of output gained. This cost is nearly $14,700 per acre less than the annual cost per acre of alternative BC13 compared to the no-action alternative. Based on these cost-effectiveness and incremental analysis data, alternative BC13a is identified as the "best buy" for the southeast shoreline of Back Cove.

Terrapin Sand Cove Evaluation

Table 21 lists the array of preliminary alternatives considered for implementation to address the loss of SAV habitat in Terrapin Sand Cove. The table provides a description of each alternative, its length, and preliminary cost estimate. Moreover, the column on the far right of the table provides an assessment of the effectiveness of the alternative. This assessment is based on the results of engineering analysis of how the alternative is expected to function in preventing loss of SAV habitat or restoring lost habitat. Alternatives with an effectiveness rating of low or very low (shaded in gray) were

eliminated from further evaluation because the probability is low or very low that they will produce the outputs that the alternatives were formulated to produce. Projects with a rating of moderate or high were included in the evaluation of expected project outputs and costs.

There were 4 preliminary alternatives (TS2, TS3, TS4, and TS5) formulated for protection of the shoreline of Terrapin Sand Cove. TS3 and TS4 are sill structures. TS3 extends across Terrapin Sand Cove 2,400 linear feet from the southeast shoreline of Back Cove. TS4 differs from TS3 by extending the line of protection 2,600 feet south to provide an expanded area for habitat protection and restoration. TS2 and TS5 are breakwater structures. TS2 extends across Terrapin Sand Cove 2,400 linear feet from the southeast shoreline of Back Cove. TS5 differs from TS2 by extending the line of protection 2,600 feet south to provide an expanded area for habitat protection and restoration.

TABLE 21
Terrapin Sand Cove Alternatives Effectiveness Assessment

Number	Alternative Description	Length of Protection	Preliminary Cost Estimate	Project Effectiveness
TS1	No-action	0 ft.	$0	Very Low
TS2	Breakwaters	2,400 ft.	$ 602,908	Moderate
TS3	Sill	2,400 ft.	$ 1,583,782	Moderate
TS4	Sill/extension	5,000 ft.	$ 3,265,025	Moderate
TS5	Breakwaters/extension	5,000 ft.	$30,336,000	Moderate

There are no remaining emergent wetlands on the Terrapin Sand Cove shoreline. Creation of wetlands behind the line of protection is infeasible because of the water depths in the cove. The 1971-1998 annual average count of SAV in the cove was 479 acres. With establishment of protection on the perimeter of the cove, restoration of lost SAV is the expected output. The breakwater alternative without an extension to the south is expected to provide conditions conducive to restoration of 120 acres of SAV habitat on an annual basis. The breakwater alternative with an extension to the south will provide conditions conducive to restoration of 360 acres of lost SAV habitat on an annual basis.

Table 22 presents the evaluation of remaining alternatives to provide restoration of SAV at Terrapin Sand Cove. The alternatives are listed in order by output in ascending order starting with the No Action alternative. Table 22 also presents the project cost estimates for the alternatives. These estimates are much higher than those for comparable structures in the other project areas. The primary reason for this disparity is that the water depths are from 2 feet to 3 feet deeper at Terrapin Sand Cove than the depths in other project areas. This greater water depth translates to a need for a much greater quantity of base stone for the structures at Terrapin Sand Cove. The equivalent annual cost was computed for a 50-year project life using the current FY 2001 interest rate of 6.375 percent.

TABLE 22
Terrapin Sand Cove Alternatives Sorted by Output in Ascending Order
(Outputs in Acres)

Alternative	Protected Wetlands	SAV Protected	SAV Restored	Total Output	Project Cost	Annual Cost
No Action	0	0	0	0	$0	$0
TS2 Breakwaters across cove	0	0	120	120	$18,356,000	$1,226,000
TS3 Sill across cove	0	0	120	120	$30,287,000	$2,023,000
TS4 Sill across cove + extension south	0	0	360	360	$42,267,000	$2,823,000
TS5 Breakwaters across cove + extension south	0	0	360	360	$30,336,000	$2,026,000

Table 23 displays the cost-effectiveness screening of Terrapin Sand Cove project alternatives. The alternatives shaded in gray were screened out because there is at least one alternative that produces greater output for the same cost or the same output for less cost. There were two alternatives (TS2, and TS5) remaining after the cost-effectiveness screening.

