APPENDIX 1
HYDROLOGIC AND HYDRAULIC APPENDIX

TOWN POND RESTORATION STUDY
PORTSMOUTH, RHODE ISLAND
WATER MANAGEMENT SECTION APPENDIX

PREPARED BY

WATER MANAGEMENT SECTION
ENGINEERING DIVISION

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
CONCORD, MASSACHUSETTS 01742

JUNE 2001

TOWN POND RESTORATION STUDY
PORTSMOUTH, RHODE ISLAND

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TOWN POND RESTORATION STUDY
PORTSMOUTH, RHODE ISLAND

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TOWN POND RESTORATION STUDY
PORTSMOUTH, RHODE ISLAND

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TOWN POND RESTORATION STUDY
PORTSMOUTH, RHODE ISLAND

1. PROJECT OVERVIEW

The Town Pond area is located in Portsmouth, Rhode Island on the south side of Mount Hope Bay. Currently, tidal flow during non-storm events only extends approximately 300 feet from Mount Hope Bay up to a railroad bridge within the marsh. The area upstream of the railroad bridge, known as Town Pond, was filled with dredged material from Fall River Harbor in 1950 and 1951. This area now has elevations ranging from 3.3 to 9.8 ft NGVD. The proposed restoration includes channel excavation and regrading of the marsh surface to reintroduce tidal flow upstream of the railroad bridge.

The purpose of this appendix was to determine optimum channel configurations to allow tidal exchange to the area south of the railroad to restore as much of the marsh as possible. This was accomplished using a one-dimensional hydrodynamic computer model. The hydraulic analysis examined four restoration alternatives; no-action, graded main and feeder channel, open water with salt marsh fringe and open water and channel hybrid.

2. BACKGROUND

The majority of the Town Pond site is located on the south side of a railroad embankment, which runs along the shore of Mount Hope Bay, approximately 0.6 miles east of Mount Hope Bridge. A small area of salt marsh currently exists north of the railroad embankment. See Plate 1 for location map.

Prior to 1950, the Town Pond area extended up to Anthony Road. Dredged material from Fall River Harbor was placed south of the railroad embankment in 1950-1951,destroying over 40 acres of salt pond. Tidal exchange currently reaches just south of the railroad embankment. Upstream of this area is overgrown with common reed (*Phragmites australis*) and shrubs.

The proposed restoration of Town Pond includes excavation of new channels from Mount Hope Bay through the southern end of the marsh and regrading the surrounding area.

3. SITE HYDROLOGY

a. Tidal Regime. In the study area, tides are semi-diurnal, with two high and low waters occurring during each lunar day (approximately 24 hours and 50 minutes). The resulting astronomic tide range varies constantly in response to relative positions of the earth, moon, and sun, with the moon having the primary tide producing effect. Maximum tide ranges occur when orbital cycles of these bodies are in phase. A complete sequence of astronomic tide ranges is approximately repeated over an interval of 19 years, known as a tidal epoch. Coastal storms and hurricanes can cause tides to be much higher than astronomically predicted.

Tidal flood profiles, developed by the Corps for the open ocean along the New England coastline were used to estimate tidal flood frequencies at Town Pond (see Plates 2 and 3). A summary of estimated tidal datums at the subject site is shown in Table 1.

b. Freshwater Drainage Area. Based on 1:25,000 U.S. Geological Survey (USGS) quadrangle sheets (revised 1985), and recent survey information, the total drainage area of the watershed was approximated as 0.8 square miles.

4. CLIMATOLOGY

a. General. The Portsmouth, Rhode Island area has a temperate climate. In the winter, coastal storms frequently bring rainfall instead of snow due to the moderating influence of the Atlantic Ocean. Prevailing winds are northwesterly in winter and southwesterly in summer.

b. Temperature and Precipitation. Climatological records, approximately 10 miles southwest of Portsmouth, at the Newport, RI, U.S. Weather Bureau gage, dating back to 1957, are available. These records are considered representative of the area. Average annual temperature based on these gage readings is 50.8 degrees Fahrenheit. Average annual precipitation at Newport is 44.5 inches. Average precipitation, temperature and snowfall values recorded at Newport are listed in Table 2.

5. FLOODING IMPACTS

The Town Pond site is bound on the west by a freshwater stream (Founders Brook) and a golf course. Founders Brook, which originates upstream of Boyds Lane, runs under Boyds Lane into a pond, through a 6 ft culvert under Anthony Road and then

continues along the marsh and golf course. It goes through two

TABLE 1
ESTIMATED TIDAL LEVELS AT TOWN POND

(Estimated from Corps of Engineers Tidal Flood Profiles, New England Coastline, dated September 1988)

	Tide Level (ft NGVD)
100-year Frequency Flood Event	13.5
50-year Frequency Flood Event	11.5
10-year Frequency Flood Event	7.5
Maximum Predicted Astronomical High Water	4.6
Mean High Water Spring (MHWS)	3.1
Mean High Water (MHW)	2.6
Mean Tide Level (MTL)	0.7
National Geodetic Vertical Datum (NVGD)	0.0
Mean Low Water (MLW)	-1.3
Mean Lower Low Water (MLLW)	-1.6

culverts which parallel the railroad embankment (both 40 inch diameter) and exits into the channel just south of the railroad opening. The upstream culvert has a broken flapgate and allows some salt water up into Founders Brook. One of the constraints of re-introducing tidal exchange to the marsh was to not impact Founders Brook with additional salt water. This can be accomplished with a new flap gate. A permanent berm will be designed on the western marsh border. A 5-ft high berm, constructed on an existing grade of approximately 4.25 ft NGVD will prevent a 25-year tidal flood from entering Founders Brook. This berm will also cut off tidal flow to the culvert under Anthony Road, protecting the ponds upstream of Anthony Road. There is currently a vegetated berm along Founders Brook which local residents would prefer remain undisturbed. There is also a golf course located on the east side of the proposed marsh which uses freshwater ponds for irrigation. Elevations of the ponds are not currently available but need to be determined to estimate flooding impacts.

TABLE 2

MONTHLY CLIMATOLOGIC DATA
NEWPORT, RI
(Period of Record - 1957 -1997)

Month	Precipitation Average Mean (in)	Temperature Maximum (°f)	Temperature Average (°f)	Temperature Minimum (°f)	Snowfall Mean (in)
January	3.7	37.6	30.6	22.9	7.3
February	3.5	37.9	31.4	23.2	7.2
March	4.4	43.5	38.0	32.6	3.1
April	4.2	50.7	46.7	42.7	0.6
May	3.6	59.1	55.8	49.5	0.0
June	2.9	68.2	64.7	61.5	0.0
July	2.9	73.3	70.8	67.9	0.0
August	3.5	74.8	70.5	65.4	0.0
September	3.8	70.0	64.3	60.0	0.0
October	3.3	60.3	55.0	51.5	0.0
November	4.6	50.7	45.6	41.5	0.45
December	4.5	41.4	35.2	24.3	3.0
Annual	44.5	53.6	50.8	48.9	22.5

6. HYDRAULIC ANALYSIS

a. General. Town Pond is currently connected to Mount Hope Bay by a small channel that runs upstream from Mount Hope Bay through the railroad opening. During non-storm tides, high ground elevations due to dredged material disposal prevent salt water from extending into Town Pond upstream of the railroad. The channel from Mount Hope Bay to the railroad opening varies in width and has inverts ranging from -0.7 ft NGVD at the mouth to 0.7 ft NGVD at the railroad. Inverts between these two points are as high as 2 ft NGVD. The railroad opening itself is 29.5 ft in width. Limited surveys upstream of the opening show ground elevations ranging from 3.6 to 9.8 ft NGVD. There are two culverts (both 40 inch diameter) just upstream of the railroad which drain Founders Brook. There is also a 6 ft culvert at the upstream end of the marsh under Anthony Road.

All flood elevations and other site characteristics are based on existing mapping (10-foot quadrangle sheets) and topographic surveys performed by NAE in 1998.

The objective of the tidal analysis was to evaluate channel configurations to obtain desired water elevations and proper drainage for the alternatives evaluated.

b. Selection of Computer Model. The hydraulic analysis of Town Pond was performed using a one-dimensional hydrodynamic model, UNET, the latest most advanced model readily available, which would provide reasonably accurate results. UNET also has the capability to accurately model culverts using the Federal Highway Administration nomographs for determining hydraulic capacities of culverts. This model became available for Corps use through its Hydrologic Engineering Center in September 1992, and was updated in March 1993 and September 1995.

UNET can simulate one-dimensional unsteady flow through a full network of open channels. Stages are a function of channel geometry, and downstream backwater effects. UNET provides the user with the ability to apply flow and stage hydrographs, bridges, spillways, levee systems, and culverts. Cross sections are input in a modified HEC-2 forewater format. UNET has been successfully used by New England District in several wetland restorations studies, including Leetes Island, Guilford, Connecticut, Galilee, Rhode Island, and Sagamore, Massachusetts.

Input needed to set up and run the UNET model includes topographic information and tide data.

(1) Topographic Surveys. Detailed surveying of the marsh was completed during 1998 by NAE to provide information on the marsh topography. From the mouth of the river to the railroad centerline, inverts and three transects were surveyed. Upstream of the railroad three transects were taken across the marsh. Surveys performed at the bridge and culverts obtained inverts and respective sizes. Transect locations are shown on Plate 4.

(2) Tide Data. Tidal ranges for various events (mean, astronomic, and spring high tide) were estimated from tidal datum planes at Town Pond (see Table 1). A tide range occurring approximately eight times per month was also developed and used for marsh restoration analyses.

c. Results

(1) Existing Conditions. Existing conditions were evaluated to determine whether the channel from Mount Hope Bay to the railroad opening needed to be modified. UNET modeling indicates that the channel does not significantly restrict high tides. Under existing conditions, high astronomic tides (4.6 ft NGVD in Mount Hope Bay) are reduced less than .3 ft from the mouth to the railroad opening. The problem with the existing channel is that it does not drain properly due to elevated inverts (2.0 NGVD). In order to drain the proposed marsh system upstream of the railroad, the channel downstream needs modification.

(2) Alternatives Evaluated. Environmental Resource Section proposed several detailed restoration alternatives. Refer to the main report, Section III.1, and the Environmental Assessment (EA), Section IV, for a detailed description of the proposed alternatives.

The hydraulic analysis conducted for this study examined four alternatives to determine optimum channel configurations to allow tidal exchange to the area south of the railroad to restore as much of the marsh as possible. These alternatives include; 1) no action, 2)graded main and feeder channels, 3) open water with salt marsh fringe, and 4) open water and channel hybrid.

Several inverts were evaluated for the graded main and feeder channel alternative; two are presented in detail here. The first was based on the assumption that the invert at the mouth of the channel would match the invert in Mount Hope Bay just downstream of the mouth (-2.7 ft NGVD). Sloping at

approximately 0.001 foot/foot, the inverts at the railroad and the upper end of the marsh were set at -2 and -0.7 ft NGVD, respectively. The second assumed that the invert at the mouth of the channel would be -2 ft NGVD, sloping to -1.3 and 0.0 ft NGVD at the railroad and upper end, respectively. Alternatives were simulated in UNET with a tide range occurring approximately eight times per month. The results of this analysis are shown on plate 5. As can be seen, height of the water surface at high tide essentially does not vary between the different inverts. The lower invert alternative lowers the low tide elevation in the marsh by less than 0.3 ft. The higher invert elevation was selected as the preliminary design condition.

After establishing the inverts, several channel bottom widths were evaluated to design one that would meet requirements for marsh restoration. Based on information provided by Environmental Resource Section, the predicted range of salt marsh cordgrass is 0.5 to 2.95 ft NGVD. Below 0.3 ft NGVD there would be permanent open water and the highest elevation that will support high marsh without Phragmites is 3 ft NGVD. The estimated frequency of flooding required to support marsh vegetation is approximately eight times per month (high tide of 3.3 ft NGVD in Mount Hope Bay). Based on these numbers, the elevation of the outer edges was put into UNET as 2.9 ft NGVD with the marsh sloping towards the channel at 1 percent to approximately 0.5 ft NGVD at the channel banks. Feeder channels at smaller widths were included in the model.

The channel width alternatives, shown in Plate 6, were simulated using a tide range occurring approximately eight times per month. Predicted high tides are shown in the middle of the proposed marsh. As can be seen, the estimated high tide of 3.3 ft NGVD in Mount Hope Bay produced high water levels ranging from 2 to 2.85 ft NGVD for channel bottom widths ranging from 2 to 6.6 ft. At this point a 5 ft bottom width main channel was selected because it provided the desired marsh regime. Feeder channels with a 3.3 ft bottom width were included in the design.

Analyses were run on the selected channel configuration for various tide ranges assuming minimal rainfall. With the proposed configuration, freshwater flows from rainfall events will be confined in Founders Brook. The only freshwater in the marsh will be from direct rainfall. The maximum tide range evaluated was the 100-year storm. Results of the UNET analyses for the proposed channels are shown in Table 3. Water surface elevations at high tide are presented at three locations; just upstream of the railroad, in the middle of the marsh, and at the upper end of the marsh.

A berm is proposed for the western marsh border to protect Founder's Brook from additional saltwater intrusion. Based on the 1998 transect survey, the existing grade elevation in the area of the proposed berm is approximately 4.25 ft NGVD. Therefore, a 5.0 ft high berm will have a crest elevation of approximately 9.25 ft NGVD. A berm with a crest elevation of 9.25 ft NGVD will protect founders brook from salt water intrusion during storm events of approximately 25-yr and less. In order to protect Founders Brook from additional saltwater intrusion during a 100-year tidal storm, the a minimum top elevation of 13.5 ft NGVD is required. The proposed berm will also cut off tidal flow under Anthony Road. The ponds used for irrigation to the east of the proposed marsh need to be surveyed to determine if they will be impacted.

In order to avoid inundation during high tide, the minimum access road elevation should be should be approximately 4.6 ft NGVD, or a minimum 1-foot higher than the astronomical tide elevation for the middle of the proposed marsh (see Table 3).

The second alternative evaluated was open water with salt marsh fringe. For this alternative the outer edges of the marsh would be excavated to elevation 2.9 ft NGVD and slope toward a tidal creek for a width of 16.4 ft. From that point the slope would change to 1:10 for 23 ft. The remainder of the marsh would slope to the centerline invert at a constant slope based on distance. The main channel from the mouth of the river would slope from -2.0 to -1.3 ft at the railroad.

Two centerline invert and weir scenarios were considered to maintain a pond upstream of the railroad. The first would have a centerline invert sloping from -1.3 ft at the railroad to 0.0 ft at the upstream end. A weir with a top elevation of -.2 ft would maintain open water depths at low tide between -1.1 and 0 ft. The second would have a centerline invert sloping from -1.0 at the railroad to -0.6 at the upstream end. A weir with a top elevation of -0.06 would allow open water depths at low tide between 3.0 and 1.8 ft. Although additional excavation would be required for the deeper pond, the quality of the habitat would likely be better. High tide elevations would be similar to those presented in Table 3 for the salt marsh alternative.

The third alternative considered for Town Pond would be a combination of the first two alternatives and would create 50% salt marsh and 50% open water. The existing dredged material would be excavated to elevation 2.9 ft along the inland edge of the project area and slope at 1 percent toward the interior of the marsh for a width of 16.4 ft. From 16.4 ft out, the slope

would change to 1:10 for 10 meters of width for most of the perimeter. Areas of wider salt marsh would slope from elevation 2.7 ft to the edge shown at variable slopes between 1 to 10 percent. The remainder of the site would slope to the centerline invert at a constant slope (based on distance). The main channel would have an invert sloping from -2.0 ft at Mount Hope Bay to -1.3 m at the railroad bridge. The centerline invert of the restored pond upstream of the railroad bridge would slope from -3.3 ft at the bridge to -2.0 ft at the upstream end. A weir with a top elevation of -0.2 ft would maintain open water depths at low tide between 3.1 to 1.8 ft deep with a median depth at the halfway point of 2.42 ft. High tide elevations would be similar to those presented in Table 3 for the salt marsh alternative.

TABLE 3
SALT MARSH ALTERNATIVE; WATER SURFACE ELEVATION AT HIGH TIDE **
(NGVD)

TIDAL EVENT	OCEAN LEVEL ft	IMMEDIATELY UPSTREAM OF RAILROAD ft	MIDDLE OF PROPOSED MARSH ft	UPPER END OF PROPOSED MARSH ft
MEAN TIDE	2.6	2.6	2.6	2.55
SPRING TIDE	3.1	2.8	2.8	2.75
ASTRON TIDE	4.6	3.9	3.6	3.6
10-YEAR	7.5	7.2	6.9	6.9
50-YEAR STORM	11.5	10.8	10.5	10.5
100-YEAR STORM	13.5	12.8	12.5	12.5

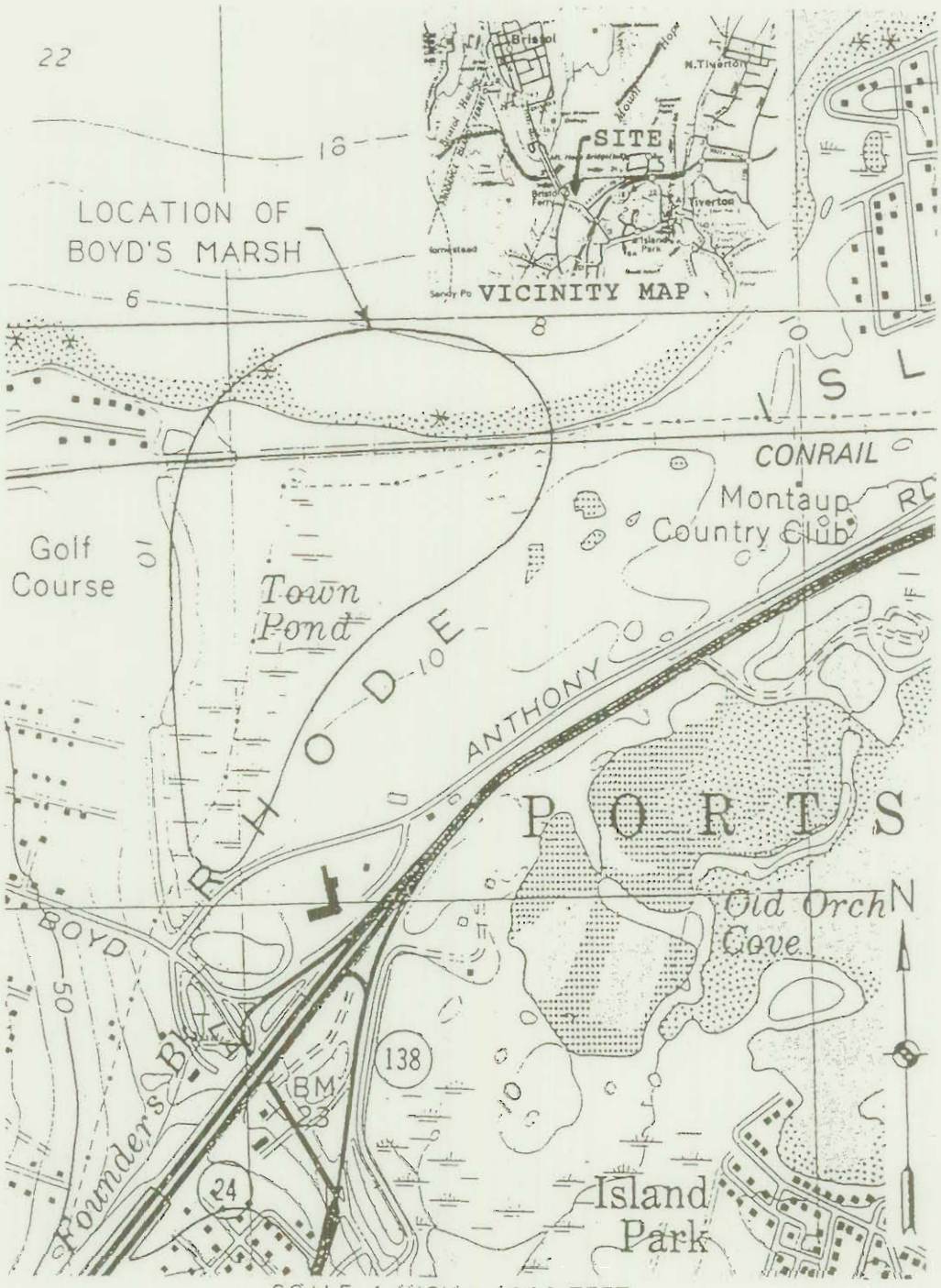
** Assuming no significant coincident rainfall

(3) Velocity changes and Impacts on the Railroad Bridge.

The proposed salt marsh alternatives will increase velocities under the railroad bridge. Under existing conditions, velocities under the bridge range from 0.1 to 0.3 fps during non-storm tides. With the proposed marsh alternatives, velocities will increase to approximately 0.3 to 0.6 fps. During storm tide conditions, velocities could rise about 1 fps. If it is determined that riprap is need to protect the railroad, a minimum D30 of 0.5 feet would be required.

7. SUMMARY

This report provides the hydrologic and hydraulic assessment of existing and proposed conditions in the marsh. Using the Corps one-dimensional hydrodynamic model "UNET", this analysis evaluates alternatives for re-introducing tidal flow into the former Town Pond Area. For the salt marsh with graded main and feeder channel alternative, a 5 ft bottom width main channel is recommended. The channel would have an invert at Mount Hope Bay at -2 ft NGVD, sloping to -1.3 ft NGVD at the railroad bridge and 0.0 ft NGVD at the upper end of the proposed marsh. 3.3 ft bottom width feeder channels would branch off of the main channel. This configuration will allow the desired tidal regime for marsh restoration. For the open water with salt marsh fringe alternative, there will be a 5 ft bottom width channel from Mount Hope Bay to the railroad bridge, sloping from -2 to -1.3 ft NGVD. The invert of the pond will range from either -3.3 to -2 ft NGVD or -1.3 to 0.0 ft NGVD) depending on the incremental analysis performed by Environmental Resource Section. Both scenarios have a weir to maintain depths upstream of the railroad. The last alternative evaluated was a combination of salt marsh and open water.



DEPARTMENT OF THE ARMY NEW ENGLAND DIVISION CORPS OF ENGINEERS WALTHAM, MA	SECTION 1135 PORTSMOUTH, RI **BOYD'S MARSH RESTORATION** LOCATION MAP	1/3

PLATE 1

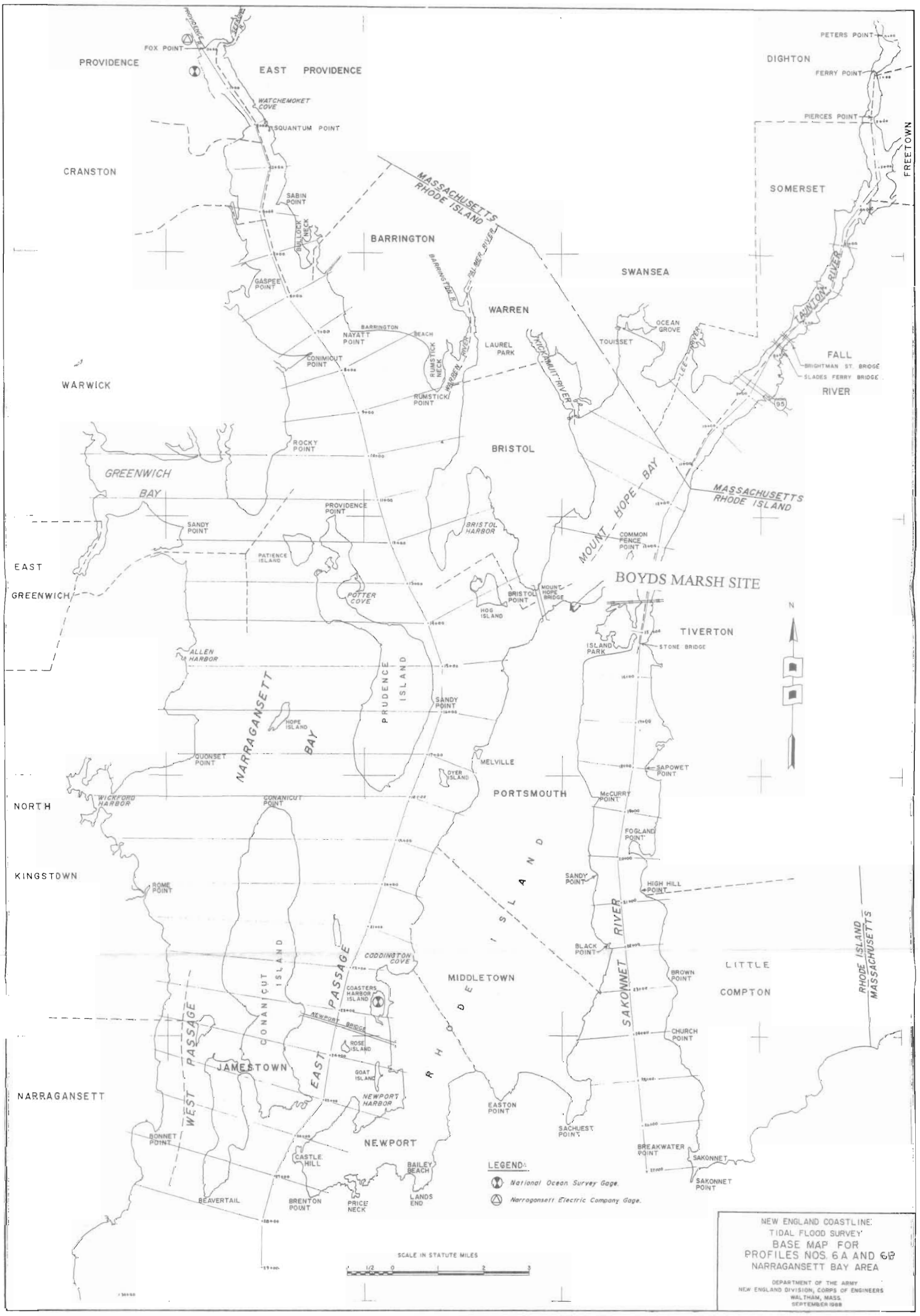
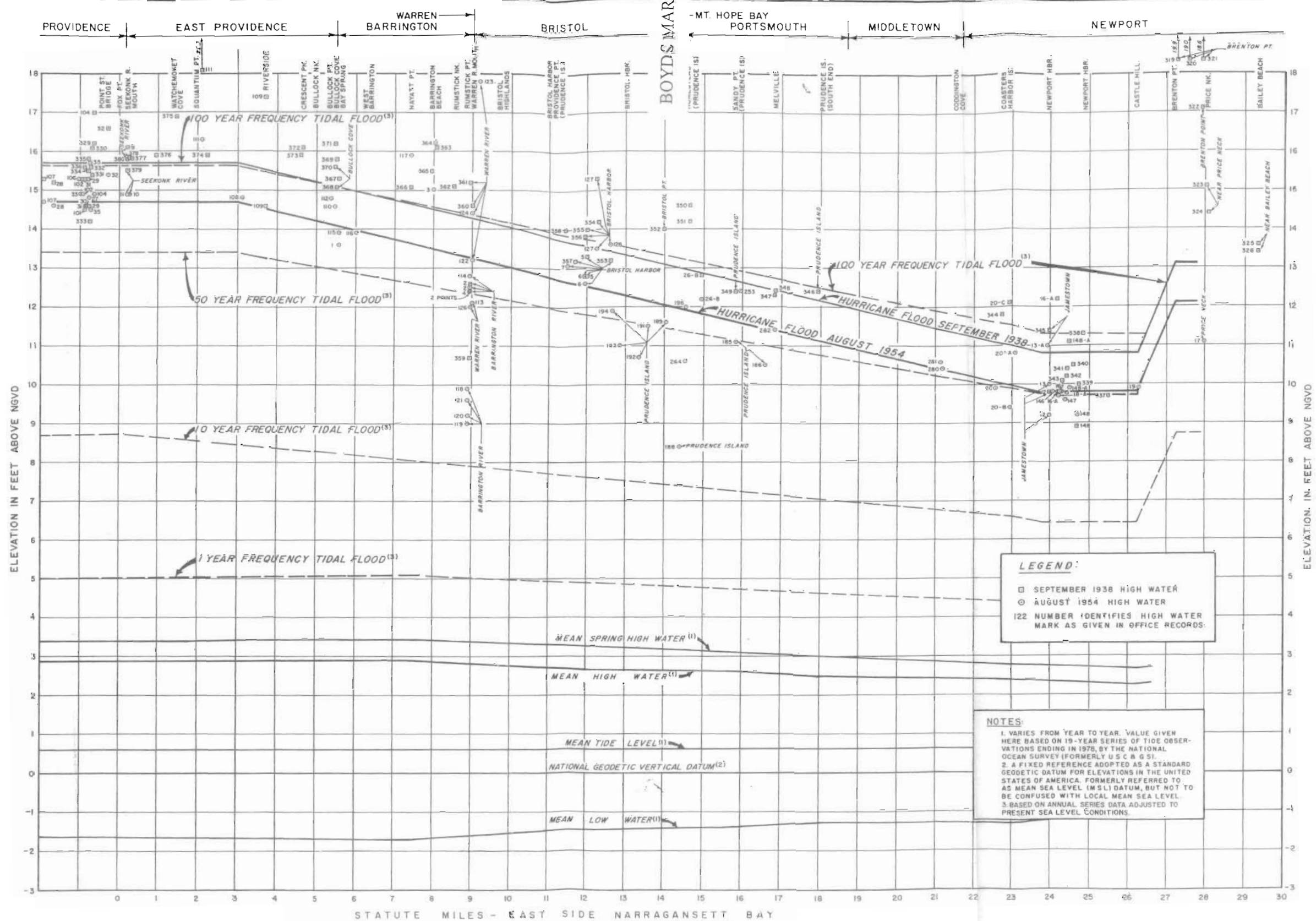

