UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

NEW ENGLAND REGIONAL OFFICE

Costs for Wetland Creation and Restoration Projects in the Glaciated Northeast

FINAL REPORT

Work Assignment No.2
EPA Contract No. 68-D5-0171

July, 1997

Louis Berger & Associates, Inc.
in association with
The BSC Group

U.S. Environmental Protection Agency,
New England Regional Office

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1.0 INTRODUCTION

The purpose of Work Assignment No. 2 was to provide a comprehensive investigation of the monetary costs for creating and restoring wetlands in the glaciated northeast. The work assignment was divided into five tasks: Task 1, Planning; Task 2, Comprehensive Literature Search; Task 3, Telephone Survey; Task 4, Office Visits for File Review; and Task 5, Preparation of Final Report. This Final Report synthesizes the data collected in Tasks 2 through 4 into the most comprehensive summary and analysis of wetland restoration costs in the northeast now available.

2.0 RESEARCH METHODS AND INFORMATION SOURCES

Task 2. Under Task 2, Berger and BSC conducted a six week literature search into the monetary costs involved in creating and restoring wetlands in the glaciated northeast, an area comprising the six New England States as well as the State of New York and the northern parts of New Jersey. The Task 2 report contained a database of restored and created wetland projects including location, size and type of wetland creation or restoration, date of construction completion, and name of applicable owner, agency, or consulting firm.

Task 3. Under Task 3, Berger and BSC utilized information obtained in Task 2 to perform a telephone survey of state agencies, including departments of transportation and environmental management/protection/services; private developers; consultants specializing in wetlands science and engineering; and wetland nurseries in order to obtain cost information for planning, construction and monitoring phases of specific projects. A list of contacts is presented in Table 2.1.

Task 4. Office visits were initially planned as part of this Work Assignment and were to be conducted during Task 4; however, both public and private agencies discouraged visits, asserting that no additional information could be gained by an office visit that could not be obtained by telephone and by fax. Under Task 4, therefore, Berger and BSC conducted a four week search in the form of literature and in depth telephone surveys in order to obtain a more detailed understanding of selected wetland creation and restoration projects and to obtain additional planning, construction and monitoring cost information for wetland creation and restoration projects listed in Tables 3.1 and 3.2 of this report. The primary goal of this Task was to obtain more detailed information on a few, solid projects to serve as case studies, and to obtain additional information to supplement the information obtained during the telephone survey (Task 3) and during the literature search (Task 2).

Table 2.1: List of Individuals Contacted

Name	Agency/Firm	Phone Number	Original Contact Date
Alexander, Mark	Connecticut Department of Transportation	860.594.2920	1/17/97
Barney, David	South Weymouth Naval Air Station Environmental Division	617.682.2884	2/11/97
Baumert, Dan	NRCS, Warwick, R.I.	401.828.1300	3/12/97
Bowen, Marcia	Normandeau Associates Yarmouth, Maine	207.846.3598	2/12/97
Capotosto, Paul	CT DEP, Wetlands Restoration Biologist, Wildlife Division	860.642.7239	2/12/97
Clingerman, Gail	New England Division U.S. Army Corp of Engineers	617.647.8283	1/7/97
Crispin, David	The BSC Group, Inc.	617.659.7981	2/19/97
Dunne, Ken	Louis Berger & Associates, Inc.	201.678.1960	1/29/97
Evans, Ray	Waterman Industries	209.562.4000	2/14/97
Golet, Frank	Univ. of Rhode Island, Wetland Science, Professor	401.874.2916	2/20/97
Hadden, Deborah	Massachusetts Port Authority	617.568.3504	2/19/97
Horbert, Chuck	RIDEM Wetlands	401.277.6820 x7402	3/12/97
Hoskins, Douglas	CT DEP	860.424.3019	1/15/97
Karr, Tony	Southern Tier Consultants, Syracuse, N.Y.	716.968.3120	3/3/97
King, Dennis	Univ. of Maryland, Env. and Estuarine Studies, Professor	410.326.7212	3/10/97
Ladd, Steven	CT Department of Transportation	860.594.2930	2/18/97
Lamandola, Joe	New York Department of Fish and Wildlife	315.785.2282	1/17/97
Larsen, David	New England Division US Army Corps of Engineers	617.647.8113	4/23/97

Name	Agency/Firm	Phone Number	Original Contact Date
Laurin, Marc	New Hampshire Department of Transportation	603.271.3226	2/7/97
Lenardis, James	Town of Rockland, Mass.	617.878.0901	2/7/97
Lowry, Dennis	Fugro/ENSR Northboro, Mass.	508.393.6779	2/12/97
MacNamera, Timothy	T & M Associates, Inc. Bedford, N.H.	603.448.1295	2/12/97
Marcus, Michael J.	New England Environmental Amherst, Mass.	413.256.0202	2/5/97
McAvery, Steve	NYSDOT, Region 1 Landscape Achitect	914.431.5729	4/9/97
Merrow, Jed	The Smart Associates Concord, N.H.	603.224.7550	2/12/97
Michaud, Sylvia	ME Department of Transportation Agusta, Maine	207.287.5735	1/15/97
Niering, William	Connecticut College	860.439.2000	1/15/97
Ouellette, Tom	Long Island Sound Program, Conn.	860.424.3034	3/10/97
Pierce, Gary	Southern Tier Consultants West Clarksville, N.Y.	716.968.3120	3/11/97
Phillips, Bill	Georgia DOT Office of Environment/Location	404.699.4434	2/4/97
Rendall, Nancy	New England Environmental Concord, N.H.	603.225.4776	2/12/97
Rhodes, Lisa	Massachusetts Highway Department, Boston, Mass.	617.973.7487	1/15/97
Ribb, Richard	Rhode Island Department of Environmental Management Narragansett Bay Program	401.277.3961 x7271	2/10/97
Ruggeri, Carl	RIDEM Wetlands Providence, R.I.	401.277.6820 x7413	3/11/97
Sammartino, Everett	Rhode Island Department of Transportation, Providence, R.I.	401.277.2207 x4055	2/3/97

Name	Agency/Firm	Phone Number	Original Contact Date
Sanford, Gary	Sanford Ecological Services, Southborough, Mass.	508.460.9900	1/12/97
Scheirer, Robert	U.S. Fish and Wildlife Concord, N.H.	603.225.1411	1/17/97
Schwartz, Carl	U.S. Fish and Wildlife Cortland, N.Y.	607.753.9334	1/15/97
Smith, Steve	Finard Company Burlington, Mass.	617.273.5555	3/10/97
Snarski, Rick	New England Environmental Services, Marlboro, Conn.	860.859.2428	3/3/97
Steinke, Tom	Wetlands and Waterways Commission, Fairfield, Conn.	860.256.3071	2/12/97
Sullivan, Pat	Environmental Specialist, USACOE New York District	212.264.7101	2/18/97
Taber, Bernadette	National Resource Conservation Service, Marion, Mass.	508.748.3600	3/10/97
Tiner, Ralph	U.S. Fish and Wildlife, Amherst, Mass.	413.253.8200	1/17/97
Weiskotten, Kurt	New York State Department of Transportation, Water and Ecology Section	518.485.5320	2/20/97
West, Mark	Gove Environmental Services, Inc.	603.778.0644	2/12/97
Wheelwright, Michael	Department of Public Works Quincy, Mass.	617.376.1901	2/11/97

3.0 RESULTS AND DISCUSSION

This section provides a summary of project costs associated with recent wetland creation and restoration projects (see Table 3.1), a discussion of variables involved in wetland creation and restoration, a detailed presentation of wetland projects in Connecticut, Maine, Massachusetts, New Hampshire, New York and Rhode Island, and a discussion of project limitations.

The motivation for wetland creation and restoration projects is based on regulatory compliance (Section 404 permitting under the Clean Water Act of 1972, various state wetland protection acts, and municipal bylaws), and public and private interests. Public interest projects include those for flood control, nonpoint source stormwater management, mosquito control, and wildlife habitat restoration or creation. Private interests are frequently directed at protecting or increasing the value of property. The study included regulatory-based wetland projects, as well as public interest projects.

For purposes of this Work Assignment, the following definitions were used:

> ***Wetland Restoration.*** Wetland restoration is the act, process, or result of returning a former wetland or a damaged, degraded or otherwise functionally impaired wetland to its pre-disturbance or unimpaired condition. Restored wetlands should be persistent and self-sustaining (Wetlands Restoration & Banking Program, *Watershed Wetlands Restoration Planning Guidance*, July 1, 1996).
>
> ***Wetland Creation.*** Wetlands are created on sites that previously were upland sites. Like restored wetlands, created wetlands should be persistent and self-sustaining.

3.1 Costs - Project Tables

Cost estimates for wetland restoration or creation, as a result of the literature search and the telephone survey including information obtained during Task 4, are presented in Table 3.1. The costs are normalized to 1997 dollars and are listed for planning and design, construction, and monitoring, as available. Costs were obtained for projects in the six New England states and for New York State. All costs were normalized to April 1997 prices, using the Consumer Price Index. Statistical information is provided at the end of the table. Available project-specific issues that may have affected the total costs are listed in the Notes section, following Table 3.1.

Although some agencies were able to provide information specifically for planning (design), construction and monitoring, frequently only the actual total price of the wetland creation and/or restoration project was available. In other cases, only one or two of the three cost variables were available, which always included construction costs. In order to provide an indication of the project costs, the total costs were listed, even if planning, construction and/or monitoring costs could not be separated from the total costs.

A separate table was prepared with estimates for freshwater and salt marsh restoration associated with the following Connecticut Department of Environmental Protection (CTDEP) programs (Table 3.2):

- CTDEP Office of Long Island Sound - Coves and Embayments Program;
- CTDEP Wetland Restoration Program - Migratory Bird Conservation Stamp Program;
- CTDEP Wildlife Division.

These projects are all typically inexpensive restoration projects involving little planning and design with significantly lower planning costs. The Migratory Bird Conservation Stamp Program is a program designed to restore the wildlife habitat for migratory birds. The Coves and Embayments Program is designed to restore degraded salt marshes through increasing tidal exchange in order to improve water quality, benthic and fish habitat. All costs were normalized to April 1997 prices, using the Consumer Price Index. Statistical information is provided at the end of the table. Any project-specific issues that may have affected the total costs are listed in the Notes section, following Table 3.2.

The wetland types were identified in accordance with *Classification of Wetlands and Deep-Water Habitats of the United States* (Cowardin *et al.*, 1979).

Table 3.1

Wetland Creation and Restoration Projects in the Glaciated Northeast
- Data Summary -

I.D. & Note No.	Project Name and Location	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) *(during construction year)*	Total Costs: Costs ($) *(adjusted to 1997 prices)*	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (% of Total Costs per acre): Planning	Construction	Monitoring	Total Cost
Connecticut																												
CT-1	Mashantucket Pequot Reservation, Ledyard	Pequot Tribe	1997 (est.)	●	●									10.0		$1,000,000	$1,000,000		●		n/a	$100,000	n/a					
CT-2	School, Ledyard	Town of Ledyard	1996		●	●								1.0		$48,200	$49,152	●	●		$1,428	$47,725	$0	$49,152	3%	97%	0%	100%
CT-3	Neck River Farms, Madison	500-acre Subdivision	1996		●	●									1.0	$35,600	$36,303	●	●	●	$5,711	$27,533	$3,059	$36,303	16%	76%	8%	100%
CT-4	Groton Dredge Spoil Disposal Site, Groton	CT Department of Environm. Prot.	1989						●					20.0		$286,841	$370,117		●		n/a	$18,506	n/a					
CT-5	Route 187/Cottage Grove Road, Bloomfield	CT Department of Transportation	1993	●			●							6.0		$212,000	$234,740		●	●	n/a	$29,897	$9,227					
CT-6	Route 7, Norwalk CT	CT Department of Transportation	1989	●	●										6.8	$2,670,000	$3,445,162		●	●	n/a	$497,154	$9,488					
CT-7	I-91, Windsor	CT Department of Transportation	1993		●		●								6.5	$837,005	$926,788		●	●	n/a	$125,547	$17,035					
CT-8	Route 9, Cromwell	CT Department of Transportation	1993	●	●										21.5	$1,878,988	$2,080,540		●	●	n/a	$96,512	$257					
CT-9	Mile Hill Road, Newtown	CT Department of Transportation	1997	●		●	●								1.0	$130,220	$130,220	●	●	●	$25,000	$95,220	$10,000	$130,220	19%	73%	8%	100%
CT-10	Routes 2 and 32, Norwich, CT	CT Department of Transportation	1997			●		●							2.3	$190,734	$190,734	●	●	●	$4,348	$74,233	$4,347	$82,928	5%	90%	5%	100%

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Massachusetts																												
MA-1	Emerald Square Mall, Attleborough	New England Development	1989		●	●									2.0	$2,210,000	$2,851,613	●	●	●	$645,161	$645,161	$135,484	$1,425,806	45%	45%	10%	100%
MA-2	Route 57, Agawam	Massachusetts Highway Department	1994		●	●									12.7	$145,541	$157,129	●	●	●	n/a	n/a	n/a	$12,334				
MA-3	South Weymouth Naval Air Station, Weymouth	U.S. Navy	1994		●	●									1.3	$218,362	$235,748	●	●	●	$41,523	$137,330	$2,492	$181,345	23%	76%	1%	100%
MA-4	Logan Airport Runway Expansion, Boston	Massachusetts Port Authority	1994						●						1.3	$715,000	$771,930	●	●	●	$53,981	$431,849	$107,962	$593,792	9%	73%	18%	100%
MA-5	Cumberland Farms, Halifax	Cumberland Farms	1989		●		●							120.0		$1,631,400	$2,105,032	●	●	●	$768	$12,903	$3,871	$17,542	4%	74%	22%	100%
MA-6	Post Island Marsh, Houghs Neck, Quincy	Town of Quincy, Dept. of Public Works	1993						●					10.0		$95,700	$105,965	●	●	●	$1,107	$9,190	$299	$10,597	10%	87%	3%	100%
MA-7	Third Marsh, Houghs Neck, Quincy	Town of Quincy, Michael C. Wheelwright	1995						●					20.0		$279,000	$292,913	●	●	●	$1,606	$12,934	$105	$14,646	11%	88%	1%	100%
MA-8	Skymeadow Golf Course, Dunstable	Skymeadow Condominium Assoc.	1987		●	●								5.0		$96,000	$135,211	●	●	●	$5,634	$19,718	$1,690	$27,042	21%	73%	6%	100%
MA-9	Bristol County Jail	Exec. Office of Admistr. and Finance, Div. of Capital Planning Operations	1997 (est.)			■									11.5	$1,400,000	$1,427,661	●	●		$15,961	$108,183	$0	$124,144	13%	87%	0%	100%
Maine																												
ME-1	Wells Interchange, Branch Brook Site, Wells	Maine Turnpike Auth.	1996		●		●								2.0	$740,000	$754,621	●	●	●	$40,790	$275,335	$61,185	$377,310	11%	73%	16%	100%
ME-2	Scarborough Connector, Scarborough	ME Department of Transportation	1995				●							21.9	3.5	$2,092,960	$2,197,333	●	●	●	$47,034	$31,811	$7,664	$86,509	54%	37%	9%	100%
ME-3	T31 MD-2, -3 Aurora and Crawford Sites, T31 MD	ME Department of Transportation	1996				●							2.3		$591,100	$602,779	●	●	●	$65,163	$141,033	$55,883	$262,078	25%	54%	21%	100%
ME-4	Topsham Fair Site, Topsham, Brunswick	ME Department of Transportation	1996				●							7.1		$1,207,710	$1,231,572	●	●	●	$74,646	$80,867	$17,948	$173,461	43%	47%	10%	100%

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Wetland Creation and Restoration Projects in the Glaciated Northeast
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ME-5	Connector Site, Biddeford	ME Department of Transportation	1991				●								3.0	$302,100	$354,890		●	●	n/a	$77,533	$40,764					
ME-6	Ichabod Lane Site, Hampden	ME Department of Transportation	1996				●							1.0	0.5	$372,000	$379,350	●	●	●	$93,104	$101,976	$57,820	$252,900	37%	40%	23%	100%
ME-7	Route 196 Site, Lewiston	ME Department of Transportation	1992				●							0.8		$158,775	$181,069	●	●	●	$141,411	$71,846	$28,168	$241,426	59%	30%	12%	100%
ME-8	Yarmouth Middle School, Yarmouth	Town of Yarmouth	1992			●	●							3.4		$15,249	$17,390	●	●	●		$3,606	$1,509	$5,115		71%	29%	100%
New Hampshire																												
NH-1	Route 25, Effingham, Freedom	NH Department of Transportation	1989		●	●									2.2	$60,000	$77,419	●	●	●	n/a	n/a	n/a	$35,191				
NH-2	Route 101, Pine Road Site, Brentwood	NH Department of Transportation	1995		●		●								105.0	$9,229,880	$9,690,163	●	●	●	$5,000	$86,287	$1,000	$92,287	5%	93%	1%	100%
NH-3	Route 101, Squamscott River Bridge, Stratham	NH Department of Transportation	1996						●					4.0		$318,000	$324,283	●	●	●	$5,099	$53,027	$22,945	$81,071	6%	65%	28%	100%
NH-4	Spaulding Turnpike, Portsmouth-Newington	NH Department of Transportation	1992		●	●								2.8	6.2	$246,600	$281,226	●	●	●	$2,851	$28,396	$0	$31,247	9%	91%	0%	100%
NH-5	Route 9 Bypass, Nelson, Stoddard	NH Department of Transportation	1995		●										3.3	$137,280	$144,126	●	●	●	$10,604	$33,071	$0	$43,675	24%	76%	0%	100%
NH-6	Route 101 & 114, Bedford	NH Department of Transportation	1995		●	●									3.6	$288,720	$303,118	●	●	●	$39,895	$44,304	$0	$84,199	47%	53%	0%	100%
NH-7	Treatment Plant Property, Littleton	NH Department of Transportation	1993		●	●			●						3.4	$181,900	$201,412	●	●	●	$3,875	$55,363	$0	$59,239	7%	93%	0%	100%
NH-8	NH Marine Terminal, Portsmouth	Port Authority of New Hampshire	1995								●			6.2	0.8	$462,000	$485,039	●	●	●	$3,150	$62,992	$3,150	$69,291	5%	91%	5%	100%
NH-9	NH Marine Terminal, Portsmouth	Port Authority of New Hampshire	1995						●						1.6	$360,000	$377,953	●	●	●	$41,995	$167,979	$26,247	$236,220	18%	71%	11%	100%
NH-10	NH Marine Terminal, Portsmouth	Port Authority of New Hampshire	1995									●		10.0	3.0	$2,743,000	$2,879,790	●	●	●	$34,646	$184,777	$2,100	$221,522	16%	83%	1%	100%
NH-11	Factory Outlet Stores, Tilton	Charter Oaks Partners	1995	●	●									3.4		$105,060	$110,299	●	●	●	$945	$29,396	$2,100	$32,441	3%	91%	6%	100%
NH-12	NH International Speedway, Loudon	Everett Prescott	1996	●	●	●									1.9	$6,000	$6,119	●		●	$1,658	n/a	$1,658					

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I.D. & Note No.	Project Name and Location	Agency/ Developer Funding Project	Year	Wetland Type										Wetland Area		Total Costs					Wetland Costs (in 1997 $$ per acre) n/a = Not available.				Wetland Costs (% of Total Costs per acre)			
				Palustrine					Estuarine									includes:										
			(Completion of Construction)	Open Water	Emergent	Scrub/Shrub	Forested	Riverine Emergent	Intertidal Emergent	Intertidal Streambed	Intertidal Flat	Subtidal Aquatic Bed	Subtidal Open Water	Restoration (acres)	Creation (acres)	Costs ($) (*during construction year*)	Costs ($) (*adjusted to 1997 prices*)	Planning ($)	Construction ($)	Monitoring ($)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning	Construction	Monitoring	Total Cost
NH-13	Rockingham Mall, Salem	New England Development	1992	●	●										5.0	$1,200,000	$1,368,496	●	●		$45,617	$228,083	$0	$273,699	17%	83%	0%	100%
NH-14	Awcomin Marsh, Rye Harbor	NH Off. of State Planning, ACOE, USF&W	1993						●					35.0		$100,100	$110,837	●	●	●	$631	$2,215	$321	$3,167	20%	70%	10%	100%
NH-15	Stewart Farm, Stratham	NH Office of State Planning	1993						●					4.0		$20,000	$22,145	●	●	●	$692	$4,152	$692	$5,536	13%	75%	13%	100%
NH-16	Route 1-A, Rye	NH Office of State Planning	1993						●					40.0		$44,400	$49,163	●	●	●	$138	$1,024	$66	$1,229	11%	83%	5%	100%
NH-17	Drakeside Road, Hampton	NH Office of State Planning	1996						●					22.0		$30,030	$30,623	●	●	●	$163	$1,066	$163	$1,392	12%	77%	12%	100%
NH-18	Locke Road, Rye	NH Office of State Planning	1995						●					14.0		$24,080	$25,281	●	●	●	$189	$1,428	$189	$1,806	10%	79%	10%	100%
NH-19	Marsh Road, Rye	NH Office of State Planning	1997						●					50.0		$40,000	$40,000	●	●	●	$90	$640	$70	$800	11%	80%	9%	100%
NH-20	Meadow Glen, Salem	Meadow Glen	1994		●	●									3.3	$92,615	$99,989	●	●	●	$1,820	$26,780	$1,700	$30,300	6%	88%	6%	100%
NH-21	Garabedian/Spicket River	Garabedian, Salem, NH	1990	●	●	●								5.6		$89,992	$110,166	●	●	●	$4,372	$13,116	$2,185	$19,673	22%	67%	11%	100%
New York																												
NY-1	Route 13/Cayuga Inlet (PIN 3057.28)	NY State Departm. of Transportation	1995		●										0.4	$35,000	$36,745		●		n/a	$91,864	n/a					
NY-2	Route 17 (PIN 5006.47)	NY State Departm. of Transportation	1995		●									5.0		$85,000	$89,239		●		n/a	$17,848	n/a					
NY-3	Route 78 (PIN 5111.55)	NY State Departm. of Transportation	1995		●										0.13	$6,886	$7,229		●		n/a	$55,611	n/a					
NY-4	Route 263 - Millersport Highway (PIN 5668.10)	NY State Departm. of Transportation	1996	●	●									3.0		$10,000	$10,198		●		n/a	$3,399	n/a (1 year)					
NY-5	Route 16 and Route 3 (PIN 5579.59)	NY State Departm. of Transportation	1997				●							0.37		$33,000	$33,000		●		n/a	$89,189	n/a					
NY-6	Tifft Street Bridge (PIN 5752.78)	NY State Departm. of Transportation	1993		●										1.7	$50,000	$55,363		●		n/a	$32,567	n/a (5 years)					

Table 3.1

Wetland Creation and Restoration Projects in the Glaciated Northeast
- Data Summary -

I.D. & Note No.	Project Name and Location	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) (during construction year)	Total Costs: Costs ($) (adjusted to 1997 prices)	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (% of Total Costs per acre): Planning	Construction	Monitoring	Total Cost
NY-7	Route 17 Interchange, Goshen NY (PIN 8006.41)	NY State Departm. of Transportation	1995	•	•	•	•								15.7	$2,229,400	$2,340,577		•		n/a	$149,081	n/a (5 years)					
NY-8a	Taconic State Parkway - Hawthorn Interch. (PIN 8126.40)	NY State Departm. of Transportation	1990	•	•										1.8	$216,000	$264,422		•		n/a	$146,901	n/a (3 years)					
NY-8b	Taconic State Parkway - Hawthorn Interch. (PIN 8126.40)	NY State Departm. of Transportation	1990	•	•										0.7	$5,250	$6,427		•		n/a	$9,181	n/a (3 years)					
NY-8c	Taconic State Parkway - Hawthorn Interch. (PIN 8126.40)	NY State Departm. of Transportation	1990	•	•										11.9	$1,666,000	$2,039,480		•		n/a	$171,385	n/a (3 years)					
NY-8d	Taconic State Parkway - Hawthorn Interch. (PIN 8126.40)	NY State Departm. of Transportation	1990	•	•	•									3.2	$198,400	$242,877		•		n/a	$75,899	n/a (3 years)					
NY-9	Taconic State Parkway - Pudding Street (PIN 8126.09)	NY State Departm. of Transportation	1995				•							1.2	1.2	$456,000	$478,740		•		n/a	$199,475	n/a (5 years)					
NY-10	Sawmill River Parkway Lawrence to Ashford (PIN 8390.29)	NY State Departm. of Transportation	1990	•	•	•									1.2	$210,000	$257,077		•		n/a	$214,231	n/a					
NY-11	Route 6 Extension (PIN 9390.29)	NY State Departm. of Transportation	1995		•	•	•								8.3	$2,235,600	$2,347,087		•		n/a	$283,465	n/a (5 years)					
NY-12	Muck Piece Prattsville NY	USFWS Partners for Wildlife	1996	•	•									50.0		$4,500	$4,589	•	•		$5	$87	n/a					