TABLE 23
Terrapin Sand Cove Cost Effectiveness Screening
(Outputs in Acres)

Alternative Description	Length of Protection	Total Output	Project Cost	Annual Cost
No Action	NA	NA	NA	NA
TS2 Breakwaters across cove	2,400 ft.	120	$18,356,000	$1,226,000
TS3 Sill across cove	2,400 ft.	120	$30,287,000	$2,023,000
TS4 Sill across cove + extension south	5,000 ft.	360	$42,267,000	$2,823,000
TS5 Breakwaters across cove + extension south	5,000 ft.	360	$30,336,000	$2,026,000

Table 24 displays the results of the incremental analysis of the two remaining cost-effective Terrapin Sand Cove restoration alternatives. The breakwaters across the cove alternative (TS2) was evaluated incrementally against the no-action alternative, and the breakwaters with an extension south alternative (TS5) was evaluated incrementally against the breakwaters across the cove alternative (TS2).

Alternative TS2 produces an incremental output of 120 total acres of output in relation to the no-action alternative. The incremental annual cost per acre of output is $10,200.

Alternative TS5 produces an incremental output of 240 total acres of output in relation to alternative TS2. The incremental annual cost per acre of output is $3,300.

TABLE 24
Incremental Values for Each Successive Cost Effective Terrapin Sand Cove Alternative (Outputs in Acres)

Alternative	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Gained
No Action	0	$0	$0	N/A	N/A	N/A
TS2 Breakwaters across cove	120	$18,356,000	$1,226,000	$1,226,000	120	$10,217
TS5 Breakwaters across cove + extension south	360	$30,336,000	$2,026,000	$800,000	240	$3,333

Table 25 evaluates the incremental cost of implementing each of the remaining plans compared to the no-action plan for the Terrapin Sand Cove shoreline restoration.

Alternative TS2 produces an incremental output of 120 acres of output in relation to the no-action alternative. The incremental annual cost per acre of output is $10,200.

Alternative TS5 produces an incremental output of 360 acres of output in relation to the no-action plan. The incremental annual cost per acre of output is $5,600.

TABLE 25
Incremental Cost of Implementing Each Remaining Plan Instead of No Action (Outputs in Acres)

Alternative	Total Output	Project Cost	Annual Cost	Incr. Cost	Incr. Output	Incr. $ per Acre Gained
No Action	0	$0	$0	N/A	N/A	N/A
TS2 Breakwaters across cove	120	$18,356,000	$1,226,000	$1,226,000	120	$10,217
TS5 Breakwaters across cove + extension south	360	$30,336,000	$2,026,000	$2,026,000	360	$5,628

Terrapin Sand Cove "Best Buy" Alternative

The results of the cost-effectiveness and incremental analyses indicate that alternative TS5 is the most productive alternative. The breakwaters with an extension south alternative produces an increment of 240 annual acres of restored habitat at an incremental annual cost of $3,300 per acre of habitat output gained compared to an incremental annual cost of $10,200 per acre of habitat output gained for alternative TS2.

In comparison to the no-action alternative, alternative TS5 produces an additional 360 annual acres of restored habitat at an annual cost of $5,600 per acre of output gained. This cost is $4,600 per acre less than the annual cost per acre of alternative TS2 compared to the no-action alternative. Based on these cost-effectiveness and incremental analysis data, the breakwaters with an extension south alternative, TS5, is identified as the "best buy" for the restoration of SAV at Terrapin Sand Cove.

Summary of Project Outputs

Table 26 presents a summary of the expected outputs of the projects selected as the "best buy" alternatives in each project area. The outputs are expressed as annual values. The total expected annual output with implementation of each of the 5 projects is 2,013 acres on an annual basis over the 50-year project life.

TABLE 26
Expected Project Outputs by Project Area
(Outputs in Acres)

Alternative	Wetlands Protected	Wetlands Created	SAV Protected	SAV Restored	Expected Annual Output
SI18	2.7	7.5	239	902	1151.2
FP2	0	3.8	29	4	33.0
BC8	1.1	5.5	181	93.7	281.3
BC13a	.5	6.7	55	76.7	138.9
TS5	0	0	0	360	360
Totals	**4.3**	**38**	**504**	**1466.4**	**1964.4**

Average Cost Analysis of Selected Alternatives

Table 27 lists the alternatives identified, from the cost effectiveness and incremental analysis, as the "best buy" among the alternatives formulated for its project area. The table lists the alternative's expected output, its project cost and annual cost and its average cost per unit of habitat output. The alternative with the lowest average cost is SI18 (shaded in gray), the full-length Western Shoreline breakwaters with backfill and planting alternative. None of the other alternatives produces an output comparable to the expected output of alternative SI18, and each of the other alternatives has a greater average cost per acre value than SI18. This analysis indicates that SI18 is the most efficient and most effective alternative of the "best buy" alternatives.