PROVIDENCE
EAST PROVIDENCE
FOX POINT
WATCHEMOKET COVE
SQUANTUM POINT
CRANSTON
SABIN POINT
BULLOCK NECK
GASPEE POINT
BARRINGTON
BARRINGTON BEACH
NAYATT POINT
CONIMICUT POINT
RUMSTICK NECK
RUMSTICK POINT
WARREN
LAUREL PARK
MASSACHUSETTS
RHODE ISLAND
SWANSEA
OCEAN GROVE
TOUISSET
DIGHTON
PETERS POINT
FERRY POINT
PIERCES POINT
FREETOWN
SOMERSET
TAUNTON RIVER
FALL RIVER
BRIGHTMAN ST. BRIDGE
SLADES FERRY BRIDGE
WARWICK
ROCKY POINT
BRISTOL
GREENWICH BAY
PROVIDENCE POINT
SANDY POINT
BRISTOL HARBOR
MOUNT HOPE BAY
COMMON FENCE POINT
EAST GREENWICH
PATIENCE ISLAND
POTTER COVE
BRISTOL POINT
MOUNT HOPE BRIDGE
HOG ISLAND
BOYDS MARSH SITE
TIVERTON
ISLAND PARK
STONE BRIDGE
ALLEN HARBOR
NARRAGANSETT BAY
PRUDENCE ISLAND
HOPE ISLAND
QUONSET POINT
MELVILLE
DYER ISLAND
SAPOWET POINT
NORTH KINGSTOWN
WICKFORD HARBOR
CONANICUT POINT
PORTSMOUTH
McCURRY POINT
FOGLAND POINT
ROME POINT
SANDY POINT
HIGH HILL POINT
RHODE ISLAND
BLACK POINT
CODDINGTON COVE
MIDDLETOWN
BROWN POINT
LITTLE COMPTON
RHODE ISLAND
MASSACHUSETTS
CONANICUT ISLAND
EAST PASSAGE
COASTERS HARBOR ISLAND
NEWPORT BRIDGE
SAKONNET RIVER
CHURCH POINT
WEST PASSAGE
JAMESTOWN
ROSE ISLAND
GOAT ISLAND
NARRAGANSETT
NEWPORT HARBOR
EASTON POINT
SACHUEST POINT
BONNET POINT
NEWPORT
BREAKWATER POINT
SAKONNET
CASTLE HILL
BAILEY BEACH
SAKONNET POINT
BEAVERTAIL
BRENTON POINT
PRICE NECK
LANDS END
LEGEND:
National Ocean Survey Gage.
Narragansett Electric Company Gage.
SCALE IN STATUTE MILES
1/2 0 1 2 3
N
NEW ENGLAND COASTLINE:
TIDAL FLOOD SURVEY
BASE MAP FOR
PROFILES NOS. 6A AND 6B
NARRAGANSETT BAY AREA
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SEPTEMBER 1988

PLATE 2

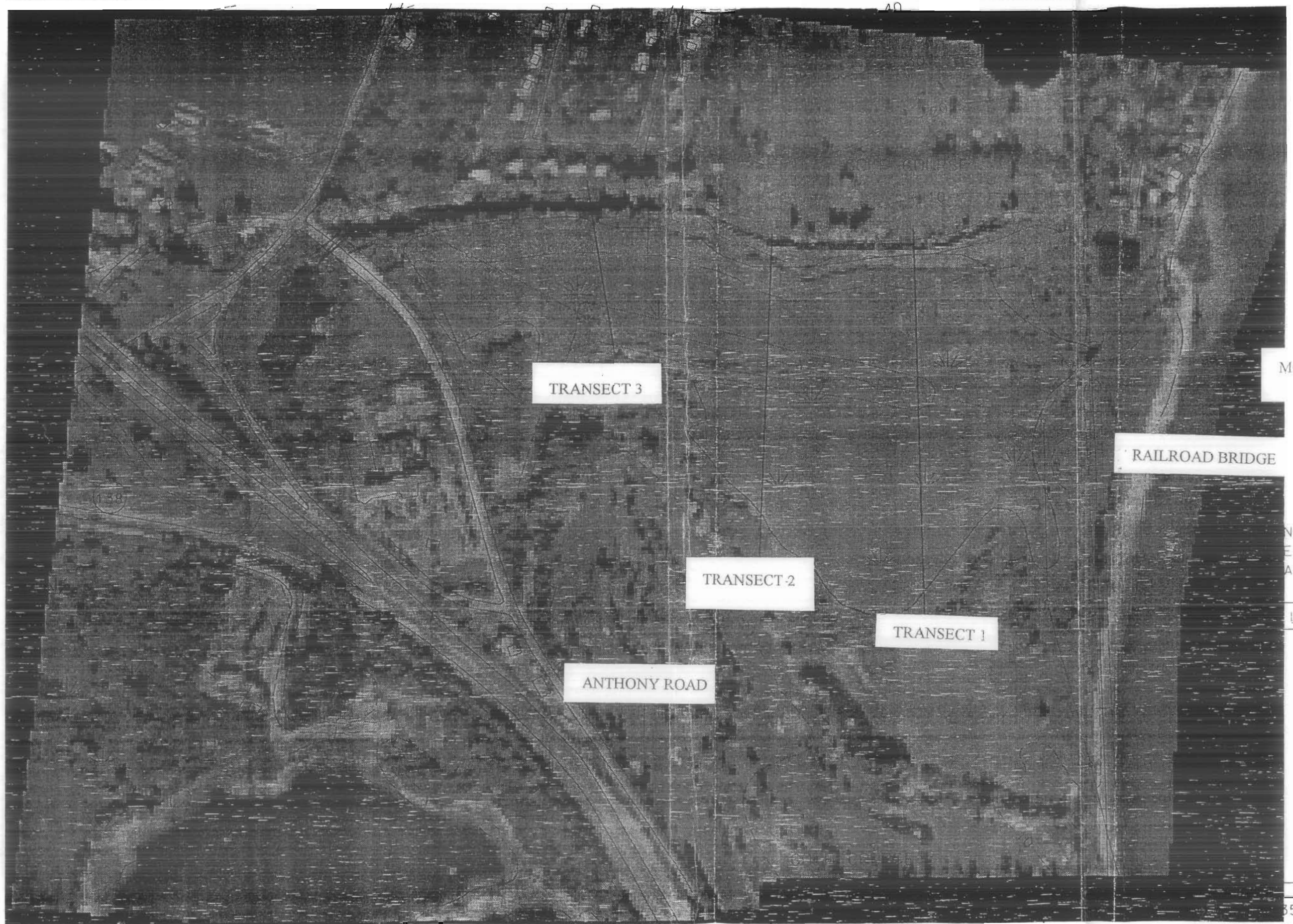


NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY

TIDAL FLOOD PROFILE NO. 6A

EAST SHORE OF NARRAGANSETT BAY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.
SEPTEMBER 1980



NG CONDITIONS
ED FROM USGS
APHIC MAP.

LEGEND
EDGE OF WATER
WETLANDS
PAVED ROAD
UNPAVED ROAD
RAILROAD TRACK
CONTOUR
BUILDING
OVERHEAD ELECTRIC LINE

SCALE: 1" = 300' 300' 150' 0 300' 600'

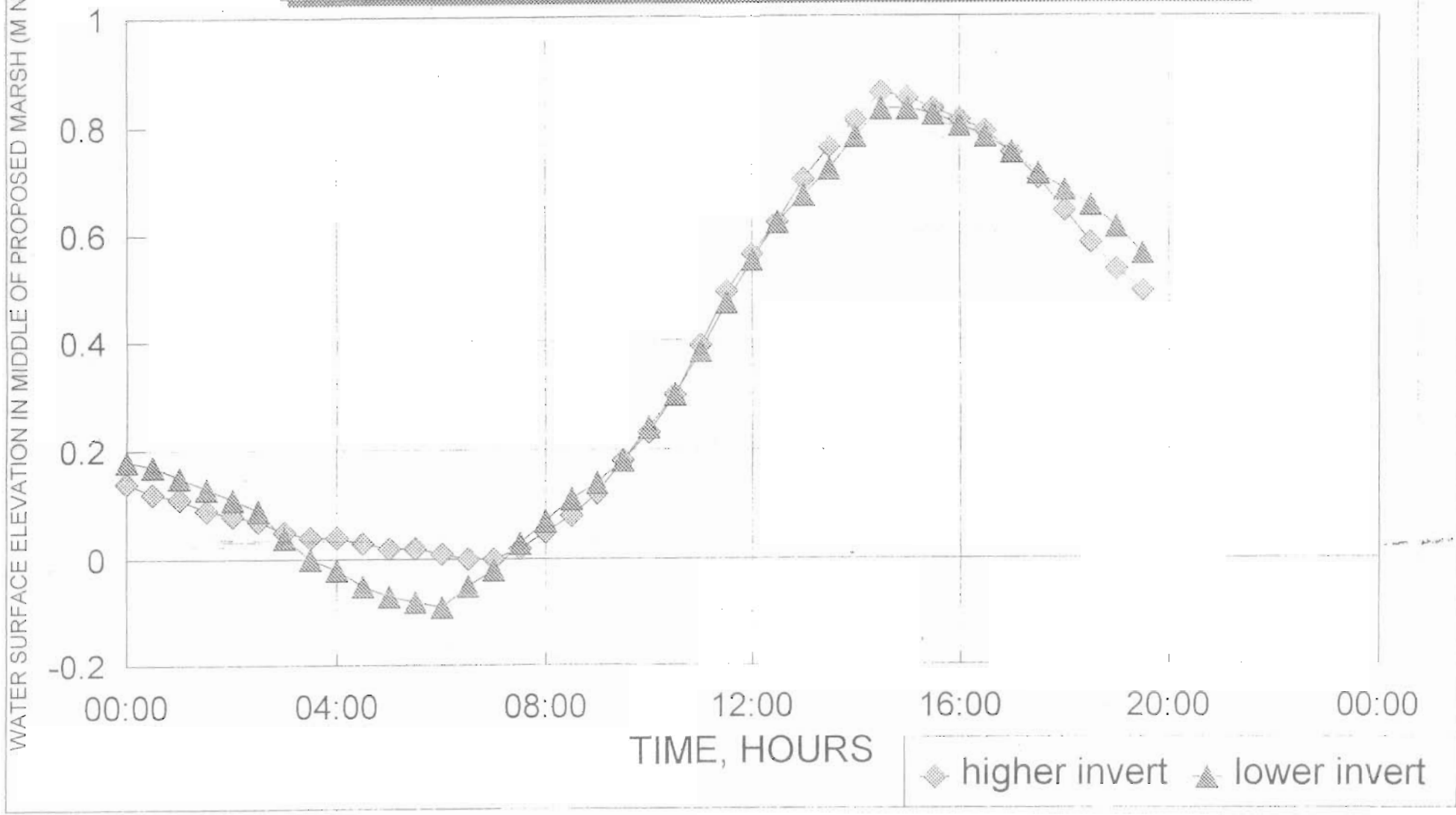
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MA

PORTSMOUTH, RI
BOYD'S MARSH RESTORATION

PLATE 4

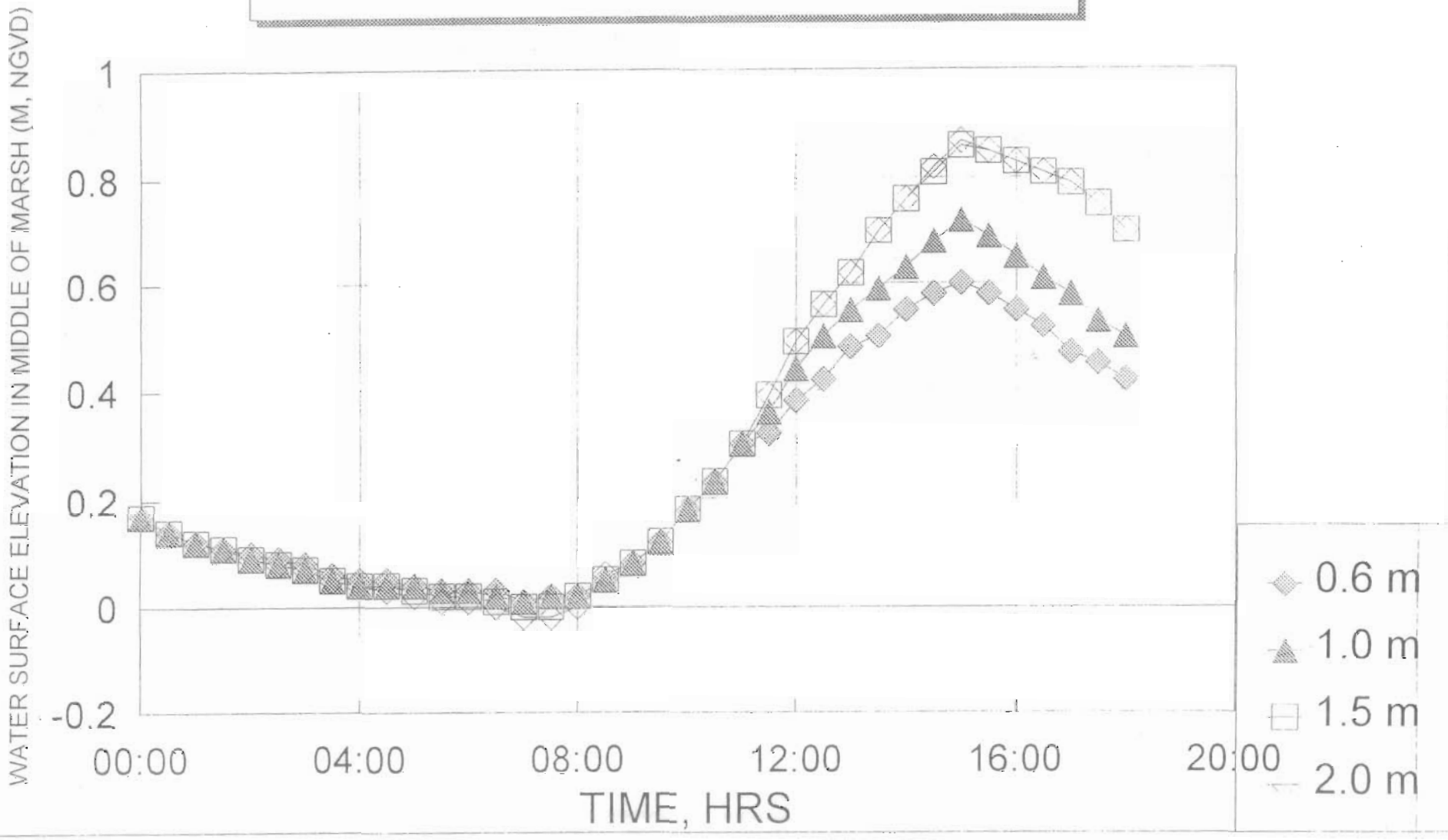
BOYDS MARSH

INVERT ANALYSIS



BOYDS MARSH

CHANNEL BOTTOM WIDTH ANALYSIS



APPENDIX 2
GEOTECHNICAL APPENDIX

TOWN POND SALT MARSH RESTORATION

GEOTECHNICAL APPENDIX

MAY 2001

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1 SITE LOCATION

2 SAMPLING LOCATION PLAN

3 SITE PLAN

4 CROSS SECTION

CALCULATIONS

SETTLEMENT OF FOUNDAITON MATERIALS

BEARING CAPACITY

SALT WATER INTRUSION REFERENCE

I. GENERAL

A geotechnical study was performed for the Feasibility Study of the Salt Marsh Restoration of Town Pond in Portsmouth, Rhode Island. The proposed project features include excavation of the in-situ dredged material in the marsh area to create salt water channels, use of the excavated material from the marsh to construct a berm along the west side (Founder's Brook), construction of a parking area for visitors, and maintenance of the access road to the utility poles. Geotechnical studies were performed to assess the nature of the materials to be excavated within the limits of the Town Pond salt marsh restoration area for use in the construction of a berm around the perimeter of the marsh. The scope of the investigation included:

a. Field Reconnaissance
b. Collection of subsurface soil samples from hand auger borings performed within the marsh.
c. Physical and chemical testing of the soil samples.
d. Review of available subsurface data.
e. Geotechnical evaluations to establish foundation and preliminary berm design.

Presently, the final alignment of the berm has not been determined (see Figure 3 for approximate location). Analyses in this report are based on assumed soil properties based on published literature and experience with similar materials as described in paragraph IV.A. below. Once the alignment and location of the berm is determined additional explorations, including sampling and testing, will be needed to prepare the final design for the plans and specifications. The additional borings will better define the actual foundation conditions and determine if there is a pervious layer of material that may affect the stability of the berm and allow salt water intrusion into the nearby fresh water sources.

II. LOCATION AND DESCRIPTION OF THE SITE

Town Pond is located on the northern tip of the town of Portsmouth, Rhode Island, adjacent to Mount Hope Bay. It is bounded on the east and west by the Montaup and Pocassett Country Clubs respectively, Anthony Road to the south, and Mount Hope Bay to the north (Figure 1). Town Pond (a.k.a. Boyd's Marsh) historically was a tidally influenced salt pond. The area was filled with material dredged from Fall River Harbor during harbor improvements conducted by USACE from 1950 – 1951. The marsh was shut off from virtually all tidal flushing and has subsequently become overgrown with common reed and shrubs. Presently, the area is being studied under Section 1135 to restore the tidal marsh. The proposed restoration of the salt marsh would include the excavation of a portion of the existing marsh for a depth of three to five feet. Disposal of the excavated material includes the proposal of construction of a berm along the western edge of the project, which would protect nearby Founder's Brook (a fresh water spring fed stream) from saltwater intrusion (Figure 3). In addition to the berm, other disposal options considered include creating an on-site disposal area and to also using the material as cap material at a local landfill. This latter option is discussed in Reference Report 6.

III. SUBSURFACE CONDITIONS

A. November 1998 Sampling Event. An initial characterization of the subsurface soil conditions was performed in November 1998. This consisted of sampling at three locations within the marsh area using a hand auger (Figure 2). Visual classification of the augered materials was done at the site, but samples were not retained for testing. The borings consisted of two-inch diameter hand augers driven to a depth of 4 to 4.5 feet. All sampling and field classification was done by USACE personnel.

B. April 1999 Sampling Event. With the results from the initial sampling, a second detailed sampling and chemical analysis was performed in April 1999. All sampling was done by USACE personnel (Figure 2). Chemical analysis was performed by Severn Trent Laboratories. Samples were taken from four locations and were retained for grain size and chemical analysis. Three of the locations were within the marsh area, the fourth location, being just north of the railroad bridge and outside the area of potential excavation, was a grab sample at the 1-foot depth. (Reference Report 6).

C. Results of Soil Testing. The subsurface explorations and soil conditions including the laboratory soil test results are described in detail in Reference Report 6. The preliminary investigation (November 1998) indicated the subsurface soil consisted of a very soft gray plastic clay with some fine to medium sands and occasional pockets of gravel below an upper stratum of about 0.5 feet of organic material. The second investigation (April 1999) primarily indicated similar subsurface conditions as described above. Sieve and hydrometer tests, to determine grain size, were performed on individual samples from each boring and indicted the material consists of clay (25%-40%), sand (13%-20%), and silt (50%-60%). The percent solids ranged from 46% to 63% indicating the water content ranged from 58% to 90%. Atterberg Limits were not measured during the testing of the samples; for preliminary design, the Liquid Limit (LL) was assumed to be less than 50, which classifies the material as an ML. The water contents of various composite samples from the augered holes ranged from 70.7% to 76.8%. At two of the sampling locations the overburden material changed from a gray silt to a black silt material with fine to coarse sand, subrounded medium gravel and shell fragments at depths of 7 and 5.5 feet. This black material is most likely the native surface material prior to the placement of the dredge material in 1951. As previously stated, all samples were taken within the limits of the proposed excavations. No geotechnical investigations were performed along the proposed alignment of the berm, parking area, or utility road.

D. US Department of Agriculture Soil Survey. The Soil Survey of Rhode Island reference indicates the soil classification in the project area as Mk-Matunuck mucky peat. This material is defined as a poorly drained soil in tidal marshes. The maps indicate this area generally consists of a very dark gray mucky peat 12 inches thick underlain by gray sand to a depth of 60 inches or more.

IV. GEOTECHNICAL ANALYSIS

A. Soil Properties. Average insitu and excavated material properties were developed based on subsurface explorations and laboratory grain-size analysis,

published literature, and experience with similar materials. The material properties are presented in the following tables.

TABLE 1	
In-situ Former Dredge Material – Foundation	Normally consolidated
Unit weight, γ	90 pcf
Water content, ω	75% - 100%
Internal friction angle, ϕ	20
Cohesion, c	0
Permeability, k	10^{-4} to 10^{-7} cm/sec
Undrained shear strength q_u	0.25 – 0.5 tsf
Modulus E_s	50 – 200 tsf
Compression Index, Cc	0.5

The in-situ material will be the foundation for the new berm and was assumed to be 7 feet thick with the groundwater 1-foot below the ground surface.

TABLE 2	
Earthen Berm	Semi-compacted excavated material
Unit weight, γ	110 pcf
Water content, ω	~ 40%
Internal friction angle, ϕ	30
Cohesion, c	0
Geometry of berm	
Top width	15 feet
Side slope	1 vertical : 3 horizontal
Height	5 feet (10 ft-NGVD)

B. Settlement. Settlement analysis was performed in accordance with the procedures outlined in "Settlement Analysis" (Ref. 4) and "Soil Mechanics" (Ref. 1). The analysis was performed for the berm geometry as outlined in Table 2 and using the soil properties assumed as shown in Tables 1 and 2. Initial settlement calculations indicate the immediate elastic settlement of the foundation soil to be 0.02 feet. The settlement due to primary consolidation was calculated to be 0.75 feet. Secondary settlements were not calculated due to the limited subsurface information. If there are underlying peat or other compressible layers in the foundation, this could increase the total settlement of the foundation. It is estimated that much of the settlement will be during the first year as the pore water pressures in the foundation materials dissipate during consolidation.

C. Bearing Capacity. Bearing capacity analysis was performed in accordance with "Bearing Capacity of Soils" (Ref. 5) and "Foundations and Earth Structures" (Ref. 2). The recommended minimum factor of safety (FS) for the foundation bearing capacity is 2.5. Using the soil properties of the foundation materials, the calculated FS is 3.3.

Therefore, the bearing capacity of the foundation is sufficient for the assumed soil conditions.

D. Slope Stability. Preliminary slope stability analyses of the berm and foundation was performed using the UTEXAS3 Slope Stability Package (Ref. 8) and in accordance with "Design and Construction of Levees" (Ref. 3). The analyses performed used the soil properties outlined in Tables 1 and 2 for the end-of-construction and high tide conditions. Circular searches were performed using the Spencer method. Rapid drawdown conditions were not analyzed due to the semi-impervious nature of the berm materials coupled with the short duration of a potentially high tide such that flood water would not be able to saturate into the embankment. Earthquake analyses were not judged to be necessary due to the fact that it is extremely unlikely that an earthquake would occur during the high tide event and the foundation soils are not considered to be subject to liquifaction. A minimum FS of 1.4 was calculated for both the end-of-construction and high tide conditions with the critical slip surface passing through the berm and foundation. Design guidance indicates a minimum FS of 1.3 for end-of construction and 1.4 for long-term; therefore the preliminary designed berm section appears to be adequate.

V. CONSTRUCTION CONSIDERATIONS

A. Excavation. Currently, there is a gravel access road that was constructed through the marsh for the installation and maintenance of the utility poles. It is assumed that this road was constructed by dumping and compacting the gravel material. Although the road is currently covered in vegetation, it most likely is still capable of carrying the load of construction equipment. The silty clayey dredge material within the marsh is considered very soft and may not be able to withstand the weight of construction equipment. Therefore, in order to excavate material to create the channels, either a temporary access road would need to be built along the channel alignments or specialized low-pressure construction vehicles would need to be utilized.

B. Berm Construction. The top 0.5-feet of the marsh area is root mat and would need to be removed along with any peat or organic material. The material to be excavated from the marsh will have a very high water content. Therefore, in order to construct a semi-compacted berm, the material will have to be dried to allow a reduction of the water content of the material, which will allow for somewhat easier workability of the material. An area of the project would need to be cleared so that excavated material can be placed to facilitate drying.

C. Excavated Material for Use as Fill. As stated above the material to be excavated has a very high water content. For this material to be used as fill under the visitor parking area, it would need to be dried out substantially so that proper compaction could be achieved. Drying out the material would require time and also an area large enough to spread the material and work it to reduce the moisture content. Depending on time constraints and available area to spread the material out, this may not be feasible. Also, if the material is to be used as the parking area foundation, the shear strength of the compacted material would need to be determined.

D. Effects of Construction on Salt Water Intrusion. The excavation of channels to allow for tidal influences into the marsh will increase the salt-water intrusion into the areas immediately adjacent to the new tidal channels. Therefore, the potential for saltwater intrusion into the nearby freshwater Founders Brook was investigated. Possible reasons for saltwater intrusion into fresh ground water could be if there was a reduction or reversal of groundwater gradient due to pumping of wells and/or if there were destruction of a natural barrier, as with the case of construction of a coastal drainage canal where tidal water advances inland and percolates into the freshwater aquifer. This Brook is not used for a public or private drinking water supply, but it is reportedly used as a source of water for irrigation of the Pocassett golf course greens. An increase in the salinity of the water could damage the greens and potentially change the habitat of the brook. The proposed alternative indicates that the edge of the new channel is about 100 feet minimum horizontal distance from Founders Brook. The material in the marsh, which is assumed to extend to Founders Brook, is primarily clay and silt with some sand and has a permeability ranging from 10^{-4} to 10^{-7} cm/sec as described in paragraph III-C herein. This type of material is considered to have a permeability of very low to impervious. Typically, fresh water flows toward the ocean creating flow lines of fresh water above and below mean sea level (MSL) and above the saltwater flow lines. As freshwater has a lower density than saltwater, this causes the freshwater to flow above the saltwater and the interface of these two generally occurs at a depth of 40 times the height of the groundwater level above MSL. This depth would reduce if there were a nearby well pumping groundwater out of the aquifer. However, there are no known water wells in the area that would reverse the groundwater gradient and raise the interface. The other potential for saltwater intrusion is by allowing tidal water advances inland, as is the case with the construction of the proposed tidal channels. Preliminary information indicates the average invert of Founders Brook is near –0.05 ft-NGVD with the water surface near 3.7 ft-NGVD. Comparatively, the mean tide expected in the proposed tidal channels is 0.7 ft-NGVD and mean high tide is 2.6 ft-NGVD. This indicates that as the tide pulses in and out of the proposed channels, there will be some flow of saltwater into the adjacent ground.