Rhode Island

I.D. & Note No.	Project Name and Location	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) (during construction year)	Total Costs: Costs ($) (adjusted to 1997 prices)	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (% of Total Costs per acre): Planning	Construction	Monitoring	Total Cost
RI-1	Bailey Brook, Middletown	NRCS 319 NPS Grant	1997	•	•									4.5		$110,000	$110,000	•	•	•	$5,500	$18,944	n/a					
RI-2	Galilee Bird Sanctuary, Narragansett	RI Department of Transportation, U.S. Army Corps of Engineers	1997 (est.)						•					98.2		$2,301,650	$2,301,650	•	•	•	$4,532	$18,785	$122	$23,438	19%	80%	1%	100%
RI-3	Route 138, Jamestown	RI Department of Transportation, U.S. Army Corps of Engineers	1995		•	•								5.3	0.1	$115,080	$120,819		•		n/a	$22,374	n/a					
RI-4	Route 99, Cumberland and Woonsocket	Transportation, U.S. Army Corps of Engineers	1991	•	•										4.1	$823,690	$967,624		•	•	n/a	$128,517	$107,489					
RI-5	Route 99, Blackstone River, Woonsocket	RI Department of Transportation, U.S. Army Corps of Engineers	1995					•						1.3		$252,248	$264,827	•	•	•	$116,026	$65,412	$22,275	$203,713	57%	32%	11%	100%

Table 3.1

Wetland Creation and Restoration Projects in the Glaciated Northeast
- Data Summary -

I.D. & Note No.	Project Name and Location	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) (during construction year)	Total Costs: Costs ($) (adjusted to 1997 prices)	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (% of Total Costs per acre): Planning	Construction	Monitoring	Total Cost

Statistics for all Projects

	Restoration (acres)	Creation (acres)	Costs ($) (adjusted to 1997 prices)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning %	Construction %	Monitoring %	Total Cost %
Count	35	40	68	42	65	47	42	39	40	40	40
Mean	17.0	6.7	$749,729	$37,949	$93,722	$16,398	$134,662	19%	73%	9%	100%
Median	5.6	2.7	$239,313	$5,049	$55,611	$2,100	$54,196	13%	76%	8%	100%
Minimum	0.4	0.1	$4,589	$5	$87	$0	$800	3%	30%	0%	100%
Maximum	120.0	105.0	$9,690,163	$645,161	$645,161	$135,484	$1,425,806	59%	97%	29%	100%

Statistics only for Projects with Complete Cost Breakdown for Planning/Construction/Monitoring

	Restoration (acres)	Creation (acres)	Costs ($) (adjusted to 1997 prices)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning %	Construction %	Monitoring %	Total Cost %
Count	24	20	39	39	39	39	39	39	39	39	39
Mean	20.2	8.1	$843,584	$40,685	$88,029	$14,956	$143,670	19%	73%	8%	100%
Median	6.7	2.7	$264,827	$5,099	$47,725	$2,100	$69,291	13%	76%	8%	100%
Minimum	0.8	0.5	$22,145	$90	$640	$0	$800	3%	30%	0%	100%
Maximum	120.0	105.0	$9,690,163	$645,161	$645,161	$135,484	$1,425,806	59%	97%	28%	100%

Table 3.1 Notes

Connecticut Projects

CT-1 Required a large volume of fill to be hauled off site. Complex hydrology and water supply issues.

CT-2 Construction costs reflect a $5,000 donation of 3,200 herbaceous plants.

CT-3 Planting costs were $6,000.

CT-4 The costs are largely excavation costs at $4.00 to $4.25 per cubic yard for 2 to 3 feet of excavated material. The area was allowed to reseed naturally.

CT-5 Red maple swamp previously filled for tennis court construction. The original restoration occurred in 1993 but the hydrology was not correct. As a result, over 80 percent of the plantings were lost. At that time, CTDOT's practice was to dig a hole and plant, with little consideration of hydrology. Reconstruction of the wetland occurred in 1995 when channels and drains were installed to correct the hydrology. Red maple plantings appear to be doing well although there was considerable damage from voles and other wildlife the first winter, in addition to heavy snow cover.

CT-6 Blasted rock to create a perched wetland system, groundwater fed; manufactured topsoil and peat on site. Project cost includes extensive rock excavation.

CT-7 Three wetlands created: one wetland was groundwater-fed, one was an impounded stream, and one was for stormwater discharge.

CT-8 This project consists of nine mitigated wetland sites; good habitat for bass.

CT-9 Bids received ranged from $95,000 to $132,508. Site is on adjacent state land and entails extension of the palustrine emergent wetland to an adjacent agricultural field. Based on past problems with hydrology, they will not plant the site until the following season.

CT-10 Construction cost includes construction of an access road ($4,774), site construction ($122,577), planting ($36,325), and miscellaneous extras ($7,000). Control structures will be installed for hydrology. Piezometers will be installed after the site is excavated and monitored for one year prior to planting to get better information on planting zones.

Massachusetts Projects

MA-4 Construction oversight costs were $20,000, which are included in the construction costs.

MA-6 *Phragmites australis* control. Construction costs included headwall/pump station ($18,000), two tide gates ($14,000) and chambers ($4,000).

MA-7 *Phragmites australis* control. Construction costs included headwall/pump station ($42,000), two tide gates ($29,000) and chambers ($16,000).

Maine Projects

ME-2 Consists of three separate sites.

ME-3 This wetland project is associated with the reconstruction of a 1.5-mile section of Route 9 in Township 31 Middle Division (T31 MD) in eastern Maine. The reconstruction project is part of an ongoing effort by MDOT to upgrade a 90 mile segment of Route 9 that has become an increasingly important transportation corridor between Bangor and the Maritime Provinces of Canada. Construction completed in 1996 and monitoring expected to continue through 2000.

ME-4 Two wetland sites were finally chosen, but these were not without problems. One of the sites was a wetland fill violation. This prompted MDOT to reconsider that site because they did not want to purchase a site that would require remediation or monetary penalties. MDOT decided to proceed with that site when the EPA decided not to take enforcement action for the violation. The second site was known to contain buried demolition debris. MDOT suspected that the debris included hazardous materials such as asbestos, and was concerned about the potential liabilities associated with their clean-up. They spent more than $11,000 on an intensive assessment of the site. When the tests revealed there were no significant hazardous materials, MDOT decided to include the site in their proposed wetland restoration package.

ME-8 Total project costs included delineation, preliminary report, and final design and development of educational curriculum.

New Hampshire Projects

NH-1 A 3.1 acre emergent wetland was created in order to mitigate impacts to 5.9+/- acres of palustrine forested wetland due to the reconstruction of NH Route 25. The wetland creation site consists of two replacement sites totaling 2.1+/- acres. Both sites are located adjacent to the new Route 25 alignment.

NH-2 Estimated costs. This site is still under construction. Approximately 320 acres of land were purchased for $2.2 million; these costs are *not* included in the listed total costs. Construction costs include hauling fill and building highway subcourse. Construction supervision by the contractor was approximately $130,000; this cost is included in the construction costs. The substantial DOT supervision costs, however, are not included.

NH-3 Estimated costs. Construction supervision made up approximately $8,000 of the overall construction cost for the project. There was no need for site acquisition; the site was within the right-of-way. Costs for permitting are not included.

NH-5 Four sites were developed to offset wetland impacts brought on by the relocation of Route 9 to bypass Granite Lake and the village of Munsonville. The total area of impacted wetlands was 4.5+/- acres (3.5+/- ac hillside seeps, 0.9 ac forested wetland, 0.1 ac Otter Brook wetland) occurred as a result of this project. Three sites were utilized in order to mitigate for wetland losses. A 2.0 ac wetland restoration area was located at site 1, and a 1.3 ac wetland creation/enhancement at sites 2 and 3. Construction costs included lining excavated areas with hydric soils and various plantings, to provide wildlife habitat at site 1 and creating detention pond and diverting roadway runoff to flow through wetland sites 2 and 3 prior to entering Otter Brook.

NH-6 Land acquisition costs were approximately $300,000. Some planting costs are not included in construction costs.

NH-7 See Section 3.3 for summary.

NH-15 Funding agencies include NH Office of State Planning, Rockingham County Conservation District, USF&W, and ACOE.

NH-16 The $37,000 construction cost entails the installation of a box culvert and excessive earthmoving.

NH-17 Construction costs include the installation of a box culvert.

NH-18 Construction costs reflect the cost of the repercussions from damaging a water pipe during construction.

NH-19 This restoration is scheduled for construction in the fall of 1997.

New York Projects

Note: All New York construction projects include the costs for excavation for the entire highway project.

NY-1 The actual project was started in the mid-1980s. At that time, it was assumed that wetland creation was necessary. The project was later advanced under NWP #3, although the ACOE would not have required creation. A monitoring plan has not been approved yet.

NY-2 This project required the development of a DOT-DEC Memorandum of Agreement for the acquisition of funding for the purchase of property for restoration purposes. The DEC carried out restoration with DOT funding and also administered monitoring of the site.

NY-3 No monitoring required. Additional ROW was required for creation adjacent to the partially impacted wetland.

NY-4 Creation not possible within DOT ROW. DEC and ACOE gave DOT credit for 3.0 acres of wetland borrow ponds not associated with any permitted activity.

NY-6 The DOT was able to get permit for the temporary filling of wetlands for construction equipment (i.e., crane pads). All temporarily filled areas were restored.

NY-7 The price per acre is artificially high because of rock excavation on the project. Four wetland areas were created within the interchange ramp system: 8.0 acres - EM/OW, 4.4 acres - FO, 3.0 acres - EM/SS, and 0.3 acres - SS.

NY-8 4 parcels, totaling 17.6 acres: 1.8 acres=OW/EM (created) at $120,000 per acre, 0.7 acres=EM/OW (restored) at $7,500 per acre, 11.9 acres=EM/OW (restored) at $140,000 per acre, and 3.2 acres=EM/OW/SS (restored) at $62,000 per acre. The total project costs of $329,500 do not include costs for needed land purchase. Agency interactions were cumbersome due to personnel changes and unclear vision of the type creation and/or restoration required.

NY-9 Construction: 4 sites - $456,000 ($190,000 per acre). Price high because of rock excavation on the rest of project. When an old dump area was excavated for creation of the wetland, organic soils were exposed. Wetland vegetation began to sprout from seed stock which could have been buried up to sixty years.

NY-10 Monitoring period nearly complete. Interim ACOE report indicates that the wetland creation meets the permitting requirements; the F&WS may not agree.

NY-11 8.28 acres created on 11 parcels: 6.09 acres FO, 1.02 acres EM, 1.17 acres SS
Construction cost does not include purchase of a 3.37 acre wetland purchase which was deeded over to "Forever Wild." The construction cost is high because permits were not secured before the project was bid. All wetland creation was conducted "out of contract" and was not bid competitively. There also was a problem with plantings which had to be replanted within a power company ROW.

Rhode Island Projects

RI-1 Stormwater improvement project in headwaters of a reservoir.

RI-2 Restoration associated with Route 138, Kingstown (no suitable estuarine sites adjacent to project area so restoration was off-site), to improve tidal flow to a marsh previously blocked by construction of the Galilee Escape Road.

Table 3.2

Connecticut Salt Marsh Restoration and Wildlife Management Programs
- Data Summaries -

I.D. & Note No.	Project Name and Location *(Note: Projects in planning phase are listed in italics.)*	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) *(during construction year)*	Total Costs: Costs ($) *(adjusted to 1997 prices)*	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (in % of Total Costs per acre): Planning	Construction	Monitoring	Total Cost
CT-11	*Pine Creek (Phase I), Fairfield*	*EPA 319 NP, State Coves and Embayments*	*2000 (est.)*						•				•	*21.0*		*$200,000*	*$183,028*		•		*n/a*	*$8,716*	*n/a*					
CT-12	*Pine Creek (Phase II), Fairfield*	*EPA 319 NP, State Coves and Embayments*	*2001 (est.)*						•				•	*17.0*		*$150,000*	*$133,273*		•		*n/a*	*$7,840*	*n/a*					
CT-13	*Pine Creek (Phase III), Fairfield*	*EPA 319 NP, State Coves and Embayments*	*2002 (est.)*						•				•	*14.0*		*$150,000*	*$129,391*		•		*n/a*	*$9,242*	*n/a*					
CT-14	Heron Marsh Pachaug State Forest, Griswold	CT DEP, Duck Stamp Program	1995	•	•									60.0		$10,050	$10,551	•	•		$92	$84	$0	$176	52%	48%	0%	100%
CT-15	Menuketesuch River Marsh, Money Point Marsh, Westbrook	CT DEP, Duck Stamp Program	1996						•				•	100.0		$25,250	$25,749	•	•		$54	$204	$0	$257	21%	79%	0%	100%
CT-16	Indian Neck Marsh, Branford	CT DEP, Duck Stamp Program	1996						•				•	10.0		$20,250	$20,650	•	•		$535	$1,530	$0	$2,065	26%	74%	0%	100%
CT-17	Como Marsh, Culter Street, Stonington	CT DEP, Duck Stamp Program	1996						•					5.0		$12,750	$13,002	•	•		$1,071	$1,530	$0	$2,600	41%	59%	0%	100%
CT-18	Lower Connecticut River Marsh Restoration, Old Lyme, Old Saybrook & East Haddam	CT DEP, Duck Stamp Program	1996						•					70.0		$45,250	$46,144	•	•		$76	$583	$0	$659	12%	88%	0%	100%
CT-19	Cromwell Meadows WMA Marsh, Cromwell	CT DEP, Duck Stamp Program	1997 (est.)	•									•	6.0		$40,250	$40,250	•	•		$875	$5,833	$0	$6,708	13%	87%	0%	100%
CT-20	Schubert Marsh, Killingworth	CT DEP, Duck Stamp Program	1997 (est.)	•					•					32.0		$10,250	$10,250	•	•		$164	$156	$0	$320	51%	49%	0%	100%
CT-21	Vineyard Marsh & Long Cove Marsh Guilford	CT DEP, Duck Stamp Program	1997 (est.)						•					50.0		$25,250	$25,250	•	•		$105	$400	$0	$505	21%	79%	0%	100%
CT-22	Quinnipiac River March (Phase I), North Haven, Hamden & New Haven	CT DEP, Duck Stamp Program	1997 (est.)						•				•	350.0		$45,250	$45,250	•	•		$15	$114	$0	$129	12%	88%	0%	100%
CT-23	Davis Pond Wetland East Lyme CT	CTDEP, Coves & Embayments Prog.	1994						•	•				15.0		$210,000	$226,721	•	•			$15,115	$0	$15,115				
CT-24	Ash Creek Fairfield CT	CTDEP, Coves & Embayments Prog.	1988						•	•				93.0		$30,000	$40,575		•		n/a	$436	n/a					
CT-25	Marsh Road Wetland Groton CT	CTDEP, Coves & Embayments Prog.	1993						•					4.0		$22,333	$24,729	•	•		$347	$5,836	$0	$6,182	6%	94%	0%	100%
CT-26	*Leetes Island Wetland Guilford CT*	*CTDEP, Coves & Embayments Prog.*	*on-going*						•					*15.0*		*$20,525*	*$20,525*	•			*$1,368*	*design ongoing*						

Table 3.2

Connecticut Salt Marsh Restoration and Wildlife Management Programs
- Data Summaries -

I.D. & Note No.	Project Name and Location (Note: Projects in planning phase are listed in italics.)	Agency/ Developer Funding Project	Year	Wetland Type										Wetland Area		Total Costs					Wetland Costs (in 1997 $$ per acre) n/a = Not available.				Wetland Costs (in % of Total Costs per acre)			
				Palustrine					Estuarine									includes:										
			(Completion of Construction)	Open Water	Emergent	Scrub/Shrub	Forested	Riverine Emergent	Intertidal Emergent	Intertidal Streambed	Intertidal Flat	Subtidal Aquatic Bed	Subtidal Open Water	Restoration (acres)	Creation (acres)	Costs ($) (during construction year)	Costs ($) (adjusted to 1997 prices)	Planning ($)	Construction ($)	Monitoring ($)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning	Construction	Monitoring	Total Cost
CT-27	*Lighthouse Point Wetland New Haven CT*	*CTDEP, Coves & Embayments Prog.*	*on-going*						•					*5.0*		*$27,316*	*$27,316*	•			*$5,463*	*design ongoing*						
CT-28	*West River Wetland New Haven CT*	*CTDEP, Coves & Embayments Prog.*	*1993 (study compl.)*						•					*70.0*		*$24,108*	*$26,694*	•			*$381*	*no construction planned*						
CT-29	Alewife Cove New London/Waterford CT	CTDEP, Coves & Embayments Prog.	1988						•				•	42.0		$407,500	$551,141	•	•		$1,465	$11,658	$0	$13,122	11%	89%	0%	100%
CT-30	Norwalk Mill Pond Norwalk CT	CTDEP, Coves & Embayments Prog.	1998 (est.)						•				•	5.0		$403,800	$392,039	•	•		$10,447	$67,961	$0	$78,408	13%	87%	0%	100%
CT-31	*Wilson Cove Wetland Norwalk CT*	*CTDEP, Coves & Embayments Prog.*	*1993 (study compl.)*						•					*8.0*		*$32,450*	*$35,931*	•			*$4,491*	*no construction planned*						
CT-32	Holly Pond Stamford CT	CTDEP, Coves & Embayments Prog.	1986						•				•	194.0		$30,000	$43,796		•		n/a	$226	n/a					
CT-33	Holly Pond Stamford CT	CTDEP, ISTEA	1997						•				•	194.0		$250,000	$250,000		•		n/a	$1,289	n/a					
CT-34	*Quiambaug Cove Stonington CT*	*CTDEP, Coves & Embayments Prog.*	*1993 (study compl.)*						•				•	*70.0*		*$85,978*	*$95,201*	•			*$1,360*	*no construction planned*						
CT-35	Middle Beach Wetland Westbrook CT	CTDEP, Coves & Embayments Prog.	1997						•					10.0		$60,750	$60,750	•	•		$6,075		$0	$6,075				
CT-36	*Cove River-Old Field Creek, West Haven CT*	*CTDEP, Coves & Embayments Prog.*	*on-going*						•			•		*100.0*		*$115,000*	*$111,650*	•			*$1,117*	*constr. expected*						
CT-37	Housatonic State Forest Sharon Mountain Block, CT	CT DEP Wildlife Division	1996		•									34.0		$15,000	$15,296		•		n/a	$450	$0					
CT-38	Hale Marsh, Natchaug State Forest, Eastford CT	CT DEP Wildlife Division	1994	•										18.0		$9,575	$10,337		•		n/a	$574	$0					
CT-39	Wickaboxet Marsh, Pachaug State Forest, Voluntown CT	CT DEP Wildlife Division	1994	•										15.0		$7,632	$8,240		•		n/a	$549	$0					
CT-40	Schubert Marsh, Cockaponset State Forest, Deep River CT	CT DEP Wildlife Division	1994	•										32.0		$12,256	$13,232		•		n/a	$413	$0					
CT-41	Cedar Marsh, Goodwin State Forest, Hampton CT	CT DEP Wildlife Division	1994	•										10.0		$3,317	$3,581		•		n/a	$358	$0					
CT-42	Brown Hill Marsh, Gay City State Park, Hebron CT	CT DEP Wildlife Division	1995	•										36.0		$14,801	$15,539		•		n/a	$432	$0					

Table 3.2

Connecticut Salt Marsh Restoration and Wildlife Management Programs
- Data Summaries -

I.D. & Note No.	Project Name and Location *(Note: Projects in planning phase are listed in italics.)*	Agency/ Developer Funding Project	Year (Completion of Construction)	Wetland Type: Palustrine: Open Water	Palustrine: Emergent	Palustrine: Scrub/Shrub	Palustrine: Forested	Riverine Emergent	Estuarine: Intertidal Emergent	Estuarine: Intertidal Streambed	Estuarine: Intertidal Flat	Estuarine: Subtidal Aquatic Bed	Estuarine: Subtidal Open Water	Wetland Area: Restoration (acres)	Wetland Area: Creation (acres)	Total Costs: Costs ($) *(during construction year)*	Total Costs: Costs ($) *(adjusted to 1997 prices)*	includes: Planning ($)	includes: Construction ($)	includes: Monitoring ($)	Wetland Costs (in 1997 $$ per acre) n/a = Not available.: Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Wetland Costs (in % of Total Costs per acre): Planning	Construction	Monitoring	Total Cost
CT-43	Gay City Marsh, Gay City State Park, Hebron CT	CT DEP Wildlife Division	1995	•										11.0		$13,350	$14,016		•		n/a	$1,274	$0					
CT-44	Dodge Marsh, Nehantic State Forest, Old Lyme CT	CT DEP Wildlife Division	1995	•										3.8		$4,948	$5,195		•		n/a	$1,367	$0					

Statistics for all Projects

	Restoration (acres)	Creation (acres)	Costs ($) (during construction year)	Costs ($) (adjusted to 1997 prices)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning	Construction	Monitoring	Total Cost
Count	34	0		34	19	27	22	14	12	12	12	12
Mean	50.6			$78,685	$1,868	$5,340	$0	$9,452	23%	77%	0%	100%
Median	19.5			$27,005	$875	$583	$0	$2,333	17%	83%	0%	100%
Minimum	3.8			$3,581	$15	$84	$0	$129	6%	48%	0%	100%
Maximum	350.0			$551,141	$10,447	$67,961	$0	$78,408	52%	94%	0%	100%

Statistics only for Projects with Complete Cost Breakdown for Planning/Construction/Monitoring

	Restoration (acres)	Creation (acres)	Costs ($) (during construction year)	Costs ($) (adjusted to 1997 prices)	Planning ($/acre)	Construction ($/acre)	Monitoring ($/acre)	Total Cost ($/acre)	Planning	Construction	Monitoring	Total Cost
Count	12	0		12	12	12	12	12	12	12	12	12
Mean	61			$100,417	$1,270	$7,991	$0	$9,261	23%	77%	0%	100%
Median	37			$25,499	$255	$1,056	$0	$1,362	17%	83%	0%	100%
Median	4			$10,250	$15	$84	$0	$129	6%	48%	0%	100%
Minimum	350			$551,141	$10,447	$67,961	$0	$78,408	52%	94%	0%	100%

Notes - Table 3.2 *(Connecticut Salt Marsh Restoration and Wildlife Management Programs)*

CT-14 Cattail in the impoundment was sprayed and then moved to open up the site to more open water.
CT-15 Marshes were grid-ditched with no standing water. Open marsh water management (OMWM) techniques include installing ponds, pannes, and certain tidal ditches to bring in salt water flows and wildlife. Six to eight ponds were installed at each site. An osprey nest was erected. A blocked tidal channel was excavated to allow salt water into this *Phragmites australis*-dominated tidal wetland.
CT-16 A blocked tidal channel was excavated to allow salt water into this *Phragmites* dominated tidal wetland. A new tidal border channel was excavated with three ponds.
CT-17 *Phragmites* in this tidal marsh were first sprayed during the summer of 1995 and then cut down and dozed down. The following spring the *Phragmites* and several inches of marsh surface were moved to the upland to expose the marsh surface to sunlight.
CT-19 Several ponds will be installed, two intertidal and two inland. Purple loosestrife control to be included.
CT-20 Three ponds and *Phragmites* control planned.
CT-21 *Phragmites* control including spraying and herbicide control is planned.
CT-22 *Phragmites* control and some OMWM will be installed in certain areas of the marsh.
CT-23 Culvert enlargement to improve fish passage, restore tidal creek and wetland.
CT-24 Culvert repair, self-regulating tide gate installation to restore degraded tidal wetland.
CT-25 Cleaned tidal ditches, restored degraded tidal wetland. Planning in 1990; Construction in 1993.
CT-26 Planning study - $21,500; Design - $20,525. Enlargement of culvert to restore degraded tidally restricted wetland.
CT-27 Planning study/design for wetland restoration by removal of historic dredged sediments. Implementation planned: will restore pre-dredging elevation and native vegetation.
CT-28 Planning study of wetland restoration by management of tide gates, wetland surface excavation, *Phragmites* control to improve circulation, water quality, anadromous fisheries habitat. Decided not to go forward with design or construction.
CT-29 Design and construction of dredging and jetty for improved tidal exchange, water quality and benthic habitat quality in tidal creek/embayment.
CT-30 Planning study/design/funding for excavation of contaminated sediment, construction of wetland jetties to improve circulation, water quality, sediment quality, fish access and restore wetland habitat.
CT-31 Planning study of wetland restoration by deepening, widening tidal ditch to improve circulation, restore native wetland vegetation.
CT-32 Tide gate replacement in former mill dam intended to increase tidal exchange, improve water quality.
CT-33 Removal of contaminated road sand to improve circulation, water quality and sediment quality.
CT-34 Planning study to determine habitat impacts of increased tidal exchange; study showed sedimentation rates normal, flushing unrestricted, remediation unnecessary.
CT-35 Culvert replacement to improve flushing and circulation, restore tidal wetland, reduce back-flooding.
CT-36 Planning study of wetland restoration alternatives, e.g., tide gate management, channel realignment to improve flushing and circulation, restore tidal wetland, reduce back-flooding.
CT-37 Herbicide treatment of *Phragmites* in four marshes. *Phragmites* cut with brush cutters the following year
CT-38 Replacement of concrete water control structure, 200 feet of riprap facing.
CT-39 Replacement of a concrete water control structure, dike riprap, an outlet pipe and standard signs.
CT-40 Replace concrete notch water control structure and installation of dike riprap.
CT-41 Concrete water control structure installed.
CT-42 Replacement of an aluminum water control structure.
CT-43 Replacement of an aluminum water control structure.
CT-44 Replacement of a concrete notch water control structure.