TABLE 27
Average Cost Per Acre of Each Selected Alternative
(Output in Acres)

Alternative	Annual Output	Project Cost	Annual Cost	Average Cost per Acre
No Action	0	$0	$0	N/A
FP2	33	$376,000	$25,000	$758
BC13a	138.9	$1,759,000	$117,000	$842
BC8	281.3	$2,343,000	$156,000	$555
TS5	360	$30,336,000	$2,026,000	$5,628
SI18	1151.2	$3,660,000	$187,000	$162
Totals with TS5	1964.4	$38,474,000	$2,511,000	$1,278
Totals with TS5 Removed	**1604.4**	**$8,138,000**	**$485,000**	**$302**

The bottom row of Table 27 also highlights the disproportionate influence on the project cost, and consequently the average cost per acre of output, of TS5, the breakwaters with an extension south alternative at Terrapin Sand Cove. If alternative TS5 were removed

from the table, the average cost per acre of output for the remaining 4 alternatives would decrease to $302 per acre on an annual basis.

Uncertainty of Outputs and Costs

In order to reflect the uncertainty associated with both the project costs and the biological effectiveness of the alternatives, the assumptions used in the cost-effectiveness and incremental analyses were examined. The assumptions used in the economic analyses were based on the engineering and biological data used to formulate the alternatives. A discussion of some of the critical assumptions used follows, along with information testing the sensitivity of cost and output assumptions on the outcome of the evaluation.

The cost effectiveness and incremental analyses applied key assumptions regarding the effectiveness of project construction on habitat outputs. One key assumption is that the projects will protect 100 percent of existing SAV habitat and 100 percent of existing wetlands starting in the project base year. Each of the "best buy" alternatives identified, with the exception of FP2 and TS5, includes backfill and planting measures. Besides creating wetlands, these measures are designed to increase the assurance that the breakwaters will function as designed. The backfill and planting measures significantly reduce the risk that the breakwaters will not protect existing wetlands and existing SAV habitat.

Another key assumption is that the selected alternatives will restore lost SAV habitat to a level equivalent to the annual average SAV habitat in the project areas for the period from 1971-1998. It was further assumed that a 10 percent per year recovery rate would be achieved with project construction, resulting in restoration of SAV habitat to the targeted average output levels after the first 10 years of the project life. After the first 10 years of the project life, no additional increases in SAV habitat restoration were factored into the analysis. Present values and annual values of restored SAV were computed for each alternative.

With regard to restored SAV habitat, there is a degree of uncertainty of attainment of the levels of output assumed for the analysis. The projects are expected to provide conditions conducive to restoration of SAV habitat, but SAV restoration depends on other factors not influenced by the projects. Restoration of SAV habitat accounts for 69 percent of the total expected project outputs. It is recognized that the actual output of restored SAV may be greater or lesser than the stated project objective, which is to restore SAV habitat levels to the level of the 28-year annual average. In recognition of the risk associated with SAV restoration, Table 28 presents a range of outputs for restored SAV habitat. The range of values presented in the table is the outcome of the assumption that the output will vary from 20 percent below the expected level to 20 percent above the expected level. The wetlands protected, the SAV protected, and the wetlands created outputs were not varied in the analysis because of the greater certainty of attainment of those outputs. The table shows that the minimum expected value, with a 20 percent reduction in SAV restored, is 1,720 annual acres of habitat output with implementation of the selected

alternatives. This level of output is 86 percent of the expected output level used in the cost effectiveness and incremental analyses.