A study was performed in 1996 on the hydrogeology of another salt marsh in Sagamore, Massachusetts (Ref. 9). This study was "undertaken to improve the understanding of the current (1994-95) hydrogeologic conditions near [Sagamore Marsh] and how the ground-water system might respond to proposed changes in the tidal-stage regime of streams that flood and drain that marsh." The extensive study and modeling indicated that the increased tidal stages in Sagamore Marsh would have negligible effect on the local groundwater levels. It also indicated the tidal pulses from the channels of the marsh "extend only 42 feet laterally into the aquifer" for that site. The subsurface soils at Sagamore are primarily sands, which is more pervious than the silts and clays encountered at the Town Pond site. Thus, the effects of saltwater intrusion into a less permeable soil stratum, such as the materials expected at the Town Pond Site, could be less than 42 feet. With the low permeability of the soils, the distance between the proposed channel and Founder's Brook, and the saltwater flow lines below the fresh water flow lines, as described above, the potential for the saltwater to reach and increase the salinity of Founder's Brook is low.

VI. RECOMMENDATIONS

A. Berm Design. All analyses in this report are based on assumed soil properties. The preliminary design indicates that with a 15-foot wide crest, the side slopes of the berm should be a minimum of 1 vertical to 3 horizontal (Figure 4). The berm would be constructed with excavated material that is allowed to dry enough to make the material workable and allow for proper placement and compaction. Compaction would be performed by the hauling and spreading equipment and with sheepsfoot or rubber tired rollers. The elevation of the berm should be constructed 1-foot higher than the proposed 10 ft-NGVD to account for future settlement of the foundation materials due to the added weight of the berm. For protection of the side slopes and crest, it is recommended that berm be covered with topsoil and seed to promote herbaceous growth. With a vegetative slope cover, maintenance of the berm will be required to keep large bushes, shrubs, and trees from growing on the slopes. Due to the assumed soft foundation soil conditions, it is recommended that a geotextile be included as a reinforcing layer between the berm and the foundation soils. A reinforcing geotextile would result in more uniform settlement of the berm due to the consolidation of the foundation materials and help to resist sliding along the berm/foundation interface reducing the potential for slope failure.

B. Visitor Parking Area. The visitor parking area would be situated along a portion of Anthony Road and its limits would need to be defined during final design. It's western limit should extend to allow vehicular access to the utility poles just east of Founder's Brook and north of Anthony Road. Also, the amount of fill required to bring the area up to grade would need to be determined and would help establish the feasibility for the use of the excavated material as backfill under the parking area. Preliminary recommendations for this area are that during construction, the parking area would be cleared of all vegetation and organic matter, filled with gravel material and compacted to provide a construction staging area. Over the course of the construction, the foundation materials should consolidate under the construction equipment loads so that future settlement of the area would be minimal. After construction is completed the area would be cleaned up and the parking area finished with a stone surface.

C. Saltwater Intrusion. The excavation of channels to allow for tidal influences into the marsh will increase the salt-water intrusion into the areas immediately adjacent to the new tidal channels. Preliminary research indicates that the chance of saltwater intrusion contaminating Founders Brook is low. This report recommends monitoring of the groundwater before, during and after construction of the tidal channels. This can be accomplished by installing hand-driven piezometers along the east bank of Founders Brook. The groundwater would be sampled and tested on a regular schedule to monitor the salinity. If the salinity of the groundwater reached a pre-determined target limit, recourse actions would be taken to prevent flow of the saltwater into Founders Brook. This could include driving sheet piles to cut off the flow or excavating a drainage trench between the new inlet channel and Founders Brook.

D. Final Design. A topographic survey of the area is required to determine the actual alignment and maximum height of the berm. Once the alignment and location of the berm is determined additional explorations and testing will be needed to prepare the final design for the plans and specifications. This would include performing borings along the

berm alignment along with soil sampling and testing. The additional borings are needed to better define the actual subsurface foundation conditions, confirm preliminary design assumptions, and determine if there is a pervious layer of material that may affect the stability of the berm and allow salt water intrusion into the nearby fresh water sources. Also, the borings would identify the thickness of the compressible material in the foundation materials. The preliminary design indicates the berm could be redesigned with a wider crest and flatter slopes in order to utilize more of the excavated material. The final geometry of the berm should be determined in conjunction with the final layout of the channels. Settlement, bearing capacity, and stability calculations will also be verified during the final design of the berm.

VII. REFERENCES

1) Department of the Navy Naval Facilities Engineering Command, Foundations and Earth Structures – NAVFAC Design Manual-7.1, May 1982.

2) Department of the Navy Naval Facilities Engineering Command, Foundations and Earth Structures – NAVFAC Design Manual-7.2, May 1982.

3) Department of the Army Office of the Chief of Engineers, Design and Construction of Levees - Engineer Manual No. 1110-2-1913, 31 March 1978 (amended 30 June 1996).

4) Department of the Army Office of the Chief of Engineers, Settlement Analysis - Engineer Manual No. 1110-1-1904, 30 September 1990.

5) Department of the Army Office of the Chief of Engineers, Bearing Capacity of Soils-Engineer Manual No. 1110-1-1905, 30 October 1992.

6) U.S. Army Corps of Engineers, New England District, Report of Geotechnical Investigations for Boyd's Marsh Restoration Feasibility Study, Portsmouth Rhode Island, 17 April 2000.

7) Holtz, Robert D., Kovacs, William D., An Introduction to Geotechnical Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1981.

8) U.S. Army Corps of Engineers, UTEXAS3 – Slope Stability Computer Program and Package, and Instructional Report GL-87-1, 1992.

9) U.S. Geological Survey, Water Resources Investigations Report 96-4200, Hydrogeology and Analysis of Ground-Water Flow System, Sagamore Marsh Area, Southeastern Massachusetts, 1996.

TOWN POND SALT MARSH RESTORATION

GEOTECHNICAL APPENDIX

MAY 2001

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BEARING CAPACITY

SALT WATER INTRUSION REFERENCE

I. GENERAL

A geotechnical study was performed for the Feasibility Study of the Salt Marsh Restoration of Town Pond in Portsmouth, Rhode Island. The proposed project features include excavation of the in-situ dredged material in the marsh area to create salt water channels, use of the excavated material from the marsh to construct a berm along the west side (Founder's Brook), construction of a parking area for visitors, and maintenance of the access road to the utility poles. Geotechnical studies were performed to assess the nature of the materials to be excavated within the limits of the Town Pond salt marsh restoration area for use in the construction of a berm around the perimeter of the marsh. The scope of the investigation included:

a. Field Reconnaissance
b. Collection of subsurface soil samples from hand auger borings performed within the marsh.
c. Physical and chemical testing of the soil samples.
d. Review of available subsurface data.
e. Geotechnical evaluations to establish foundation and preliminary berm design.

Presently, the final alignment of the berm has not been determined (see Figure 3 for approximate location). Analyses in this report are based on assumed soil properties based on published literature and experience with similar materials as described in paragraph IV.A. below. Once the alignment and location of the berm is determined additional explorations, including sampling and testing, will be needed to prepare the final design for the plans and specifications. The additional borings will better define the actual foundation conditions and determine if there is a pervious layer of material that may affect the stability of the berm and allow salt water intrusion into the nearby fresh water sources.

II. LOCATION AND DESCRIPTION OF THE SITE

Town Pond is located on the northern tip of the town of Portsmouth, Rhode Island, adjacent to Mount Hope Bay. It is bounded on the east and west by the Montaup and Pocassett Country Clubs respectively, Anthony Road to the south, and Mount Hope Bay to the north (Figure 1). Town Pond (a.k.a. Boyd's Marsh) historically was a tidally influenced salt pond. The area was filled with material dredged from Fall River Harbor during harbor improvements conducted by USACE from 1950 – 1951. The marsh was shut off from virtually all tidal flushing and has subsequently become overgrown with common reed and shrubs. Presently, the area is being studied under Section 1135 to restore the tidal marsh. The proposed restoration of the salt marsh would include the excavation of a portion of the existing marsh for a depth of three to five feet. Disposal of the excavated material includes the proposal of construction of a berm along the western edge of the project, which would protect nearby Founder's Brook (a fresh water spring fed stream) from saltwater intrusion (Figure 3). In addition to the berm, other disposal options considered include creating an on-site disposal area and to also using the material as cap material at a local landfill. This latter option is discussed in Reference Report 6.

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A. November 1998 Sampling Event. An initial characterization of the subsurface soil conditions was performed in November 1998. This consisted of sampling at three locations within the marsh area using a hand auger (Figure 2). Visual classification of the augered materials was done at the site, but samples were not retained for testing. The borings consisted of two-inch diameter hand augers driven to a depth of 4 to 4.5 feet. All sampling and field classification was done by USACE personnel.

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The in-situ material will be the foundation for the new berm and was assumed to be 7 feet thick with the groundwater 1-foot below the ground surface.

TABLE 2	
Earthen Berm	Semi-compacted excavated material
Unit weight, γ	110 pcf
Water content, ω	~ 40%
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V. CONSTRUCTION CONSIDERATIONS

A. Excavation. Currently, there is a gravel access road that was constructed through the marsh for the installation and maintenance of the utility poles. It is assumed that this road was constructed by dumping and compacting the gravel material. Although the road is currently covered in vegetation, it most likely is still capable of carrying the load of construction equipment. The silty clayey dredge material within the marsh is considered very soft and may not be able to withstand the weight of construction equipment. Therefore, in order to excavate material to create the channels, either a temporary access road would need to be built along the channel alignments or specialized low-pressure construction vehicles would need to be utilized.

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VI. RECOMMENDATIONS

A. Berm Design. All analyses in this report are based on assumed soil properties. The preliminary design indicates that with a 15-foot wide crest, the side slopes of the berm should be a minimum of 1 vertical to 3 horizontal (Figure 4). The berm would be constructed with excavated material that is allowed to dry enough to make the material workable and allow for proper placement and compaction. Compaction would be performed by the hauling and spreading equipment and with sheepsfoot or rubber tired rollers. The elevation of the berm should be constructed 1-foot higher than the proposed 10 ft-NGVD to account for future settlement of the foundation materials due to the added weight of the berm. For protection of the side slopes and crest, it is recommended that berm be covered with topsoil and seed to promote herbaceous growth. With a vegetative slope cover, maintenance of the berm will be required to keep large bushes, shrubs, and trees from growing on the slopes. Due to the assumed soft foundation soil conditions, it is recommended that a geotextile be included as a reinforcing layer between the berm and the foundation soils. A reinforcing geotextile would result in more uniform settlement of the berm due to the consolidation of the foundation materials and help to resist sliding along the berm/foundation interface reducing the potential for slope failure.

B. Visitor Parking Area. The visitor parking area would be situated along a portion of Anthony Road and its limits would need to be defined during final design. It's western limit should extend to allow vehicular access to the utility poles just east of Founder's Brook and north of Anthony Road. Also, the amount of fill required to bring the area up to grade would need to be determined and would help establish the feasibility for the use of the excavated material as backfill under the parking area. Preliminary recommendations for this area are that during construction, the parking area would be cleared of all vegetation and organic matter, filled with gravel material and compacted to provide a construction staging area. Over the course of the construction, the foundation materials should consolidate under the construction equipment loads so that future settlement of the area would be minimal. After construction is completed the area would be cleaned up and the parking area finished with a stone surface.

C. Saltwater Intrusion. The excavation of channels to allow for tidal influences into the marsh will increase the salt-water intrusion into the areas immediately adjacent to the new tidal channels. Preliminary research indicates that the chance of saltwater intrusion contaminating Founders Brook is low. This report recommends monitoring of the groundwater before, during and after construction of the tidal channels. This can be accomplished by installing hand-driven piezometers along the east bank of Founders Brook. The groundwater would be sampled and tested on a regular schedule to monitor the salinity. If the salinity of the groundwater reached a pre-determined target limit, recourse actions would be taken to prevent flow of the saltwater into Founders Brook. This could include driving sheet piles to cut off the flow or excavating a drainage trench between the new inlet channel and Founders Brook.

D. Final Design. A topographic survey of the area is required to determine the actual alignment and maximum height of the berm. Once the alignment and location of the berm is determined additional explorations and testing will be needed to prepare the final design for the plans and specifications. This would include performing borings along the

berm alignment along with soil sampling and testing. The additional borings are needed to better define the actual subsurface foundation conditions, confirm preliminary design assumptions, and determine if there is a pervious layer of material that may affect the stability of the berm and allow salt water intrusion into the nearby fresh water sources. Also, the borings would identify the thickness of the compressible material in the foundation materials. The preliminary design indicates the berm could be redesigned with a wider crest and flatter slopes in order to utilize more of the excavated material. The final geometry of the berm should be determined in conjunction with the final layout of the channels. Settlement, bearing capacity, and stability calculations will also be verified during the final design of the berm.

VII. REFERENCES

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3) Department of the Army Office of the Chief of Engineers, Design and Construction of Levees - Engineer Manual No. 1110-2-1913, 31 March 1978 (amended 30 June 1996).

4) Department of the Army Office of the Chief of Engineers, Settlement Analysis - Engineer Manual No. 1110-1-1904, 30 September 1990.

5) Department of the Army Office of the Chief of Engineers, Bearing Capacity of Soils-Engineer Manual No. 1110-1-1905, 30 October 1992.

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7) Holtz, Robert D., Kovacs, William D., An Introduction to Geotechnical Engineering, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1981.

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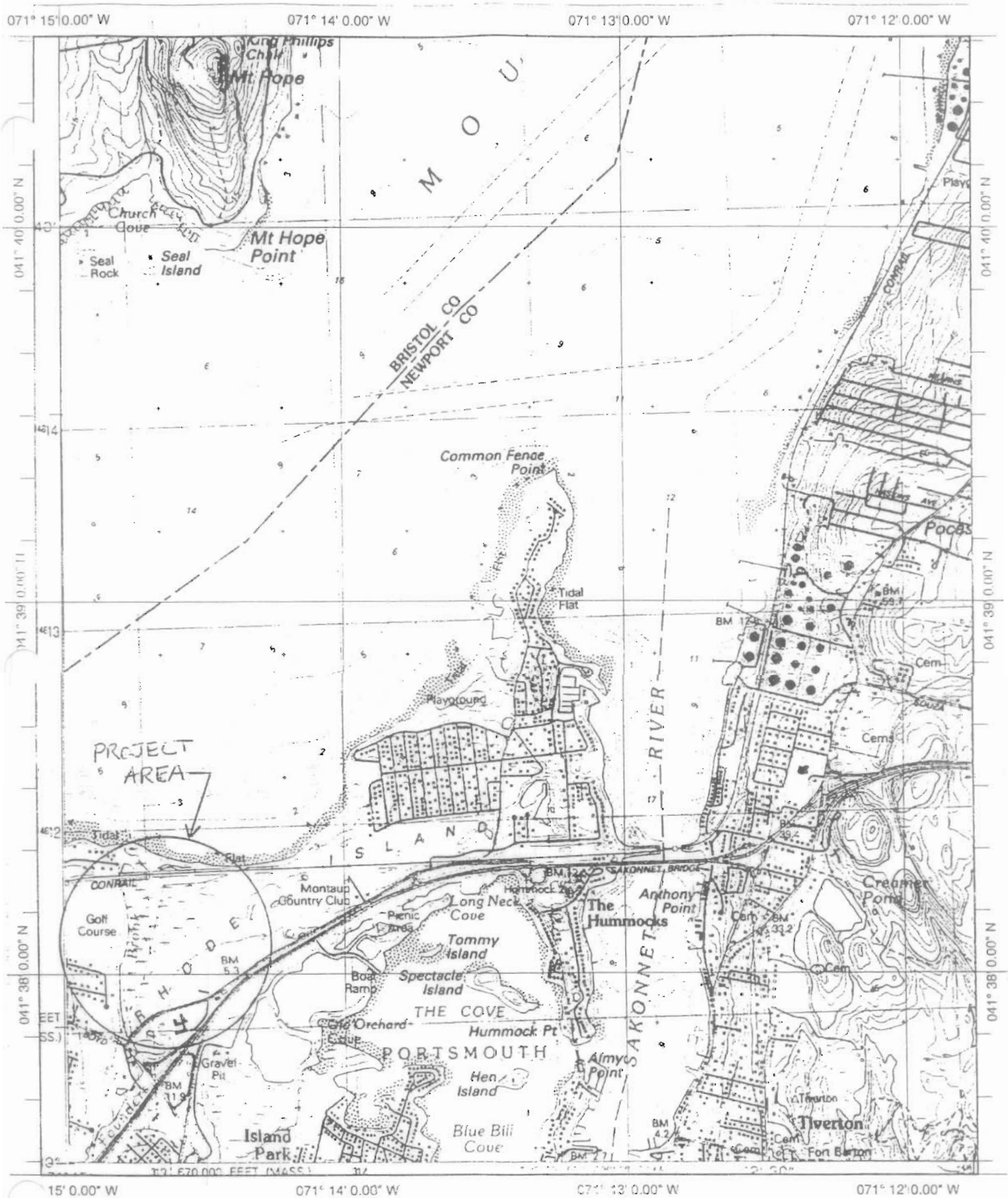


Name: FALL RIVER
Date: 5/29/101
Scale: 1 inch equals 2000 feet

Location: 041° 38' 59.3" N 071° 13' 25.1" W
Caption: FIGURE 1
SITE LOCATION

Copyright © 1997 Mapquest, Inc.

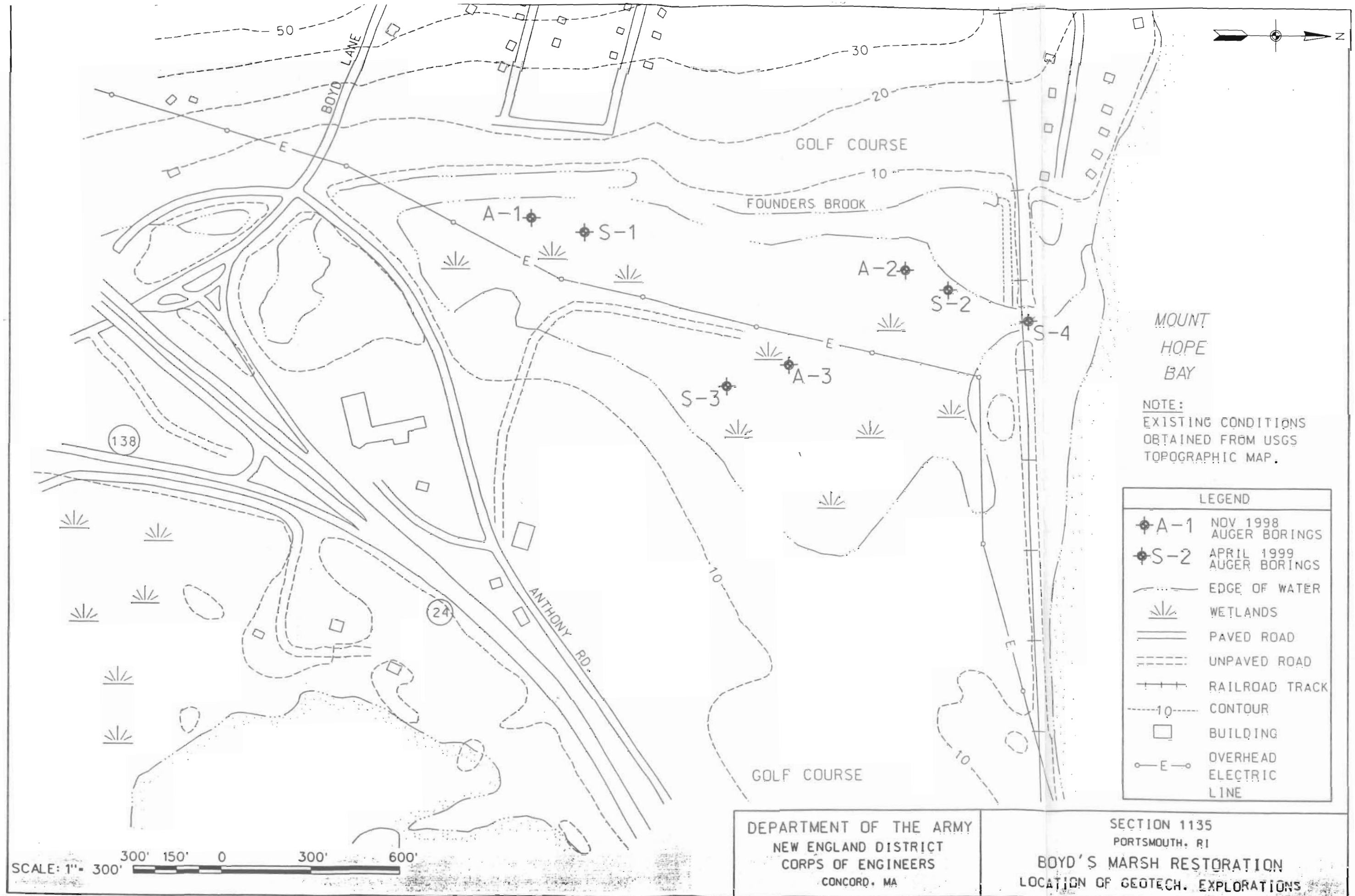
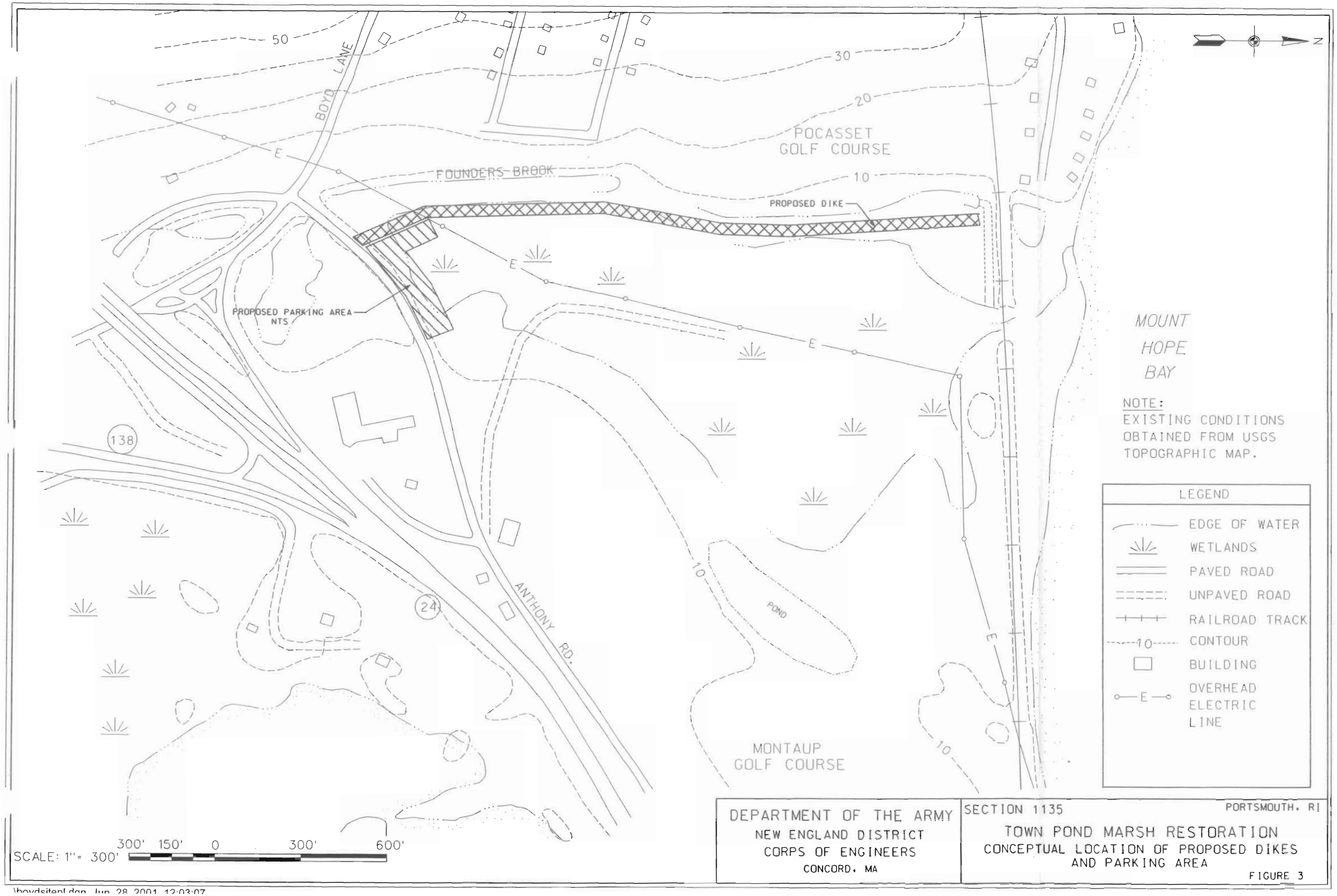

50
30
20
10
BOYD LANE
GOLF COURSE
FOUNDERS BROOK
A-1
S-1
A-2
S-2
S-4
A-3
S-3
MOUNT HOPE BAY
138
24
ANTHONY RD.
GOLF COURSE
NOTE:
EXISTING CONDITIONS OBTAINED FROM USGS TOPOGRAPHIC MAP.
LEGEND
A-1 NOV 1998 AUGER BORINGS
S-2 APRIL 1999 AUGER BORINGS
EDGE OF WATER
WETLANDS
PAVED ROAD
UNPAVED ROAD
RAILROAD TRACK
10 CONTOUR
BUILDING
E OVERHEAD ELECTRIC LINE
SCALE: 1" = 300'
300' 150' 0 300' 600'
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MA
SECTION 1135
PORTSMOUTH, RI
BOYD'S MARSH RESTORATION
LOCATION OF GEOTECH. EXPLORATIONS

FIGURE 2



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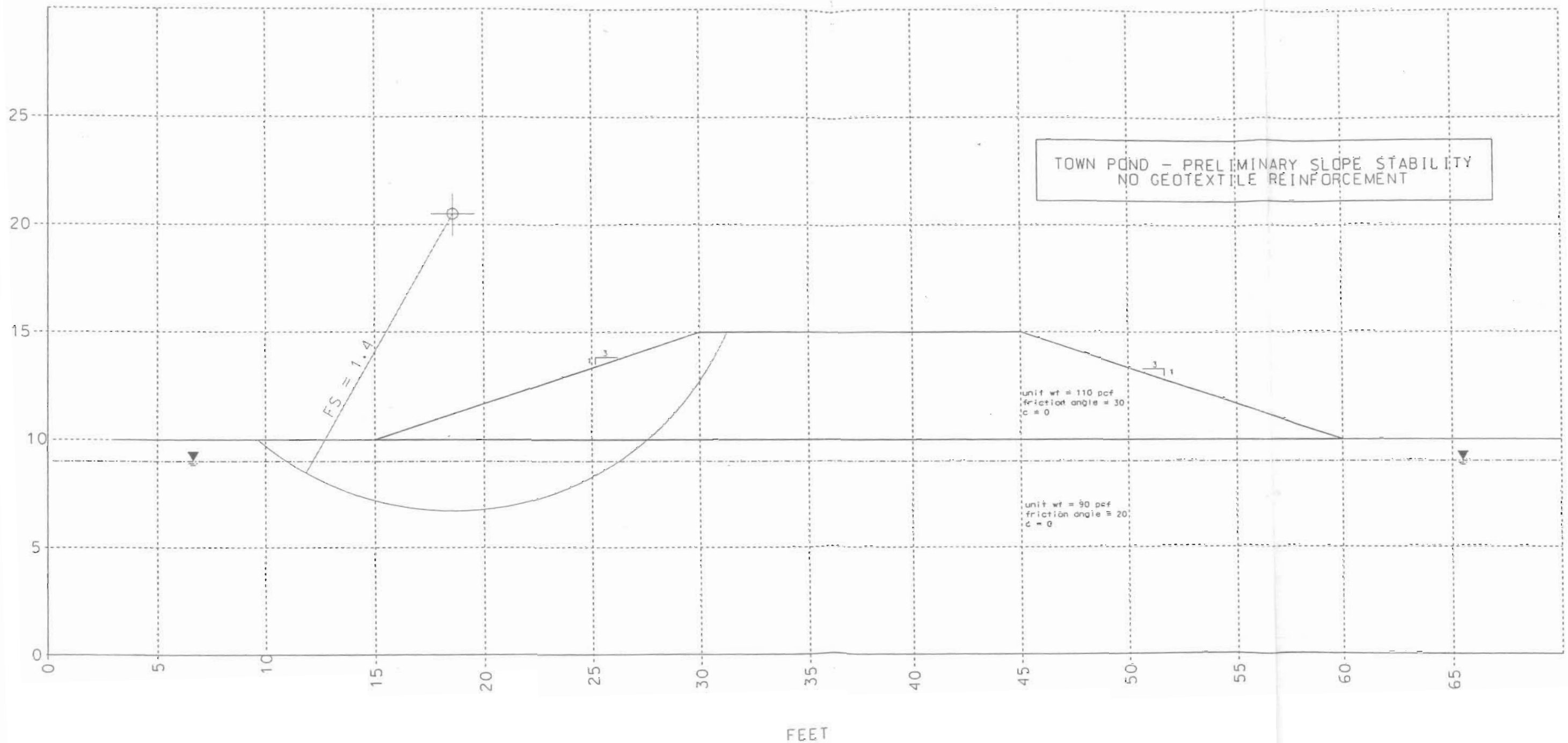

SECTION 1135 PORTSMOUTH, RI

TOWN POND MARSH RESTORATION
PRELIMINARY DIKE DESIGN AND SLOPE STABILITY

FIGURE 4

APPENDIX 3
INCREMENTAL ANALYSIS

Incremental Analysis
for
Town Pond Restoration
Portsmouth, Rhode Island

June 22, 2001

Prepared by
New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, Massachusetts

Technical Working Draft

INCREMENTAL ANALYSIS
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INTRODUCTION

This report documents the incremental analysis performed by the New England District of the Corps of Engineers for the Town Pond Restoration Project. The incremental analysis evaluates alternatives for modifying a dredged material disposal site to restore estuarine habitat for fish and wildlife. The site was filled with dredged material from improvement dredging of the Fall River Ship channel in 1950. Prior to dredged material disposal, the site consisted of salt pond, salt marsh, and other estuarine habitats.