3.2 Variables Affecting Wetland Creation/Restoration Costs

This work assignment has identified numerous variables inherent in wetland creation and restoration which can affect cost. The following presents general cost-related information obtained from various sources including the phone survey, BSC and Berger staff, and the literature.

3.2.1 Design and Construction

Richard Snarski of New England Environmental Services indicated that a rough average for conceptual design of wetland creation would be $5,000 for sites ranging from a half acre to two acres (with a range from $3,000 to $7,000). This fee reflects conceptual wetland design, hydrology assessment (exclusive of borings and monitoring well installation), and planting design but does not reflect the price of producing engineering plans, surveys, and subsurface investigations. He added that his wetland restoration design services typically run between $2,000 and $3,000 per acre. According to a Natural Resources Conservation Service (NRCS) 'rule of thumb', design fees represent 20 to 30 percent of the construction cost. Neither methodology accounts for the time (and money) entailed in the federal and state permitting process.

Permitting can be a considerable cost factor. During the telephone survey conducted for this work assignment, when queried about the cost of a particular project, respondents might say: "for the first time the wetland was constructed, or the second?" or, when asked about the cost of project planning and design, respondents might reply: "How many meetings do you want me to include? Do you mean how much time did we spend on it before the regulations changed and we had to start from scratch again?" Another responded that he has bid on one project four times, an indication of the variability associated with creating a cost-effective and successful wetland.

Volunteer labor can significantly lower the price of wetland construction or restoration. In Massachusetts, the Wetlands Restoration and Banking Program (WRBP) uses a watershed approach to implement a "proactive" wetlands restoration program. WRBP proposes to train volunteers including civic groups, schools, and neighbors to ultimately help with project evaluation, design, construction, and monitoring.

Site Selection. Where offsite wetland restoration or creation is required, several variables affect the cost of design and construction. A major cost item is the availability of land adjacent to the project site or within the same hydrologic reach. Other items include mapping of the site, property ownership information, collection of hydrologic data, and data gathering from state and local agencies. In addition, public participation processes might be involved which could be lengthy (and therefore costly) depending on the acceptance of the project by the neighborhood.

Most project costs researched are exclusive of land costs. It is recognized that the fair market value of land could be a major project cost. As observed by Dr. King of the University of Maryland, for projects in urban and suburban areas with high development pressures and limited available land for either wetland creation or restoration, there is pressure to conduct wetland creation in more remote areas with lower land costs.

During discussions with Sylvia Michaud of the State of Maine Department of Transportation and Marc Laurin of the State of New Hampshire Department of Transportation, both suggested that if off-site creation or restoration is necessary, extensive site research efforts can be a significant factor in the ultimate planning and design cost. They also noted that the site must be agreed upon by all agencies involved, both state and federal, and one agency may require a second site research effort, thus increasing the planning and design cost.

Hydrology and Geology. Cost variables may be associated with determining the following surface and subsurface data for project design:

- *Site mapping and topographic survey.* Detailed mapping of the site, including tributaries and downstream reaches. If design is based upon topographical plans with a greater contour interval, quantities for soil to be removed can be off substantially.

- *Depth to groundwater and subsurface geology and chemistry.* Although some projects may be advanced based on hydrologic benchmarks, borings and installation of monitoring wells provide critical information on subsurface conditions including depth of fill in previously degraded wetlands, groundwater table, and characterization of the soil. A water budget may be developed to determine the hydrologic regime. The price of water budget modeling (estimated by Gary Pierce of Southern Tier Consulting in New York at $1,000) could be as high as $50,000, depending on user familiarity with this methodology. Boring and groundwater monitoring programs are mandatory for federally-funded projects to allow for accurate contract bidding.

Wetland Creation vs. Restoration. Selection of wetland type for freshwater and tidal wetlands presents a range of cost variables. Project goals and the potential of the site to support wetland functions and values must be analyzed to determine the type of wetland to be constructed. The decision to restore a tidal marsh through *Phragmites* control and tide gate replacement could represent significantly lower project costs than would be associated with creation of groundwater-based palustrine emergent wetland in an upland, forested location.

Structure Design. Projects dependent upon upland sources of surface water may require construction of a weir to impound a stream. Other sites may require installation of culverts to improve flow of water between two wetland areas previously divided. Salt marsh restoration may require installation of self-regulating tide gates to maximize tidal flow while protecting adjacent developed areas from flooding. Many of these items are designed by contractors and bid separately, thereby adding a major price component to the project.

Planting Plan. For tidal wetlands, planting represents an additional project variable although one that typically constitutes only 3 to 8 percent of the total project cost, according to Edgar W. Garbisch. Planting prices range from $0.00, for a site to reseed itself, to $32,000 per acre. According to Gary

Pierce of Southern Tier Consulting, much of the price of planting depends on the density. As indicated below, a forested wetland could be significantly less expensive to plant than a shrub wetland, based on the spacing required. Depending on density, herbaceous species may be installed for between $5,000 and $12,000 per acre; bare root shrubs may be installed for between approximately $20,000 and $33,000 per acre; and bare root trees, planted 10 feet on centers, may be planted for less than $2,500 per acre.

Numerous wetland scientists advocate reuse of wetland soils and plantings removed from the wetland impact site. Although this reduces the need for planting costs, costs associated with hauling and handling this material may rival the cost of plant materials and installation. John Rockwell, NRCS Wetland Specialist, advocates cutting off plants (such as bayberry, honeysuckle, and *Iva*) at between one and two feet in height to encourage vigorous branching, prior to excavation. Paul Capotosto, CT DEP Wetlands Restoration Biologist, has indicated that seed stock available in the wetland soil may be sufficient to reestablish wetland vegetation within one to two growing seasons, especially in tidal areas.

Ken Dunne of Louis Berger & Associates, Inc. noted that as wetland nurseries become more common, offering a greater variety of species suitable for the local area, prices have also decreased. Projects bid and designed in the 1980s may not be representative of the price or success of plantings conducted in the mid 1990s. On highway projects, the price of wetland plantings is frequently not separated from landscaping required for the entire project. Planting costs could therefore be under-represented in wetland construction costs.

Site Preparation. Site preparation also affects the construction costs. Regular clearing and grubbing is typically $1,000 per acre; selective clearing could be conducted for $3,000 per acre. If wetland restoration/creation is selected in an upland wooded area, the cost of tree cutting and stump removal could add approximately $10,000 on a per acre basis.

Earthmoving may account for up to 95 percent of the construction cost of wetland creation and restoration. Elaborate contouring required to create mound and pool topography could cost an additional $2,000 to $3,000 per acre. Our contacts stressed that the primary cost of wetland creation is the price of excavating material, stockpiling and hauling. Earthmoving costs cited range from $3 to $8 per cubic yard. For example, for a one-acre creation project that requires the removal of a 3 foot thick layer of soil at $5 per cubic yard, the excavation cost alone would be approximately $25,000.

If rock excavation and blasting is required, the price is estimated at $40 per cubic yard. If the material is used on-site, handling costs are lowered significantly. Many of our contacts stressed that the price of wetland construction can be an insignificant overall project cost if material excavated from a wetland creation site is used as fill material on site. This is especially applicable to highway projects with extensive rights of way but more problematic for smaller private developments such as malls and office parks.

State transportation agencies find that the clearing and earthmoving process involved in site preparation is tied in with the earthmoving process for the roadway. Scientists at the Massachusetts Turnpike Authority stated that a significant portion of the earthmoving for the roadway occurs simultaneously with earthmoving for construction of the wetland creation sites. The same equipment is utilized for both projects on the same day or during the same week and, as a result, the costs are difficult to separate. Further, the New York State Department of Transportation includes the entire price of the wetland creation and/or restoration in the entire excavation price on the highway project. Currently, New York DOT does not have the methodology to separate this key component. They are aware of the problem and are attempting to modify their record keeping.

Another factor which affects the outcome of the site preparation cost is the utilization of landowner equipment for construction. Wetland restoration areas such as those undertaken by the U.S. Fish and Wildlife Partners in Wildlife, in many cases, rely on the landowner, usually a farmer, to use their own equipment in order to break tile drains and create earth berms. This significantly reduces the overall construction cost.

Engineering plans, specifications and estimates (PS&E). Grading plans are prepared as part of the PS&E package. The number of sheets in the plan set is directly proportional to the price of engineering for a wetlands project. As a 'rule of thumb', each sheet in a plan set may be produced for between $3,000 and $7,000, with an average price of $5,000 per sheet. State DOTs require plans, profiles, cross-sections, grading, details, sediment and erosion control plans, landscaping plans, structures plans, utilities, and boundary surveys, among others. The price of engineering design may therefore be estimated on the number of sheets (and the scale) required in the plan set. For a project specifying a sheet count of 50 in the plan set, the average engineering fee would be roughly $250,000. Many of the same sheets would be required regardless of whether the wetland project is for 10 or 100 acres, thereby lowering the costs per acre with increasing wetland size.

3.2.2 Monitoring

Many wetland restoration and creation projects are monitored for one or more parameters for a period of three to five years after construction. Based upon our conversations with individuals thus far in the work assignment, it appears that the cost of monitoring wetland restoration and creation areas is minor in comparison to the planning, design, and construction of the project.

Four major factors affect the overall cost of monitoring a wetland restoration or creation project. These include the level of monitoring, frequency of monitoring, the length of the monitoring period, and the number of monitoring reports. The regulatory agency under which the project is permitted (i.e., U.S. Army Corps of Engineers or state environmental agencies) usually specifies the parameters to be monitored.

Level of Monitoring. The level of monitoring may include a detailed program such as the one required for the Massachusetts Port Authority's Logan Airport Salt Marsh Replication or a broader program such as the ones described for freshwater creation projects of the New Hampshire Department of Transportation. Burt Bryan of The BSC Group, Inc. stated that the monitoring program for the Logan Salt Marsh Replication includes biomass measurements and stem counts within numerous sampling plots within the wetland restoration/creation area and control plots located outside the wetland restoration/creation area. The Logan Airport project also includes general observations of the entire wetland. Other projects may include some type of aerial photography and photo-interpretation in conjunction with the sampling program. Freshwater projects, such as those of the New Hampshire Department of Transportation, incorporate a broader monitoring program. According to Marc Laurin of that office, most monitoring programs include the monitoring of random vegetative plots for percent cover, density, and mortality. Further, observations of overall hydrology (quantitative) of the entire wetland are also included as part of this monitoring process. Everett Sammartino of the Rhode Island Department of Transportation has indicated that avian counts, groundwater levels, and soil identification may also be specified in monitoring programs.

Frequency of Monitoring. The frequency of monitoring affects the cost of monitoring a wetland restoration or creation area. The frequency may include monthly monitoring during the growing season, semi-annual or annual monitoring, depending upon the requirements of the issued permit. Naturally, a more intensive monthly monitoring program is more costly than one that requires only annual monitoring.

Length of Monitoring. The length of monitoring required may range from two years to as many as 10 to 15 years. Many of the New Hampshire Department of Transportation's wetland restoration and creation projects have been monitored anywhere from 3 to 10 years, most being monitored for 5 years. Projects involving restoration of salt marshes through increased tidal flow, such as the City of Quincy's Post Island Marsh and Third Marsh, are required to perform a five year monitoring program to measure and track the mortality of *Phragmites australis*.

Number of Reports. The number of reports required will also impact the overall monitoring costs. Some restoration or creation projects may only require an annual report, while others may require monthly monitoring with multiple reports during the growing season and an additional annual report. Numerous reports will require more hours of preparation and will usually increase the overall monitoring cost.

One factor which is not usually required but is included in many monitoring programs is wildlife and wildlife habitat observations. This wildlife observation program may target many species and require documentation of species such as in Normandeau Associates' vernal pool creation. If a more detailed wildlife observation program is required, it may considerably increase the price of monitoring.

Finally, discussions with staff from many state transportation agencies and with Michael Wheelwright, planner from the City of Quincy, reveal that monitoring costs may be built-in or volunteers may monitor the wetlands. If agency staff monitor, as in many of the New Hampshire Department of Transportation's project it is difficult to separate out the monitoring cost because it may not be recorded as a separate task. If volunteers monitor the wetland then the cost of monitoring will most likely be significantly reduced.

3.3 Detailed Project Examples

Detailed cost information and project summaries were obtained for a range of project types and locations. The projects include salt marsh restoration and creation, eelgrass creation, wet meadow restoration and emergent and scrub/shrub creation. Each project contains a project description contains costs and 15 projects have been supplemented with tables detailing additional costs. The project ID No. refers to the listing in either Table 3.1 or Table 3.2.

3.3.1 Pine Creek Salt Marsh, Fairfield, CT (CT-11 to CT-13)

The Wetlands and Waterways Commission in the Town of Fairfield, Connecticut, has been involved in restoration of salt marsh for more than 25 years. In the 1960s, the salt marsh in Fairfield was identified for use as a garbage dump and in 1966, the state approved diking the marshland. In 1969, however, the project was curtailed by a state regulation prohibiting filling tidal marsh. The town was left with a diked-off marsh which had become dominated by *Phragmites* and was a fire hazard.

The Town of Fairfield has utilized its advantage as a college town through implementation of a very successful program wherein Fairfield University has integrated salt marsh restoration into several academic programs. Several of the marsh restoration projects have been the focus of dissertations; graduate and undergraduate students provide manpower for data gathering, monitoring, and cleanup; and university labs provide analytical services. Project costs are therefore kept low.

To date, tidal flushing has been restored to over 300 acres through removal of dikes; cleanup of trash and debris; installation of self-regulating tide gates (SRT) and flapper tide gates; channel, ditch and reservoir pond excavation; initiation of open water marsh water management (OMWM) mosquito program; and filling of superfluous mosquito drainage ditches. Benefits identified by the town for salt marsh restoration include the following: restoration of navigation downstream without dredging through increased scouring; reduction in stormwater surcharge in upland areas; increase in salinity in the marsh which discourages *Phragmites* growth and mosquito breeding; improved habitat for minnows and killifish, which eat mosquito larvae; and reduction in the potential for fire.

The Town of Fairfield has recently completed design for the Pine Creek East salt marsh restoration project. The purpose of the project is to maintain existing coastal storm flood protection while restoring 51 acres of diked tidal wetlands, thereby eliminating or reducing *Phragmites* fires, peat fires, mosquito breeding, back-water storm sewer flooding, area-side flooding below the dikes, over beach flooding behind the dikes, floatable debris, highly acidic marsh waters, organic enrichment of marsh water above the marsh community's capacity to assimilate or export it, and odors, while simultaneously restoring the ability of the marsh to assimilate contaminants, export detritus and nutrients to the food web in Long Island Sound and provide much needed habitat for living marine resources such as shellfish, waterfowl, fish and wildlife.

The Town of Fairfield funded the $43,000 planning stage for the Pine Creek East project including engineering design, survey, mosquito sampling, sampling for dissolved oxygen and salinity, and removal of debris. A critical factor during design was to determine the desired water elevation in the marsh. The town has recently solicited funding for construction through the EPA Clean Water Act 319(h) Non-point Source Program and through the Long Island Sound Coves and Embayments Program. The program as proposed will be staged in three phases:

- Phase I, Year 1998-2000. Construction of a coffer dam, dike, sewer saddle, three 48" diameter culverts, two 48" SRTs, four flapper tide gates, one cross-culvert, cleaning of marshes, clearing of channels and installation of OMWM system. 21 acres, estimated construction cost: $200,000.

  SRTs have float-operated valves within a standard culvert which allow inflow of tidal water while allowing outflow at low tide, including upland freshwater. SRTs are similar to a tide gate except that two-way flow is maintained; salt is allowed into the marsh while draining upland areas of storm drainage and freshwater flow.

- Phase II, Year 2000-2001. Installation of a 48-inch SRT, realignment and extension of storm sewer system, retro-fitting of siphon/sumps on catch basins, and construction of storm water detention basins. 17 acres, estimated construction cost: $150,000.

- Phase III, Year 2001-2002. Installation of new cross-culvert and 48-inch SRT, clearing and cleaning of the marsh and implementing an OMWM mosquito control program. 14 acres, estimated cost: $150,000.

Construction costs include the cost of monitoring for 10 years. The Town of Fairfield is able to utilize graduate and undergraduate students at local universities for monitoring all salt marsh restoration in the town for approximately $1,000 per year. This covers the cost of hip boots and waders, steel bar for transect points, miscellaneous supplies, and a small stipend or mileage. This price is below typical market prices. The Town of Fairfield will provide in-kind services as local contribution for construction funding. Tasks undertaken by the town include design, engineering, and survey by a wide range of town departments.

The construction costs also reflect a program to compensate adjacent property owners for salt-kill of freshwater plants, gardens and ornamentals growing on and along the edge of the marsh where residents have cleared firebreaks. To compensate for this loss, the Town has historically provided replacement plants, to a maximum value of $500 per lot for planting and in-kind services if there is sufficient space and elevation on the upland portion of the lot to avoid further salt kill. Other losses, such as the rust-colored water and dead vegetation in early stages of marsh restoration, and the hydrogen-sulfide odor associated with a restored salt marsh at low tide, are compensated through a reevaluation of the assessed value of the real property affected by the project.

In 1981 the Town of Fairfield also restored 200 acres of salt marsh at Ash Creek by removing a cross-channel dike and constructing a new peripheral dike for flood control of adjacent residential property. To achieve full tidal flow, earthwork was conducted at $100/foot in 1981 (to remove dikes and build new ones). Total construction price to open 30 acres was $260,000 or nearly $9,000 per acre in 1981 costs. In the second phase of the project, 90 acres were opened with the installation of three SRTs five feet in diameter (at $15,000 per SRT).

3.3.2 Mile Hill Road, Newtown, CT (CT-9)

The CTDOT recently received three bids, detailed in Table 3.3 below, for the construction of a one acre wetland creation site associated with Mile Hill Road in Newtown, Connecticut. A combination of open water, emergent, scrub/shrub and forested wetland will be constructed within a fallow field, adjacent to an existing wetland. This wetland will be located on state land approximately 200 feet outside of the Mile Hill roadway right-of-way. The CTDOT is currently negotiating a land acquisition fee for the property which is owned by the State of Connecticut. As a result, the cost of acquiring the property may be significantly low.

CTDOT engineers estimated that the construction phase of this project would be approximately $151,960, including earthwork and plantings. The bid prices which are listed in Table 3.3 were received in February 1997 and range from $95,270 to $132,508. The planning and design phase of this project has amounted to $25,000 per acre, to date, and monitoring is estimated at $2,000 per acre per year for five years totaling $10,000.

In order to avoid some of the problems which occurred in the Route 187 wetland creation (see Table 3.1 notes, CT-5 for more information), planting of the wetland will be performed one growing season after the excavation and grading of the creation area. This should allow sufficient time for the hydrologic regime to get established between the existing wetland and the creation site.

Table 3.3

CTDOT Wetland Creation Project
Mile Hill Road, Newtown, CT (1.0 acre)
(Bid Prices for Complete Construction Costs)

Description	Total Quantity/Unit	Engineer's Prices		Low Bidder's Prices		2nd Bidder's Prices		3rd Bidder's Prices	
		Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price
Environmental Site Improvements	1 lump sum	$1,500	$1,500	$2,000	$2,000	$800	$800	$2,500	$2,500
Pond Excavation	10,000 cu. yrd.	$8	$80,000	$3.50	$35,000	$5	$50,000	$7.40	$74,000
Cofferdam and Pumping	1 lump sum	$10,000	$10,000	$1,000	$1,000	$10,000	$10,000	$4,650	$4,650
Temporary Crossings	1 lump sum	$2,500	$2,500	$4,000	$4,000	$1,500	$1,500	$1,250	$1,250
Wire Fence with Metal Posts	730 lin. foot	$5	$3,650	$7	$5,110	$7	$5,110	$6.50	$4,745
Wetland Creation	4,840 sq. yrd	$7	$33,880	$3.50	$16,940	$2.50	$12,100	$2.55	$12,342
Hamamelis Virginiana Common	45 each	$12	$540	$40	$1,800	$38	$1,710	$41	$1,845
Furnishing, Planting & Mulching	102 sq. yrd	$125	$12,750	$45	$4,590	$45	$4,590	$48	$4,896
Cornus Amomum Silky Dogwood 3'-4'	45 each	$12	$540	$18	$810	$18	$810	$19	$855
Ilex Verticillata Common Winterberry 3'	45 each	$15	$675	$45	$2,025	$48	$2,160	$52	$2,340
Sambucus Canadensis-American Elder	45 each	$14	$630	$50	$2,250	$48	$2,160	$52	$2,340
Vaccinium Corymbosum Highbush	45 each	$14	$630	$35	$1,575	$35	$1,575	$38	$1,710
Viburnum Dentatum Arrowwood	90 each	$12	$1,080	$18	$1,620	$18	$1,620	$19	$1,710
Viburnum Lentago Nannyberry	45 each	$14	$630	$50	$2,250	$48	$2,160	$53	$2,385
Viburnum Prunifolium Blackhaw	45 each	$14	$630	$50	$2,250	$48	$2,160	$53	$2,385
Crataegus Coccinea Thicket	45 each	$15	$675	$100	$4,500	$95	$4,275	$100	$4,500
Acer Rubrum Red Maple 3'-4' Ht.	30 each	$10	$300	$30	$900	$33	$990	$35	$1,050
Acer Rubrum Red Maple 6'-8' Ht.	30 each	$15	$450	$40	$1,200	$39	$1,170	$41.50	$1,245
Wetland Conservation Mixture	180 pounds	$5	$900	$30	$5,400	$30	$5,400	$32	$5,760
Total Construction Costs		***Engr.***	**$151,960**	***1st Bid***	**$95,220**	***2nd Bid***	**$110,290**	***3rd Bid***	**$132,508**

(with permission from Steven Ladd, Connectiticut Department of Transportation)

3.3.3 Post Island Marsh, Houghs, Neck, Quincy, Massachusetts (MA-6)

The following was written by Michael Wheelwright of the Town of Quincy, Department of Public Works.