TABLE 28
Range of Potential Outputs by Project Area
(+/– 20% deviation from expected value for SAV Restored)
(Outputs in Acres)

Alternative	Wetlands Protected	Wetlands Created	SAV Protected	SAV Restored Range	Expected Annual Output Range
SI18	2.7	7.5	239	722-1,082	986-1,663
FP2	0	0	29	3-5	32-34
BC8	1.1	5.5	181	75-113	263-301
BC13a	.5	6.7	55	61-92	123-154
TS5	0	0	0	288-432	288-432
Totals	**4.3**	**19.7**	**504**	**1149-1724**	**1,677-2,252**

Table 29 presents a range of values for project costs. The first two columns display the project cost and the annual cost used in the cost-effectiveness and incremental analyses. The middle columns display the project cost and the annual cost assuming that the cost will be 20 percent greater than the estimated cost. The two columns on the right show the project cost and the annual cost assuming the actual cost is 20 percent less than the estimated level.

TABLE 29
Range of Project Costs by Project Area
(+/- 20% deviation from estimated project costs)

Alternative	Project Cost	Annual Cost	Project Cost + 20%	Annual Cost +20%	Project Cost - 20%	Annual Cost -20%
FP2	$376,000	$25,000	$384,000	$30,000	$301,000	$20,000
TS5	$30,336,000	$2,026,000	$36,403,000	$2,431,000	$24,269,000	$1,621,000
BC13a	$1,759,000	$117,000	$2,110,000	$140,000	$1,407,000	$94,000
BC8	$2,343,000	$156,000	$2,811,000	$187,000	$1,874,000	$125,000
SI18	$3,882,000	$187,000	$4,658,000	$224,000	$3,106,000	$150,000

Table 30 presents a sensitivity analysis to determine the change in average cost per acre of habitat output if the restored SAV habitat is 20 percent less than expected and the project cost is 20 percent greater than currently estimated. This scenario represents the worst outcome given the parameters of the sensitivity analysis. The average cost per acre of habitat output with this scenario is $1,780, which is $502 per acre more than the cost per acre resulting from the costs and outputs used in the cost-effectiveness and incremental analyses.

The data presented in Table 30 point out the disproportionate influence on the project cost and consequently on the average cost per acre of output of alternative TS5. The bottom row of the table, shaded in gray, presents the results of the analysis if TS5 were removed from consideration. Without TS5, the average cost per acre of output under the proposed scenario would decrease from $1,780 per acre to $414 per acre, a difference of $1,366.

TABLE 30
Average Cost Analysis
(Assumes 20% cost increase and 20% SAV Restored decrease)

Alternative	Total Output	Project Cost	Annual Cost	Average Cost
FP2	32	$384,000	$30,000	$938
TS5	288	$36,403,000	$2,431,000	$8,441
BC13a	123	$2,110,000	$140,000	$1,138
BC8	263	$2,811,000	$187,000	$711
SI18	986	$4,658,000	$224,000	$227
Totals with TS5	**1,692**	**$46,366,000**	**$3,012,000**	**$1,780**
Totals without TS5	**1,404**	**$9,963,000**	**$581,000**	**$414**

Summary of Cost Effectiveness and Incremental Analyses

A cost-effectiveness and incremental analysis process was used to evaluate the alternatives formulated for the protection and restoration of habitat on Smith Island. Separate evaluations were conducted for each of the project areas. The evaluation identified 5 alternatives as "best buy" alternatives for their respective project areas. The expected annual habitat value of the 5 alternatives is 1,964 acres. The estimated cost of implementation of the 5 projects is $38,500,000. The annual cost over the 50-year project life is $2,511,000. The average cost per acre of habitat with construction of the 5 projects is $1,278.

A sensitivity analysis was performed to measure the effect on the average cost per acre of habitat of variations in project costs and project outputs. The analysis used a cost estimate 20 percent greater than the current estimate and an output level 14 percent less than the expected output level. These variations resulted in a cost of $46,366,000 and habitat output of 1,692 annual acres. The resulting cost per acre of habitat with construction of the 5 "best buy" alternatives is $1,780, an increase of $502 per acre from the expected output and cost levels.

An additional analysis was performed to highlight the disproportionate influence on project cost and average cost per acre of alternative TS5. With removal of this alternative from the set of selected projects, the total cost of the remaining selected projects would amount to $8,138,000, a decrease of 79 percent from the cost estimate with TS5 included. Moreover, the average cost per acre of output would decrease from $1,278 per acre to $302 per acre with removal of TS5 from the set of projects, a 76 percent decrease in the average cost per acre of habitat. These data indicate that, from an economic perspective, alternative TS5 provides a relatively meager output for its cost in comparison to the other "best buy" project alternatives identified.