The purpose of this incremental analysis is to display and evaluate the fish and wildlife habitat benefits and incremental costs of various restoration alternatives. The incremental cost associated with an alternative is the added cost for each additional unit of benefit. The information generated in this assessment will help to identify the best restoration alternative.

Fish and wildlife resources may have both economic and ecological value. The Corps of Engineers guidance for performing incremental analysis describes fish and wildlife resources with substantial commercial and/or recreational value as National Economic Development (NED) resources. Fish and wildlife resources with substantial non-monetary, ecological value are defined as Environmental Quality (EQ) resources. This incremental analysis displays the EQ outputs of alternative plans and compares the marginal cost of the various options.

ENVIRONMENTAL QUALITY OBJECTIVES (MISSION, GOALS, AND OBJECTIVES)

Town Pond, also known as Boyd's Marsh, historically contained salt pond, salt marsh, and other estuarine habitats. These habitats were converted to common reed (*Phragmites australis,* hereafter referred to as phragmites) marsh after the Corps of Engineers placed dredged material from the Fall River dredging project on the site creating a surface elevation above the level of tides. The restoration project is intended to restore estuarine habitats by removing or redistributing the dredged material and restoring elevations, hydrologic, and physical conditions that will support estuarine habitats.

The area of historic[1] habitats at Town Pond are shown in Figure 2 of the Environmental Assessment based on interpretation of 1939 aerial photography. Based on that mapping, the approximate area of former estuarine habitat south of the railroad embankment and north of Boyd's Lane was:

- 47 acres of salt pond and intertidal flats
- 34 acres of salt marsh.

1 The goal of Corps of Engineers restoration projects is to restore modern historic conditions.

Therefore, the historic ratio of open water to marsh was about 1.4:1. Upland areas surrounding the pond were primarily open agricultural.

The depth of Town Pond at two transect locations is shown on plans for dredged material disposal from 1948 and 1949. At a transect near the middle of Town Pond, the depth extended to slightly above mean low water (MLW). Nearer to the inlet the pond had a depth of about 3 feet below MLW .

Goals and Objectives

Prior to beginning a restoration project it is important to establish and agree to the goals and objectives. These statements form the basis of project design and evaluation and are the basis for developing performance criteria for project monitoring and success evaluation. Goals refer to the target characteristics to be restored, such as water quality, hydrology, or wetland flora and fauna. Objectives are more precise, such as the specific characteristics of water quality to be achieved or the species composition of the various communities of biota to be restored. Performance indicators, which are developed as the project progresses and are the basis of the monitoring plan, are specific, measurable quantities such as pH or concentration of chlorophyll in a water sample. The goals and objectives for the Town Pond Restoration Project are outlined below. Due to the differences among alternatives considered and the stage of this project, the goals and objectives are relatively general.

Project Goals

- Restore a combination of salt pond, salt marsh, and intertidal mudflat that maximizes fish and wildlife habitat value within project constraints.
- Maintain the value of existing estuarine habitats in the tidal inlet downstream of the railroad embankment as much as practicable.
- Increase the habitat value for estuarine dependent fish and wildlife, while maintaining some cover for the existing wildlife community.
- Avoid increasing salinity in Founder's Brook.
- Cause no increase in flooding potential to surrounding uplands.

Project Objectives

- Restore elevations and substrates at intertidal elevations (spring high water to mean sea level) that allow salt marsh plants and associated animal communities to recolonize the site.

- Restore elevations and substrates at lower intertidal elevations (about mean sea level to mean lower low water) that allow invertebrates adapted to intertidal areas and the animals that feed on them to recolonize the site.

- Restore permanent open water to allow populations of shallow subtidal invertebrates and possibly submerged aquatic vegetation and the animals that feed on them to recolonize the site.

- Restore habitats in appropriate ratios to maximize use by fish and wildlife.

- Maintain salinity concentration in Founder's Brook of 0 parts per thousand.

- Ensure existing flood heights on surrounding uplands remain unchanged.

UNITS OF MEASUREMENT AND MODELS

Model Considerations

Once the project goals and objectives are established and alternative means of achieving them are formulated, the units of measurement must be determined. More than one unit of measurement may be used in an incremental analysis as long as the same units are used to describe increments that address a single objective. In many cases, acres can be used as a simple and practical unit of measure. For instance, if the project alternatives would restore different size increments of similar quality salt marsh, acres would be a good unit of measure. In the case of Town Pond, the alternatives would restore varying combinations of salt pond, mudflat, and salt marsh habitats. The historic combination of habitats and the type of alteration (excavation and grading) require the evaluation of different types of habitats of about the same size, but with different qualities. Therefore, habitat models are the best way to discriminate among alternatives.

Habitat Evaluation Procedures (HEP) models were used to evaluate existing and alternative habitats for the Town Pond Restoration Project. HEP was developed by the U.S. Fish and Wildlife Service as a system to measure and document the value of fish and wildlife resources for impact assessment. Using HEP, the quality of habitat for selected evaluation species is documented with a Habitat Suitability Index (HSI). The models generate an HSI by evaluating how well key habitat components supply requirements for a species. The HSI ranges from 0.0 to 1.0 with an HSI of 1 representing optimum habitat and an HSI of 0.0 signifying unsuitable habitat for the species. The HSI is developed by comparing measurable components of a habitat to models for the individual habitat components, frequently in the form of Suitability Graphs. Suitability Graphs have potential values of habitat components on the x-axis and Suitability Index (SI) on the y-axis. For instance, if a species requires at least 50 percent herbaceous vegetation to utilize a habitat, areas with less than fifty percent herbaceous vegetation would have an SI value of zero; the habitat would not be suitable for the species. If optimum habitat for the species consisted of 90 percent herbaceous vegetation, areas meeting this

percentage criterion would been given an SI of 1. Areas with intermediate percentages of herbaceous vegetation would be assigned SI values between 0 and 1. Normally, several SI values are combined in a model to estimate the overall HSI for the species and the habitat.

The HSI is used to estimate Habitat Units (HU), which are a measure of habitat quality and quantity. Each HU is equal to one unit (e.g. acre, hectare) of optimal habitat. To determine the number of habitat units, the HSI value is multiplied by the area of available habitat. For instance, 10 acres of habitat with a HSI of 0.6 would produce 6 HUs. Generally, several species representing different components of the habitat are used in a HEP evaluation.

Model Selection

To select an appropriate group of models for the Town Pond Project, we reviewed the list of available HEP models to identify species appropriate to the existing habitat types and the types of habitats that may be restored. In light of the restoration goals and objectives and the habitats to be restored, we considered the models for red-winged blackbird (*Agelaius phoeniceus*), great blue heron (*Ardea herodias*), clapper rail (*Rallus longirostris*), wintering black duck (*Anas rubripes*), wintering lesser scaup (*Aythya affinis*), alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*), and hard clam (*Mercenaria campechiensis, Mercenaria mercenaria*). We discussed the potential models with a technical work group established for the project. The US Fish and Wildlife Service recommended using the clapper rail model, since there was evidence of their presence at the site before it was filled. The models reviewed and reasons for selecting or not selecting them are summarized in Table 1.

Based on our review of these seven models, we selected the red-winged blackbird, clapper rail, wintering black duck, and wintering lesser scaup models to evaluate the restoration alternatives. The four models provide an assessment that considers all of the major habitat types involved and species likely to use them. Although all of the species are birds, the habitats represented by the models include subtidal open water with clam habitat, submerged aquatic vegetation, salt marsh vegetation with invertebrates, and broad-leaved monocot vegetation (e.g. phragmites or cattails (*Typha* spp.)).

INVENTORY AND SIGNIFICANCE OF FISH AND WILDLIFE RESOURCES

We determined the area of existing cover types at the project site by mapping cover types on 1996 aerial photography (Figure 3). Based on that mapping, the approximate area of existing habitats in the area that was formerly estuarine habitat between the railroad embankment and Boyd's Lane are:

- 43 acres of phragmites marsh
- ___ acres of shrub communities

- 0.0 acres of salt marsh
- 0.0 acres of tidal creeks.

A dike was constructed across the upper end of the marsh after Town Pond was filled with dredged material. The dike is now an extension of Anthony Road, which segments a portion of the former marsh/estuarine habitat from the area that would be restored with the project. This area includes the pond visible from the Boyd's Lane/Anthony Road interchange. It contains approximately 5.1 acres of phragmites, 0.4 acre of cattail marsh, and the 1.2 acre freshwater pond. In addition, about 5 acres of the former marsh are now freshwater ponds, turfgrass, and shrub rows in the golf course to the east of the restoration site. Upland areas surrounding the marsh are primarily golf courses, with areas of homes, and fragmented forest.

Table 1. Habitat Evaluation Procedures Models Considered and Reasons for Selecting or Not Selecting Them

Model	Status	Reasons for Selecting or Not Selecting
Clapper rail	Selected	Applies to tidal water and estuarine emergent wetlands and contains variables that will be affected by the alternatives.
Red-winged blackbird	Selected	Provides few criteria for distinguishing between alternatives, but is useful for evaluating Without Project Conditions.
Great blue heron	Not Selected	Applies primarily to heronries and provides little detailed design/evaluation information for the habitat components that can be manipulated by the project.
Wintering black duck	Selected	Applies to estuarine open water and emergent wetlands and contains variables that will be affected by the alternatives.
Wintering lesser scaup	Selected	Applies to estuarine areas including shallow subtidal habitats and addresses emergent wetland.
Alewife and blueback herring	Not Selected	Not appropriate for the project since salinities will be higher than the HSI threshold for alewife and blueback herring habitat.
Hard clam	Not Selected	Not appropriate since most of the variables are water quality parameters that would be difficult to predict accurately prior to implementation.

WITHOUT PROJECT CONDITION ANALYSIS

The guidance for performing incremental analysis requires a prediction of the Without Project Conditions. The Without Project Conditions (also known as No Action Alternative) are the most likely changes to occur at the site without the project and are the basis for the evaluation of the action alternatives. Under the Without Project Conditions, no change in the composition of the present marsh vegetation is expected. Successional change to shrub and forested wetland habitat at the site would be very slow because of the tenacity of phragmites, the water holding capacity and texture of the dredged material substrate, and the potential for fires which encourage the regrowth of phragmites.

ENVIRONMENTAL PLAN INCREMENTS

Four alternatives with off-site disposal that achieve as much restoration as possible are considered in this section in addition to the Without Project Conditions or No Action alternative. The analysis also considers 2 alternatives that retain all excavated material on-site since an off-site disposal site may not be available, or the cost of offsite disposal may make its use impracticable. The alternatives are described in the following paragraphs.

Alternative 1, No Action

No change from existing conditions. The existing marsh elevations and dominance by phragmites remain.

Alternative 2, Salt Marsh and Tidal Creek Restoration

The existing dredged material would be excavated to elevations that will support salt marsh (mostly low marsh) with creeks to convey tidal flow (Figure 4). There would be approximately 2.9 acres (1.2 hectares) of high marsh, 20.8 acres (8.4 hectares) of low marsh, 0.3 acres (0.1 hectares) of mudflats, and 0.8 acres (0.34 hectares) of tidal creeks.

Alternative 3, 50 % Salt Marsh and 50 % Open Water

The existing dredged material would be excavated to elevations that will support about half salt marsh and half mudflat/open water (Figure 5). There would be 2.9 acres (1.2 hectares) of high marsh, 8.4 acres (3.4 hectares) of low marsh, 4.3 acres (1.7 hectares) of mudflats, and 9.2 acres (3.7 hectares) of permanent open water. A weir with a top elevation of -0.06 m would maintain permanent open water depths between 0.88 to 0.54 m deep with a median depth at the halfway point of 0.71 m.

Alternative 4a, Shallow Open Water with Salt Marsh Fringe

The existing dredged material would be excavated to elevations that will support about half salt marsh and half mudflat/open water (Figure 6). There would be approximately 2.9 acres (1.2 hectares) of high marsh, 4.0 acres (1.6 hectares) of low marsh, 14.7 acres (6.0 hectares) of mudflats, and 3.2 acres (1.3 hectares) of permanent open water. A weir with a top elevation of -0.06 m would maintain a maximum permanent open water depth of 0.28 m with a median depth at the halfway point of 0.14 m.

Alternative 4b, Deep Open Water with Salt Marsh Fringe

The existing dredged material would be excavated to elevations that will support about half salt marsh and half mudflat/open water (Figure 7). There would be approximately 2.9 acres (1.2 hectares) of high marsh, 4.0 acres (1.6 hectares) of low marsh, 5.7 acres (2.3 hectares) of mudflats, and 12.2 acres (5.0 hectares) of permanent open water. A weir with a top elevation of -0.06 m would maintain permanent open water depths between 0.88 to 0.54 m deep with a median depth at the halfway point of 0.71 m.

Alternative 5, Salt Marsh and Tidal Creek Restoration with On-site Disposal

As with Alternative 2, the existing dredged material would be excavated to elevations that would support salt marsh (mostly low marsh) with creeks to convey tidal flow (Figure 8). There would be approximately 1.20 acres (0.49 hectares) of high marsh, 13.72 acres (5.55 hectares) of low marsh, 0.2 acres (0.08 hectares) of mudflats, and 0.5 acres (0.2 hectares) of tidal creeks.

Alternative 6, 50 % Salt Marsh and 50 % Open Water with On-site Disposal

As with Alternative 3, the existing dredged material would be excavated to elevations that would support about half salt marsh and half mudflat/open water (Figure 9). There would be 2.33 acres (0.95 hectares) of high marsh, 4.48 acres (1.81 hectares) of low marsh, 2.98 acres (1.20 hectares) of mudflats, and 5.37 acres (2.17 hectares) of permanent open water. A weir with a top elevation of -0.06 m would maintain permanent open water depths between 0.88 to 0.54 m deep with a median depth at the halfway point of 0.71 m.

WITH PROJECT ANALYSIS

The purpose of the HEP analysis described in this section is to evaluate alternatives to display their potential benefits from providing habitat for the species formerly inhabiting the site rather than impact assessment. The results do not predict existing or future population levels, but rather the capacity of the habitat to support wildlife. The environmental effects of the alternatives are described in detail in the Environmental Assessment.

The methods and results of applying the four selected HEP models are described below. Although the models are created to describe the habitat of a single species, to some extent they represent the quality of the habitat for similar species. For instance, the black duck model also at least partially describes the value of habitats for other dabbling ducks (e.g. mallards). The models applied and the types of wildlife represented by the models are shown in Table 2.

Table 2. HEP Models Applied for the Project and the Species They Represent

Model	Represents
Red-Winged Blackbird	Perching birds that use reeds and similar vegetation for roosting and open water areas for feeding.
Clapper Rail	Birds and other animals that use tall salt marsh cordgrass for cover or nesting and wading birds that feed in mudflats bordering salt marsh.
Wintering Black Duck	Dabbling ducks and other animals that feed in the salt marsh, tidal flats and shallow water. Fish and invertebrates that live in tidal flats and shallow water.
Wintering Lesser Scaup	Diving birds, clams and other invertebrates, and fish.

To apply the HEP models to each of the off-site disposal alternatives, we predicted changes in the physical, and vegetative variables of the cover types to estimate future HSI values. These predictions were made based on the plans developed for each alternative shown in Figures 2-5 of the main report. The area of various habitat types predicted based on these plans and is shown in Table 3.

Table 3. Area of Cover Types at Town Pond under Various Off-site Disposal Alternatives

Alternative	Total Area of Habitat (m2)	Total Subtidal/ Intertidal Habitat (m^2)	Total Estuarine Marsh Habitat (m^2)	Area of Subtidal Open Water (m^2)	Area of Intertidal Open Water (m^2)
1	108,100	0	0	0	0
2	108,100	4,400	103,700	0	4,400
3	108,100	54,800	53,300	37,400	17,400
4a	108,100	72,600	35,500	13,100	59,500
4b	108,100	72,600	35,500	49,500	23,100

Each model was applied to each of the alternatives using the information in Table 3 and predictions about the habitats with the project. The results of applying the models are shown Tables 4 through 8. Since the habitat suitability indices are based on predictions, actual values for various suitability indices can not be measured and are based on judgements about future conditions. These judgements are summarized, along with general information about application of the models, in the paragraphs that follow. Variables that did not require significant adjustments in Suitability Index ratings are not described in the text.

Red-winged Blackbird Model Results

Variables for the Nesting Red-winged Blackbird Model are shown in Table 4. Although red-winged blackbirds may feed in salt marshes (Amos and Amos, 1985), the HEP model for red-winged blackbirds applies most directly to freshwater habitats, therefore, several assumptions were made in applying the model to this project. The results are shown in Table 4. Variable 1 refers to the type of emergent vegetation available in the wetland. Although the predominant vegetation with the restoration alternatives will be broad-leaved monocots, we rated these alternatives with the lower of the two Suitability Index options because red-winged blackbirds do not appear to nest frequently in salt marsh cordgrass. Variable 2 is based on the permanence of water. Because the freshwater ponds at Founder's Brook provide permanent open water throughout the year, we increased the rating for this variable from 0.1, which would have been applied if only the water regime in the phragmites wetland was considered, to 0.5. Variable 4 considers the abundance of larvae of emergent aquatic insects. This variable normally requires field sampling. Since, most of the desired model outputs have to do with future predicted conditions that cannot be measured, we estimated the ratings of this variable at 1 for all alternatives. This neutralized this variable in the rating process in terms of comparisons among alternatives. We also assumed that the higher salinity open water with the restoration alternatives would produce suitable insect larvae for red-winged blackbird feeding.

Table 4. Nesting Red Winged Blackbird Model Results

Alternative	Type of Emergent Vegetation (V1)	Permanence of Water (V2)	Presence of Carp (V3)	Larvae of Emergent Aquatic Insects (V4)	Density of Emergent Vegetation (V5)	Overall Red-Winged Blackbird HSI
1	1.0	0.5	1	1	0.3	**0.15**
2	0.1	0.5	1	1	0.3	**0.02**
3	0.1	1.0	1	1	1.0	**0.10**
4a	0.1	1.0	1	1	0.1	**0.01**
4b	0.1	1.0	1	1	0.1	**0.01**

Clapper Rail Model Results

Variables for the Clapper Rail Model are shown in Table 5. None of the variables in the clapper rail model had to be adjusted for the evaluation other than predictions made to represent the plans.

Table 5. Clapper Rail Model Results							
	% Persistent Persistent Emergent Shoreline Bordered by Tidal	SI	% Covered by Robust Emergent	SI	% Area of Emergents w/in 15 m of Tidal	SI	Overall Clapper Rail
Alternative	Flats or Channels	V1	Wetlands	V2	Water	V3	HSI
1	0	0	100	1.00	0	0	0.00
2	100	1	96	0.96	27	1	0.99
3	100	1	49	0.49	55	1	0.79
4a	100	1	33	0.33	100	1	0.69
4b	100	1	33	0.33	100	1	0.69

Wintering Black Duck Model Results

Variables for the Wintering Black Duck Model are shown in Tables 6 and 7. Several of the variables in the black duck model had to be estimated or adjusted for the evaluation. Variable 3 required an estimate of the area occupied by rooted vascular plants (e.g. eelgrass). The suitability index for this variable leveled off at 1 when the percent cover reached 20 percent. We assumed that eelgrass can be established in at least 20 percent of the subtidal area for all of the alternatives with permanent open water; therefore, alternatives 3, 4a, and 4b were assigned SI's of 1. (Alternative 2 would have no subtidal habitat.) Variable 4 has to do with intertidal and subtidal habitats with clams at greater than 300 clams per square meter. The suitability index for this variable leveled off at 1 when the percentage of the area with clams at greater than 300 per m^2 reached 25. We assumed that, with seeding, clams could be established at this density in at least 25 percent of the intertidal/subtidal area for all of the alternatives; therefore, alternatives 2, 3, 4a, and 4b were assigned SI's of 1 for this variable.

The black duck model was applied separately for open water and emergent wetland habitats as recommended in the model documentation. However, we assumed the adjacent open water habitat had an influence on the value of the wetland habitat for Variable 5 and included it in the overall relationship for this variable. Variable 5 is to the percentage of salt marsh occupied by creeks, ponds, and impoundments. Therefore, the percent estuarine emergent wetland listed in the table reflects the overall relationship between open water and marsh at the site, rather than within the marsh portions of the site.

Variable 6 required an estimate of the area of ponds on the marsh portion of the site occupied by the rooted vascular plants, *Ruppia* sp. (widgeon grass) and *Potamogeton* sp. (pondweed). We assumed that eelgrass in the larger open water portion of the site could represent this variable and would be established at 20 percent cover as discussed previously. Based on the relationship in the Suitability Graph, the SI for these variables was estimated at 0.1

for alternatives 3, 4a, and 4b, which have permanent open water. Variable 7 concerns the percentage of the emergent marsh that supports snails at greater than 750 per square meter. The suitability index for this variable leveled off at 1 when the percentage of the area with snails at this density reached 25. We assumed that snails will establish at this density in at least 25 percent of the marsh for all of the alternatives that restore salt marsh; therefore, alternatives 2, 3, 4a, and 4b were assigned SI's of 1 for this variable.

Table 6. Wintering Black Duck Model - Open Water								
	% Subtidal OW				Estimated		% mudflats	
	<=1 m deep	SI		SI	% subtidal	SI	w/>= 300	SI
Alternative	at MLW	V_1	% Mudflat	V_2	w/plants	V_3	clams/m2	V_4
1	na	0.0	0	0.00	0	0	0	0
2	0	0.0	100	0.60	0	0	25	1
3	100	0.6	32	1.00	20	1	25	1
4a	100	0.6	82	1.00	20	1	25	1
4b	100	0.6	32	1.00	20	1	25	1

Table 7. Wintering Black Duck Model - Emergent Wetland									
	% Estuarine		Estimated	Estimated			HSI	HSI	Overall
	Emergent with	SI	% substrate	% Emergent Marsh			for	for	Black Duck
Alternative	Ponds & Creeks	V5	w/Pondweed	V6	w/Snails	V7	OW	Marsh	HSI
1	0	0.00	0	0.0	0	0	0.00	0.00	**0.00**
2	4	0.05	0	0.0	25	1	0.36	0.28	**0.28**
3	51	0.70	20	0.1	25	1	0.86	0.63	**0.75**
4a	67	0.45	20	0.1	25	1	0.86	0.50	**0.74**
4b	67	0.45	20	0.1	25	1	0.86	0.50	**0.74**

Lesser Scaup Model Results

Variables for the Wintering Lesser Scaup Model are shown in Table 8. Several

predictions were required to apply the lesser scaup model. For Variable 1, Percent of Area Supporting Clams, we estimated the percentage of the area supporting clams would be 80 percent of the total area of subtidal and intertidal habitat. The Suitability Graph for this variable leveled off at an SI of 1 when the percentage of habitat supporting clams reached 50. Based on the Suitability Graph relationship, this resulted in SI predictions ranging from 0.07 to 1. Variable 2, Percentage of the Area Supporting Emergent Vegetation, required a significant change in the model. Up to 5 percent, the habitat is given a SI of 1. The SI declines from 1 to 0 when the percentage of the area increases from 5 percent to 10 percent, then remains at 0 with any increase in percentage. Since the emergent marsh with all alternatives is located along the perimeter of the site, we modified this relationship and gave Alternatives 4a and 4b, which have a thin fringe of marsh border, an SI of 1, and Alternative 3 an SI of 0.5.

Table 8. Wintering Lesser Scaup Model									
							Human		Overall
	% of Area		% of Area		Water		Disturbance		Lesser
	Supporting	SI	Supporting	SI	Depth	SI	to Feeding	SI	Scaup
Alternative	Clams	V1	Marsh	V2	at MSL	V3	Area	V4	HSI
1	0	0.00	100	0.0	0.0	0.0	Light	1	**0.00**
2	3	0.07	96	0.0	0.3	0.3	Light	1	**0.00**
3	41	0.81	49	0.5	0.8	0.8	Light	1	**0.76**
4a	54	1.00	33	1.0	0.2	0.2	Light	1	**0.68**
4b	54	1.00	33	1.0	0.8	0.8	Light	1	**0.94**

Summary of Results

Based on the application of the HEP models, the overall HSI value for each off-site disposal alternative is shown in Table 9. The HUs for each of these alternatives are shown in Table 10.

The feasibility of off-site disposal depends on the availability of a disposal site that is reasonable in terms of the overall scope and cost of the project. The local sponsor has attempted to identify off-site disposal options at nearby landfills. This process is continuing at the time this document is being prepared. If the project team identifies an off-site disposal site that is not unreasonably expensive, the one of the off-site disposal options may be selected. However, if off-site disposal were not practicable, on-site disposal would be necessary. On-site disposal would reduce the restoration area and HUs associated with the alternatives. Preliminary coordination with the local sponsor, the public, and within the project team indicated that the most likely alternatives for implementation would be Alternatives 2 and 3 because of their lower cost and level of benefits. Therefore, we calculated the benefits for these two alternatives using the HSIs for Alternatives 2 and 3. Alternatives 2 and 3 are similar to Alternatives 5 and 6, but

Alternatives 5 and 6 have offsite disposal. Therefore, the HUs are different. The HUs for these alternatives are shown in Table 11.