The wetland restoration of Post Island Marsh's once impounded 10 acre salt marsh helped to rebuild its estuarine ecosystem. By reestablishing the tidal flow, the soil salinity was increased, thus encouraging indigenous animal, fish, shellfish and birds to reestablish themselves.

To date, this action together with vigorous mowing has resulted in stunting *Phragmites australis*, thus reducing spot fires and eradication of mosquito larvae beds. Interplanting of smooth cord grass (*Spartina alterniflora*) helped to complete the restoration, included as a portion of the planting costs.

Problem. The subject marsh had been cut off from regular incursions of sea water for nearly six decades, resulting in an overgrowth of nuisance *Phragmites australis* that posted a serious fire hazard. Further, existing drainage ditches had become clogged, and intermediate bogs developed and became mosquito breeding habitats.

Lacking sufficient tidal water, the marsh became brackish, this was accelerated by fresh water runoff from adjoining upland property leading to the overgrowth by the *Phragmites australis* that colonized the disturbed site. This unwanted plant material was extremely voracious, growing in very dense stands and providing little wildlife value and maximum fire hazard.

Solution. By reestablishing tidal action and increasing the soil salinity of the marsh the common reed was stressed and subsequent crops were stunted. In their place indigenous plant material was encouraged (e.g., smooth cord grass which in turn promoted a habitat in which flora, fauna, fish, shellfish and invertebrates could begin to reestablish themselves.

Back-Up Strategy. A resource management strategy, that is being held in abeyance, is the use of black plastic sheeting which will be laid down after the final mowing of *Phragmites* to dramatically increase the temperature of the root zone, further inhibiting growth, if needed.

Field Demonstration. The remedial portion of the project has had educational and cultural benefits as well. The Harvard Graduate School of Design (Landscape Ecology) students have studied the rate and effects of salinization of the soil as part of an ongoing field demonstration. In addition, European and South American scientists have visited the marsh on tour in connection with wetland studies focusing on the hydrological functioning of wetlands and ground water development sponsored by the Applied Science Department of Harvard University.

Summary. Reintroducing tidal flow to restricted marshes does not produce vegetative changes over night but the process is effective over time. All parties involved are encouraged by the results to date. The self regulating tide gate in tandem with intensive plant material modification and long term estuarine management was the first to be implemented on this scale in the Commonwealth of Massachusetts.

Costs.	$47,000	Construction
	$18,000	Headwall/Pump Station
	$14,000	Tide Gate Chamber
	$10,000	Engineering Services
	$ 4,000	Chambers
	$ 2,700	*Phragmites* Strategies

3.3.4 Third Marsh, Houghs Neck, Quincy, Massachusetts (MA-7)

The following was written by Michael Wheelwright of the Town of Quincy, Department of Public Works.

This is the second project of this type in the city. It probably holds the same ranking within Massachusetts as the earlier Post Island Marsh Project. Both involve the restoration of tidal marshlands and are located in the Houghs Neck section of the city. The Third Marsh covers a total area of roughly 20 acres, making it somewhat larger than the Post Island area.

Problem. Being low and next to the shoreline, this area was originally a salt marsh subject to tidal flooding from Quincy Bay. In the 1940's homes were built around these marshlands, necessitating construction of drainage and flood protection facilities, including seawalls, street drainage, and installation of one way tide gates to mitigate mosquito and flood hazards for abutters.

The one-way tide gates were installed at the mouths of marshlands to block incoming tides. Once installed, the tide gates allowed only the discharge of direct rainfall and storm runoff from tributary areas, resulting in the killing of salt marsh flora, fauna, and other wild life habitat. This gradually converted the area to freshwater ecology.

Solution. The restoration process has reestablished tidal flushing of the marsh on a regular basis, thereby saturating the soils with salt water, which in turn promotes the growth of salt water species. By planting indigenous salt water species, removing all debris and extraneous materials, and continuously monitoring, it is expected that the environmental balance will be restored.

The entire project can be divided into two distinct marsh areas. Part I is the main marsh (approximately 15 acres) located west of Rock Island Road. The main work in this area relates to the restoration of marshlands to salt water conditions. Part II covers the partially developed area east of Rock Island Road (approximately 5 acres). The main problem relates to providing adequate internal area drainage while protecting abutters from tidal flooding. The project design in Part I will disconnect this area from the Edgewater Drive tide gate system and all inflow/outflows in this area will be regulated through a new automatic level control gate system at Spring Street. This gate opens and closes at predetermined elevations so that nearby homes will not be flooded.

In addition, about 500 feet of dike was constructed at Rock Island Road to protect homes located to its east. Planting indigenous species, creating interior irrigation ditches and cleaning up and continuously monitoring the area is expected to cause salt water vegetation growth in the marsh area.

Flood protection and drainage of Part II involved separating this section from Part I by plugging the culvert under Rock Island Road. All inflow/outflows from this area are controlled through the new automatic level control tide gate system installed at Edgewater Drive.

Internal area drainage has been achieved by cleaning wetland areas and drainage in low spots through a drain line discharge into the existing channel leading to the new tide gate chamber. To keep the outfall pipe clean, it was necessary to modify the outlet structure at its mouth to minimize blockage and silt deposition.

Cost.	$159,000.00	Construction
	$ 42,000.00	Headwall
	$ 30,600.00	Engineering
	$ 29,400.00	Two Tide Gates
	$ 16,000.00	Chambers
	$ 2,000.00	*Phragmites* Strategies

3.3.5 Biddeford Connector, Biddeford, Maine (ME-5)

According to the report by Woodlot Alternative, Inc., published in March 1996, *An Evaluation of the Maine Department of Transportation Compensatory Wetland Mitigation Program*, the wetland creation site is associated with the construction of a new connector road between the Maine Turnpike and U.S. Route 1. A 1986 plan prepared by MDOT (in conjunction with Maine Division of Fish and Wildlife) called for the relocation of 1,100 feet of Richardson Brook and the creation of 0.7 acres of wetland to improve fisheries habitat and to mitigate for the impacts. This work was completed in the spring of 1988. Subsequently, the Corps, EPA, and USFWS ruled that this wetland creation project did not constitute adequate compensation under Section 404(b)1 regulations, and they requested that MDOT submit a plan for additional 1:1 functional replacement for 2.4 acres of impact before a Corps permit would be granted. MDOT agreed to additional compensation. A proposed 1988 off-site wetland creation plan was canceled for various reasons. After an extensive and protracted site search effort, MDOT submitted another wetland plan, which was approved in August of 1989 by the EPA. Final plans were approved by the Corps in January 1991. The final plans called for on-site wetland creation in eight individual wetland basins, enhancement of upland riparian habitat adjacent to Richardson Brook, and preservation of 0.6 acres of on-site wetland. Cost information for approximately 3.0 acres of wetland creation are listed in Table 3.1 of this report.

Intensive monitoring began immediately thereafter and continued until 1994. In the spring of 1992, the Corps conducted an unannounced site inspection and compiled a report stating that the wetland creation effort had not been successful. MDOT responded by hiring a consultant to perform an in-depth review and analysis of the wetland project to rebut the Corps' report. As a result, a second and third plan were developed.

Stream relocation alone was estimated at $125,000 in one MDOT report, and it was estimated by Woodlot Alternatives, Inc. in their 1996 report that site selection, preliminary mitigation, preliminary engineering, and construction engineering for this project cost MDOT an additional $25,000 to $30,000. (*More information expected from Sylvia Michaud, MDOT*)

3.3.6 Route 196, Lewiston, Maine (ME-7)

The Lewiston/Route 196 wetland restoration project was associated with the widening of three miles of Route 196 in the towns of Lewiston and Lisbon. As discussed in Woodlot Alternative, Inc.'s, article, *An Evaluation of the Maine Department of Transportation Compensatory Wetland Mitigation Program,* published in March 1996, affected wetlands were under Corps jurisdiction, but the impact acreage was exempted from Federal mitigation requirements by applicable Nationwide Permits. A total of 0.74 acres of MDEP Class 2 and 3 wetlands were impacted by the project, with all but 0.09 acres exempt from MDEP mitigation requirements. Most impacted wetlands were narrow, stream-associated floodplains and vegetated roadside drainage ditches.

MDEP required MDOT to have an approved conceptual wetland replacement plan before they would issue the permit to widen the road, rather than just prior to construction as had previously been agreed. This placed unplanned time constraints on the widening project, and prompted MDOT to hire wetland consultants to search for sites and prepare plans. After considering some 41 potential sites, MDOT submitted a preliminary plan to MDEP to perform on-site mitigation by removing historic man-made fill from the floodplain of No Name Brook, enhancing adjacent floodplain to improve the stream buffer, and preserving the entire 3.4-acre parcel to protect it from development. A permit for the widening project and the wetland restoration was then quickly approved.

This effort greatly exceeded MDEP's wetland restoration requirements (0.09 acres owed after exemptions vs. 3.4 acres of restoration). MDEP specified that banking credits would be allowed only for future impacts within the No Name Brook watershed. MDOT decided to go ahead with the full wetland restoration project because they estimated that the cost for the 3.4 acre project would not be significantly greater than if they just undertook 0.09 acres of restoration, and that it would not be a significant percentage of the highway project cost.

The Lewiston/Route 196 wetland project was accomplished at the highest per-acre-owed cost ($1,759,237) including 0.8 acres of restoration listed in Table 3.1 and 2.65 aces of floodplain enhancement not discussed in this report. The highest project costs were incurred in the construction phases, due primarily to land acquisition, excavation/grading, and planting costs. The planning and design cost of $124,000 per acre reflects the cost of acquiring the site.

3.3.7 Scarborough Connector, Scarborough, Maine (ME-2)

As discussed in Woodlot Alternative, Inc.'s, article, *An Evaluation of the Maine Department of Transportation Compensatory Wetland Mitigation Program,* published in March 1996, the Scarborough Connector wetland restoration/creation project resulted from the construction in 1992-1994 of a new interchange on the Maine Turnpike in Scarborough and a new access road connecting the interchange to U.S. Route 1. The interchange/connector was mandated by the Maine legislature in 1982 to improve access to the Scarborough Industrial Park and to facilitate a safer Turnpike.

The first conceptual wetland restoration/creation plan was submitted in May 1988. MDOT and its engineering consultants explored several alternative alignments in an effort to avoid and minimize wetland impacts. The final alternative was chosen after numerous interagency meetings and field visits.

The Federal agencies (the Corps, EPA, and USFWS) rejected the plan, saying that it would not adequately compensate for impacts to wildlife habitat. In an effort to meet Federal requirements, MDOT initially identified several potential wildlife habitat restoration sites.

Due to the extensive nature of the proposed wetland restoration/creation, final planning and construction took place in several phases over 3 years. There were six separate sites:

- Sites 1 and 2 involved removing two existing turnpike access ramps to restore 3.2 acres of previously filled wetlands;
- Site 3 involved restoring 0.7 acres of wetland that were previously impacted by a road;
- Sites 4 and 5 involved creating 3.5 acres of wetland in the in-field loop of the new interchange;
- Site 6 involved restoring 18 acres of floodplain and wetland and upland riparian habitat along a recently degraded section of Mill Brook, a small perennial stream that was considered by MDEP to be a Class C minor drainage (the lowest of four water quality classes for freshwater streams and rivers).

The costs of most phases of the wetland restoration/creation, particularly in preliminary planning, land acquisition, and construction (including construction monitoring) were much higher than for other MDOT projects in this study. The high cost of preliminary planning appears to have resulted from extensive agency involvement and the need to develop very detailed plans for agency review. Land acquisition costs were high, as expected in that area. The high costs of construction monitoring were not anticipated, resulting from problems with landscape materials, the planting contractor, changes in consultant personnel, and the overall complexity of the plans. For example, the consultant's initial estimates for construction monitoring were $81,000 in 1991, but this task cost MDOT nearly $324,000 when completed. When the post construction monitoring is completed at the end of 1998, the time span for this wetland restoration/creation project from start to finish will be approximately 13 years (assuming no remediation will be necessary).

3.3.8 Port Authority of New Hampshire, Great Bay Estuary, New Hampshire (NH-8 to NH-10)

The following information was obtained from Dr. Fred and Catherine Short's Article, The Port that Supports, in the Spring 1997 issue of Conservation Matters, Conservation Law Foundation.

The Port Authority of New Hampshire proposed to expand the State Port Facility by adding a new pier, containment structure, wharf, and two-lane connecting bridge which would result in an impact to estuarine habitat. The U.S. Army Corps of Engineers and the New Hampshire Wetlands Board issued a permit for construction. However, state and federal resource protection agencies stipulated wetland restoration/creation for the projected habitat loss, and that the wetland restoration/creation was required to meet specific criteria before actual port construction could begin.

The restoration and creation sites are located along the Piscataqua River and in Little Bay, both part of the Great Bay Estuary and have a total cost of approximately $3,500,000 for planning and design, construction and planting.

According to the article, finding sites for the wetland restoration/creation was a major preliminary task and has not been accounted for in the planning costs. In the case of eelgrass, several locations were chosen along the Piscataqua River and in Little Bay, in the quieter areas of these heavily traveled waters. Transplants put into intertidal sites largely failed, as eelgrass there was scraped away during the following severe winter by large sheets of tidally driven ice. Creating new mud flat meant finding previously filled upland areas that could be excavated and put back under water. Tracing land ownership and negotiating with town officials is time consuming.

A unique aspect of the wetland restoration/creation project was its replacement not only of eelgrass habitat, but of potential habitat as well. Construction of the port would have affected areas which were very suitable for eelgrass growth, even though no eelgrass was actually growing there. Any construction would mean permanently destroying the possibility of eelgrass growth. The regulatory agencies, therefore, considered compensation for this potential habitat loss as they formulated the permit for port construction. As a result, more of each kind of habitat was created or enhanced than was projected to be lost to construction of the new port facility. For eelgrass, the created to impacted ratio was 1.4 to 1, for salt marsh 2 to 1, and for mud flat 1 to 1.

Dr. Frederick Short stated that the $160,000 per acre construction cost for the 1.6 acre salt marsh creation involved the removal of material to the correct elevation after initial construction. Further, construction costs associated with the eelgrass beds within the Piscataqua River were approximately $360,000 per acre because of the complexity involved in developing the terrace. Terrace construction involved adding sediment to the river bottom with a total cost of $300,000 per acre. The remaining $60,000 per acre involved purchasing and planting the plants.

The multi-year wetland restoration/creation project combined the efforts of the University of New Hampshire, Dames and Moore, and Great Meadow Farms, a salt marsh restoration company based in Massachusetts. The University of New Hampshire's Jackson Estuarine Laboratory, located on Great Bay, was the headquarters for the project. All aspects of the work involved research as well as practical application.

3.3.9 Three Salt Marsh Restoration Projects, New Hampshire

Following are three summaries of salt marsh restoration projects funded by the New Hampshire Office of State Planning, published in their September 1996, Coastal Program Bulletin. At this point detailed costs are not available.

***Sandy Point Salt Marsh, Stratham** (NH-18):* Although most restoration focuses upon marshes adversely affected by human intervention, salt marshes can also deteriorate due in part to natural causes, such as severe storms or increased rates of sedimentation. Sandy Point salt marsh in Greenland/Stratham is an example of a marsh which has been degraded by both natural and human causes. The marsh is located on the southern shoreline of Great Bay and is a feature of the Sandy Point Discovery Center. The marsh is part of lands which are protected under the Great Bay National Estuarine Research Reserve. The prevailing winds transport a great deal of natural and human-made debris to Sandy Point. Over time this debris had accumulated to partially fill the upper portions of a tidal creek and to create a low-relief berm parallel to the shoreline. The choked channel and berm limited the amount of salt water reaching the marsh behind the berm, and trapped fresh water draining from the upland. The resulting soil salinities encouraged *Phragmit*es to colonize the area.

The goal of the restoration project was to halt the further spread of *Phragmites* into the marsh. With the help of volunteers, tidal creeks through and behind the dike were hand-dug in an effort to increase tidal flushing and freshwater drainage of the marsh. Students in Dr. Breck Bodwen's Field Wetland Ecology course at the University of New Hampshire determined soil salinity levels in the marsh before and during the restoration project, and discovered that the salinity levels did increase after the creeks were excavated. Continued monitoring of tidal flooding, soil salinity levels, fish use, and changes in the plant community of the marsh is being carried out by students and scientists at the Jackson Estuarine Laboratory. Funding for this restoration project was provided by a U.S. Fish & Wildlife grant secured by the NH Coastal Program.

***Awcomin Salt Marsh, Rye** (NH-14):* This large marsh system directly borders Rye Harbor on the Gulf of Maine. In 1941 and 1962, sediments dredged from the harbor were deposited and contained in areas surrounded by dikes. The 1941 dike, although not tall, surrounded a large area of roughly 35 acres. The 1962 dike was placed on top of a portion of the 1941 area. It surrounded a smaller area, roughly 10 acres, but was taller than the 1941 dike. These deposited dredge spoils raised the level of the marsh, thereby decreasing the frequency of tidal flooding. The 1962 dike was so tall that it effectively eliminated any tidal flooding of the area within it. The soil within the dikes became less and less saline, and by the late 1980's most of the area within the 1962 dike had been colonized by *Phragmites*. This stand of *Phragmites* had also spread outside the 1962 dike into areas contained by the 1941 dike. Resource managers in the state were concerned that *Phragmites* would continue to spread out into the healthy part of the Awcomin Marsh, so they began to explore restoration efforts that would halt its spread.

The goal of the restoration work was to increase the tidal exchange within the marsh, to promote freshwater drainage and to halt and possibly reverse the spread of the Phragmites. Restoration work began in 1992 with funds from the NH Coastal Program, the National Oceanic and Atmospheric

Administration, and the U.S. Fish and Wildlife Service with the cooperation of several other federal, state, and local agencies. A portion of the 1962 berm was removed, and a large tidal "loop" channel was dug in the 1941 impact area. Several "farmer's ditches" were also dug to help aid with the infusion of salt water that would promote the growth of salt meadow hay (*Spartina patens*) and to remove fresh water. Additional restoration work was completed in 1993 when a large amount of dredge spoil was excavated from the filled portion of the marsh. Following the restoration work, most Phragmites stands were less vigorous, and its spread appeared to have been stopped. By the spring of 1994, glasswort and cordgrass had begun to colonize the excavated areas, indicating that the marsh elevation and the soil salinity were more suitable for the growth of salt marsh plants.

Stuart Farm, Stratham *(NH-15):* Mill Brook, a tributary to the Squamscott River (at Stuart Farm), had once been bordered by a tidal marsh, but tidal flow to this marsh was eliminated in the 1960's when a driveway to the farm was upgraded. An undersized culvert and a tidal gate were installed in one branch of the saltwater creek, allowing for drainage of fresh water from the farm, but no reverse flow for tidal waters. Eventually the salt marsh became a fresh water wetland, parts of which were dominated by purple loosestrife.

In the fall of 1993 a project to reintroduce tidal flow to the marsh began with funding from the NH Coastal Program and the U.S. Fish and Wildlife Service. The filled branch of the creek was excavated, a larger culvert was installed, and the flap valve on the tidal gate in the other creek branch was removed. The marsh is now flooded daily by tidal waters, and spring meltwaters drain more rapidly. Salinity levels have increased, and salt meadow hay, black grass and rough cordgrass (*Spartina pectinata*) are replacing the invasive purple loofestrife. Alewives had been found in the downstream areas prior to restoration work but were denied access to their upstream spawning areas by the tidal gate. Perhaps the restoration efforts at Stuart Farm will lead to a self-sustaining population of alewives in this marsh.

3.3.10 Route 101/114 Interchange, Bedford, New Hampshire (NH-6)

Much of the following information was obtained from the New Hampshire Department of Transportation, Bureau of the Environment's Fact Sheet.

This wetland creation site was created to replace wetlands lost due to the construction of the New Hampshire Route 101/114 interchange project. The total wetland impacts as a result of the project are 1.7+/- acres (1.3ac forested/scrub shrub, 0.2 ac emergent, and 0.2 ac open water). The wetland creation site is located on an 8.1+/- acre parcel, of which 2.8 acres were disturbed (containing a large storage pile, several construction ditches and culverts, and degraded wetland pockets). The land acquisition cost for this parcel was approximately $300,000.

Approximately 3.6 acres of emergent, and scrub/shrub wetlands were constructed as a result of the construction of Route 101/114 interchange project. The New Hampshire DOT attempted to create diversity of cover and vegetation types to enhance wildlife habitat, create dense stands of emergents to retain sediments, develop the vegetative communities with a varied planting scheme, create several tiers of wetland hydrological zones: temporarily flooded, saturated slope, seasonally flooded, and seasonally saturated, semi-permanently flooded, and permanently flooded, provide hydrology by both groundwater discharge and surface water runoff (watershed of 65+/- acres). Further, the construction costs included lining excavated areas with a minimum of 12 inches of humus removed from the impacted wetlands.

3.3.11 Route 101, Pine Road Gravel Pit, Epping-Hampton, New Hampshire (NH-2)

Much of the following information was obtained from the New Hampshire Department of Transportation, Bureau of the Environment's Fact Sheet.

The Pine Road wetland creation site is being developed to offset impacts associated with the upgrading of a 17.6 mile segment of NH Route 101/51 between Epping and Hampton, New Hampshire. Approximately 103 wetland areas were impacted. Although it is only one element of a more comprehensive wetland creation plan, to date, the Pine Road site is the largest wetland creation effort to be undertaken by the New Hampshire Department of Transportation. The site consists of approximately 380 acres located south of the proposed relocation of NH Route 101 and west of Pine Road in Brentwood, NH.

Initial site conditions included:

- approximately 117 acres disturbed by gravel mining;
- disturbed areas were unvegetated or sparsely covered with herbs and shrubs;
- undisturbed portions are largely covered by wetlands, though some uplands and open water areas exist; and
- the site overlays an expansive high yield aquifer.

The creation area included approximately 105 acres of wetland emergent, scrub/shrub and open water. The project's goals included providing wildlife habitat, floodflow alteration, sediment and toxicant retention, nutrient removal and groundwater recharge and to promote education, recreation, and improved visual quality.

New Hampshire DOT along with their consultant Normandeau Associates, Inc. created a variety of wetland communities including: aquatic bed, emergent marsh, scrub/shrub, open water and forested wetlands within the one, 105 acre wetland. They were able to excavate enough material to utilize the underlying aquifer as the primary water source. Finish grading was used to form mound and pool micro-topography to facilitate growth of woody species and simulate natural conditions. During construction of the site, according to Marc Laurin of the New DOT, they were able to utilize hydric and upland soils harvested from project construction within the creation area.

Additional costs, although minimal in comparison to the overall cost, include funding for the construction of an observation platform to be used for educational and recreational purposes.

3.3.12 Treatment Plant Property, Littleton, New Hampshire (NH-7)

Much of the following information was obtained from the New Hampshire Department of Transportation, Bureau of the Environment's Fact Sheet.

Two wetland creation sites were created to replace wetlands lost due to (1) reconstruction of US Route 302/Meadow Street, (2) construction of a new bridge over the Ammonoosuc River, and (3) construction of an access road to Littleton Industrial Park. Approximately 1.7+/- acres (1.4 ac palustrine, 0.3 ac riverine & open water) of wetlands were impacted as a result of these projects.

Two wetland creation sites were created in order to mitigate for the wetland impacts involved in this project. The first site is located on the north bank of the Ammonoosuc (half of site is reverting field, the other half dominated by pioneer species) and consists of 2.8+/- acres of forested scrub-shrub wetland. The second site is located between B&M Railroad & South Street and is adjacent to a former salvage yard contaminated with petroleum hydrocarbons (remediation of contaminated soil was done prior to construction and is not reflected in the costs) and consists of 0.6+/- acres emergent wetlands.

Planning and design costs for this project do not include site acquisition costs. Both wetland creation sites were located on town property and therefore did not require purchase. Construction costs reflect excavation for wetland construction only, final and finish grading and setting final grade elevation to provide saturation/inundation period during the growing season, planting various wetland tree and shrub species at site 1, planting a mix of annual and perennial grasses at site 2, placing a base of 6"-12" of loam or humus throughout site 1, placing a base of organic soil throughout site 2 and finally, stabilizing and preventing erosion of newly planted area at site 1 by planting a mix of annual and perennial grass seed.

3.3.13 Spaulding Turnpike and Gosling Road, Portsmouth-Newington, New Hampshire (NH-4)

Much of the following information was obtained from the New Hampshire Department of Transportation, Bureau of the Environment's Fact Sheet.

This wetland restoration/creation site was created to replace wetlands lost to the widening of the Spaulding Turnpike and construction of a full diamond interchange at Gosling Road. The total wetland impacts as a result of the project are 10+/- acres. Approximately 11.4 acres of restoration, enhancement and creation were constructed in order to mitigate for wetland impacted by this project. The restoration, enhancement and creation totaled:

Wetland types	Area (acres)
Open Water	1.0
Shallow Marsh	3.2
Deep Marsh	1.8
Scrub/Shrub	3.0
Total	9.0

Construction costs for this project totaled approximately $24,900 per acre and reflect restoring the vegetative communities with a varied planting scheme, creating several tiers of wetland hydrological zones: temporarily flooded, saturated slope, seasonally flooded, seasonally saturated, semi-permanently flooded, and permanently flooded (grading), providing hydrology through a spillway from Newfields Ditch (Hodgson Brook) during high flow periods, and on-site seasonal groundwater discharges, excavating the *Phragmites* dominated area, and over-excavating the wetland creation areas and lining with 12 inches of organic soils, from impacted wetlands.

The NH DOT had an engineering consultant perform monitoring for one year and produce a final report for $2,000. Otherwise the monitoring costs have been built in to routine schedules of the scientists at the NH DOT's Bureau of the Environment.

3.3.14 Route 101, Squamscott River Bridge, Stratham, New Hampshire (NH-3)

Source: Barry and Garlo, 1995

Restoration of a brackish tidal marsh in Stratham, New Hampshire, was required as a result of the expansion of the Squamscott River Bridge. Excavation of approximately ten feet of fill from this site in the summer of 1993 was accomplished over a period of ten days with an excavator and a bulldozer. Dry conditions enabled work to proceed quickly. Erosion controls included coconut fiber rolls and pallets or mats.

Project chronology:

October 1993	Planting consisted of 990 saltmeadow bulrush and 750 saltmarsh hay plants rooted in coconut fiber 2-inch pots. The fiber rolls were also planted with plugs of smooth cordgrass and saltmeadow bulrush on approximately two foot centers.
Winter 1993/1994	The bulrush and saltmarsh hay plants were uprooted and replanted.
May-June 1994	4,300 narrow-leaved cattail, 1,000 saltmeadow bulrush, and 2,000 saltmarsh hay plants were installed on three foot centers.
July 1994	1,500 cattail root clumps were collected from the adjacent marsh and used to fill in areas seemingly having difficulty getting re-established.
July-August 1994	Coconut fiber rolls with cordgrass/bulrush plugs did not provide enough contact with soil and roots had dried out. Pallets were removed and the area was replanted with cattails which had been harvested from the adjacent marsh.

3.3.15 Muck Piece, Former McDougal Property, Prattsville, Stueben County, New York (NY-12)

This former potato field, located in Steuben County, had been farmed for at least twenty years. Infestation with golden nematode had reduced the agricultural capability of the acreage, making it a prime candidate for wetland restoration (golden nematode can be eliminated without pesticides by saturating the soil). Originally the site had been a forested wetland. To divert hillside drainage, a stream had been channelized and diversion ditches has been cut on three sides of the field. Clay tile drains, measuring 6-inches in diameter with 18-inch length, had been installed on 50-foot centers across the field. The goal of the wetland restoration project was to incorporate the site into a refuge system for wildlife management. The project entailed two fields, this 50 acre site and a 30-acre site across the street. The "muck piece" site is the wetland restoration of the 50-acre parcel.

A "back of the envelope" sketch design was developed in the field by USFWS staff in one day. Travel time to the site accounted for half the design cost. Construction costs included the cost of hiring an excavator for 44 hours at $85 per hour and the cost of a USFWS technician at $20 per hour for 25 hours to direct the start of work, as needed during construction, and at the end to acknowledge project completion. Construction included cutting a trench perpendicular to a drain outlet to determine the clay tile spacing (found to be 50-foot on center), removal of lengths of clay pipe drains in the field, opening up the original drainage ditch, berming peripheral drains along the foot of the hillside, and creating a hummock and dip topography.

Hydrology was rapidly restored through removal of drains. As the site became saturated the excavator became stuck in the mud. It became too difficult to work with the equipment as planned. Excavator ruts helped create the intended "hummock and dip" topography; the spot where the equipment was stuck became open water. Exposed soil was seeded with a standard mix of wet and dry species including red fescue, trefoil, and a little reed canary grass. Original ground cover was "quack grass" and teasel. Within one growing season the site revegetated in accordance with the new hydrology. Vegetation includes rush, sedge, plantain, and cattail.

3.3.16 Restoration of Salt Marsh at Galilee, Rhode Island (RI-2)

Source: David Larsen, New England District, Corps of Engineers

The Galilee Saltmarsh Restoration project is the first New England project to be funded under Corps of Engineers Section 1135 authority. This authority allows the Corps to become involved in environmental restoration to enhance the environment in areas where prior Corps actions have caused degradation of the environment. Section 1135 projects must have a non-federal sponsor providing 25 percent participation for construction. Other Section 1135 projects in the planning stages include Sagamore Marsh restoration in Massachusetts, and a project in Portsmouth, Rhode Island to restore an area of previous dredge disposal.

The 128-acre Galilee Bird Sanctuary, located in Narragansett, is managed by the Rhode Island Department of Management (RIDEM). Eastern and western project areas have been identified for saltmarsh restoration. The total acreage of the restoration project is 98 acres, including 84 acres of intertidal estuarine habitat, with 14 acres proposed as open water and intertidal channels. The 34-acre western section of the Galilee saltmarsh had previously been used for the disposal of dredge spoils from the adjacent Point Judith federal navigation project. During construction of the Galilee Escape Road in the mid-1950s, tidal flow from the saltmarsh northward was restricted to two small culvert pipes. Restoration of the 64-acre eastern side of the saltmarsh is a compensatory measure for filling associated with the Rhode Island Department of Transportation (RIDOT) construction of the western approach for the Jamestown Bridge (Route 138) in Narragansett. The western side of the marsh was designed by the Corps of Engineers; the eastern side is under design by RIDEM.

Participating state agencies for the restoration of the Galilee Saltmarsh include the RIDOT and RIDEM. Additional partners include Duck Unlimited for the construction of a viewing area at the top of the former disposal area and an interpretive walkway along an old causeway through the marsh, and the University of Rhode Island for environmental awareness of ecological processes within the saltmarsh.

The project goal is to restore the natural channel. A large culvert will be constructed beneath the Galilee Escape Road and a self-regulating tide gate (SRT) will be installed. Project proponents are concerned about flooding of adjacent residential properties during storm tides (realistically, these areas would be subject to washover over the road during storm events regardless of saltmarsh restoration). The Corps completed all hydrological analysis including topographical survey, tidal investigation, water level documentation necessary for sizing structures and for establishing calibration. A feasibility report was conducted for $215,000; preparation of plans and specifications were completed for $230,000 for both eastern and western sections. The engineer's construction estimate was $1,345,000 for the western section and $755,000 for the eastern section. Bid prices for the entire construction (east and west) was $1,844,650 (approximately $300,000 below the government estimate). Monitoring is not required for this project; no wetland planting is proposed. Operation and maintenance costs projected for this site are $12,000 annually to maintain gates, remove debris, occasionally deploy stop logs, and to monitor water levels.

The construction contract was awarded in August 1996 with a 12-month construction period anticipated. Twin 6-foot by 10-foot culverts are now under construction at the eastern and western project areas beneath the Galilee Escape Road.

3.3.17 Route 99, Blackstone River Bridge, Rhode Island (RI-4)

Everett Sammartino of the Rhode Island Department of Transportation provided cost estimates for wetland creation/restoration associated with construction of a new bridge across the Blackstone River in Woonsocket. This project consisted of riverine floodplain enhancement of a 0.6 acre area and restoration of wetland of an additional 0.7 acre area, for a total area of 1.3 acres. The river bank had been covered with riprap; project design called for establishment of grass, sedges, and burreed with knoll and pool topography in open water. As indicated in Table 3.4, project design associated with wetland creation/restoration was invoiced from 1983 to 1993. Over the ten year period, design fees totaled $143,669.

To determine the construction cost of wetland restoration/enhancement, unit costs were pulled off contract books and averaged for the station numbers within the wetland area. Items included within the cost estimate, including RIDOT item codes, are listed in the table. Major items included removal of Class "C" and "D" riprap, costs associated with installation and removal of modified silt fence and special silt curtain, backfilling of the site with loam, site survey to maintain grade, and planting and seeding. Construction monitoring was conducted routinely by RIDEM.

Monitoring was conducted for two years after construction. Reports were prepared four times per year over the period in accordance with the Section 404 permit. Items included vegetation counts, avian monitoring, water table levels in observation wells, and soil profiles.

Table 3.4
Rhode Island Department of Transportation
Rt 99 @ Blackstone River Bridge, Woonsocket
Wetland Enhancement/Restoration Cost Estimate

Size: 1.3 Acres Riverine Floodplain Enhancement

DESIGN COSTS	
Design Total = $143,669	(1983 to 1993)

CONSTRUCTION COSTS				
#	**Item**	**Unit Cost**	**Amount**	**Total Cost**
1	Removal of Class "C" Rip-Rap (Item Code 917.9905)	$7.50/CY	2,200 CY	$16,500
2	Removal of Class "D" Rip-Rap (Item Code 917.9906)	$7.50/CY	1,200 CY	$9,000
3	Removal of Temporary Access Road Liner (Sta 34+/- to 35 + 91)	No item or reference found in contract book: Assume paid for under rip-rap removal.		
4	Removal of Erosion Controls (Silt Fence) (Sta. 34+/- to 35 + 91) Item Code: 206.0220	$2.60/LF	800 LF	$2,080
5	Scarify Exposed Substrate (Sta 34+/- to 35 + 91)	No item or reference found in contract book: Assume paid for under rip-rap removal.		
6	Seed Disturbed Area with Wetland Seed Mix (Sta 34+/- to 35 + 91) Item Code: L02.9901	$0.10/SY	8,715 SY	$871.50
7	Removal of Rip-Rap Through Open Water at Wetland (Sta 34+/- to 35 + 91)	No item or reference found in contract book: Assume paid for under rip-rap removal.		
8	Stake/Flag Limits of Work Around Wetland Restoration/Enhancement Area	Done by RIDOT survey crew. No item or reference found in contract book.		
	For a three person field crew	$600/Day	2 Days	$1200
	For office work $38/hr	$300/Day	1 Day	$300
9	Install Erosion Control Devices Around Wetland Restoration/Enhancement Area			
	Modified Silt Fence: Item Code:206.9905	$4/LF	1,000 LF	$4,000
	Special Silt Curtain: Item Code:206.9906	$10/LF	60/LF	$600

#	Item	Unit Cost	Amount	Total Cost
10	RIDOT's recommended sequence of excavation for the wetland Restoration/Enhancement Area			
	A & B: Excavation	No item or reference found in contract book: Assume paid for under rip-rap removal.		
	C: Remove Rip-Rap from Sta. 33 + 41 to 32+/-	No item or reference found in contract book: Assume paid for under rip-rap removal.		
	D: Removal of Temporary Access Road Liner (Sta. 32 to 33 + 41)	No item or reference found in contract book: Assume paid for under rip-rap removal.		
	E : Remove Erosion Control Devices B/W Sta. 32 & 33 + 41 (Item Code: 206.0220)	$2.60/LF	280 LF	$728
	F: Excavate Wetland Under Temporary Access Road to Appropriate Grades	No item or reference found in contract book: Assume paid for under rip-rap removal.		
11	R & D Excavated Material Removed from Enhancement Area	No item or reference found in contract book: Assume paid for under rip-rap removal.		
12	Dewatering	N/A		
13	Survey to Verify Grades After Excavation Before Loam Placement	Done by RIDOT survey crew.		
	Field days	$600/Day	1 Day	$600
	Office days	$300/Day	0.5 Days	$150
14	Backfilling of Restoration/Enhancement Area W/Loam (Item Code L01.9902)	$9/CY	494 CY	$4,446
15	Compaction Survey to Verify Final Grades	Done by RIDOT survey crew		
	Field days	$600/Day	0.5 Days	$300
16	Compaction/Final Grading of Loam Islands In Enhancement/Restoration Area	No specific item found in contract book: Assume paid for under backfilling w/loam.		
17	Seeding Enhancement Area After Loam Compaction: Assume a 50% re-seeding (Item Code: L02.9901)	0.10/SY	4,358 SY	$436
18	Plantings			$39,785
19	Guarantee of Plant Materials	Not factored into cost.		
20	Erosion Control Removal at wetland restoration/enhancement area	Cost included in installation.		
Construction Total $80,997				

MONITORING COSTS	
Monitoring Total - *2 years*	**$27,582**

Cost Summary - 1.3 Acres Wetland Enhancement	
Design Total	**$143,669**
Construction	**$80,997**
Monitoring Total	**$27,582**
Total	**$252,248**

3.3.18 Other Rhode Island Wetland Creation/Restoration Costs (RI-3, RI-4, RI-5)

In addition to Route 99 (Blackstone River Bridge), Table 3.5 presents information on major cost items for two more RIDOT projects: Route 138 in Jamestown (highway constructed along new and existing alignment), and Route 99 in Woonsocket and Cumberland (highway on new alignment). Key costs associated with these projects are earth excavation (prices range from $2.20 per cubic yard to $11.00 per cubic yard for stockpiling, rehandling, hauling and spreading wetland soil), and planting costs.

Table 3.5

RIDOT Wetland Replacement Projects
Major Construction Items

Project	Route 138, Jamestown			Route 99, Cumberland and Woonsocket			Route 99 @ Blackstone River Bridge, Woonsocket		
Area	Restored 5.3 acre Palustrine scrub/shrub wetland; Created 0.1 acre emergent marsh (stormwater detention)			Created 4.1 acres palustrine emergent wetland and open water			1.3 acre riverine floodplain enhancement		
Total Costs	n/a			n/a			$252,248	($194,037/acre)	
Design	No design cost available			No design cost available			$143,669	($110,515 /acre)	
Construction	$115,080	($21,300 /acre)		$448,700	($109,439 /acre)		$80,997	($62,305 /acre)	
Monitoring	No monitoring required			$375,000	($91,463 /acre; for 5 years)		$27,582	($21,217 /acre; for 2 years)	
Description	**Cost Unit**	**Quantity**	**Total Cost**	**Cost Unit**	**Quantity**	**Total Cost**	**Cost Unit**	**Quantity**	**Total Cost**
Wetland soil stockpiled, rehandled, hauled & spread	$11.00 /CY	1,194 CY	$13,134						
Organic-rich Soils for Wetland Restoration & Replication Area	$2.00 /SY	19,360 SY	$38,720	$2.00 /SY	28,947 SY	$57,894			
Plantable Soil 4" Deep	$0.70 /SY	1,171 SY	$820	$0.70 /SY	7,402 SY	$5,181			
Native Grass Seed Mixture	$0.70 /SY	19,360 SY	$13,552	$0.70 /SY	14,457 SY	$10,120	$0.10 /SY	13,073 SY	$1,307
Selective Clearing	$3,000.00 /AC	2 AC	$6,000						
Earth Excavation	$3.17 /CY	7,400 CY	$23,458	$2.20 /C	65,137 CY	$143,301			
Hay bales, silt fence, special silt curtain, including removal			$5,195			$25,330			$7,408
Planting						$147,704			$39,785
Excelsior Matting				$2.00 /SY	5,474 SY	$10,948			
Removal of Class "C" & "D" Rip-Rap							$7.50 /CY	3,400 CY	$25,500
Backfilling of Restoration/ Enhancement Areas	$9.00 /CY	494 CY	$4,446				$9.00 /CY	494 CY	$4,446
Survey									$2,550

4.0 DATA DISCUSSION

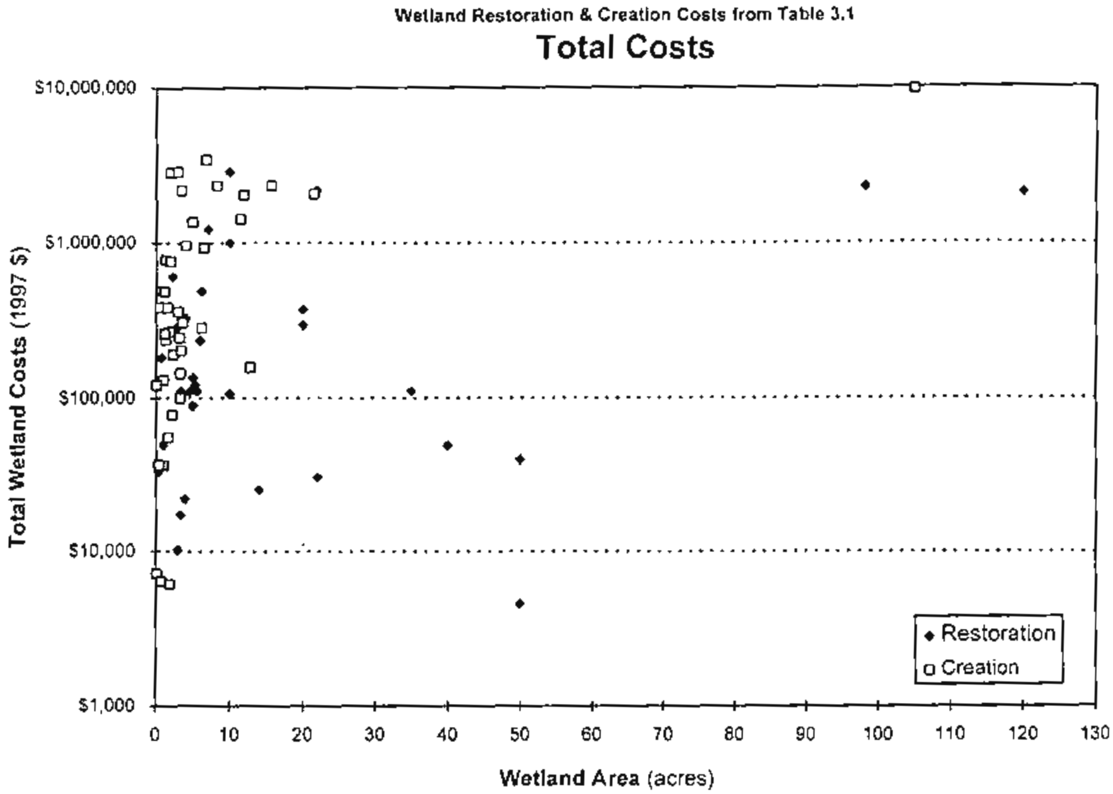
As previous studies have found, there is a very large range in costs per unit area for wetland restoration and creation projects, depending on numerous factors including those discussed in Section 3.2. Size of wetlands in the database in Table 3.1 ranges from 0.1 to 120 acres, and total costs range from $4,600 to $9,690,000 per project, and from $800 to $1,426,000 per acre (Figure 4.1; see also statistical summary at the end of Table 3.1). In Figure 4.2, wetland area in acres is compared to cost per acre, shown on a logarithmic scale. In order to better display the data, an expanded scale for the wetland area was provided in the lower half of the page. Costs per acre decline gradually with increasing wetland size, for both restoration and creation projects, although for any specific size range there is such a wide range of costs as to make precise prediction impossible on the basis of size alone.

Size does have an influence on the extremes of the cost range. Although the costs per acre range from $800 to $1,426,000, and the size of projects from 0.7 to 120 acres, the only projects costing over $300,000 per acre are small, two acres or less in extent, and the only projects costing less than $5,000 per acre are large in extent (larger than 14 acres).

There is a larger database of projects for which at least construction costs are available, but not necessarily all associated costs. When construction costs are plotted vs. wetland area for the 65 projects for which construction costs are available, the trend appears similar to that for total costs, at least for restoration projects (Figure 4.3). It is to be expected that construction costs would follow a trend similar to that of total costs, since construction costs comprise a median of 76 percent of the total cost of all projects. The per-acre construction costs of creation projects do not appear to decrease with size, based on the limited data available, but remain close to$100,000 per acre. This is probably because in the case of creation projects, construction is a higher portion of the total project cost (median of 79 percent in the projects in our database) than is the case with restoration projects (median of 69 percent). In the case of restoration projects, a marsh or other wetland may be restored to its original function by opening up circulation and restoring the original water balance to an area, so that large areas may be restored with little more effort than smaller areas, creating an economy of scale, and decreasing the cost per acre for larger projects. With a wetland creation project, all of the area must undergo some construction, so that unit costs tend to remain the same for larger projects.

As mentioned in Section 3.1, a separate table, Table 3.2, was prepared for freshwater and salt marsh restoration projects of the Connecticut Department of Environmental Protection (CTDEP). These are typically inexpensive restoration projects with significantly lower planning costs. These projects, however, also show considerable variety in their total costs and cost per acre (Figures 4.4 and 4.5 and 38; see also statistical summary at the end of Table 3.2). The CTDEP costs fall into two patterns. One group of projects maintains consistently relatively low total cost and low cost per acre as project size get larger, and another group has some relatively high costs compared with low acreage. The notes following Table 3.2 indicate that those projects which maintain low costs even with high acreage involve removal or repair of culverts or tide gates and sometimes ditch realignment, all techniques by which a large area of marsh can be restored through increased circulation, with only minor amounts

Figure 4.1


Wetland Restoration & Creation Costs from Table 3.1
Total Costs
$10,000,000
$1,000,000
$100,000
$10,000
$1,000
Total Wetland Costs (1997 $)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Wetland Area (acres)
Restoration
Creation