Table 9. Habitat Suitability Index Scores by Species and Overall for Off-site Disposal Alternatives

Alternative	Red Winged Black Bird	Clapper Rail	Wintering Black Duck	Wintering Lesser Scaup	Overall
1	0.15	0.00	0.00	0.00	0.15
2	0.02	0.99	0.28	0.00	1.28
3	0.10	0.79	0.75	0.76	2.39
4A	0.01	0.69	0.74	0.68	2.13
4B	0.01	0.69	0.74	0.94	2.38

Table 10. Habitat Units for Town Pond Restoration Project Off-site Disposal Alternatives

Alternative	Habitat Units$_{hectares}$
1	1.6
2	13.8
3	25.8
4a	23.0
4b	25.8

Table 11. Habitat Units for Town Pond Restoration Project On-site Disposal Alternatives

Alternative	Habitat Units$_{hectares}$
5	9.6
6	16.0

DISPLAY OF BENEFITS AND COSTS

Incremental Cost Curve

In this section, the costs of the alternative restoration plans are compared with the environmental benefits, within the framework of an incremental cost analysis, to display the most cost effective alternatives. An incremental cost analysis examines how the costs of additional units of environmental output increase as the level of environmental output increases. For this analysis, the environmental outputs are measured in habitat units. The analysis is in accordance

with IWR Report 95-R-1, Evaluation of Environmental Investments Procedures Manual-Interim: Cost Effectiveness and Incremental Cost Analyses, May 1995; and ER 1105-2-100, Planning Guidance Notebook, Section 3-5, Ecosystem Restoration, April 2000. The program IWR-PLAN, developed for the Institute for Water Resources (IWR), was used to conduct the analysis.

An incremental cost curve can be identified by displaying cost effective solutions. Cost effective solutions are those increments that result in same output, or number of habitat units, for the least cost. An increment is cost effective if there are no others that cost less and provide the same, or more, habitat units. Alternatively, for a given increment cost, there will be no other increments that provide more habitat units.

Management plans to improve environmental conditions include restoration of combinations of salt marsh and open water intertidal habitats. Project description, project cost, and the number of habitat units, in terms of hectares, created by each plan are shown in Table 12. Costs are discounted at an interest rate of 6 3/8 %. This interest rate, as specified in the Federal Register, is to be used by Federal agencies in the formulation and evaluation of water and land resource plans for the period October 1, 2000 to September 30, 2001. The project economic life is considered to be 25 years.

Column 1 shows plan designators. Each alphanumeric designator represents a management plan. Plan 1 is the no project plan. Plan 2 is the restoration of salt marsh and creek habitats with off-site disposal of excavated material. Plan 3 is the restoration of a combination of fifty-percent salt marsh and fifty-percent water/intertidal habitat creation with off-site disposal of excavated material. Plan 4 (variations a and b) is the restoration of the previously existing intertidal/subtidal habitats with salt marsh fringe and off-site disposal of excavated material. Variation 4B would provide for a deeper pond than variation 4A, thereby enhancing waterfowl and fisheries habitat value. Plan 5 is the restoration of salt marsh and creek habitats with on-site disposal of excavated material. Plan 6 is the restoration of a combination of fifty-percent salt marsh and fifty-percent open water/intertidal habitats with on-site disposal of excavated materials. All plans are mutually exclusive and thus cannot be combined in the analysis. Project cost and the number of habitat units created by the plan, hectares of salt marsh/inter-tidal habitat, are shown in columns 2 and 3, respectively. Project cost includes a discounted sum of annual O & M over the project life as well as the one time implementation cost.

Table 12

Plan Cost and Benefit

Alternatives	Total Cost ($000)	HU hectares
1	0.0	1.6
2	2,905.9	13.8

3	3,907.9	25.8
4A	3,666.9	23
4B	4,230.9	25.8
5	2,105.9	9.6
6	2,403.9	16

The incremental analysis identified five cost-effective plans. Best buy plans are a subset of cost effective plans. For each best buy plan there are no other plans that will give the same level of output at a lower incremental cost. There are two best buy plans including the no project alternative.

Increments that comprise the best buy plan curve are Alternatives 1 and 3. The best buy plan curve is the incremental cost curve. Incremental cost and incremental output are the changes in cost and output when the cost and output of each successive plan in terms of increasing output are compared. Incremental cost per output is the change in cost divided by the change in output, or incremental output, when proceeding to plans with higher levels of output. Table 13 shows incremental cost for each cost effective alternative.

Table 13

Plan Incremental Cost for
Cost Effective Alternatives

Alternatives	Incremental Cost
3	$161,500
6	$166,900
4A	$171,300
5	$263,200

In the incremental cost curve, incremental cost per unit increases with output, or habitat units. Development of the incremental cost curve facilitates the selection of the best alternative. The question that is asked at each increment is: is the additional gain in environmental benefit worth the additional cost? In this study, the incremental cost curve consists of only two points represented by Alternative 1 (without project) and Alternative 3 which is a combination of salt marsh and inter-tidal restoration with off-site disposal. This plan would provide an additional 25.8

habitat units over the without project alternative at a cost of $3,908,000. The incremental cost per unit is $161,500 per habitat unit. If the local sponsor cannot afford off-site disposal, Alternative 6 is the next best alternative with an incremental cost of $166,900 per habitat unit. Although Alternative 6 is not best buy, it is cost effective and thus economically rational.

RECOMMENDATIONS

Based on the results of the incremental analysis and consideration of the benefits and costs of each alternative, the Corps of Engineers recommends Alternative 3, 50 % Salt Marsh and 50 % Open Water for implementation if off-site disposal is practicable. If off-site disposal is not practicable, the Corps recommends Alternative 6. In addition to their low incremental cost, both alternatives would produce a mixture of habitat types that would support a diversity of fish and wildlife.

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APPENDIX 4
REAL ESTATE REPORT

DEPARTMENT OF THE ARMY
U.S.ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

PRELIMINARY REAL ESTATE COSTS
SECTION 1135 - RESTORATION STUDY

FOR

TOWN POND (aka BOYD'S MARSH)
PORTSMOUTH, RHODE ISLAND

JUNE 2001

PREPARED BY:

Robert P. Abbott
Staff Appraiser

REVIEWED & APPROVED:

James F. Leary
Lead Appraiser

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ADDENDA

COMPARABLE SALES DATA	Exhibit A

AUTHORITY:

Section 1135–Project Modification for Improvement of the Environment: Authorizes modifications to water resources projects constructed by the Corps of Engineers for the improvement of the environment. Non-Federal sponsors are responsible for **25 percent** of the project cost and usually **100 percent** of the operation, maintenance, replacement, and rehabilitation.

Up to **80 percent** of the non-Federal share may be provided as work-in-kind. Non-government entities may serve as the non-Federal sponsor. The Federal per project limit is **$5 million.**

PURPOSE:

The purpose of this project is to restore the **40 acre** estuarine habitat and the associated values to fish and wildlife habitats. Eelgrass provides important habitat for finfish, shellfish, and other aquatic animals.

INSPECTION:

The property being affected by the proposed project was inspected in the field during the week of **4 June 2001** by Mr. Robert P. Abbott, Staff Appraiser, U. S. Army Corps of Engineers, New England District, Real Estate Division.

PROJECT DESCRIPTION:

Restoration of up to **40 acres** of former salt marsh where past Corps activities have degraded the quality of the environment. Disposal activities associated with Fall River dredging choked off virtually all of the former tidal exchange in the former Town Pond area. The project area has subsequently become overgrown with common reed **(Phragmites australis)** and shrubs.

The proposed scheme for restoration of productive salt marsh would include the excavation of new channels south of the existing railway embankment and regrading of the surrounding area to an elevation approximately half way between mean high water and mean sea level **(elevation 1.6 feet NGVD)**. Most of the excavated material would be utilized to construct a berm that would act to segregate the saltwater marsh from freshwater course that flows along the west side of the marsh.

The restoration would provide meaningful and productive ecological improvements to an area that can readily support increased populations of marine life.

The current proposal will mechanically excavate approximately 9500 cubic yards of material to create over 3000 linear feet of new channel. The feasibility report will investigate alternatives of various channel widths and profiles, as well as proposals for site grading, to determine what design criteria will maximize the restoration cost effectively.

COORDINATION:

Salt marsh restoration has been identified as a priority of the Coastal America Regional Implementation Team, and this effort is a Coastal America Project. The Rhode Island Department of Environmental Management has communicated its support of the subject project.

The groups who have participated in meetings held to date are listed below:

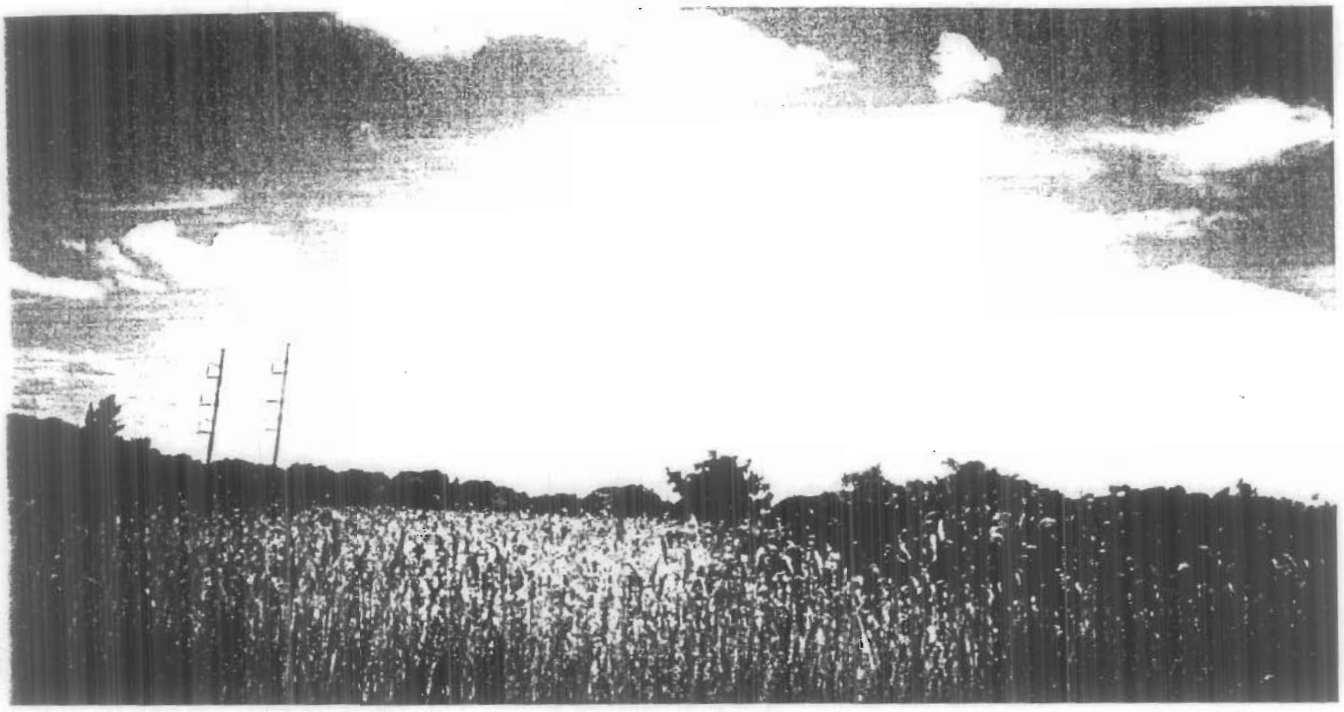
Coastal America Regional Implementation Team
Federal Coastal America Partners
National Marine fisheries Service
U. S. Environmental Protection Agency
Rhode Island Coastal Resources Management Council
Rhode Island Department of Environmental Management
Rhode Island Department of Administration, Office of Planning
Town of Portsmouth, R.I.

VIEWS OF SPONSOR:

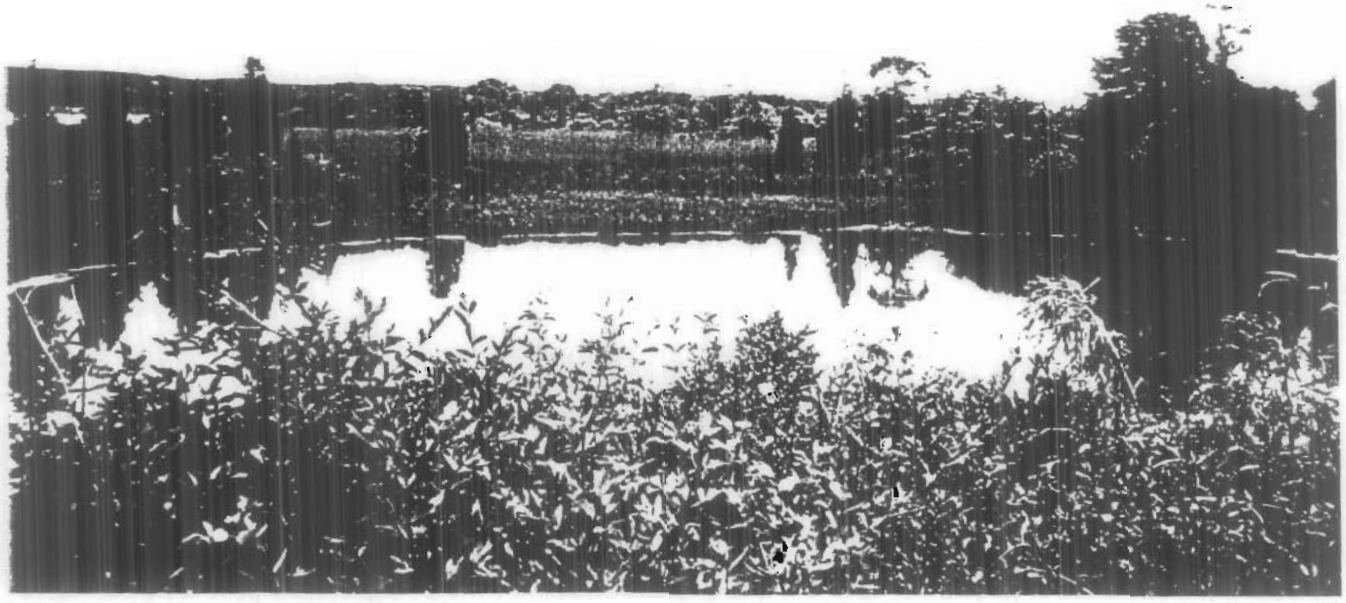
The State of Rhode Island and Providence Plantations, through the Department of Environmental Management, strongly support the initiative to restore the wetlands of Town Pond (aka Boyd's Pond) project. The sponsor realizes the considerable benefits such a project would bring to the Marsh Restoration and requested the Corps to proceed with the feasibility stage study, an indication their intent to work with us in a partnership and a move to secure the State's share of the funding.

PHOTOGRAPHS

Taken by R. Abbott



Town Pond Area



PHOTOGRAPHS

Taken by R. Abbott

Staging Areas

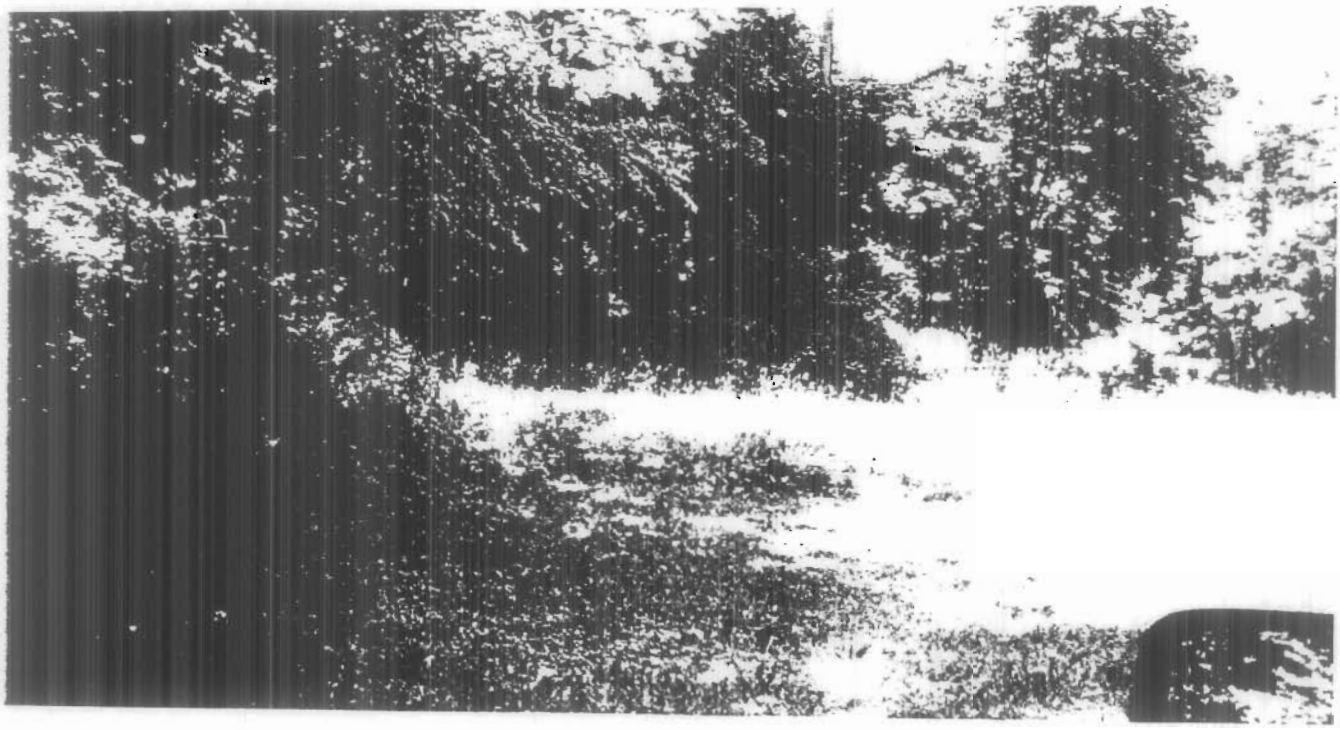
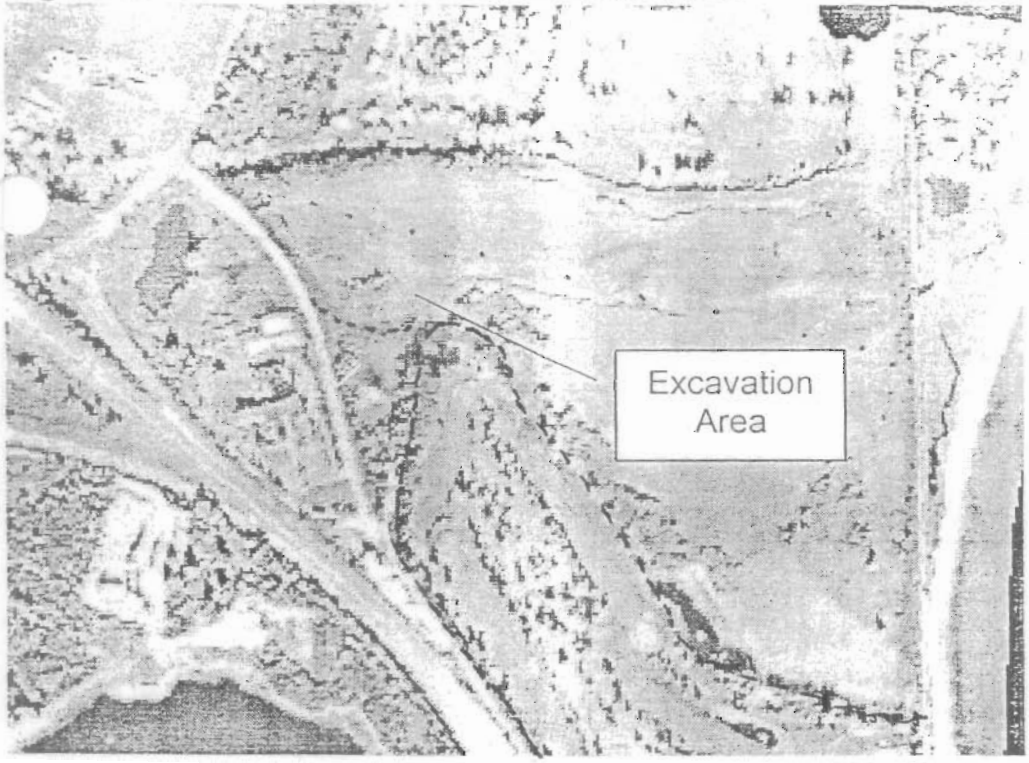
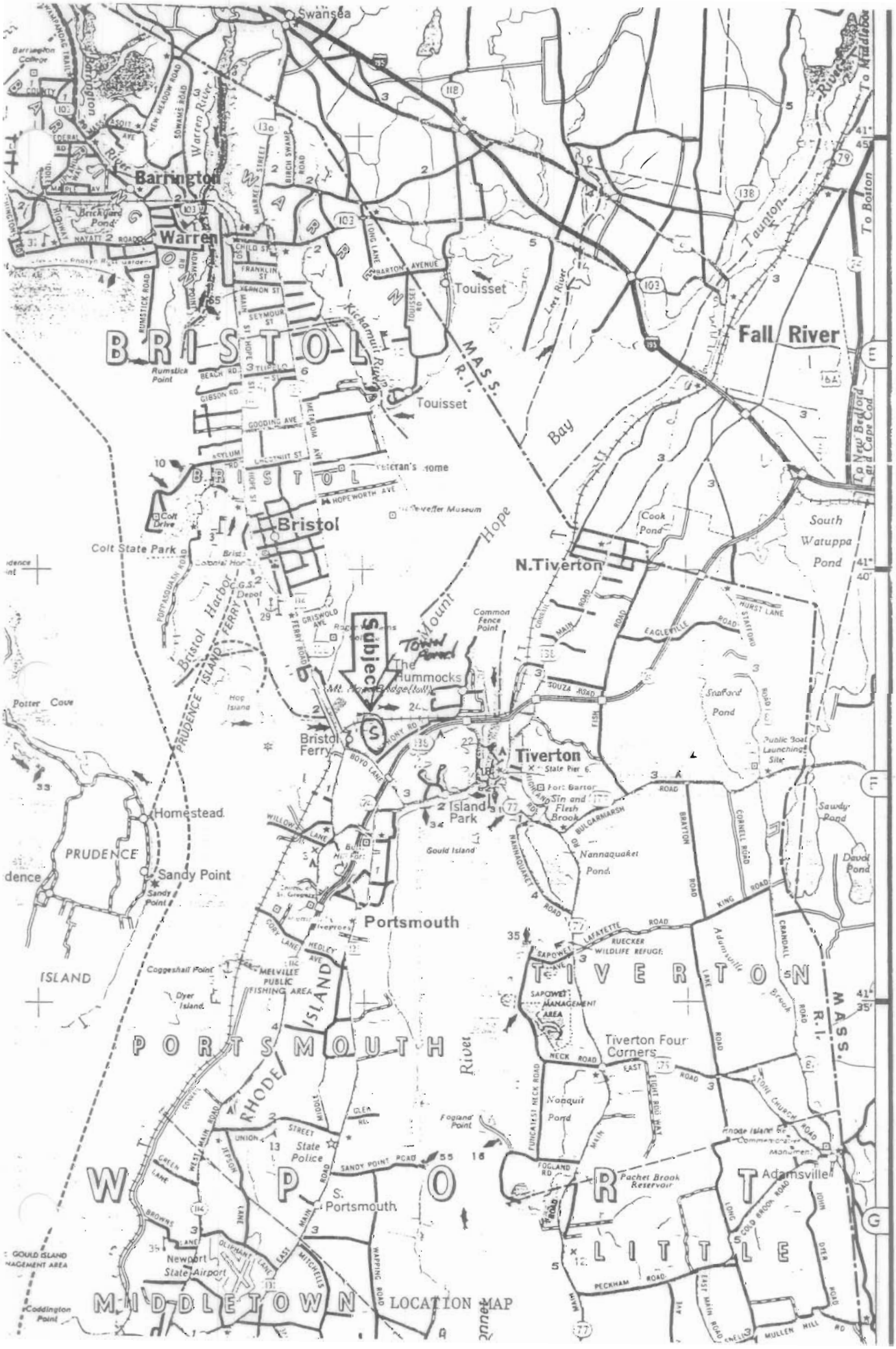


Figure 1. Town Pond Pilot Excavation Area




Swansea
Barrington
Warren
Touisset
Fall River
BRISTOL
Bristol
Colt State Park
Bristol Harbor
Bristol Ferry
Subject
The Hummocks
Mount Hope Bay
N.Tiverton
Tiverton
Island Park
Portsmouth
Homestead
PRUDENCE
Sandy Point
ISLAND
Coggeshall Point
Dyer Island
MELVILLE PUBLIC FISHING AREA
PORTSMOUTH
RHODE ISLAND
S. Portsmouth
Newport State Airport
MIDDLETOWN
Coddington Point
Potter Cove
Hog Island
Gould Island
Common Fence Point
Cook Pond
South Watuppa Pond
Stafford Pond
Sawdy Pond
Devol Pond
Nannaquaket Pond
Nonquit Pond
Pachet Brook Reservoir
Fogland Point
Tiverton Four Corners
Adamsville
LITTLE COMPTON
Fort Barton
Sin and Flesh Brook
Public Boat Launching Site
State Pier 6
Veteran's Home
Kickamuit River
Lees River
Taunton River
Warren River
Rumstick Point
Brickyard Pond
Barrington College
To Boston
To New Bedford and Cape Cod
To Middleboro
MASS.
R.I.
LOCATION MAP

GOVERNMENT OWNED FACILITIES:

Section III of the Act of Congress approved July 8, 1958 **(PL 85-500)** authorized the protection, realteration, reconstruction, relocation or replacement of municipally-owned facilities. A preliminary inspection of the property area indicated no Government-owned facilities are affected.

PROTECTION AND ENHANCEMENT OF CULTURAL ENVIRONMENT:

Upon review, a determination will be made if an Environmental Impact Statement for the proposed restoration project is required or not, under the provisions of the **National Environmental Policy Act of 1969.**

ENDANGERED SPECIES:

Coordination with the U. S. Fish and Wildlife Service and National Marine Fisheries Service will be conducted in compliance with the **Endangered Species Act of 1973** to determine whether there are Federally listed endangered or threatened species in the area of the proposed projects. Coordination with the Rhode Island Department of Environmental Management will be conducted to determine whether there are State-listed species in the project areas.

CLEAN WATER ACT:

A Clean Water Act, Section 404(b)(1) evaluation will be completed for the project. State Water Quality Certification will be obtained prior to implementation.

RIGHTS TO BE ACQUIRED:

The Local Sponsor will be required to provide all lands, easements, rights-of-way, relocations, and disposal areas (LERRDS) necessary for project purposes.

FEE ACQUISITION:

The highest type of interest in real estate is complete ownership, known as ownership in fee simple, or in fee simple absolute. There are no fee acquisitions with this project.

PERMANENT EASEMENT AREAS:

Permanent easements areas for construction and maintenance purposes will be necessary. Preliminary investigation indicates permanent easement area will total approximately **fourty (40+) acres** involving **one (1) ownership** and will be needed for the proposed project for the **Town Pond area**.

TEMPORARY EASEMENTS:

Temporary Easements involving **two (2)** ownerships for **four (4) acres,** will be required for staging areas.

CONTINGENCIES:

A contingency allowance of **25 percent** is considered to be reasonably adequate to provide for possible appreciation of property values from the time of this estimate to the acquisition date, for possible minor property line adjustments or for additional hidden ownership's which may be developed by refinement to taking lines, for adverse condemnation awards and to allow for practical and realistic negotiations.

ACQUISITION COSTS:

Acquisition costs will include Sponsor's **costs for mapping, surveying, legal description, title evidence, appraisals, negotiations, closing and administrative costs for possible condemnations**. The **acquisition costs** are based upon this office's experience in similar civil works projects in the general area and are estimated at **$7,500 per ownership**. A total of **two (2)** ownerships will be affected by the project.

EXECUTIVE ORDER 11988 FLOOD PLAIN MANAGEMENT:

This project is located in a floodplain zoned area.