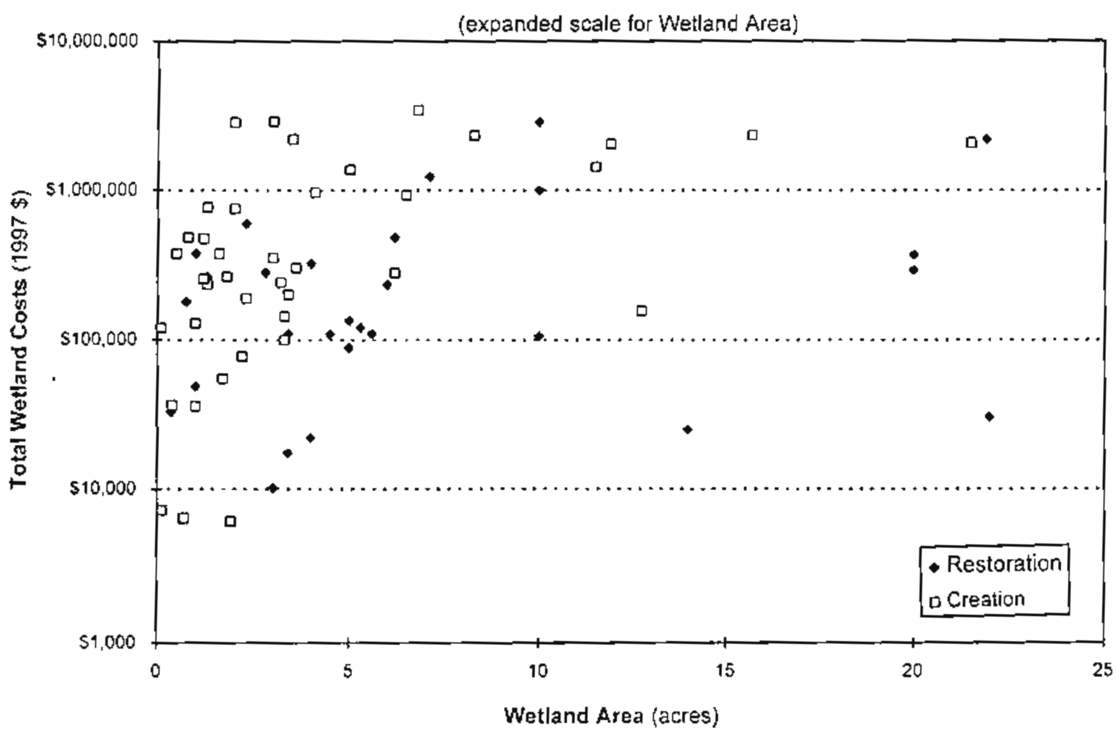
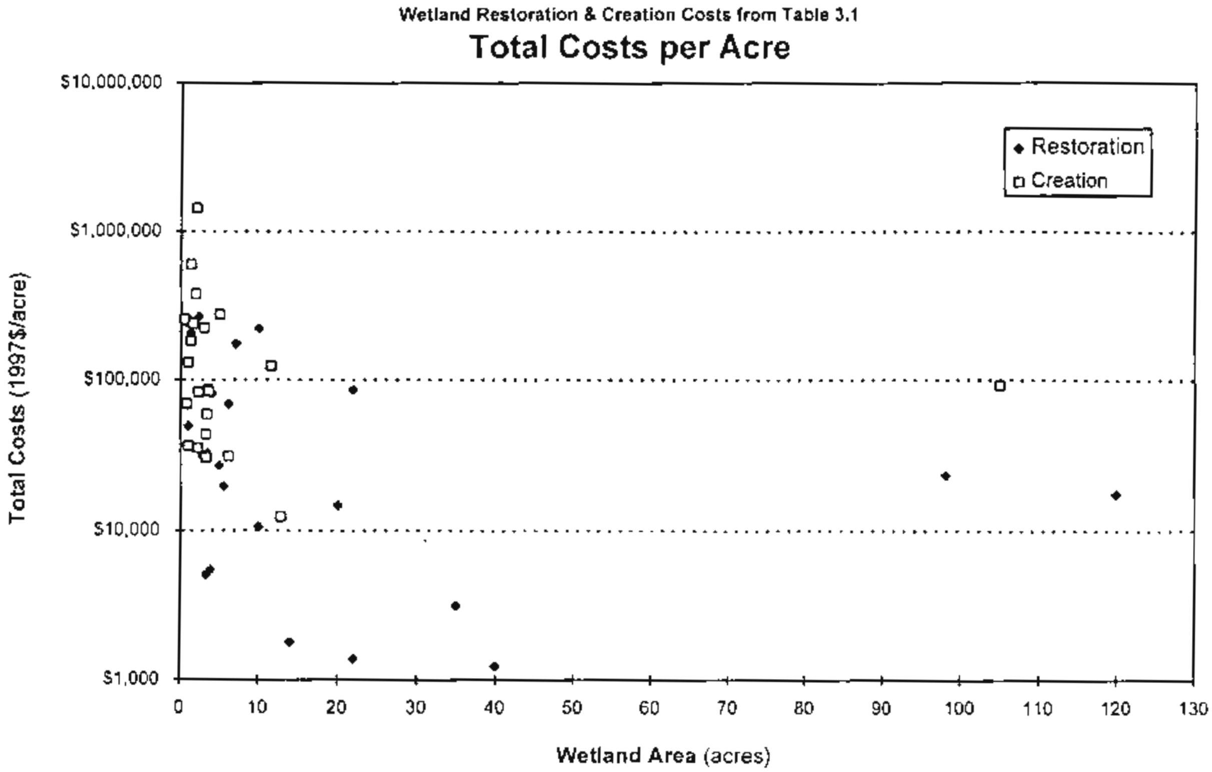

(expanded scale for Wetland Area)
$10,000,000
$1,000,000
$100,000
$10,000
$1,000
Total Wetland Costs (1997 $)
0
5
10
15
20
25
Wetland Area (acres)
Restoration
Creation

Figure 4.2


Wetland Restoration & Creation Costs from Table 3.1
Total Costs per Acre
$10,000,000
$1,000,000
$100,000
$10,000
$1,000
Total Costs (1997$/acre)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Wetland Area (acres)
Restoration
Creation

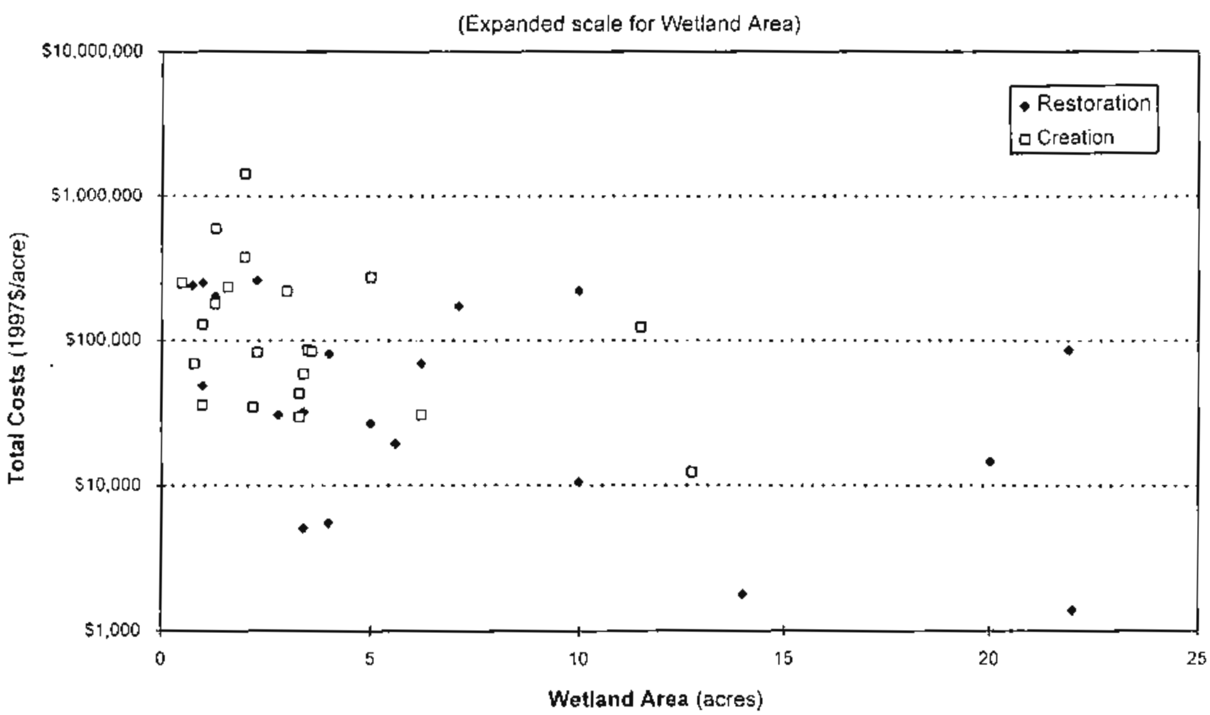
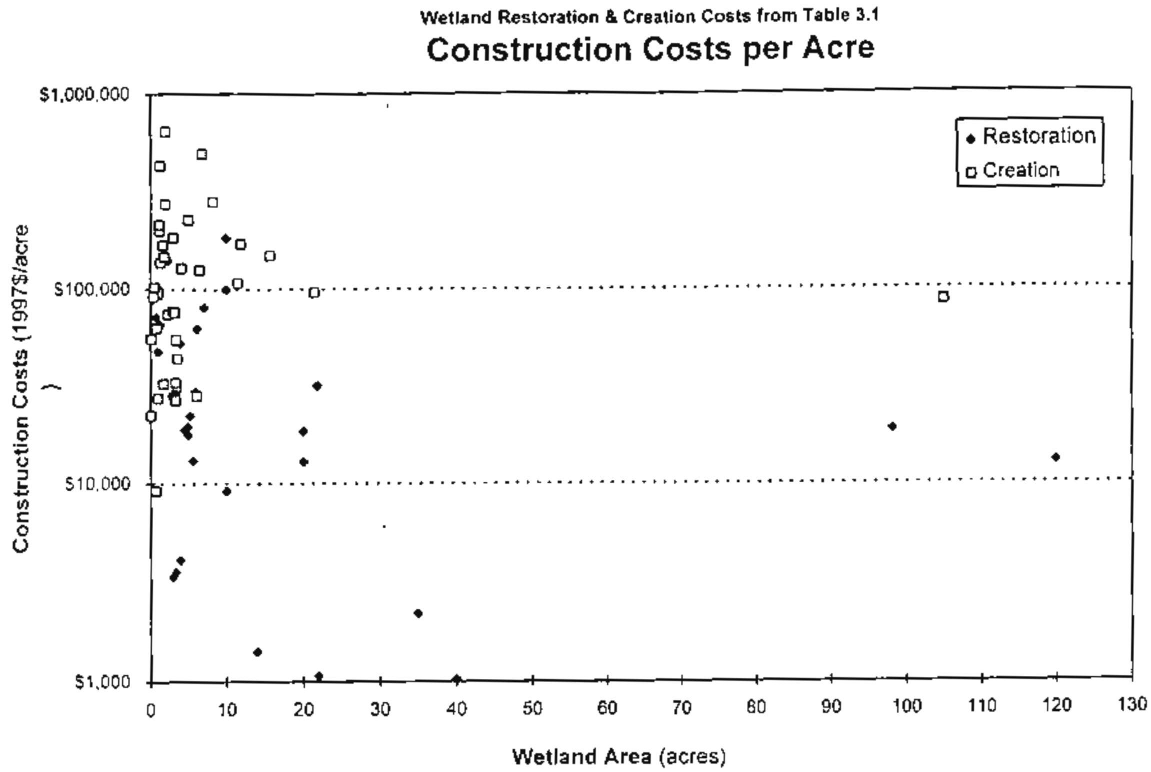

(Expanded scale for Wetland Area)
$10,000,000
$1,000,000
$100,000
$10,000
$1,000
Total Costs (1997$/acre)
0
5
10
15
20
25
Wetland Area (acres)
Restoration
Creation

Figure 4.3


Wetland Restoration & Creation Costs from Table 3.1
Construction Costs per Acre
$1,000,000
$100,000
$10,000
$1,000
Construction Costs (1997$/acre)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Wetland Area (acres)
Restoration
Creation

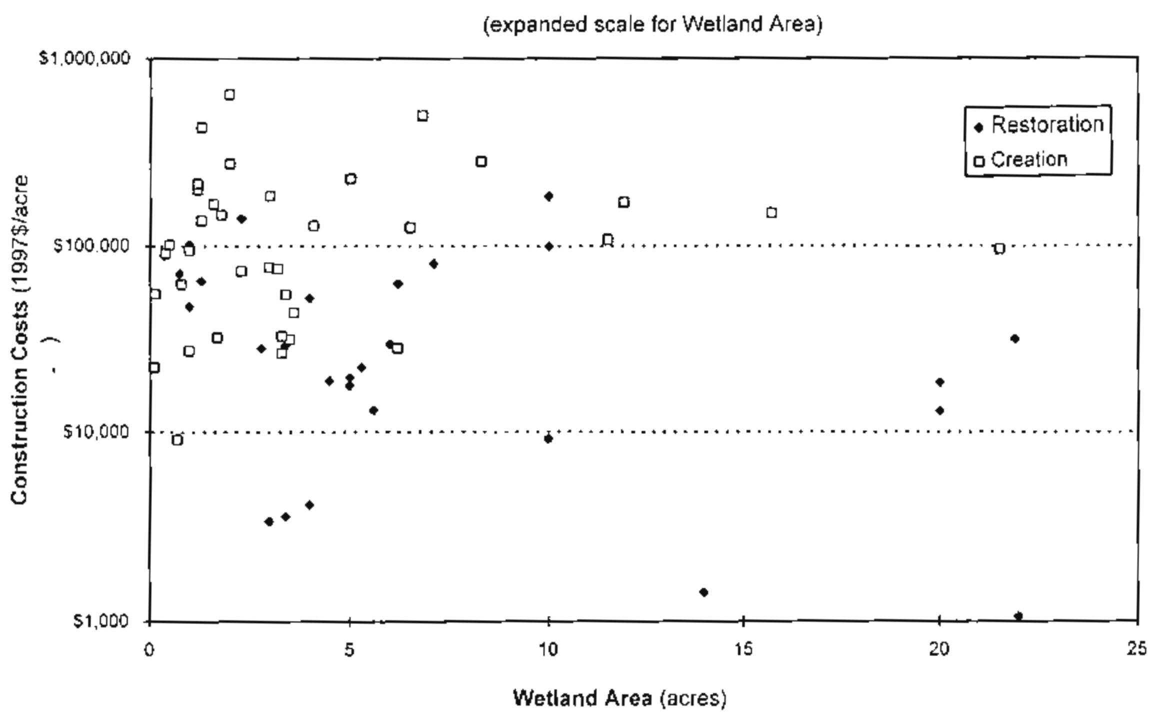
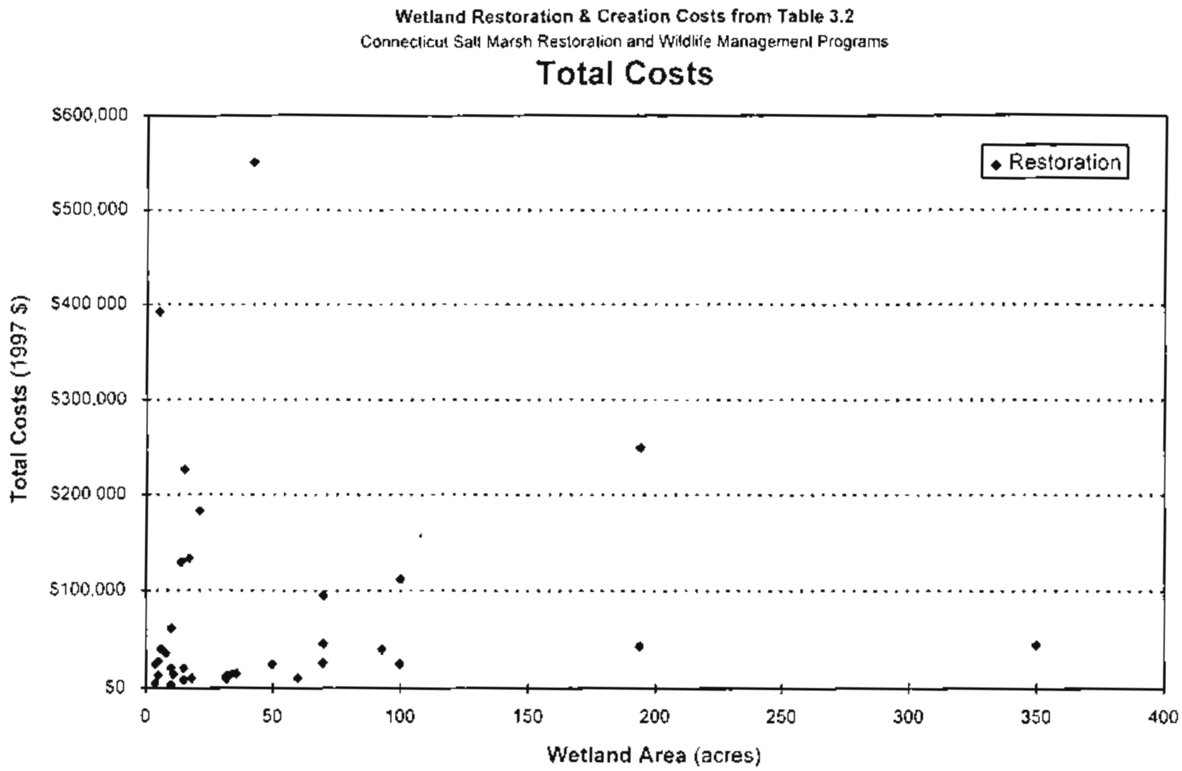

(expanded scale for Wetland Area)
$1,000,000
$100,000
$10,000
$1,000
Construction Costs (1997$/acre)
0
5
10
15
20
25
Wetland Area (acres)
Restoration
Creation

Figure 4.4


Wetland Restoration & Creation Costs from Table 3.2
Connecticut Salt Marsh Restoration and Wildlife Management Programs
Total Costs
Restoration
Total Costs (1997 $)
$600,000
$500,000
$400 000
$300,000
$200 000
$100,000
$0
0
50
100
150
200
250
300
350
400
Wetland Area (acres)

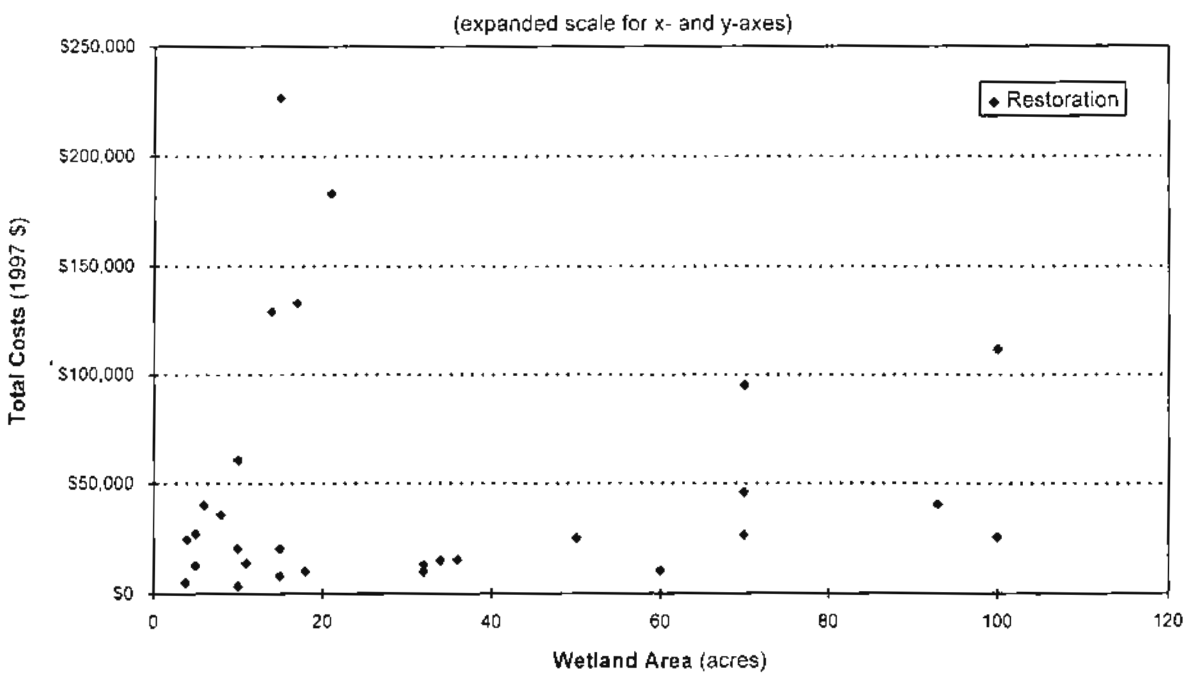
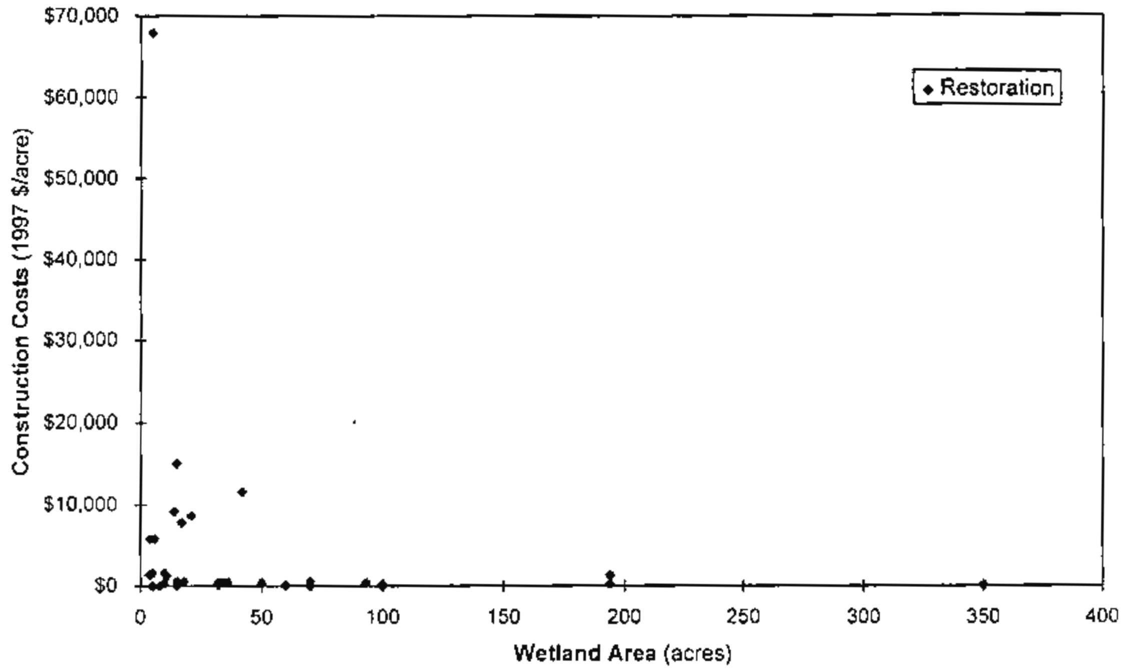

(expanded scale for x- and y-axes)
Restoration
Total Costs (1997 $)
$250,000
$200,000
$150,000
$100,000
$50,000
$0
0
20
40
60
80
100
120
Wetland Area (acres)

Figure 4.5

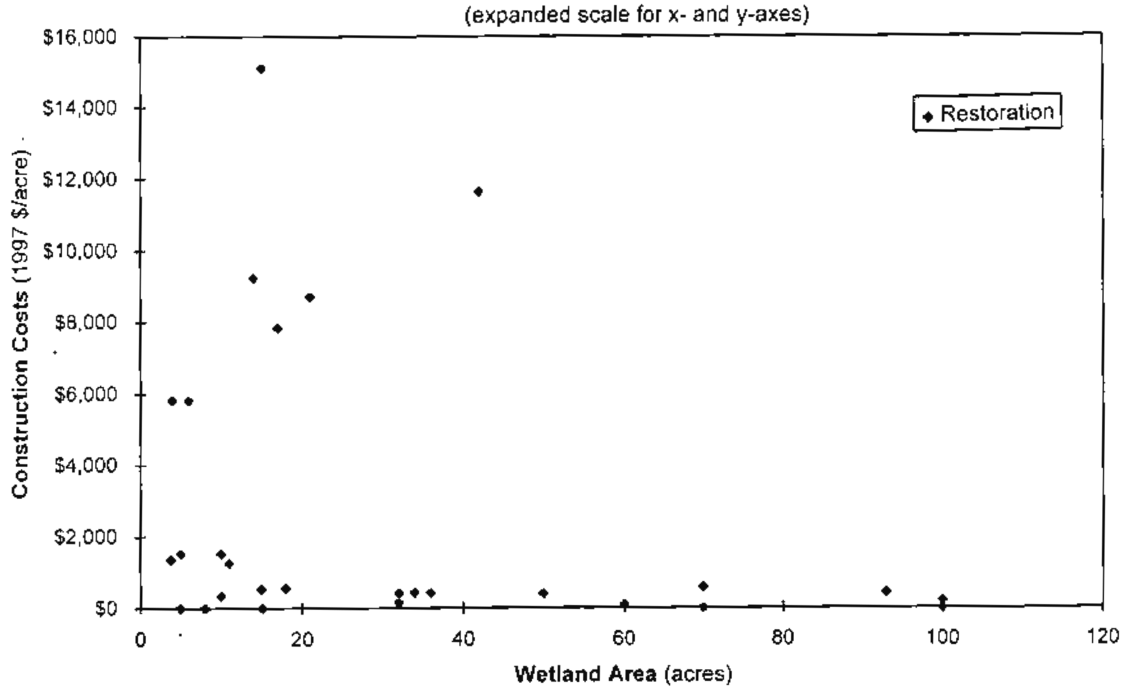
Wetland Restoration & Creation Costs from Table 3.2

Connecticut Salt Marsh Restoration and Wildlife Management Programs

Construction Costs per Acre



(expanded scale for x- and y-axes)



of construction. These projects typically have per-acre costs of well under $1,000. Those projects which have high costs per unit area often involve excavation and jetty construction, and the single project with by far the highest cost per acre, the Norwalk Mill Pond at $68,000 per acre, requires excavation of contaminated soil as well as construction of wetland jetties.

5.0 ADDITIONAL INFORMATION RELATED TO COSTS

Additional information on wetland restoration and creation costs nation-wide has been compiled by the Georgia Department of Transportation for a Federal Highway Administration project during questionnaire surveys in 1993 and 1995 (Appendix A). This information was compiled as a first step in pursuing a region-wide wetland banking agreement between FHWA and federal resource agencies. The Georgia database with wetlands larger than one acre with cost information includes 289 projects from several widespread areas of the country. The database does not contain information on projects from New York and only few projects from New England. The mean and median cost per acre of all Georgia study projects, $46,000 and $8,000 respectively, is much lower than the $135,000 and $54,000 mean and median for the northeastern projects in Table 3.1. There appear to be regional trends in wetland costs, as the figures for the Georgia study are brought down by a large number of very low-cost projects in Mississippi, as well as some in Arkansas and Iowa, whereas the highest per-acre costs are found in those states closest to the northeast, New Jersey and Pennsylvania.

Dr. Dennis King of the University of Maryland Center for Environmental and Estuarine Studies has produced several studies for the Environmental Protection Agency addressing the cost of wetland creation and restoration (King and Bohlen, 1994a,b,c.; King *et. al.*, 1993). Dr. King indicated that there are a wide range of costs associated with wetland restoration/creation, depending on the individual site. He points toward an inverse relationship between cost per acre and project size for wetland projects, as a result of economy of scale. Some of King's preliminary conclusions on the analysis of cost data for wetland restoration projects undertaken throughout the United States are as follows (King and Bohlen, 1994c).

- Restoration success depends on the level of spending on restoration and the motivation of the restoration provided, as well as the state of restoration science and site-specific conditions.

- Site-specific differences can cause the cost of apparently similar projects to differ significantly, sometimes by a factor of five or ten. However, predictability and reliability increases substantially if only a few basic facts are known about the restoration site. So far, analysis suggests that cost adjustment factors based on simple indicators of site conditions can reduce cost estimating error within acceptable bounds.

- Wetland restoration is an emerging field of applied science with very few engineering or performance standards, and the range of skills and experience among restoration specialists is enormous. This is reflected in a wide range of costs and success rates for most types of restoration projects.

6.0 SUMMARY AND CONCLUSIONS

Louis Berger and Associates, Inc., in conjunction with The BSC Group, Inc., has conducted a literature and in depth telephone survey in order to obtain as inclusive a survey as possible of the monetary costs of wetland creation and restoration projects in the glaciated northeast, and to obtain a more detailed understanding of selected wetland creation and restoration projects.

The wetlands for which we gathered information, exclusive of 34 projects under the auspices of the State of Connecticut, included 35 restoration projects and 40 creation projects. Total costs for these projects ranged from $4,600 to $9,690,000, with a median of $239,000, and cost per acre ranged from $800 to $1,426,000, with a median of $54,200.

Some of the conclusions reached with regard to influences of project costs were as follows:

- Permitting can be a substantial part of project expenses and is included in the planning costs, which ranged from 3% to 59%, with a median of 13%, of total project costs.

- Site selection can also be a major part of project costs if wetland creation occurs off-site.

- Variation of project goals, i.e., of the type of wetland desired, can greatly influence project costs, as restoring tidal influence to a salt marsh, for example, typically costs much less than creation of a palustrine emergent wetland requiring grading.

- The necessity of building structures, site preparation, and earthmoving can add greatly to project costs, and can comprise up to 95 percent of construction costs.

- Engineering plans, part of the planning process, can cost up to $5,000 per sheet, and can be expensive if many are required. A small project will require almost as many plans as a large project, creating an economy of scale.

- Monitoring costs can vary greatly depending on agency requirements, but are generally a small part of project costs, a median of 8 percent in the projects studied.

- Cost per acre for wetland projects decreases slightly with project size, although there is too much variation in any one size range to make reliable predictions on size alone. The most expensive projects on a per-acre basis are the smallest, and the ones costing the least per acre are the largest.

- Construction cost per unit area tends to be more independent of project size in creation projects than in restoration projects, probably because construction typically involves the whole site in creation projects, and may only involve part of it in restoration projects.

Office visits were planned as part of our data-gathering procedure; however, both public and private agencies tended to encourage telephone interviews and follow-up and discourage office visits, stating that no additional information could be obtained from such a visit. Our contacts consisted mainly of individuals within state and federal agencies, private consultants, and developers/owners. Extensive telephone follow-up with these key contacts enabled Berger and BSC to develop detailed summaries to designate 15 projects as case studies, discussed in Section 3.3 of this report and to provide additional monetary cost information for Table 3.1 and 3.2 of this report. The validity of our data, as presented in Table 3.1, is limited to the validity of information received from these points of contact. Berger and BSC staff wish to thank representatives of agencies, consulting firms, and wetland nurseries who graciously cooperated with this data quest.

7.0 REFERENCES

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Appendix 1

State of Georgia
Department of Transportation:
Wetland Questionnaire Responses of Wetland Creation, Restoration, Enhancement, and Preservation Projects nation-wide

(Surveys in 1993 and 1995)

Please note that the costs for these projects are not as well constrained as the costs for the projects listed in the main part of the report. For example, the total costs listed for the projects compiled by the Georgia DOT may or may not include planning costs and land acquisition costs. However, since construction costs are typically the main part of the total costs, the large data base provides useful estimates of the ranges of costs associates with different types of wetland projects. All projects listed in the table are projects exceeding 1 acre in size.

Information provided by:
Bill Phillips, Georgia DOT,
Office of Environment/Location

Georgia DOT Study: Wetland Size and Cost Information of Projects nation-wide

State	Project Name	Creation	Restoration	Enhancement	Preservation	No. of Acres Mitigated	Total Costs (original costs, unadjusted for inflation)	Total Costs (original costs, adjusted to 1997 prices) (*)	Total Costs/acre (all project; 1997 prices)	Total Costs/acre (Creation; 1997 prices)	Total Costs/acre (Restoration; 1997 prices)	Total Costs/acre (Enhancement/ Preservation; 1997 prices)	Total Costs/acre (Combination [or n/a]; 1997 prices)
Questionnaire Survey from 1995													
Arkansas	#BR-27-3	●				3.0	$4,500	$4,737	$1,579	$1,579			
Arkansas	R60119			●		28.0	$56,000	$58,947	$2,105			$2,105	
Arkansas	60559	●				12.0	$24,000	$25,263	$2,105	$2,105			
Arkansas	R60101	●				36.0	$72,000	$75,789	$2,105	$2,105			
Arkansas	R60101			●		14.0	$28,000	$29,474	$2,105			$2,105	
Florida	Baymeadow Road Extension	●				9.5	$285,000	$300,000	$31,579	$31,579			
Florida	SR. A-1-A	●		●		1.8	$102,000	$107,368	$60,319				$60,319
Florida	Lejeune Rd. Interchange			●		1.0	$28,480	$29,979	$29,979			$29,979	
Florida	Hwy 20 Bridge			●		642.0	$428,347	$450,892	$702			$702	
Georgia	EDS-565(2) Effingham Co.		●	●	●	17.1	$252,359	$265,641	$15,535				$15,535
Georgia	NH-165-1(49) Cobb/Cherokee	●			●	3.2	$2,500,000	$2,631,579	$822,368	$822,368			
Iowa	Black Hawk (218)	●				23.3	$75,557	$79,534	$3,413	$3,413			
Iowa	Louisa 70			●		18.6	$33,083	$34,824	$1,872			$1,872	
Iowa	Linn 100	●				20.0	$268,805	$282,953	$14,148	$14,148			
Iowa	Des Moines 61	●				10.7	$84,022	$88,444	$8,266	$8,266			
Iowa	Wash. 22	●				9.7	$70,213	$73,908	$7,627	$7,627			
Iowa	Dalles 141	●				10.9	$79,571	$83,759	$7,684	$7,684			
Iowa	Mahaska 163	●				15.0	$61,993	$65,256	$4,350	$4,350			
Iowa	Story 30	●				1.6	$24,978	$26,293	$16,433	$16,433			
Iowa	Wash. 218	●				11.4	$71,682	$75,455	$6,619	$6,619			
Iowa	Bremer	●				21.0	$152,760	$160,800	$7,657	$7,657			
Iowa	Bremer	●				21.0	$152,760	$160,800	$7,657	$7,657			
Kansas		●			●	19.3	$173,337	$182,460	$9,454	*$9,454*			
Maine	Milbridge-Machiasport				●	64.0	$43,495	$45,784	$715			$715	
Maine	Rt. 9 Phase I (4 sites)		●	●		2.3	$571,929	$602,031	$261,752				$261,752
Michigan	M-5 Haggerty Road	●				15.0	$600,000	$631,579	$42,105	$42,105			
Michigan	M-28 Covington	●				5.0	$92,146	$96,996	$19,399	$19,399			
Mississippi	US 98 Perry Greene Co.					27.3	$14,300	$15,053	$552				$552
Mississippi	US 45/Lauderdale					6.9	$3,600	$3,789	$547				$547
Mississippi	US 45/LOWNDES					18.4	$11,300	$11,895	$645				$645
Mississippi	US 98/Lamar					1.5	$800	$842	$561				$561
Mississippi	US 84/Jones					3.5	$1,800	$1,895	$544				$544
Mississippi	US 45/Clarke					26.3	$13,800	$14,526	$553				$553
Mississippi	US 63/George					31.0	$16,200	$17,053	$550				$550
Mississippi	US 45/Clarke					40.1	$21,000	$22,105	$551				$551
Mississippi	US 45/Clarke					33.2	$17,400	$18,316	$552				$552
Mississippi	US 72/Benton					2.9	$1,900	$2,000	$685				$685
Mississippi	US 45/Monroe					5.6	$3,600	$3,789	$678				$678
Mississippi	US 82/Webster					4.0	$2,600	$2,737	$683				$683
Mississippi	SR 27/Lawrence					2.6	$1,700	$1,789	$683				$683
Mississippi	US 72/Benton					4.1	$3,900	$4,105	$1,004				$1,004
Mississippi	US 72/Benton					11.6	$34,800	$36,632	$3,152				$3,152
Mississippi	SR 26/Pearl River					2.0	$1,300	$1,368	$684				$684
Mississippi	US 61/Tunica& Coahoma					12.8	$8,100	$8,526	$666				$666
Mississippi	US 61/Tunica					5.7	$3,600	$3,789	$662				$662
Mississippi	US 61/DeSoto					1.9	$1,200	$1,263	$675				$675
Mississippi	US 98/Pike					2.9	$1,800	$1,895	$658				$658
Mississippi	SR 304/DeSoto					21.6	$137,000	$144,211	$6,673				$6,673
Mississippi	US 82/Webster					2.0	$1,300	$1,368	$684				$684
Mississippi	SR 278/Monroe					19.1	$12,200	$12,842	$671				$671
Mississippi	SR 278/Monroe					3.3	$6,500	$6,842	$2,086				$2,086
Mississippi	SR 8/Chickasaw					3.8	$8,000	$8,421	$2,199				$2,199
Mississippi	US 72/Tippah					39.4	$73,200	$77,053	$1,954				$1,954
Mississippi	SR 35/Leake					2.7	$9,800	$10,316	$3,821				$3,821
Montana						27.0	$128,369	$135,125	$5,005				$5,005
Montana						4.4	$35,583	$37,456	$8,493				$8,493
Nebraska	PR#F-2-1(109)/F-2-1-(1010)					15.6	$310,905	$327,268	$20,965				$20,965
New Jersey	I-287 (Northern Section)	●				32.6	$4,130,000	$4,347,368	$133,355	$133,355			
New Jersey	I-287 (Central Section)	●				10.0	$2,700,000	$2,842,105	$284,211	$284,211			
New Jersey	I-287 (Southern Section					49.4	$14,400,000	$15,157,895	$306,840				$306,840
New Jersey	Rt. 152	●				24.1	$2,500,000	$2,631,579	$109,194	$109,194			

Georgia DOT Study: Wetland Size and Cost Information of Projects nation-wide

State	Project Name	Creation	Restoration	Enhancement	Preservation	No. of Acres Mitigated	Total Costs (original costs, unadjusted for inflation)	Total Costs (original costs, adjusted to 1997 prices) (*)	Total Costs/acre (all project; 1997 prices)	Total Costs/acre (Creation; 1997 prices)	Total Costs/acre (Restoration; 1997 prices)	Total Costs/acre (Enhancement/ Preservation; 1997 prices)	Total Costs/acre (Combination [or n/a]; 1997 prices)
New Jersey	Rt. 37 Lake Shenandoah			●		7.0	$430,000	$452,632	$64,662			$64,662	
New Jersey	Rt. 70	●				3.4	$580,000	$610,526	$179,567	$179,567			
New Jersey	Rt. 30 (5f, 4e)	●				2.6	$1,000,000	$1,052,632	$411,184	$411,184			
North Dakota	HWY 46			●		1.5	$23,840	$25,095	$16,730			$16,730	
North Dakota	HWY 23			●		24.0	$22,000	$23,158	$965			$965	
North Dakota	Hardsfield	●		●		14.1	$350,095	$368,521	$26,173				$26,173
North Dakota	HWY 17			●		7.0	$15,000	$15,789	$2,243			$2,243	
Oregon	M-F	●		●	●	6.0	$500	$526	$88				
Oregon	Neh-bvCr	●		●		1.8	$75	$79	$43				$43
Pennsylvania	Garden View to Beauty's Run	●				3.9	$246,210	$259,168	$66,453	$66,453			
Pennsylvania	Beauty's Run to Powy's	●				15.4	$912,041	$960,043	$62,179	$62,179			
Pennsylvania	PP&L	●				3.6	$5,500	$5,789	$1,599	$1,599			
Pennsylvania	Penns Creek	●				6.5	$674,911	$710,433	$109,129	$109,129			
Pennsylvania	Dist. 4-0/Sect. MIT	●				1.5	$500	$526	$351	$351			
Pennsylvania	Dist. 6-0/Exton Bypass (Phase I)	●				9.5	$1,600,000	$1,684,211	$177,285	$177,285			
Pennsylvania	Dist. 6-0/Exton Bypass (Phase II)	●				28.1	$4,600,000	$4,842,105	$172,317	$172,317			
Pennsylvania	SR 0581-A01/Cumb Co.	●				1.4	$166,778	$175,556	$124,508	$124,508			
Pennsylvania	SR0011-005/Perry Co.	●				3.1	$679,903	$715,687	$228,654	$228,654			
Pennsylvania	SR 6422	●				10.7	$538,000	$566,316	$53,175	$53,175			
Pennsylvania	SR 0079/I-79	●				1.1	$126,425	$133,079	$125,546	$125,546			
Pennsylvania	SR0022/US 22	●				1.3	$83,196	$87,574	$67,365	$67,365			
Pennsylvania	SR0279-06C	●				15.0	$1,200,000	$1,263,158	$84,211	$84,211			
Rhode Island	Rt 138 NorthKingstown	●				1.3	$62,178	$65,451	$50,347	$50,347			
South Carolina	SC 61Expressway	●				7.0	$90,000	$94,737	$13,534	$13,534			
South Carolina	SR 1240/Horry Co.			●		3.0	$9,300	$9,789	$3,263			$3,263	
South Carolina	SR 802/Battery Creek	●				4.8	$178,000	$187,368	$39,281	$39,281			
South Carolina	SC 174/Charleston	●				3.3	$100,000	$105,263	$32,092	$32,092			
South Dakota	P0042(13)345/P CEMS 1324			●		48.0	$40,000	$42,105	$877			$877	
South Dakota				●		15.5	$26,062	$27,434	$1,770			$1,770	
Texas	SH 35 Mitigation Areas				●	9.0	$21,000	$22,105	$2,456			$2,456	
Texas	SH100/Cameron Co.	●		●		16.8	$51,750	$54,474	$3,242				
Texas	US 290/Harris Co.	●				20.0	$612,234	$644,457	$32,223	$32,223			
Texas	FM2478/Walker Co.	●		●		28.0	$1,069,210	$1,125,484	$40,196				
Texas	SH242 Montgomery Co.	●				16.0	$333,432	$350,981	$21,936	$21,936			
Texas	SH242 Montgomery Co.	●				114.0	$669,446	$704,680	$6,181	$6,181			
Texas	US 290&FM 359/Waller Co.	●				12.2	$443,716	$467,069	$38,222	$38,222			
Texas	Anderson Tract/Smith Co.				●	2,244	$900,000	$947,368	$422			$422	
Texas	Blue Elbow Swamp/Organe Co.				●	3,300	$1,068,000	$1,124,211	$341			$341	
Texas	US 281/Live Oak			●		56.0	$61,600	$64,842	$1,158			$1,158	
Texas	Caddo Lake/Marion Co.			●		50.0	$50,000	$52,632	$1,053			$1,053	
Texas	SH 6/Brazos Co.			●		8.0	$221,760	$233,432	$29,179			$29,179	
Virginia	VGP-95-Nat23	●				1.5	$111,662	$117,539	$76,324	$76,324			
Virginia	Fort Belvoir	●				2.7	$152,276	$160,291	$59,148	$59,148			
Virginia	VGP-94-4021	●				2.0	$32,500	$34,211	$17,278	$17,278			
Virginia	Hwy 81	●				13.8	$900	$947	$69	$69			
Virginia	VGP-93-4130	●				1.5	$15,263	$16,066	$11,004	$11,004			
Washington				●	●	4.0	$71,749	$75,525	$18,881				$18,881
Washington					●	3.0	$225,659	$237,536	$79,179			$79,179	
Washington		●		●		2.6	$208,282	$219,244	$83,047				$83,047
Washington		●				4.3	$126,946	$133,627	$31,294	$31,294			
Washington				●	●	34.3	$355,542	$374,255	$10,924			$10,924	
Washington		●				1.2	$341,195	$359,153	$299,294	$299,294			
Washington		●				5.1	$2,214,293	$2,330,835	$457,026	$457,026			
Washington				●		4.3	$474,985	$499,984	$115,737			$115,737	

Questionnaire Survey from 1993

State	Project Name	Creation	Restoration	Enhancement	Preservation	No. of Acres Mitigated	Total Costs (unadjusted)	Total Costs (1997 prices)	Total Costs/acre (all project)	Total Costs/acre (Creation)	Total Costs/acre (Restoration)	Total Costs/acre (Enhancement/ Preservation)	Total Costs/acre (Combination)
Alabama	ST-1454(12), Lee	●				2.0	$5,000	$5,556	$2,778	$2,778			
Alabama	BRF-391(7)(8), Bullock	●				4.0	$20,000	$22,222	$5,556	$5,556			
Alabama	F-448(7), Coffee	●				7.0	$35,000	$38,889	$5,556	$5,556			
Alabama	Co.	●				4.0	$30,000	$33,333	$8,333	$8,333			

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Alabama	BRS-1808(103) Piney Woods Ck. and Polby Br., Conecun Co.	●				4.0	$10,000	$11,111	$2,778	$2,778			
Alabama	NH-40 Henryville to Bucas Gap Gap, Marshall Co.			●		5.2	$15,600	$17,333	$3,333			$3,333	
Alabama	M-7510(3) Mobile Co. University Blvd.	●				5.0	$10,000	$11,111	$2,222	$2,222			
Arizona				●		28.0	$200,000	$222,222	$7,937			$7,937	
Arkansas	Project No. 20071				●	5.0	$6,770	$7,522	$1,504			$1,504	
Arkansas	Project No. 20071 - Continued			●		10.0	$21,540	$23,933	$2,393			$2,393	
Arkansas	Project No. 5944	●				16.0	$15,000	$16,667	$1,042	$1,042			
Arkansas	Project No. 60110			●		10.0	$15,600	$17,333	$1,733			$1,733	
Arkansas	Project No. 60110 - Continued	●				65.0	$56,400	$62,667	$964	$964			
Arkansas	Project No. R70054			●		4.0	$2,000	$2,222	$556			$556	
Arkansas	Project No. R70060	●				8.0	$18,832	$20,924	$2,616	$2,616			
Arkansas	Project No. 7940			●		5.0	$5,000	$5,556	$1,111			$1,111	
Arkansas	Project No. 80012	●				3.0	$8,062	$8,958	$2,986	$2,986			
Arkansas	Project No. R00063			●		2.0	$4,000	$4,444	$2,222			$2,222	
Arkansas	Project No. R00079	●				4.0	$8,000	$8,889	$2,222	$2,222			
California	HUM, DN-101-125.6/R135.0R0.0/R0.5 Park Bypass	●				6.0	$88,000	$97,778	$16,296	$16,296			
California	MEN-1-64.1/65.1 Cleone Mitigation Site	●				1.5	$20,000	$22,222	$14,815	$14,815			
California	LAX-53-0.0/3.5 Anderson Marsh St., Park Site	●				2.5	$16,000	$17,778	$7,111	$7,111			
California	MEN-101-30.8/36.2 Forsythe Creek Revegetation	●				12.0	$171,091	$190,101	$15,842	$15,842			
California	SHA 299 7.2 /8.5, 9.0 Crystal Creek Curve Realignment - Continued	●				2.7	$70,000	$77,778	$28,807	$28,807			
California	SCL-152 21.8/27.2 Widen/Realign Highway Pacheco Pass		●			55.0	$313,600	$348,444	$6,335		$6,335		
California	SCL-237 R3.2/9.4 Freeway Upgrade	●				50.0	$11,200	$12,444	$249	$249			
California	SCL-85 R0.0/R17.0 Coyote Creek	●				13.0	$744,600	$827,333	$63,641	$63,641			
California	SCL-85 R0.0/R17.0 Coyote Creek -	●				24.0	$91,000	$101,111	$4,213	$4,213			
California	SBD-83 0.6/0.8 Euclid Ave. Rehab (AC, Widen)			●		1.5	$10,000	$11,111	$7,407			$7,407	
California	SBD-30, 330 20.2/32.6, 28.7/30.2 30/330 Freeway Project	●				1.9	$16,000	$17,778	$9,357	$9,357			
California	SJ-12 Potato Slough Bridge			●		6.0	$10,500	$11,667	$1,944			$1,944	
California	ORA-1 Dunes Restoration		●			24.0	$290,000	$322,222	$13,426		$13,426		
California	ORA-74 Hot Springs		●			1.0	$53,000	$58,889	$58,889		$58,889		
Connecticut	Route 187 Proj. 11-136	●				6.0	$162,000	$180,000	$30,000	$30,000			
Connecticut	Route 7 Proj. 102-190	●				1.8	$263,000	$292,222	$162,346	$162,346			
Connecticut	Route 7 Proj. 102-190	●				4.4	$2,700,000	$3,000,000	$681,818	$681,818			
Connecticut	I-91 Proj. 164-178	●				3.6	$254,000	$282,222	$78,395	$78,395			
Connecticut	I-91 Project 164-178	●				2.9	$484,000	$537,778	$185,441	$185,441			
Connecticut	Route 9 Proj 33-103/104			●		21.5	$1,874,000	$2,082,222	$96,848			$96,848	
Delaware	Relocated Rt. 896 over Muddy Run, Glasgow Bypass	●				3.0	$96,456	$107,173	$35,724	$35,724			
Delaware	SR 896, Summit Bridge to I-95			●		6.0	$103,800	$115,333	$19,222			$19,222	
Delaware	SR 1, Relief Route, Early Action Phase	●				300.0	$750,000	$833,333	$2,778	$2,778			
Delaware	US 113 At St. Jones River Barkers Landing	●				7.0	$154,428	$171,587	$24,512	$24,512			
Delaware	BR 7 Over Christina River & Eagle Run	●				8.5	$2,674,450	$2,971,611	$349,601	$349,601			
Florida	SR 60 @ Wednyakapica	●				2.5	$52,045	$57,828	$23,131	$23,131			
Florida	US 17 Wauchuca	●				11.5	$317,233	$352,481	$30,704	$30,704			
Florida	SR 951 Phase 1			●		2,000.0	$59,560	$66,178	$33			$33	
Florida	Bear Island @ SR 29			●		5,000.0	$74,309	$82,566	$17			$17	
Florida	SR-107 Nassau County	●				1.2	$93,600	$104,000	$88,889	$88,889			
Florida	SR-9A Jones Creek & Ginhouse Creek				●	110.0	$330,000	$366,667	$3,333			$3,333	
Florida	SR-15, US-17 In Putnam & Clay Counties	●				14.0	$78,000	$86,667	$6,190	$6,190			