RELOCATION COSTS:

Public Law 91-646, Uniform Relocations Assistance Act of **1970,** provide for uniform and equitable treatment of persons displaced from their homes, businesses, or farms by a Federally Assisted Program. It also established uniform and equitable land acquisitions policies for these projects. Included among the items under **PL 91-646** are following:

a. Moving Expenses

b. Relocation Allowance (Business)

c. Replacement Housing (Tenants)

d. Relocation Advisory Services

e. Recording Fees

f. Transfer Taxes

g. Mortgage Prepayment Costs

h. Real Estate Tax Refunds (Pro-Rata)

The land is unimproved and preliminary investigations indicate that there are no owners will require relocation assistance at this time. Should the existing preliminary taking lines be changed to include improvements, then the taking authority must certify that there will be available, in areas generally not less desirable and at rents/prices within the financial means of the those that would be displaced, decent, safe, and sanitary facilities, equal in number to the number of, and available to, such displaced persons who require such dwellings and reasonably accessible to their places of employment. The ownerships affected by the permanent easement interests vary according to the plan and are reflected in the real estate costs.

Therefore, final estimates will include, for planning purposes, an estimate of **$250.00 per ownership** carried for planning purposes and limited to the expenses, incidental to the transfer of real estate interests.

SEVERANCE DAMAGES:

Severance damages usually occur when partial takings are acquired which restrict the remaining portion from full economic development. The severance damages are measured and estimated on the basis of a **"Before"** and **"After"** appraisal method and will reflect actual value loss incurred to the remainder as a result of partial acquisition. Detailed appraisals will reflect these losses.

EVALUATION AND CONCLUSION:

A careful and thorough search of the Town of Portsmouth, Rhode Island and Registry of Deeds records was made to obtain sales data.

Considerable effort was made to interview either grantor or grantee to establish the authenticity of each transaction. The sales were inspected in the field. Real Estate appraisers, broker's and knowledgeable officials of each town were interviewed to obtain sales data used in arriving at the estimated values for this report. Those sales considered to be similar in nature and character to the properties which will be affected by the proposed project are listed in the addenda of this report.

The proposed **temporary easement areas,** total approximately **four (4) acres of undeveloped land,** adjacent to the project, was estimated by the appraiser as having a **$ 30,000.00 per acre** value. A fair return of **10%** on the **$ 120,000.00** estimated market value **amounted to $ 12,000.00 annually** for use of the subject properties for staging purposes.

According to the City's Assessor, wetland sales ranged from **$ 2,000.00** to **$ 3,000.00** per acre. A nominal value of **$ 2,500 per acre** was used in estimating the market value for the permanent easement area. **The Permanent Easement area consists of 40 acres** for a total estimated market value of **$ 100,000.00.** It is the appraiser's opinion, that the Permanent Easement Value was equal to **50%** of the Fee Value, for a total of **$50,000.00** due to the project's purpose and requirements.

The following sales of land were utilized and analyzed in arriving at the market value for the temporary easement interests.

COMPARABLE SALES

	COMP 1	COMP2	COMP3	COMP4
Address:	Wapping Road Portsmouth,R.I.	Briarwood Ln Portsmouth,R.I.	West Main Rd Portsmouth,R.I.	Old Mill Ln Portsmouth,R.I.
Zoning:	Residential	Residential	Residential	Residential
Date:	9/2000	7/2000	4/2000	8/2000
Size:	7.5+acres	5.8+acres	5.74+acres	3.01+acres
Price:	$ 225,000.-	$ 160,000.-	$ 170,000.-	$ 90,000.-
Unit Cost:	$ 30,000.-	$ 28,674.-	$ 29.617.-	$ 29,900.-

Comparable Sale No: 1 was considered by the appraiser as most comparable to the subject based on it's location, access and topography. Sales 2,3,and 4 were some what Similar in size and location.

PRELIMINARY REAL ESTATE PLANNING REPORT
TOWN POND, aka BOYD'S MARSH
PORTSMOUTH, RHODE ISLAND

SUMMARY

FEE VALUE: (LAND & IMPROVEMENTS)	$ 0
PERMANENT EASEMENT VALUE: (40 Acres x $2,500 per acre – 50%=)	$ 50,000.00
TEMPORARY EASEMENT VALUE: (4.0 Acres x $ 30,000 per acre - 10%=)	$ 12,000.00
CONTINGENCY: (25%)	$ 15,500.00
SUBTOTAL:	$ 77,500.00
ACQUISITION COSTS: (2 Ownwerships X $ 7,500.00=)	$ 15,000.00
RELOCATION COSTS: (None)	$ 0
SEVERANCE DAMAGES:	$ 0
MISC. COSTS	$ 500.00
ESTIMATED REAL ESTATE VALUE	$ 93,000.00
CALL	$ 95,000.00

ADDENDA

Exhibit A

COMPARABLE SALE No.1

Grantee: Kielbasa, Robert & Grady, Roger

Grantor: Corey, Mary

Address: Wapping Road, Portsmouth, Rhode Island

Sales Price: $ 225,000.00

Sales Date: 9/2000

Size: 7.5+ Acres

Unit Price: $ 30,000.00

Zoning: Residential

Map: 66-13

Verfied: Town Assessor

COMPARABLE SALE No.2

Grantee: Miller, Charles E.

Grantor: Medeiros, Micheal & Dietra

Address: Briarwood Lane, Portsmouth, Rhode Island

Sales Price: $ 160,000.00

Sales Date: 7/2000

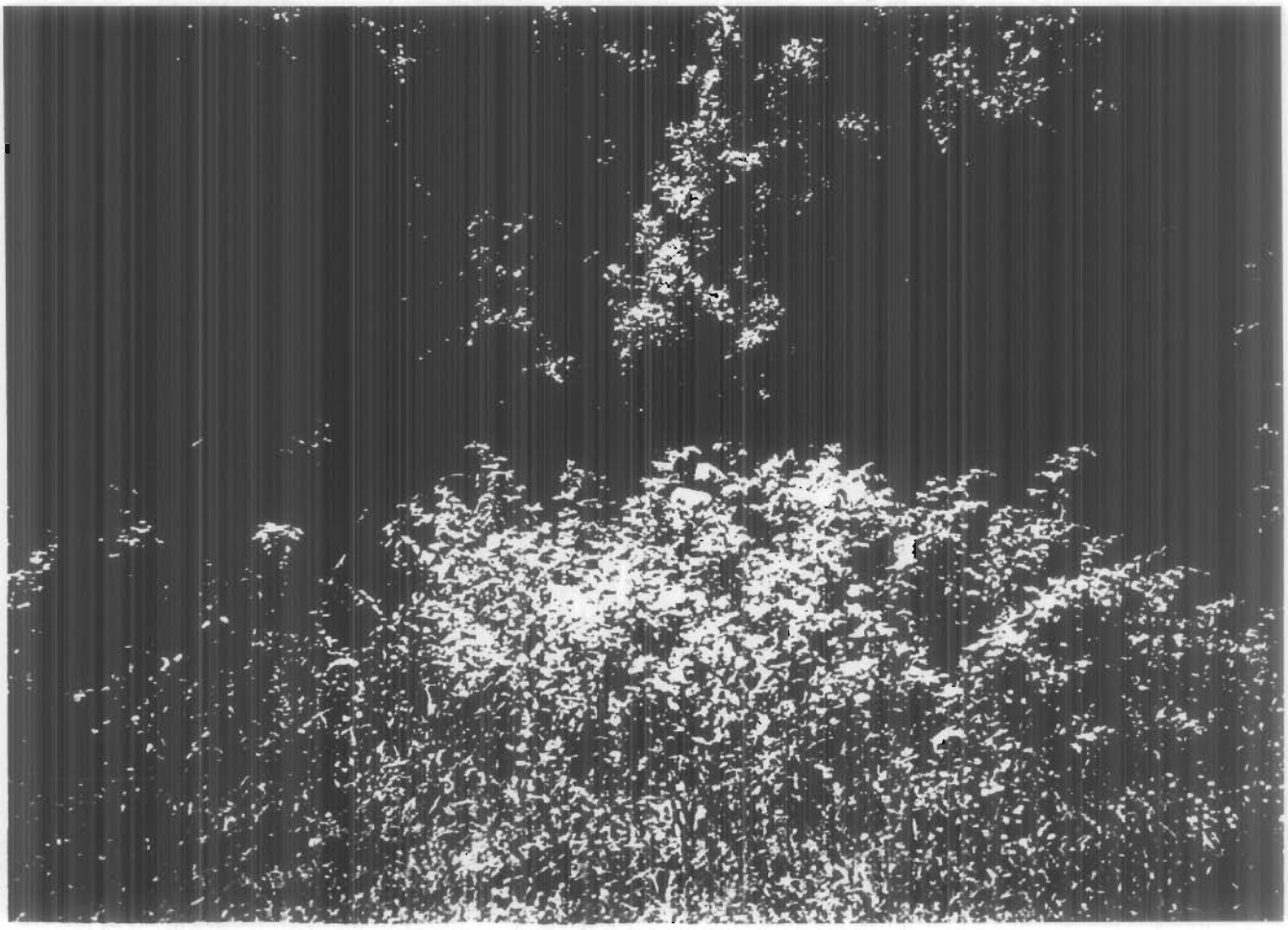
Size: 5.8+ Acres

Unit Price: $ 28,674.00

Zoning: Residential

Map: 66-13

Verfied: Town Assessor



COMPARABLE SALE No.3

Grantee: Roderigues, Lark F.

Grantor: Caplin, Robert W.

Address: West Main Road, Portsmouth, Rhode Island

Sales Price: $ 170,000.00

Sales Date: 4/2000

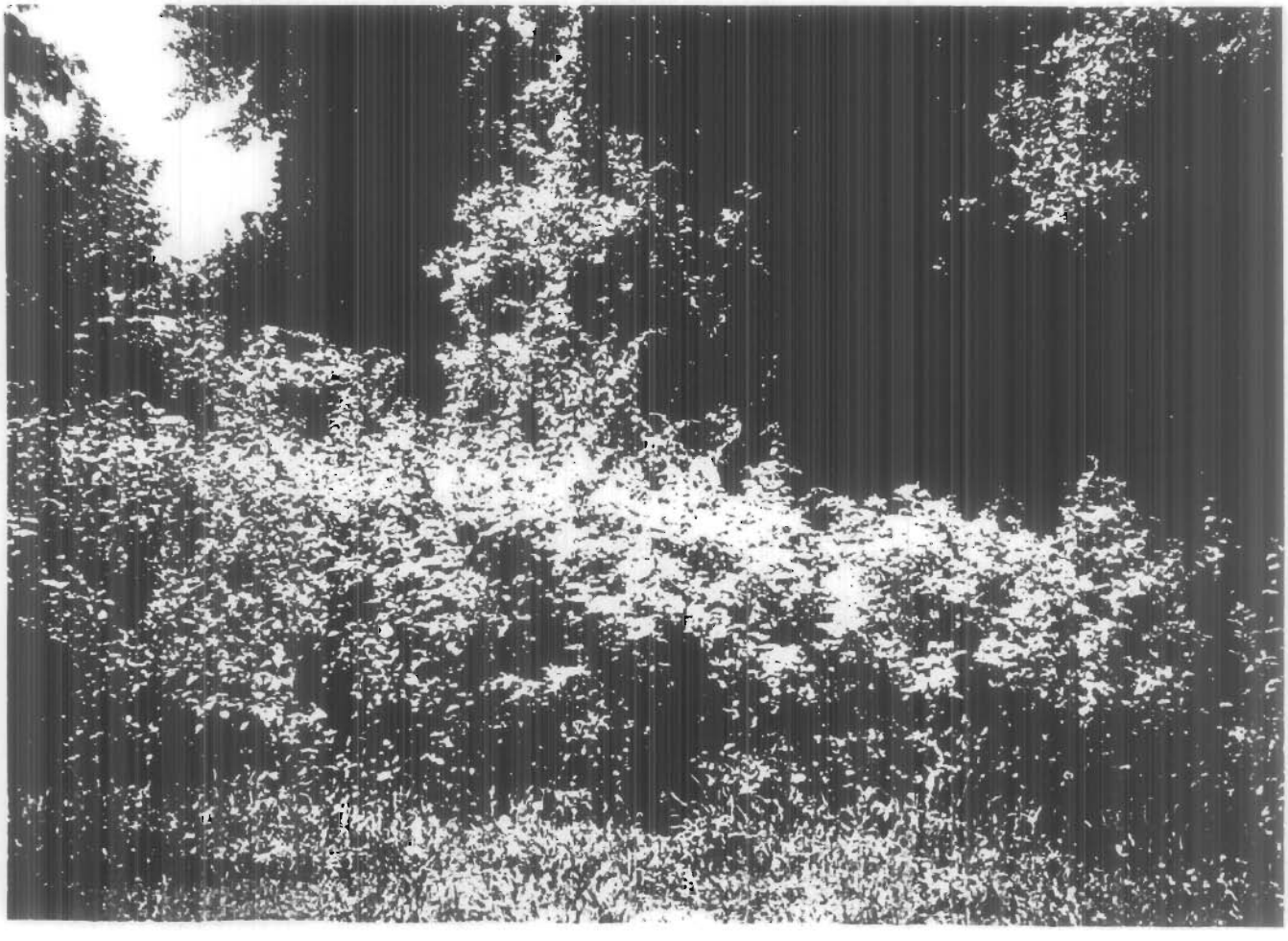
Size: 5.74+ Acres

Unit Price: $ 29,617.00

Zoning: Residential

Map: 44-10

Verfied: Town Assessor



COMPARABLE SALE No.4

Grantee: Silva, L & F

Grantor: Gomas, Louis & Margaret.

Address: Old Mill Road, Portsmouth, Rhode Island

Sales Price: $ 90,000.00

Sales Date: 8/2000

Size: 3.01 + Acres

Unit Price: $ 29,900.00

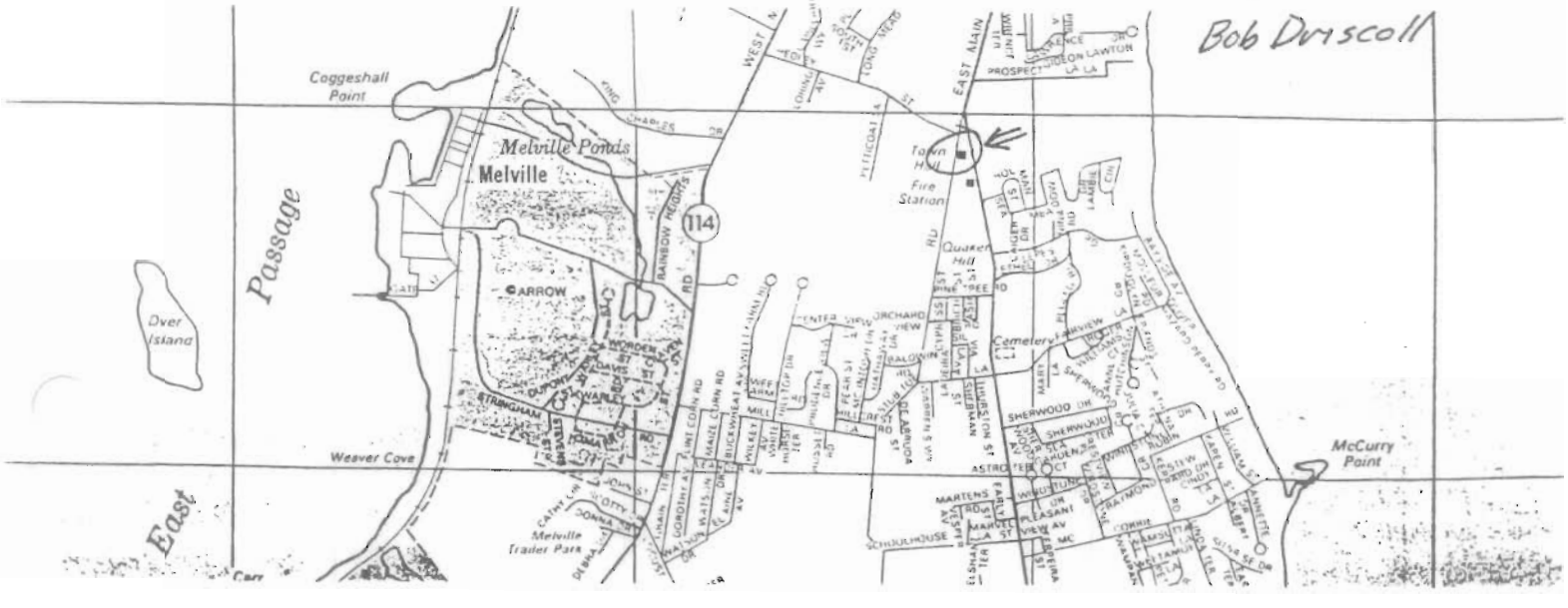
Zoning: Residential

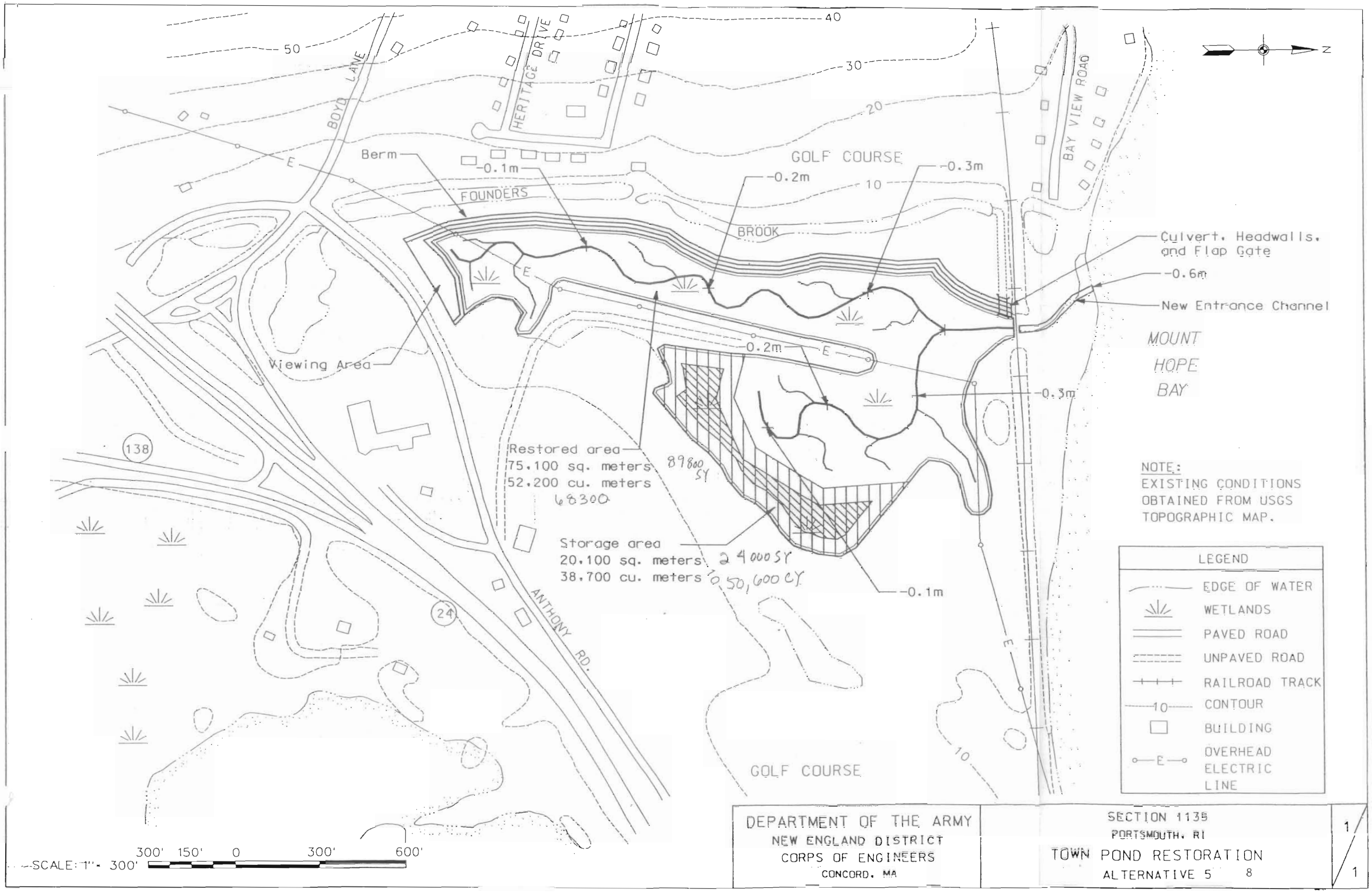
Map: 67-72

Verfied: Town Assessor

Town Admin.

Bob Driscoll




40
50
30
20
10
BOYD LANE
HERITAGE DRIVE
BAY VIEW ROAD
N
GOLF COURSE
FOUNDERS
BROOK
Berm
-0.1m
-0.2m
-0.3m
Culvert, Headwalls, and Flap Gate
-0.6m
New Entrance Channel
MOUNT HOPE BAY
Viewing Area
-0.2m
-0.3m
Restored area
75,100 sq. meters
52,200 cu. meters
68300
89800 SY
Storage area
20,100 sq. meters
38,700 cu. meters
24000 SY
50,600 CY
-0.1m
138
24
ANTHONY RD.
GOLF COURSE
NOTE:
EXISTING CONDITIONS OBTAINED FROM USGS TOPOGRAPHIC MAP.
LEGEND
EDGE OF WATER
WETLANDS
PAVED ROAD
UNPAVED ROAD
RAILROAD TRACK
CONTOUR
BUILDING
OVERHEAD ELECTRIC LINE
SCALE: 1" = 300'
300' 150' 0 300' 600'
DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MA
SECTION 1135
PORTSMOUTH, RI
TOWN POND RESTORATION
ALTERNATIVE 5
8
1/1

APPENDIX 5
STRUCTURAL REPORT

BOYD'S MARSH

RESTORATION STUDY

INLET & OUTLET

HEADWALL/WINGWALL

May 2001

Joe C.

N

BOYD LANE

HERITAGE DRIVE

BAY VIEW ROAD

ANTHONY RD.

Berm

GOLF COURSE

GOLF COURSE

INLET

OUTLET

MOUNT HOPE BAY

138

24

50

40

30

20

10

E

NOTE:
EXISTING CONDITIONS OBTAINED FROM USGS TOPOGRAPHIC MAP.

LEGEND	
	EDGE OF WATER
	WETLANDS
	PAVED ROAD
	UNPAVED ROAD
	RAILROAD TRACK
10	CONTOUR
	BUILDING
E	OVERHEAD ELECTRIC LINE

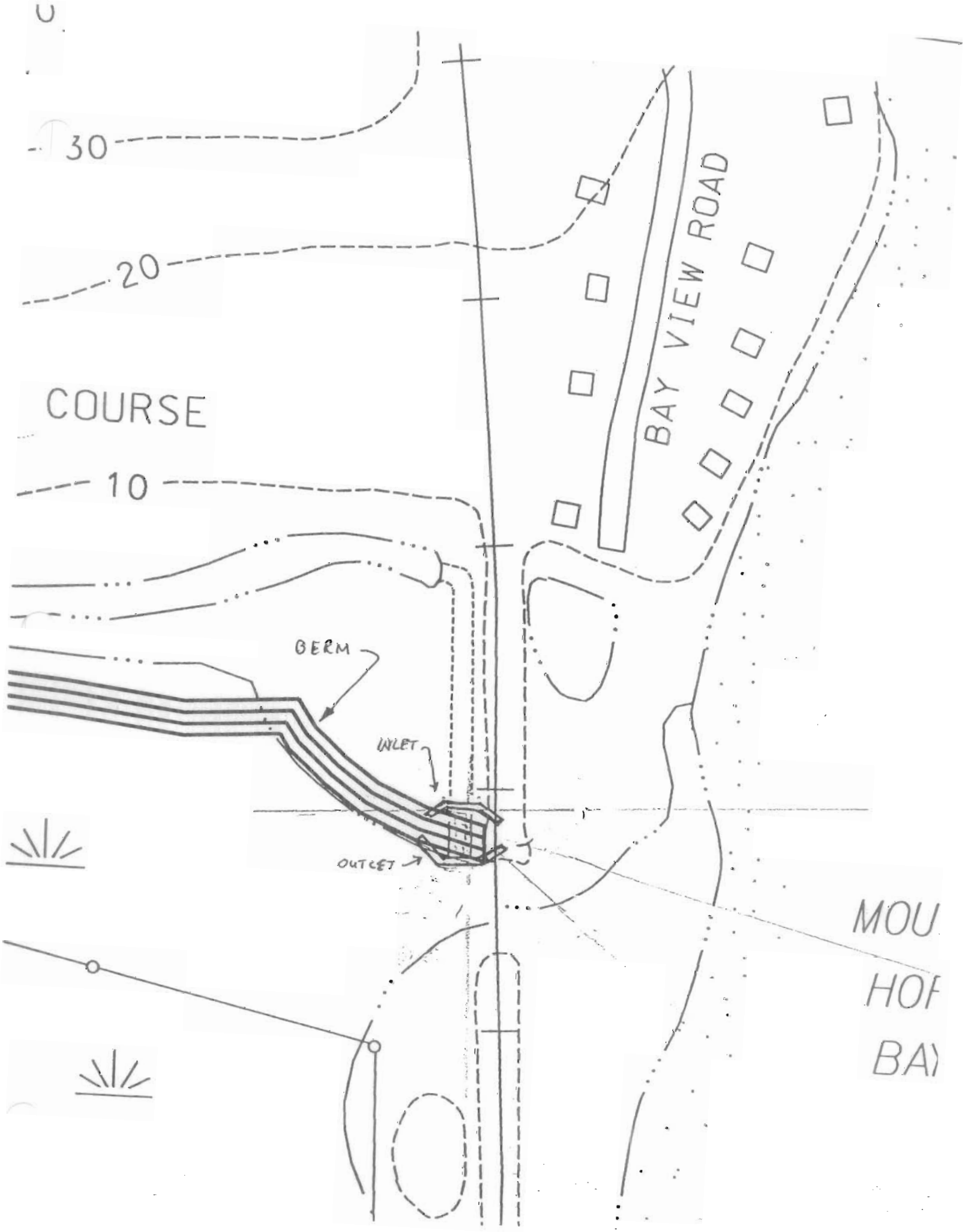
SCALE: 1" = 300'

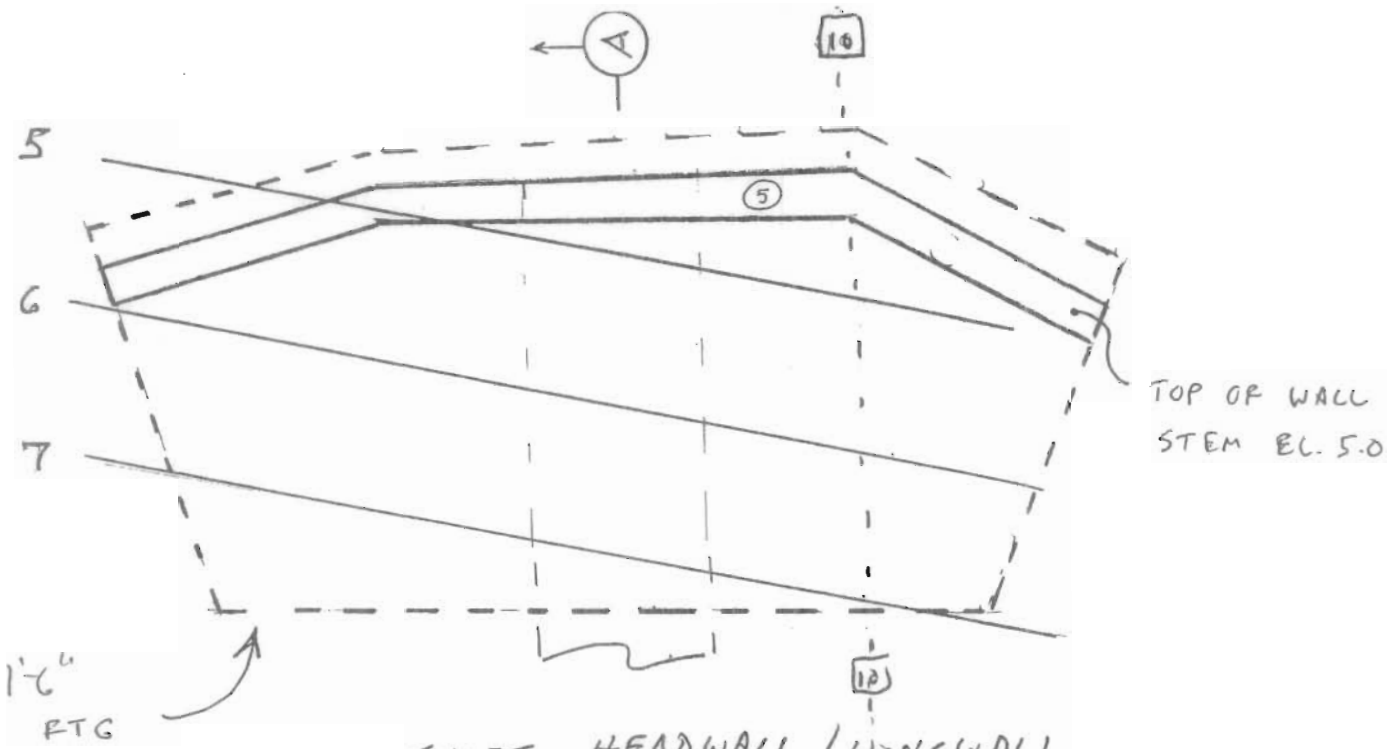
300' 150' 0 300' 600'

DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT
CORPS OF ENGINEERS
CONCORD, MA

SECTION 1135
PORTSMOUTH, RI
TOWN POND RESTORATION

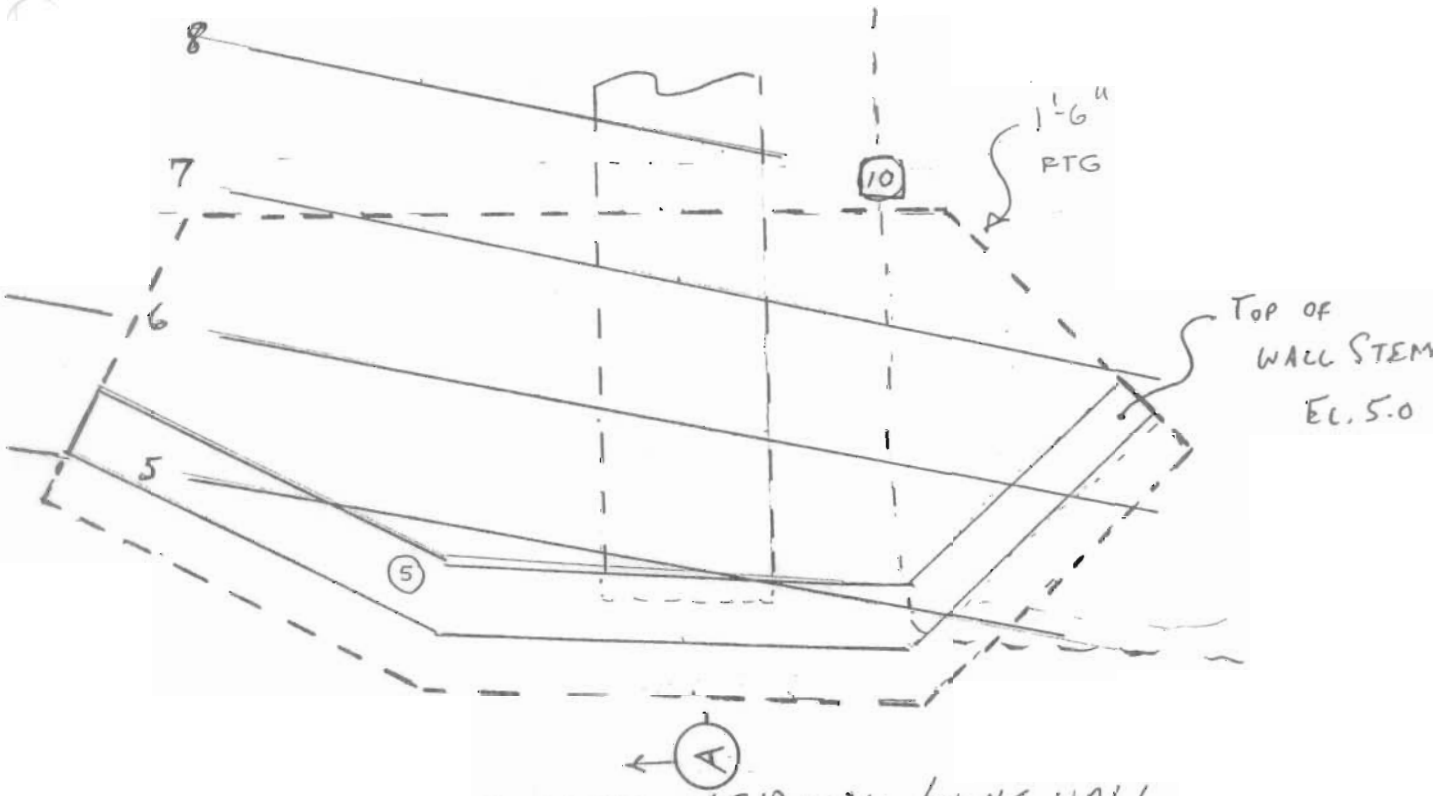
1/1


30
20
COURSE
10
BAY VIEW ROAD
BERM
INLET
OUTLET
MOU
HOF
BA



INLET HEADWALL / WINGWALL

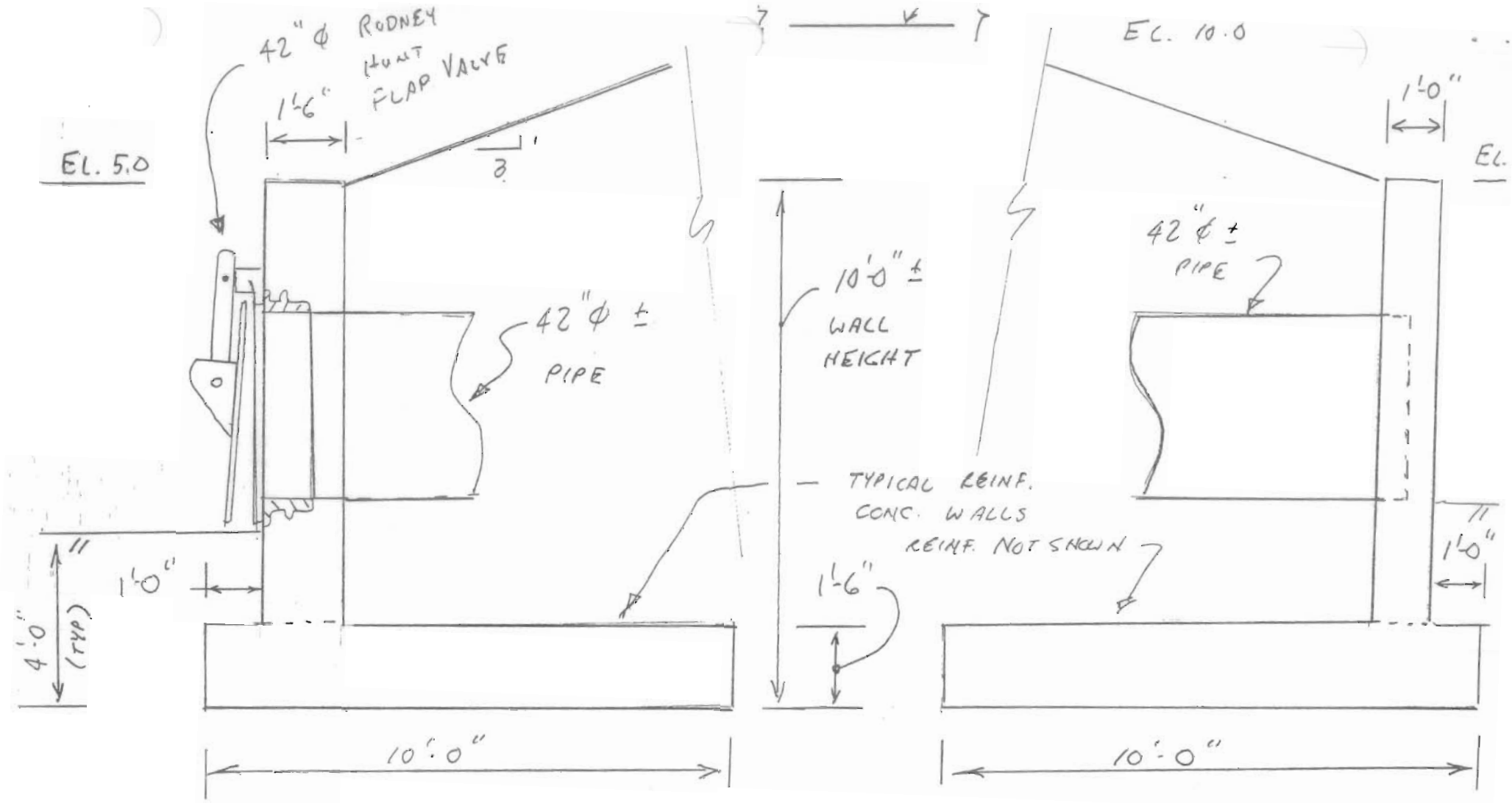
SCALE 1/4" = 1'-0"



OUTLET HEADWALL/WING WALL

W/ FLAP GATE

SCALE 1/4" = 1'-0"



OUTLET HEADWALL/WING WALL
SCALE 3/8" = 1'-0"

INLET HEADWALL/WINGWALL
SCALE 3/8" = 1'-0"

BOYD'S MARSH
REINF. CONC.
HEADWALL QUANTITIES

INLET	FOOTING	12 C.Y.
	STEM	10 C.Y.
OUTLET	FOOTING	12 C.Y.
	STEM	15 C.Y.

OUTLET FLAP VALVE

RODNEY HUNT SERIES FV-AC
42" Ø
MOUNTED TO CAST IRON WALL THIMBLE

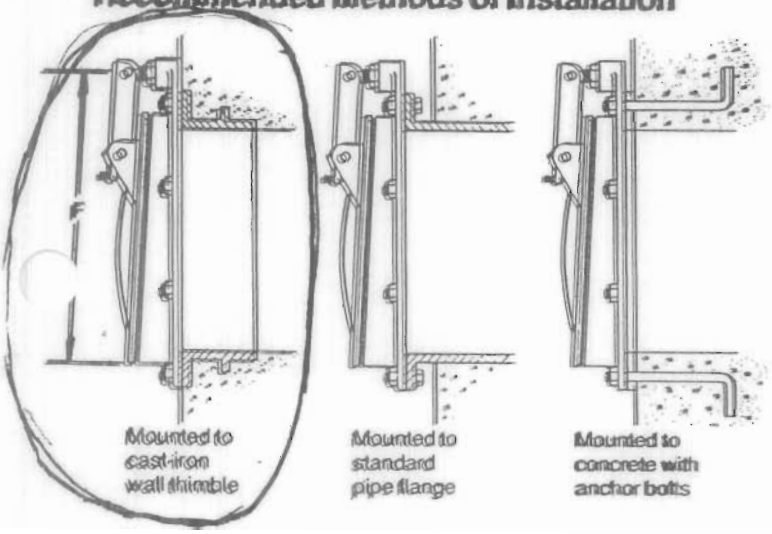
Flap Valves
Series FV-AC

Circular Opening for Gravity Flow Conditions

The Rodney Hunt Series FV-AC Circular Flap Valves are designed to withstand the stresses resulting from high seating head conditions and to maintain sensitivity to unseating heads. The cast-iron body and cover are furnished with either bronze seats or a resilient seat bonded directly into the body.

Series FV-AC Circular Flap Valves are available in sizes with openings from 4-inch diameter to 96-inch diameter and can be attached directly to pipe flanges, wall thimbles or concrete.

Recommended Methods of Installation



SPECIFICATIONS

The Flap Valve, size as indicated on the drawings, will be flange framed with resilient or bronze seats, Rodney Hunt Series FV-AC. The body will be cast-iron, ASTM A126-B.

Bronze seats ASTM B21-CA464 or ASTM B133-CA110, will be pneumatically impacted into dove-tailed grooves machined in the cast-iron body and cover and machined to a 63 micro-inch finish for maximum water tightness.

Resilient seat, neoprene or Buna-N, when specified, will be bonded in a groove machined in the body to provide a wide seating surface for the seat machined in the cover.

The cover, or flap, will be cast-iron, ASTM A126-B, with spherically dished design to withstand maximum operating loads. The hinge arms will be high-tensile bronze, ASTM B584-CA865. The hinge pins, designed in double shear, will be silicon bronze, ASTM B98-CA655, or Type 304 stainless steel. Each hinge arm will have two pivot points, an adjustable lower pivot with limited rotation and a threaded upper hinge post to adjust flap valve sensitivity. A lubrication fitting will be supplied for each pivot.

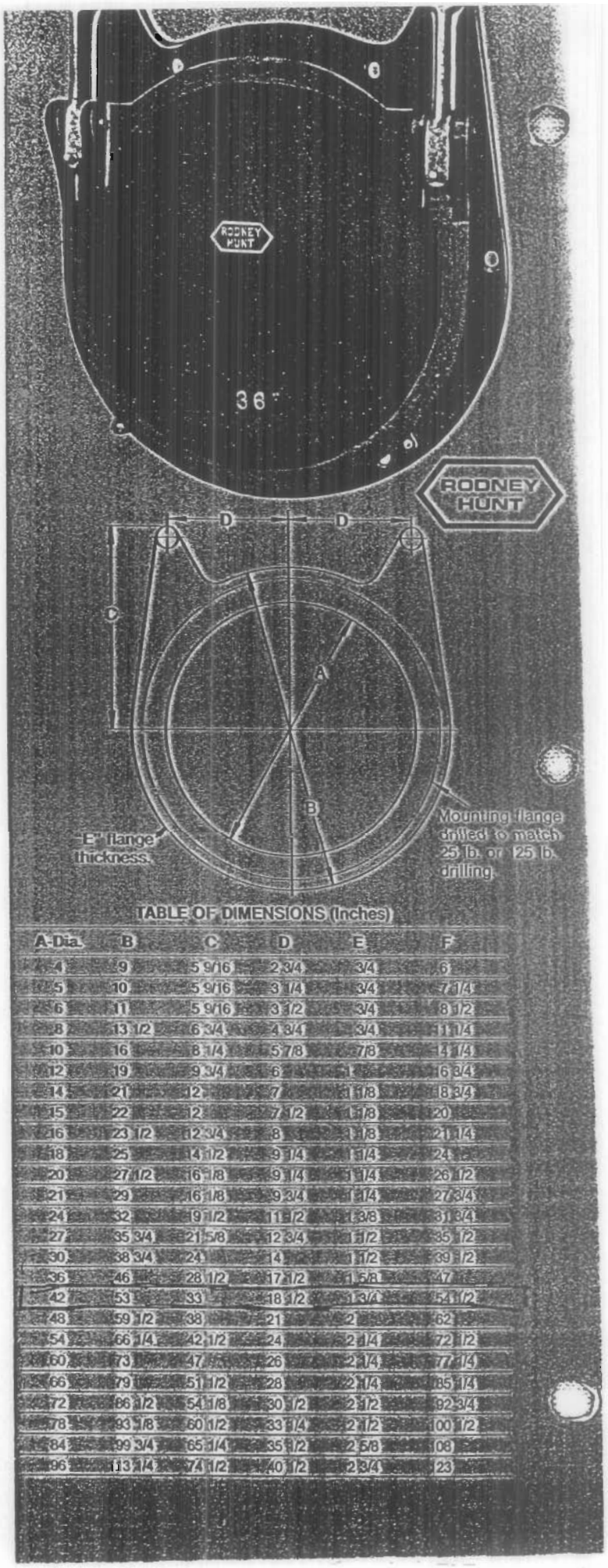


TABLE OF DIMENSIONS (Inches)

A-Dia.	B	C	D	E	F
4	9	5 9/16	2 3/4	3/4	6
5	10	5 9/16	3 1/4	3/4	7 1/4
6	11	5 9/16	3 1/2	3/4	8 1/2
8	13 1/2	6 3/4	4 3/4	3/4	11 1/4
10	16	8 1/4	5 7/8	7/8	14 1/4
12	19	9 3/4	6	1	16 3/4
14	21	12	7	1 1/8	18 3/4
15	22	12	7 1/2	1 1/8	20
16	23 1/2	12 3/4	8	1 1/8	21 1/4
18	25	14 1/2	9 1/4	1 1/4	24
20	27 1/2	16 1/8	9 1/4	1 1/4	26 1/2
21	29	16 1/8	9 3/4	1 1/4	27 3/4
24	32	19 1/2	11 1/2	1 3/8	31 3/4
27	35 3/4	21 5/8	12 3/4	1 1/2	35 1/2
30	38 3/4	24	14	1 1/2	39 1/2
36	46	28 1/2	17 1/2	1 5/8	47
42	53	33	18 1/2	1 3/4	54 1/2
48	59 1/2	38	21	2	62
54	66 1/4	42 1/2	24	2 1/4	72 1/2
60	73	47	26	2 1/4	77 1/4
66	79	51 1/2	28	2 1/4	85 1/4
72	86 1/2	54 1/8	30 1/2	2 1/2	92 3/4
78	93 1/8	60 1/2	33 1/4	2 1/2	100 1/2
84	99 3/4	65 1/4	35 1/2	2 5/8	108
96	113 1/4	74 1/2	40 1/2	2 3/4	123

General Features of Rodney Hunt Flap Valves

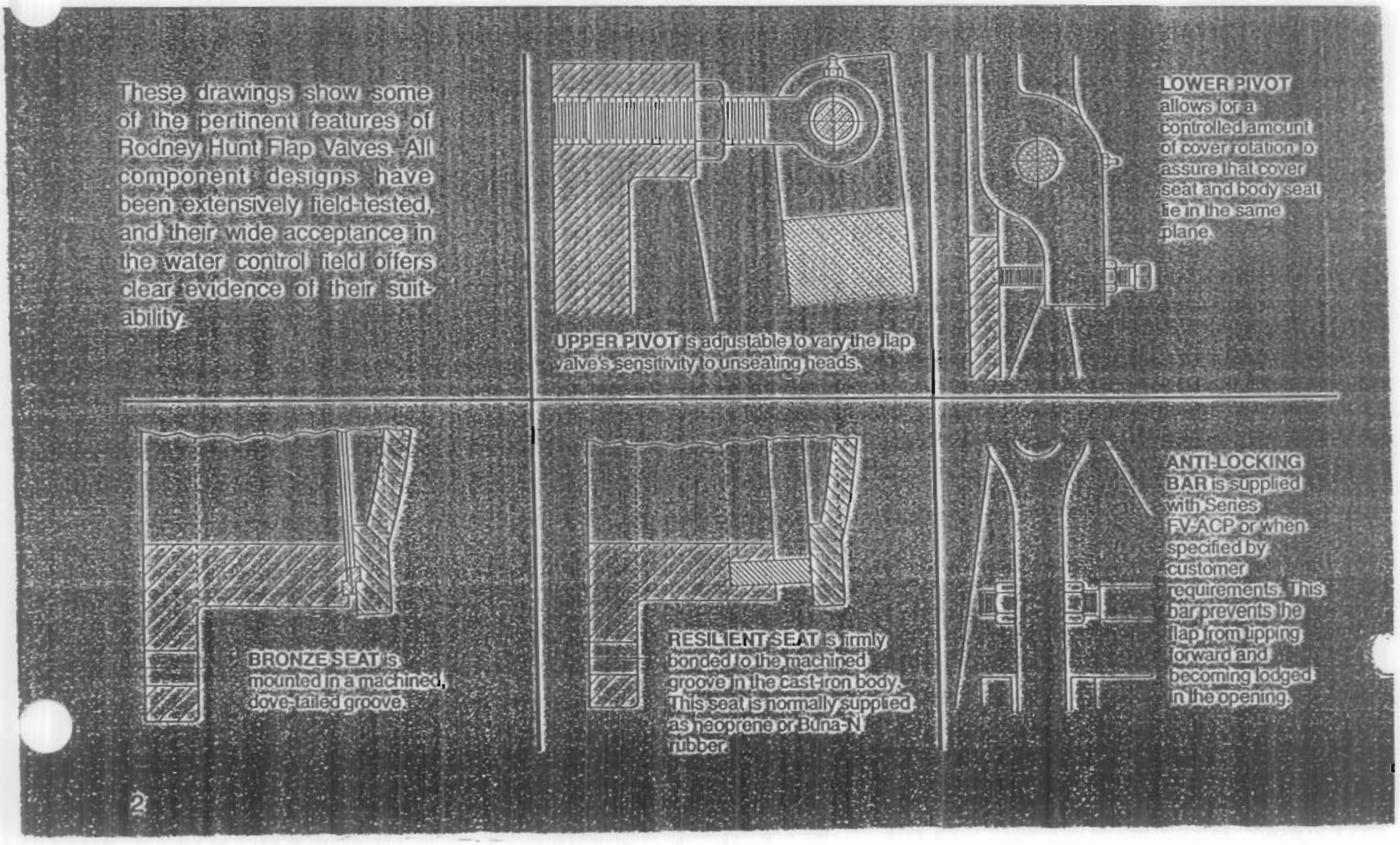
Rodney Hunt Circular and Rectangular Flap Valves are designed to withstand the stresses resulting from high seating head conditions and to maintain maximum sensitivity to unseating heads. These flap valves are found in sewage treatment plants, water purification projects, drainage projects, dry docks, locks, tanks and many other kinds of installations. Because of our past experience in furnishing valves for a wide variety of applications, Rodney Hunt is equipped to design and manufacture flap valves to meet almost any requirement.

These flap valves have many noteworthy features, some of which are illustrated below. The cast-iron body and cover are furnished with either bronze seats or a resilient seat bonded into the body. The hinge arms are high-strength bronze of a double pivot-point design. The lower pivot allows for a controlled amount of cover rotation to assure that the cover seat and the body seat lie in the same plane. The upper pivot point is adjustable to vary the flap valve's sensitivity to unseating heads. The cover on the circular flap valve is spherically dished for maximum strength and rigidity with minimum weight. All Rodney Hunt Flap Valves are furnished with a machined back flange so that they can be attached directly to pipe flanges, wall thimbles or concrete. These flap valves have been extensively tested to arrive at the best design that combines minimum head loss with maximum sensitivity.

Sensitivity

The design of the Rodney Hunt flap valve makes it un-

Design and Construction Details

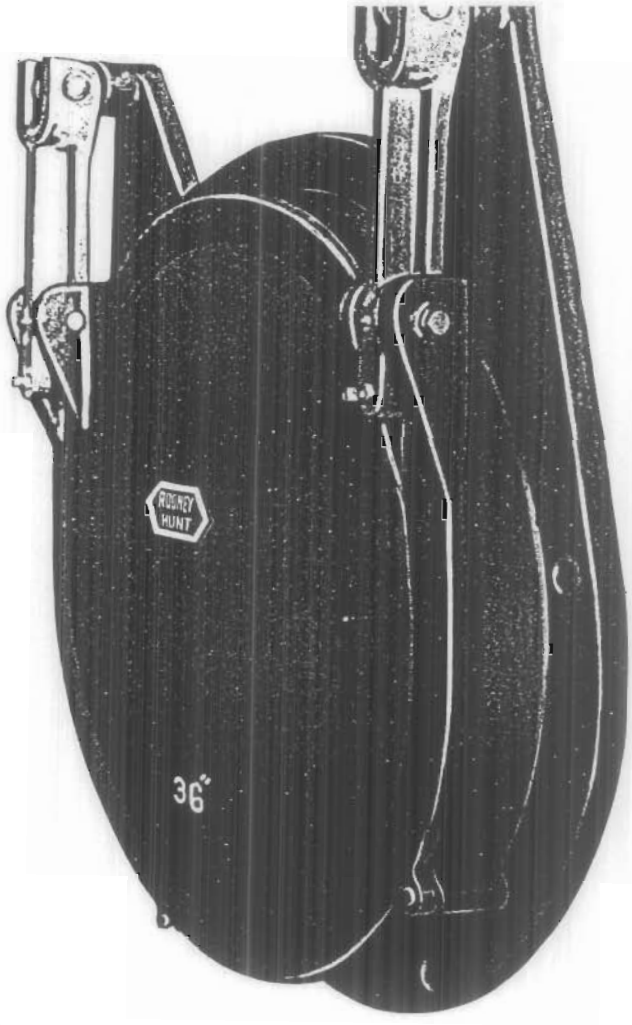


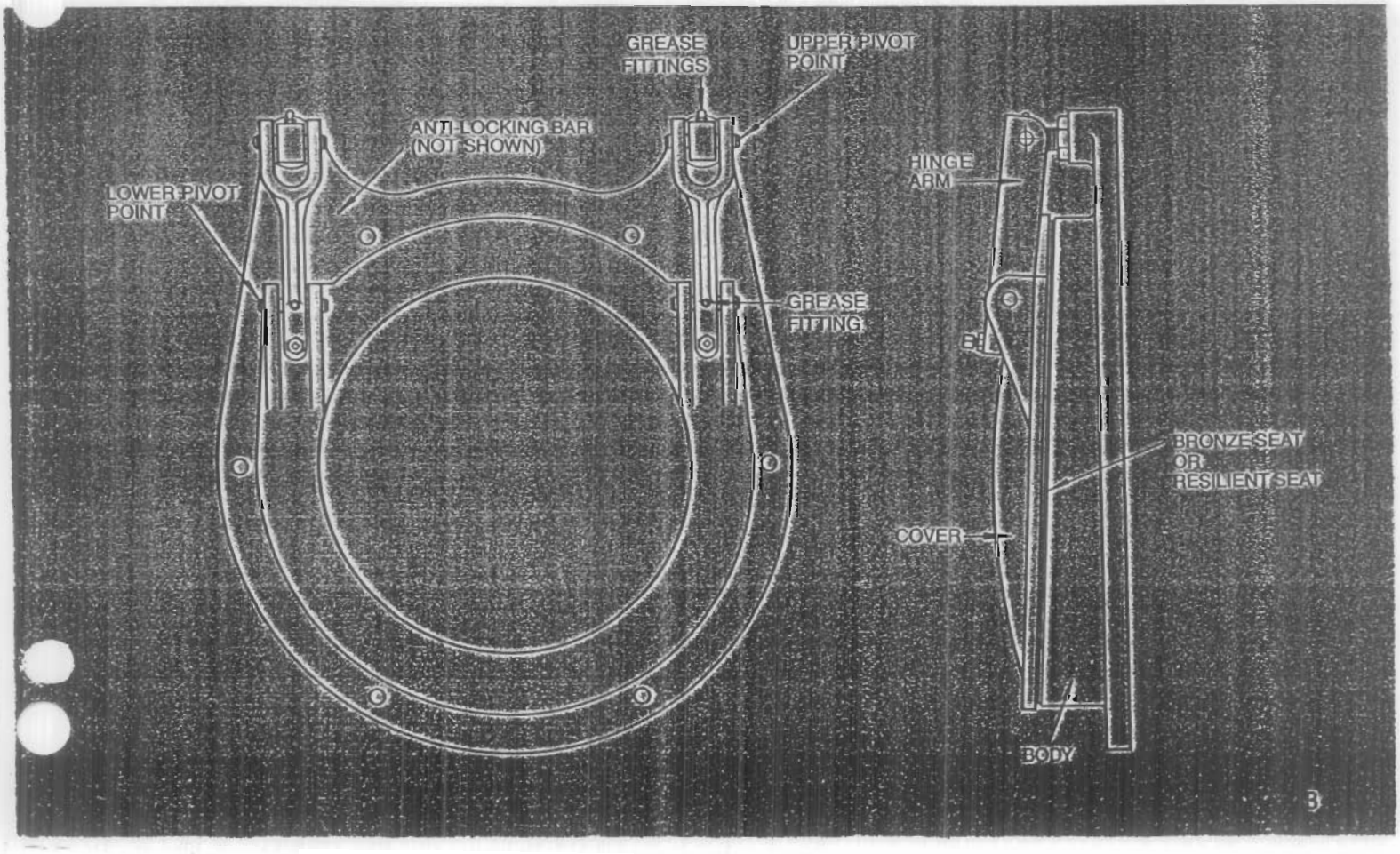
usually sensitive to low unseating head conditions. Tests and experience indicate that the flap valve will open when there is a differential head across the flap of 0.2 feet or less.