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Florida	SR-15, US-17 In Putname & Clay Counties, Continued				●	3.0	$3,000	$3,333	$1,111			$1,111	
Florida	I-295, I-10 Interchange	●				3.8	$45,240	$50,267	$13,333	$13,333			
Florida	SR-9A, Sawmill Slough				●	153.5	$460,500	$511,667	$3,333			$3,333	
Florida	I-295, I-95 to Buckman Bridge				●	100.0	$400,000	$444,444	$4,444			$4,444	
Florida	Merril Barber Bridge	●				13.3	$1,200,000	$1,333,333	$100,251	$100,251			
Florida	Merrill Barber Bridge - Continued				●	53.0	$1,600,000	$1,777,778	$33,543			$33,543	
Florida	Consent Order for I-595 Violation	●				10.0	$298,445	$331,606	$33,161	$33,161			
Florida	Pond Apple Slough Mitigation	●				4.7	$380,000	$422,222	$90,800	$90,800			
Florida	Okeechobee Blvd. From SR-7 to Fl. Turnpike	●				7.3	$10,600	$11,778	$1,625	$1,625			
Florida	SR-A1A Burnt Bridge			●		1.7	$24,899	$27,666	$16,274			$16,274	
Florida	I-595 Mitigation	●				43.0	$35,278,273	$39,198,081	$911,583	$911,583			
Florida	I-595 Mitigation - Continued			●		4.6	$230,100	$255,667	$56,190			$56,190	
Florida	I-595 Mitigation - Continued				●	178.8	$12,539,000	$13,932,222	$77,921			$77,921	
Florida	15 Miles West of CR-512 to I-95	●				44.0	$186,400	$207,111	$4,707	$4,707			
Florida	I-595 @ US 1, Ongoing			●		2.9	$100,000	$111,111	$37,922			$37,922	
Florida	C-18 Canal Wetland Creation for SR 706 Widening Impacts	●				2.1	$49,279	$54,754	$26,451	$26,451			
Florida		●				9.6	$685,000	$761,111	$78,953	$78,953			
Florida	Continued			●		2.0	$60,000	$66,667	$33,333			$33,333	
Florida	Seminole WPI 5157501 thru 5157514	●				140.0	$270,000	$300,000	$2,143	$2,143			
Florida	Seminole WPI 5157501 thru 5157514			●		756.0	$1,290,000	$1,433,333	$1,896			$1,896	
Florida	Seminole WPI 5157501 thru 5157514				●	839.0	$1,440,000	$1,600,000	$1,907			$1,907	
Florida	Veterans Expressway - Continued	●				77.2	$5,900,727	$6,556,363	$84,894	$84,894			
Florida	Veterans Experssway - Continued			●		2.9	$4,183	$4,648	$1,603			$1,603	
Florida	Veterans Expressway - Continued				●	78.8	$395,090	$438,989	$5,570			$5,570	
Florida	Veterans Expressway - Continued				●	240.0	$240,000	$266,667	$1,111			$1,111	
Georgia	U.S. 84, Thomas Co. EDS-84(8)	●				3.0	$90,000	$100,000	$33,333	$33,333			
Georgia	Limerock Road, Houston Co. GIP-	●				12.3	$369,000	$410,000	$33,333	$33,333			
Georgia	Waynesboro Bypass, Burke Co. EDS-555(3)	●				9.3	$279,000	$310,000	$33,333	$33,333			
Georgia	Sylvania Bypass, Screven Co. EDS-565(5)	●				2.2	$66,000	$73,333	$33,333	$33,333			
Georgia	Clarke Avenue Ext.	●				2.4	$72,000	$80,000	$33,333	$33,333			
Georgia	Attapulgus Bypass, Decatur Co. EDS-27(116)	●				17.7	$531,000	$590,000	$33,333	$33,333			
Georgia	Blakely Bypass, Early Co. EDS-27(129)		●			21.7	$390,600	$434,000	$20,000		$20,000		
Georgia	Ocmulgee Road, Wilcox/Dodge Co. BRF-030-2(14)	●				8.6	$258,000	$286,667	$33,333	$33,333			
Georgia	Watkinsville Bypass, Oconee Co. NH-002-5(41)			●		6.9	$13,800	$15,333	$2,222			$2,222	
Georgia	Watkinsville Bypass, Oconee Co. NH-002-5(41) - Continued		●			4.6	$82,800	$92,000	$20,000		$20,000		
Georgia	SR 57 Biss/Jones/Twigs FLF-540(1)	●				1.8	$32,400	$36,000	$20,000	$20,000			
Georgia	West Thomasville Bypass, Thomas Co. NH-033-1(51)	●				4.8	$86,040	$95,600	$20,000	$20,000			
Georgia	U.S. 84 Wayne/Long EDS-84(11)	●				14.0	$420,000	$466,667	$33,333	$33,333			
Georgia	East Cuthbert Bypass, Randolph Co. EDS-27(134)	●				1.4	$25,000	$27,778	$19,841	$19,841			
Illinois	Total Mitigation	●				23.8	$430,000	$477,778	$20,075	$20,075			
Illinois	Total Mitigation - Continued	●				13.1	$356,000	$395,556	$30,195	$30,195			
Iowa	U.S. 218 Black Hawk County			●		10.0	$20,000	$22,222	$2,222			$2,222	
Iowa	Iowa 70 Louisa County			●		15.0	$15,000	$16,667	$1,111			$1,111	
Iowa	U.S. 63 Bremer County			●		13.0	$40,000	$44,444	$3,419			$3,419	
Kansas		●				19.0	$194,400	$216,000	$11,368	$11,368			
Kansas		●				17.3	$160,000	$177,778	$10,276	$10,276			
Louisiana				●		1.9	$3,740	$4,156	$2,187			$2,187	
Louisiana				●		1.6	$2,750	$3,056	$1,910			$1,910	
Louisiana				●		3.0	$6,600	$7,333	$2,444			$2,444	
Louisiana				●		8.0	$13,200	$14,667	$1,833			$1,833	
Louisiana				●		6.5	$9,510	$10,567	$1,626			$1,626	

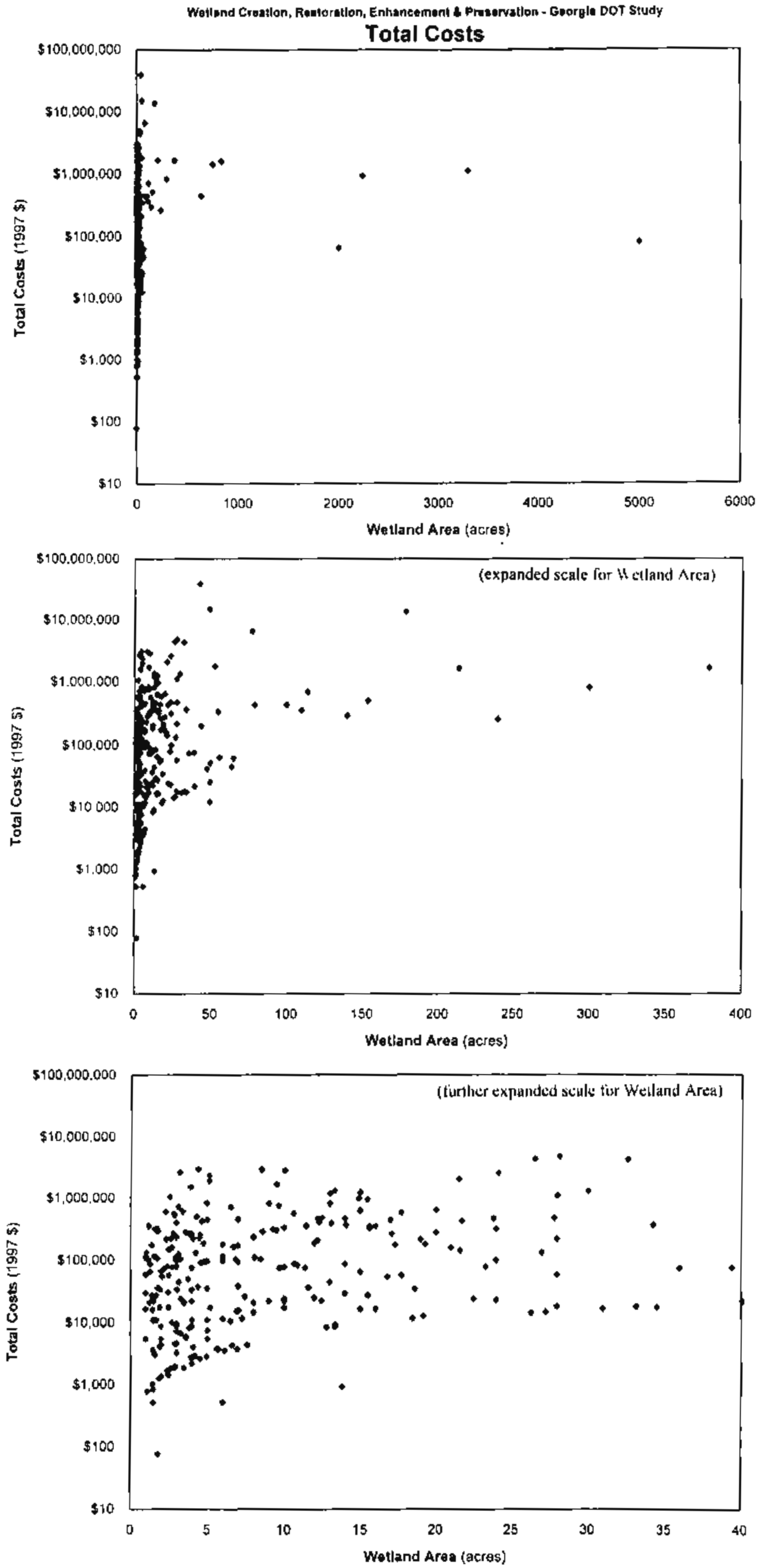
Georgia DOT Study: Wetland Size and Cost Information of Projects nation-wide

State	Project Name	Creation	Restoration	Enhancement	Preservation	No. of Acres Mitigated	Total Costs (original costs, unadjusted for inflation)	Total Costs (original costs, adjusted to 1997 prices) (*)	Total Costs/acre (all project; 1997 prices)	Total Costs/acre (Creation; 1997 prices)	Total Costs/acre (Restoration; 1997 prices)	Total Costs/acre (Enhancement/ Preservation; 1997 prices)	Total Costs/acre (Combination [or n/a]; 1997 prices)
Maine	Alexander-Baileyville 3306.00				●	22.5	$22,000	$24,444	$1,086			$1,086	
Maine	Alexander-Baileyville 3306.00 - Cont.		●			4.5	$202,682	$225,202	$50,045		$50,045		
Maine	Biddefor 615.10; 615.11; 615.12; 615.13		●			3.0	$360,000	$400,000	$133,333		$133,333		
Maine	Falmouth 4079.00				●	4.1	$199,665	$221,850	$54,110			$54,110	
Maine	Lewiston 2914.00				●	3.0	$71,578	$79,531	$26,510			$26,510	
Maine	Scarborough 2935.00; 2935.11; 2935.21; 2935.22; 2935.42		●			3.9	$1,400,000	$1,555,556	$398,860		$398,860		
Minnesota	District One: Fifty Projects	●				378.6	$1,500,000	$1,666,667	$4,402	$4,402			
Mississippi		●				4.5	$2,370	$2,633	$583	$583			
Mississippi		●				6.1	$3,209	$3,566	$583	$583			
Mississippi		●				2.5	$1,300	$1,444	$582	$582			
Mississippi		●				7.6	$3,979	$4,421	$582	$582			
Mississippi		●				4.9	$2,590	$2,878	$583	$583			
Mississippi		●				2.4	$1,521	$1,690	$707	$707			
Mississippi		●				13.4	$8,510	$9,456	$707	$707			
Mississippi		●				2.6	$1,661	$1,846	$707	$707			
Mississippi		●				1.1	$700	$778	$707	$707			
Mississippi		●				4.0	$2,514	$2,793	$707	$707			
Mississippi		●				6.6	$3,911	$4,346	$658	$658			
Mississippi		●				4.2	$2,674	$2,971	$707	$707			
Mississippi		●				1.5	$923	$1,026	$707	$707			
Mississippi		●				13.3	$7,905	$8,783	$658	$658			
Mississippi		●				28.0	$16,592	$18,436	$658	$658			
Nebraska	F-2-1(1010), Antioch East to Lakeside	●				15.6	$310,905	$345,450	$22,130	$22,130			
Nebraska	F-BHF-2-2(105), Thomas County, Thedford West	●				3.2	$40,141	$44,601	$14,114	$14,114			
Nebraska	F-2-3(1013), Blaine County, Dunning to Anselmo			●		2.4	$197,044	$218,938	$93,165			$93,165	
Nebraska	F-14-2(112), Merrick County, Central City South	●				8.1	$99,473	$110,526	$13,679	$13,679			
Nebraska	F-20-3(1006), Rock County, Bassett East	●				17.7	$51,971	$57,746	$3,259	$3,259			
Nebraska	F-BRF-26-1(127), Garden County, Oshkosh to Lewellen	●				1.7	$10,022	$11,136	$6,550	$6,550			
Nebraska	F-30-5(1025), Merrick County, Silver Creek to Duncan	●				7.4	$23,625	$26,250	$3,533	$3,533			
Nebraska	F-75-2(116), Sarpy County, Capehart Rd	●				1.3	$18,998	$21,109	$16,753	$16,753			
Nebraska	F08102(1010), Butler County, N-64 to Platte River	●				6.9	$93,501	$103,890	$15,166	$15,166			
Nebraska	F-91-6(1002) & (1003), Colfax County, Howells East & West and Leigh East	●				8.5	$93,620	$104,022	$12,267	$12,267			
New Jersey	70, 12A, 13B	●				1.0	$100,000	$111,111	$111,111	$111,111			
New Jersey	37 (86)	●				2.8	$500,000	$555,556	$198,413	$198,413			
New Jersey	147 (1C, 1E)	●				26.5	$4,000,000	$4,444,444	$167,715	$167,715			
Oklahoma		●				17.0	$400,000	$444,444	$26,144	$26,144			
Oklahoma					●	34.5	$16,029	$17,810	$516			$516	
Oklahoma					●	50.0	$23,250	$25,833	$517			$517	
Nebraska	F-281-2(1008) Hall County & F-281-2(1009) Howard Co	●				12.5	$20,284	$22,538	$1,807	$1,807			
Nebraska	EACF-BR-BW-281-4(107), Holt Co., O'Neill So	●				6.7	$146,850	$163,167	$24,281	$24,281			
Nebraska	F-383-3(1007), Morrill Co, Angora	●				1.5	$3,250	$3,611	$2,457	$2,457			
New Jersey	Route 522	●				14.9	$898,000	$997,778	$67,010	$67,010			
Pennsylvania	Washington Co, SR 1125, Sec 830, M Valley Expressway	●				5.0	$750,500	$833,889	$167,784	$167,784			
Pennsylvania	SR 6060, Sec A04, Uniontown Bypass, Fayette County	●				2.8	$241,000	$267,778	$95,635	$95,635			
Tennessee	TN DOT			●		214.0	$1,500,000	$1,666,667	$7,788			$7,788	
Pennsylvania	6008-A09, Rt 8 So. Brakleyville Venango Co.	●				2.5	$135,000	$150,000	$60,000	$60,000			
Pennsylvania	2040-00D, Meadville, Spring St. Ext., Crawford Co.	●				5.0	$400,000	$444,444	$88,889	$88,889			

Georgia DOT Study: Wetland Size and Cost Information of Projects nation-wide

State	Project Name	Creation	Restoration	Enhancement	Preservation	No. of Acres Mitigated	Total Costs (original costs, unadjusted for inflation)	Total Costs (original costs, adjusted to 1997 prices) (*)	Total Costs/acre (all project; 1997 prices)	Total Costs/acre (Creation; 1997 prices)	Total Costs/acre (Restoration; 1997 prices)	Total Costs/acre (Enhancement/ Preservation; 1997 prices)	Total Costs/acre (Combination [or n/a]; 1997 prices)
Pennsylvania	1126-C05, Rt. 17, Erie Co.	●				12.5	$430,000	$477,778	$38,222	$38,222			
Pennsylvania	Mowhair Co., 47015-004, PP and L	●				3.6	$5,500	$6,111	$1,688	$1,688			
Pennsylvania	Licoming Co. 3032-A11, Beauty's Run	●				3.9	$246,210	$273,567	$70,145	$70,145			
Virginia	0003-111-102-C504; VGP-91-0925-15(6)	●				4.0	$240,788	$267,542	$66,719	$66,719			
Virginia	0095-029-114-PE103; VGP-91-4036(9)	●				2.5	$27,772	$30,858	$12,544	$12,544			
Virginia	0637-020-221-C501-B663; VGP-92-4010(	●				3.0	$30,300	$33,667	$11,075	$11,075			
Virginia	6017-016-111-D610; VGP-90-4021(6)	●				3.1	$113,721	$126,357	$40,241	$40,241			
Virginia	6058-087-E03 (Franklin Bypass); VGP-90-4067(5)	●				27.8	$430,482	$478,313	$17,212	$17,212			
Virginia	Courtland Bypass, 60658-087-E04; COE-90-1683-15(5)	●				12.2	$187,764	$208,627	$17,087	$17,087			
Virginia	6360-066-103-PE106-C510; VGP-91-401	●				1.8	$289,120	$321,244	$183,568	$183,568			
Virginia	6058-040-E05, PE102, C503; VGP-91-4058(5)	●				9.0	$733,914	$815,460	$90,607	$90,607			
Washington	SR 16 Mullenix Interchange			●		1.0	$15,000	$16,667	$16,667			$16,667	
Washington	SR 16 Mullenix Interchange	●				1.6	$290,000	$322,222	$201,389	$201,389			
Washington	SR 2 Snohomish River to Cavalero Corner				●	10.0	$70,000	$77,778	$7,778			$7,778	
Washington	SR 2 Snohomish River to Cavalero Corner			●		15.0	$1,100,000	$1,222,222	$81,481			$81,481	
Washington	SR 527 208th to 164th	●				5.1	$1,755,000	$1,950,000	$382,353	$382,353			
W. Virginia	Corridor H Lorente to Sand Run				●	1.0	$5,000	$5,556	$5,556			$5,556	
W. Virginia	Corridor H Lorente to Sand Run - Cont.			●		2.0	$5,000	$5,556	$2,778			$2,778	
W. Virginia	Corridor H Lorente to Sand Run - Cont.	●				13.0	$1,075,000	$1,194,444	$91,880	$91,880			
W. Virginia	Corridor H Sand Run to Elkins				●	5.0	$10,000	$11,111	$2,222			$2,222	
W. Virginia	Corridor H Sand Run to Elkins - Cont.	●				30.0	$1,200,000	$1,333,333	$44,444	$44,444			
Wyoming	0401(19) Baggs-Encampment Baggs Section, Carbon County	●				5.0	$32,000	$35,556	$7,111	$7,111			
Wyoming	Bear River Information center	●				2.0	$8,000	$8,889	$4,444	$4,444			
Wyoming	4875(2) Evanston Streets, Washington Ave., Uinta County			●		3.3	$22,000	$24,444	$7,430			$7,430	
Wyoming	0302(33) Sheridan-Gillette Ucross West Section, Sheridan County			●		3.5	$19,187	$21,319	$6,091			$6,091	
STATISTICS (1993 and 1995 Surveys combined)													
	Count					289.0		289	289	165	8	75	38
	Mean					**68.6**		**$591,616**	**$46,224**	**$64,527**	**$87,611**	**$15,025**	
	Median					6.7		$80,000	$8,333	$20,000	$35,022	$2,393	
	Minimum					1.0		$79	$17	$69	$6,335	$17	
	Maximum					5,000		$39,198,081	$911,583	$911,583	$398,860	$115,737	

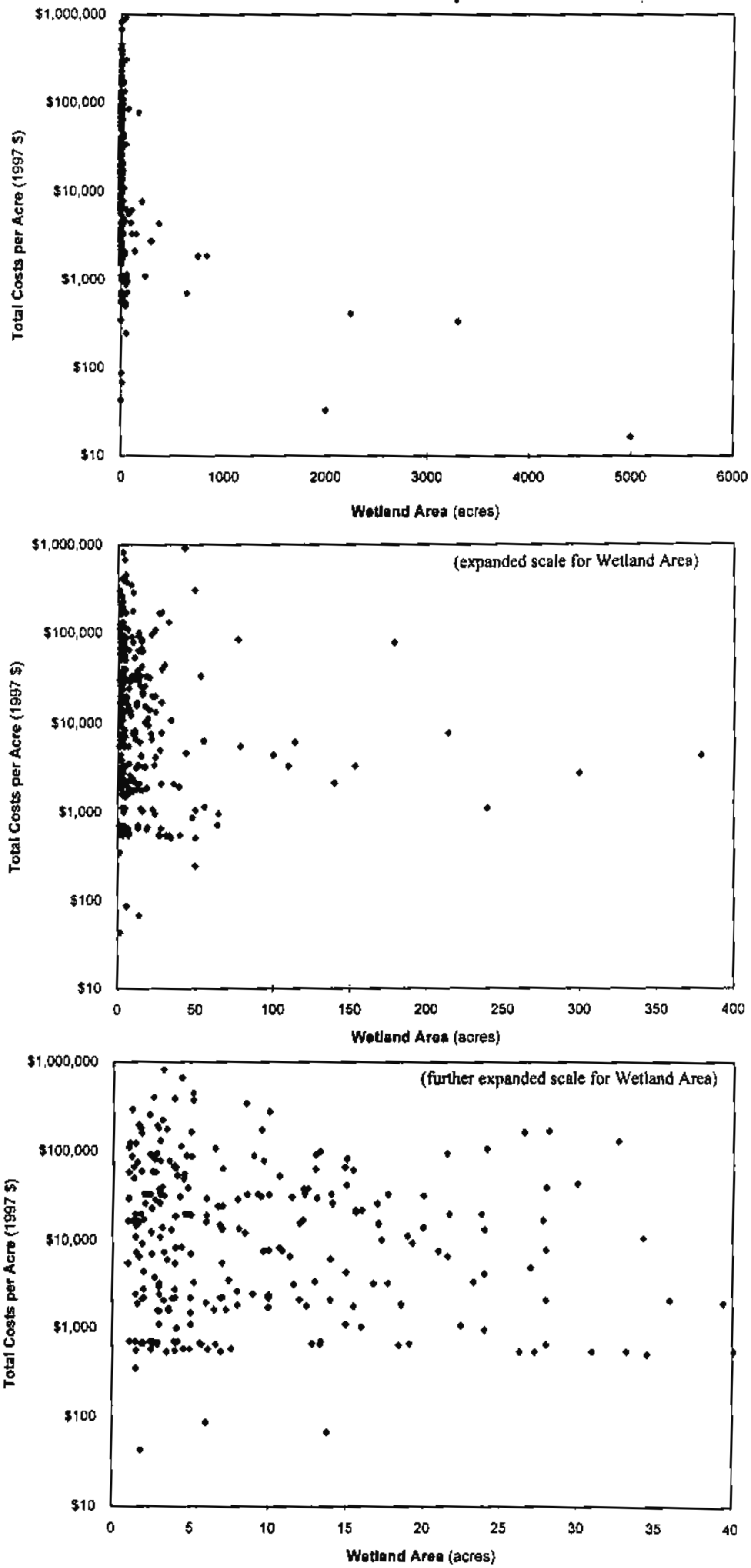
(*) The original prices were adjusted to 1997 prices using the consumer price index. Since information of the year of construction of the individual projects was not readily available, all prices were adjusted for the years of the two questionnaires, i.e., 1995 and 1993, respectively. This adjustment is considered sufficient for this level of analysis, which was designed to merely provide rough estimates of the ranges of costs associated with wetland projects in other parts of the country.



Wetland Creation, Restoration, Enhancement & Preservation - Georgia DOT Study
Total Costs
Total Costs (1997 $)
$100,000,000
$10,000,000
$1,000,000
$100,000
$10,000
$1,000
$100
$10
0
1000
2000
3000
4000
5000
6000
Wetland Area (acres)
(expanded scale for Wetland Area)
Total Costs (1997 $)
0
50
100
150
200
250
300
350
400
Wetland Area (acres)
(further expanded scale for Wetland Area)
Total Costs (1997 $)
0
5
10
15
20
25
30
35
40
Wetland Area (acres)

Wetland Creation, Restoration, Enhancement & Preservation - Georgia DOT Study

Total Cost per Acre



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