Head Loss

The head loss through a flap valve is dependent upon the degree of opening of the valve. In general, tests have shown that the head loss due to the flap is not measurable with a gate discharging into the atmosphere.

With the flap valve submerged, the head loss does not exceed 0.3 feet. The exit loss for the flap valve must be taken into account, but the loss due to the flap alone is very low.





APPENDIX 6
MCASES COST ESTIMATE FOR RECOMMENED ALTERNATIVE

TOWN POND FEASIBILITY COST ESTIMATES

	ALT 2	ALT 3	ALT 4A	ALT 4B	ALT 5	ALT 6
CONSTRUCTION COST (INCL ESC & CONT)	$2,331,000	$3,186,000	$2,969,000	$3,463,000	$1,625,000	$1,867,000
E & D DURING CONSTRUCTION	$123,000	$184,000	$174,000	$203,000	$84,000	$107,000
S & A	$174,000	$260,000	$246,000	$287,000	$119,000	$152,000
REAL ESTATE	$95,000	$95,000	$95,000	$95,000	$95,000	$95,000
FEASIBILITY STUDY	$177,000	$177,000	$177,000	$177,000	$177,000	$177,000
PLANS & SPECS PHASE	$152,000	$152,000	$152,000	$152,000	$152,000	$152,000
TOTAL COST*	**$3,052,000**	**$4,052,000**	**$3,812,000**	**$4,377,000**	**$2,252,000**	**$2,551,000**

*Includes Rounding Fix to match MCACES Cost Estimate Bottom Line Cost

Town Pond FS - ALT 2
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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Release 1.2c

This project is a portion of the Town Pond Feasibility Study. Several Alternatives for the Town Pond (previously called Boyd's Marsh) in Portsmouth, Rhode Island are being evaluated. The wetlands portion will consist of various configurations, depths, and disposal volumes which creates the differences between alternatives.

The project involves a restored wetland area with channels and plantings, a berm assumed to be built from excavated on-site silty clay material which has a high moisture content (requires dewatering prior to use), a 15000 SF parking area, restore/create haul road to utility poles through site, and the assumption that all materials will be disposed of off-site at a haul charge only with a distance of 20 miles Round Trip (per Project Manager). No disposal fee is assumed. Other items include an assumed 42" 45 LF corr poly culvert through the dike with an inlet and outlet headwall and flap gate, rip rap at the RR opening and a weir of RR ties across the RR opening.

One general contractor is assumed to do the all the work.

Construction Sequence/Method Assumptions:
Basic crew size is assumed to be one 3.5 CY excavator, one LGP Dozer, two 16.5 CY trucks, a labor, and a surveyor.

First, mob vehicles, set up a staging area, and put silt fence/haybales around the entire site. Assume a quick pass to clear/mow the area is done with the dozer over the entire area. The utility haul road will be built up with an assumed 1' of bank run gravel and will include turnouts at each utility pole. The parking area will be cleared and prepared to then be used as part of the dewatering area for building the berm. It is assumed that the southwest corner of the site (at the end of berm) will be large enough for drying several days worth of material at a time and that no rain/snow falls to hamper the process.

Then the top 6" of peat and fragmities would be stripped and disposed of off-site. Then the excavator and dozer would excavate, grade, and load clay material right into the trucks, without dewatering, but liners are assumed necessary due to moisture content. The trucks would haul and dump material at the off-site location 10 miles away. No disposal charge is assumed. Some of the material will be hauled to the on-site dewatering area for use in the berm. The trucks would probably do some switching off between on-site and off-site dumping to allow drying. The dozer would also spend some of it's time dewatering the material for the berm.

At the future berm location, 6" of peat will be stripped and disposed of on-site to create a better foundation for the structure. A layer of geotextile will be placed to help with uniform settling per geotech. Then dried material will be loaded and hauled to the berm area and backfilled in lifts and compacted. The cross section is assumed to be 5' high, 45' at the bottom and 15' at the top when completed. Topsoil and seed was assumed added to the berm per geotech and 20 shrubs are to be placed along it to help keep people off it for safety.

The culvert, flap gate, and headwalls as described previously will be installed when appropriate. The same applies for the 30 LF of weir assumed

to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

In order to excavate the stream on the other side of the RR bridge, a cost allowance was assumed for some inexpensive method of access (piling up material?)

At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work.

Plantings for the marsh area are assumed to be bought by the government directly, loaded into volunteer vehicles and planted over a two week period by volunteers with federal oversight by one experienced person. Monitoring of the site was assumed to be $10,000.

For all estimates, labor rates are based on Davis Bacon General Decision Number RI010001, Modification 2, dated 18 May 2001. Escalation is assumed from May 2001 to Feb 2003 (mid point of construction) and is based on Civil Works Construction Cost Index System (CWCCIS), EM1110-2-1304, dated March 2001. Work is assumed to start in October 2002 and last 8 months.

Contingency is assumed at 20% since this is for the feasibility phase: quantities are based on three transects across the marsh, unit prices are mostly based on unit price book rates and some historical data, and design/assumptions are at a conceptual level. Engineering and Design During Consutrction is assumed at 6% and Construction Supervision and Administration is assumed at 8%.

This Cost Estimate also includes costs provided by Project Manager for this Feasibility Study, the Plans and Specifications Phase of the work (with escalation from 1997), and Real Estate.

6/13/2001
Note: Plans and Specifications estimate still needs updating and vegetation quantities need another review from environmental prior to issuing in Final Feasibility Report.

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09 Channels and Canals								
09.01 Channels								
09.01.99 Associated General Items								
09.01.99.01 Mobilization and Site Prep								
09.01.99.01.01 Mob Vehicles & Set-up stage area		15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00 LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road		62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00 SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking		10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep		156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands								
09.01.99.02.05 Clear Brush from Wetland Area	23.50 ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00 CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	67700.00 CY	414,000	23,000	87,000	31,000	44,000	600,000	8.87
09.01.99.02.20 Hauling To Dewatering Area	19000.00 CY	37,000	2,000	8,000	3,000	4,000	54,000	2.84
09.01.99.02.30 Hauling 20 MI RT Off-site Disp	69000.00 CY	584,000	32,000	123,000	44,000	63,000	846,000	12.26
TOTAL Excavate/Restore Wetlands	86700.00 CY	1,158,000	63,000	244,000	88,000	124,000	1,677,000	19.35
09.01.99.03 Build Berm From Existing Mat'l								
09.01.99.03.01 Spread Material for dewatering	21200.00 CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00 CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00 CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00 CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00 CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00 CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00 SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00 SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off		1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00 CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate								
09.01.99.04.01 Culvert Structure w/Gate								
09.01.99.04.01.01 Culvert	45.00 LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00 EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall		9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall			11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate			31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00	LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading									
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.07 Rip Rap at RR Opening									
09.01.99.07.01 Machine Placed Rip Rap	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water									
09.01.99.08.01 Install Weir near RR Opening	30.00	LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00	LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream									
09.01.99.09.01 Allowance for Access over RR			1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream			1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup									
09.01.99.12.02 DeMob Veh & Remove stage area			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items			1,625,000	88,000	343,000	123,000	174,000	2,353,000	
TOTAL Channels			1,625,000	88,000	343,000	123,000	174,000	2,353,000	
TOTAL Channels and Canals			1,625,000	88,000	343,000	123,000	174,000	2,353,000	
90 Vegetating Marsh Area (Fed&Vol)									
90.01 Federal Planting Oversight	2.00	WK	9,000	0	2,000	0	0	11,000	5693.22

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
90.02 Purchase Plantings for Marsh	100000.00 SY	200,000	11,000	42,000	0	0	253,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)		209,000	11,000	44,000	0	0	264,000	
91 Monitoring								
91.01 Monitoring		9,000	0	2,000	0	0	11,000	
TOTAL Monitoring		9,000	0	2,000	0	0	11,000	
92 Real Estate		95,000	0	0	0	0	95,000	
95 Feasibility Study Costs								
95.01 Feasibility Study Costs		177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs		177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase								
96.01 Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 2		2,234,000	107,000	414,000	123,000	174,000	3,052,000	

Town Pond FS - ALT 3
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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This project is a portion of the Town Pond Feasibility Study. Several Alternatives for the Town Pond (previously called Boyd's Marsh) in Portsmouth, Rhode Island are being evaluated. The wetlands portion will consist of various configurations, depths, and disposal volumes which creates the differences between alternatives.

The project involves a restored wetland area with channels and plantings, a berm assumed to be built from excavated on-site silty clay material which has a high moisture content (requires dewatering prior to use), a 15000 SF parking area, restore/create haul road to utility poles through site, and the assumption that all materials will be disposed of off-site at a haul charge only with a distance of 20 miles Round Trip (per Project Manager). No disposal fee is assumed. Other items include an assumed 42" 45 LF corr poly culvert through the dike with an inlet and outlet headwall and flap gate, rip rap at the RR opening and a weir of RR ties across the RR opening.

One general contractor is assumed to do the all the work.

Construction Sequence/Method Assumptions:
Basic crew size is assumed to be one 3.5 CY excavator, one LGP Dozer, two 16.5 CY trucks, a labor, and a surveyor.

First, mob vehicles, set up a staging area, and put silt fence/haybales around the entire site. Assume a quick pass to clear/mow the area is done with the dozer over the entire area. The utility haul road will be built up with an assumed 1' of bank run gravel and will include turnouts at each utility pole. The parking area will be cleared and prepared to then be used as part of the dewatering area for building the berm. It is assumed that the southwest corner of the site (at the end of berm) will be large enough for drying several days worth of material at a time and that no rain/snow falls to hamper the process.

Then the top 6" of peat and fragmities would be stripped and disposed of off-site. Then the excavator and dozer would excavate, grade, and load clay material right into the trucks, without dewatering, but liners are assumed necessary due to moisture content. The trucks would haul and dump material at the off-site location 10 miles away. No disposal charge is assumed. Some of the material will be hauled to the on-site dewatering area for use in the berm. The trucks would probably do some switching off between on-site and off-site dumping to allow drying. The dozer would also spend some of it's time dewatering the material for the berm.

At the future berm location, 6" of peat will be stripped and disposed of on-site to create a better foundation for the structure. A layer of geotextile will be placed to help with uniform settling per geotech. Then dried material will be loaded and hauled to the berm area and backfilled in lifts and compacted. The cross section is assumed to be 5' high, 45' at the bottom and 15' at the top when completed. Topsoil and seed was assumed added to the berm per geotech and 20 shrubs are to be placed along it to help keep people off it for safety.

The culvert, flap gate, and headwalls as described previously will be installed when appropriate. The same applies for the 30 LF of weir assumed

to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

In order to excavate the stream on the other side of the RR bridge, a cost allowance was assumed for some inexpensive method of access (piling up material?)

At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work.

Plantings for the marsh area are assumed to be bought by the government directly, loaded into volunteer vehicles and planted over a two week period by volunteers with federal oversight by one experienced person. Monitoring of the site was assumed to be $10,000.

For all estimates, labor rates are based on Davis Bacon General Decision Number RI010001, Modification 2, dated 18 May 2001. Escalation is assumed from May 2001 to Feb 2003 (mid point of construction) and is based on Civil Works Construction Cost Index System (CWCCIS), EM1110-2-1304, dated March 2001. Work is assumed to start in October 2002 and last 8 months.

Contingency is assumed at 20% since this is for the feasibility phase: quantities are based on three transects across the marsh, unit prices are mostly based on unit price book rates and some historical data, and design/assumptions are at a conceptual level. Engineering and Design During Consutrction is assumed at 6% and Construction Supervision and Administration is assumed at 8%.

This Cost Estimate also includes costs provided by Project Manager for this Feasibility Study, the Plans and Specifications Phase of the work (with escalation from 1997), and Real Estate.

6/13/2001
Note: Plans and Specifications estimate still needs updating and vegetation quantities need another review from environmental prior to issuing in Final Feasibility Report.

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09 Channels and Canals									
09.01 Channels									
09.01.99 Associated General Items									
09.01.99.01 Mobilization and Site Prep									
09.01.99.01.01 Mob Vehicles & Set-up stage area			15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00	LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road			62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00	SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking			10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep			156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands									
09.01.99.02.05 Clear Brush from Wetland Area	23.50	ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00	CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	122400.00	CY	749,000	41,000	158,000	57,000	80,000	1,085,000	8.87
09.01.99.02.20 Hauling To Dewatering Area	19000.00	CY	37,000	2,000	8,000	3,000	4,000	54,000	2.84
09.01.99.02.30 Hauling 20 MI RT Off-site Disp	123700.00	CY	1,045,000	57,000	220,000	79,000	112,000	1,513,000	12.23
TOTAL Excavate/Restore Wetlands	141400.00	CY	1,953,000	106,000	412,000	148,000	210,000	2,829,000	20.01
09.01.99.03 Build Berm From Existing Mat'l									
09.01.99.03.01 Spread Material for dewatering	21200.00	CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00	CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00	CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00	CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00	CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00	CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00	SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00	SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off			1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00	CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate									
09.01.99.04.01 Culvert Structure w/Gate									
09.01.99.04.01.01 Culvert	45.00	LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00	EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall			9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall			11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate			31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00	LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading									
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.07 Rip Rap at RR Opening									
09.01.99.07.01 Machine Placed Rip Rap	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water									
09.01.99.08.01 Install Weir near RR Opening	30.00	LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00	LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream									
09.01.99.09.01 Allowance for Access over RR			1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream			1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup									
09.01.99.12.02 DeMob Veh & Remove stage area			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items			2,420,000	132,000	510,000	184,000	260,000	3,505,000	
TOTAL Channels			2,420,000	132,000	510,000	184,000	260,000	3,505,000	
TOTAL Channels and Canals			2,420,000	132,000	510,000	184,000	260,000	3,505,000	
90 Vegetating Marsh Area (Fed&Vol)									
90.01 Federal Planting Oversight	2.00	WK	9,000	0	2,000	0	0	11,000	5693.22

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
90.02 Purchase Plantings for Marsh	40000.00 SY	80,000	4,000	17,000	0	0	101,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)		89,000	5,000	19,000	0	0	113,000	
91 Monitoring								
91.01 Monitoring		9,000	0	2,000	0	0	11,000	
TOTAL Monitoring		9,000	0	2,000	0	0	11,000	
92 Real Estate		95,000	0	0	0	0	95,000	
95 Feasibility Study Costs								
95.01 Feasibility Study Costs		177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs		177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase								
96.01 Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 3		2,910,000	143,000	556,000	184,000	260,000	4,052,000	

Town Pond FS - ALT 4a
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

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At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work.

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6/13/2001
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	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09 Channels and Canals									
09.01 Channels									
09.01.99 Associated General Items									
09.01.99.01 Mobilization and Site Prep									
09.01.99.01.01 Mob Vehicles & Set-up stage area			15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00	LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road			62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00	SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking			10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep			156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands									
09.01.99.02.05 Clear Brush from Wetland Area	23.50	ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00	CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	113400.00	CY	694,000	38,000	146,000	53,000	74,000	1,006,000	8.87
09.01.99.02.20 Hauling To Dewatering Area	19000.00	CY	37,000	2,000	8,000	3,000	4,000	54,000	2.84
09.01.99.02.30 Hauling 20 MI RT Off-site Disp	114700.00	CY	969,000	53,000	204,000	74,000	104,000	1,403,000	12.23
TOTAL Excavate/Restore Wetlands	132400.00	CY	1,823,000	99,000	384,000	138,000	196,000	2,640,000	19.94
09.01.99.03 Build Berm From Existing Mat'l									
09.01.99.03.01 Spread Material for dewatering	21200.00	CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00	CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00	CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00	CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00	CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00	CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00	SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00	SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off			1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00	CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate									
09.01.99.04.01 Culvert Structure W/Gate									
09.01.99.04.01.01 Culvert	45.00	LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00	EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall			9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall			11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate			31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00	LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading									
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.07 Rip Rap at RR Opening									
09.01.99.07.01 Machine Placed Rip Rap	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water									
09.01.99.08.01 Install Weir near RR Opening	30.00	LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00	LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream									
09.01.99.09.01 Allowance for Access over RR			1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream			1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup									
09.01.99.12.02 DeMob Veh & Remove stage area			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items			2,289,000	124,000	483,000	174,000	246,000	3,316,000	
TOTAL Channels			2,289,000	124,000	483,000	174,000	246,000	3,316,000	
TOTAL Channels and Canals			2,289,000	124,000	483,000	174,000	246,000	3,316,000	
90 Vegetating Marsh Area (Fed&Vol)									
90.01 Federal Planting Oversight	2.00	WK	9,000	0	2,000	0	0	11,000	5693.22

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
90.02 Purchase Plantings for Marsh	20000.00	SY	40,000	2,000	8,000	0	0	51,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)			49,000	3,000	10,000	0	0	62,000	
91 Monitoring									
91.01 Monitoring			9,000	0	2,000	0	0	11,000	
TOTAL Monitoring			9,000	0	2,000	0	0	11,000	
92 Real Estate			95,000	0	0	0	0	95,000	
95 Feasibility Study Costs									
95.01 Feasibility Study Costs			177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs			177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase									
96.01 Plans & Specifications Phase			120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase			120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 4a			2,739,000	134,000	520,000	174,000	246,000	3,812,000	

Town Pond FS - ALT 4b
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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This project is a portion of the Town Pond Feasibility Study. Several Alternatives for the Town Pond (previously called Boyd's Marsh) in Portsmouth, Rhode Island are being evaluated. The wetlands portion will consist of various configurations, depths, and disposal volumes which creates the differences between alternatives.

The project involves a restored wetland area with channels and plantings, a berm assumed to be built from excavated on-site silty clay material which has a high moisture content (requires dewatering prior to use), a 15000 SF parking area, restore/create haul road to utility poles through site, and the assumption that all materials will be disposed of off-site at a haul charge only with a distance of 20 miles Round Trip (per Project Manager). No disposal fee is assumed. Other items include an assumed 42" 45 LF corr poly culvert through the dike with an inlet and outlet headwall and flap gate, rip rap at the RR opening and a weir of RR ties across the RR opening.

One general contractor is assumed to do the all the work.

Construction Sequence/Method Assumptions:
Basic crew size is assumed to be one 3.5 CY excavator, one LGP Dozer, two 16.5 CY trucks, a labor, and a surveyor.

First, mob vehicles, set up a staging area, and put silt fence/haybales around the entire site. Assume a quick pass to clear/mow the area is done with the dozer over the entire area. The utility haul road will be built up with an assumed 1' of bank run gravel and will include turnouts at each utility pole. The parking area will be cleared and prepared to then be used as part of the dewatering area for building the berm. It is assumed that the southwest corner of the site (at the end of berm) will be large enough for drying several days worth of material at a time and that no rain/snow falls to hamper the process.

Then the top 6" of peat and fragmities would be stripped and disposed of off-site. Then the excavator and dozer would excavate, grade, and load clay material right into the trucks, without dewatering, but liners are assumed necessary due to moisture content. The trucks would haul and dump material at the off-site location 10 miles away. No disposal charge is assumed. Some of the material will be hauled to the on-site dewatering area for use in the berm. The trucks would probably do some switching off between on-site and off-site dumping to allow drying. The dozer would also spend some of it's time dewatering the material for the berm.

At the future berm location, 6" of peat will be stripped and disposed of on-site to create a better foundation for the structure. A layer of geotextile will be placed to help with uniform settling per geotech. Then dried material will be loaded and hauled to the berm area and backfilled in lifts and compacted. The cross section is assumed to be 5' high, 45' at the bottom and 15' at the top when completed. Topsoil and seed was assumed added to the berm per geotech and 20 shrubs are to be placed along it to help keep people off it for safety.

The culvert, flap gate, and headwalls as described previously will be installed when appropriate. The same applies for the 30 LF of weir assumed

to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

In order to excavate the stream on the other side of the RR bridge, a cost allowance was assumed for some inexpensive method of access (piling up material?)

At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work.

Plantings for the marsh area are assumed to be bought by the government directly, loaded into volunteer vehicles and planted over a two week period by volunteers with federal oversight by one experienced person. Monitoring of the site was assumed to be $10,000.

For all estimates, labor rates are based on Davis Bacon General Decision Number RI010001, Modification 2, dated 18 May 2001. Escalation is assumed from May 2001 to Feb 2003 (mid point of construction) and is based on Civil Works Construction Cost Index System (CWCCIS), EM1110-2-1304, dated March 2001. Work is assumed to start in October 2002 and last 8 months.

Contingency is assumed at 20% since this is for the feasibility phase: quantities are based on three transects across the marsh, unit prices are mostly based on unit price book rates and some historical data, and design/assumptions are at a conceptual level. Engineering and Design During Consutrction is assumed at 6% and Construction Supervision and Administration is assumed at 8%.

This Cost Estimate also includes costs provided by Project Manager for this Feasibility Study, the Plans and Specifications Phase of the work (with escalation from 1997), and Real Estate.

6/13/2001
Note: Plans and Specifications estimate still needs updating and vegetation quantities need another review from environmental prior to issuing in Final Feasibility Report.

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09 Channels and Canals									
09.01 Channels									
09.01.99 Associated General Items									
09.01.99.01 Mobilization and Site Prep									
09.01.99.01.01 Mob Vehicles & Set-up stage area			15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00	LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road			62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00	SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking			10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep			156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands									
09.01.99.02.05 Clear Brush from Wetland Area	23.50	ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00	CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	140200.00	CY	858,000	47,000	181,000	65,000	92,000	1,243,000	8.87
09.01.99.02.20 Hauling To Dewatering Area	19000.00	CY	37,000	2,000	8,000	3,000	4,000	54,000	2.84
09.01.99.02.30 Hauling 20 MI RT Off-site Disp	141500.00	CY	1,195,000	65,000	252,000	91,000	128,000	1,730,000	12.23
TOTAL Excavate/Restore Wetlands	159200.00	CY	2,213,000	120,000	467,000	168,000	237,000	3,205,000	20.13
09.01.99.03 Build Berm From Existing Mat'l									
09.01.99.03.01 Spread Material for dewatering	21200.00	CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00	CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00	CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00	CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00	CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00	CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00	SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00	SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off			1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00	CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate									
09.01.99.04.01 Culvert Structure w/Gate									
09.01.99.04.01.01 Culvert	45.00	LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00	EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall			9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall		11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate		31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00 LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading								
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00 DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00 DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.07 Rip Rap at RR Opening								
09.01.99.07.01 Machine Placed Rip Rap	35.00 CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00 CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water								
09.01.99.08.01 Install Weir near RR Opening	30.00 LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00 LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream								
09.01.99.09.01 Allowance for Access over RR		1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream		1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup								
09.01.99.12.02 DeMob Veh & Remove stage area		12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup		12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items		2,679,000	146,000	565,000	203,000	287,000	3,881,000	
TOTAL Channels		2,679,000	146,000	565,000	203,000	287,000	3,881,000	
TOTAL Channels and Canals		2,679,000	146,000	565,000	203,000	287,000	3,881,000	
90 Vegetating Marsh Area (Fed&Vol)								
90.01 Federal Planting Oversight	2.00 WK	9,000	0	2,000	0	0	11,000	5693.22

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
90.02 Purchase Plantings for Marsh	20000.00 SY	40,000	2,000	8,000	0	0	51,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)		49,000	3,000	10,000	0	0	62,000	
91 Monitoring								
91.01 Monitoring		9,000	0	2,000	0	0	11,000	
TOTAL Monitoring		9,000	0	2,000	0	0	11,000	
92 Real Estate		95,000	0	0	0	0	95,000	
95 Feasibility Study Costs								
95.01 Feasibility Study Costs		177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs		177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase								
96.01 Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 4b		3,129,000	155,000	602,000	203,000	287,000	4,377,000	

Town Pond FS - ALT 5
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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One general contractor is assumed to do the all the work.

Construction Sequence/Method Assumptions:
Basic crew size is assumed to be one 3.5 CY excavator, one LGP Dozer, two 16.5 CY trucks, a labor, and a surveyor.

First, mob vehicles, set up a staging area, and put silt fence/haybales around the entire site. Assume a quick pass to clear/mow the area is done with the dozer over the entire area. The utility haul road will be built up with an assumed 1' of bank run gravel and will include turnouts at each utility pole. The parking area will be cleared and prepared to then be used as part of the dewatering area for building the berm. It is assumed that the southwest corner of the site (at the end of berm) will be large enough for drying several days worth of material at a time and that no rain/snow falls to hamper the process.

Then the top 6" of peat and fragmities would be stripped and disposed of in one corner of the on-site disposal area. Then the excavator and dozer would excavate, grade, and load clay material right into the trucks. The trucks would haul and dump material at the on-site disposal area or the dewatering area (probably doing some switching off to allow drying). The dozer would also spend some of it's time grading and shaping the disposal area and some time dewatering the material for the berm.

At the future berm location, 6" of peat will be stripped and disposed of on-site to create a better foundation for the structure. A layer of geotextile will be placed to help with uniform settling per geotech. Then dried material will be loaded and hauled to the berm area and backfilled in lifts and compacted. The cross section is assumed to be 5' high, 45' at the bottom and 15' at the top when completed. Topsoil and seed was assumed added to the berm per geotech and 20 shrubs are to be placed along it to help keep people off it for safety.

The culvert, flap gate, and headwalls as described previously will be installed when appropriate. The same applies for the 30 LF of weir assumed to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

In order to excavate the stream on the other side of the RR bridge, a cost

allowance was assumed for some inexpensive method of access (piling up material?)

At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work. Then hydroseeding is assumed applied to the upland/on-site disposal area.

Plantings for the marsh area are assumed to be bought by the government directly, loaded into volunteer vehicles and planted over a two week period by volunteers with federal oversight by one experienced person. Monitoring of the site was assumed to be $10,000.

For all estimates, labor rates are based on Davis Bacon General Decision Number RI010001, Modification 2, dated 18 May 2001. Escalation is assumed from May 2001 to Feb 2003 (mid point of construction) and is based on Civil Works Construction Cost Index System (CWCCIS), EM1110-2-1304, dated March 2001. Work is assumed to start in October 2002 and last 8 months.

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This Cost Estimate also includes costs provided by Project Manager for this Feasibility Study, the preliminary Plans and Specifications Phase of the work (with escalation from 1997), and Real Estate.

6/13/2001
Note: Plans and Specifications estimate still needs updating and vegetation quantities need another review from environmental prior to issuing in Final Feasibility Report.

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09 Channels and Canals									
09.01 Channels									
09.01.99 Associated General Items									
09.01.99.01 Mobilization and Site Prep									
09.01.99.01.01 Mob Vehicles & Set-up stage area			15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00	LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road			62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00	SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking			10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep			156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands									
09.01.99.02.05 Clear Brush from Wetland Area	23.50	ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00	CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	49300.00	CY	302,000	16,000	64,000	23,000	32,000	437,000	8.87
09.01.99.02.30 Hauling To D.A or to Dewater	68300.00	CY	132,000	7,000	28,000	10,000	14,000	191,000	2.80
09.01.99.02.40 Grading to Assist Backfill D.A.	50600.00	CY	74,000	4,000	16,000	6,000	8,000	108,000	2.13
TOTAL Excavate/Restore Wetlands	68300.00	CY	631,000	34,000	133,000	48,000	68,000	913,000	13.37
09.01.99.03 Build Berm From Existing Mat'l									
09.01.99.03.01 Spread Material for dewatering	21200.00	CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00	CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00	CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00	CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00	CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00	CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00	SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00	SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off			1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00	CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate									
09.01.99.04.01 Culvert Structure w/Gate									
09.01.99.04.01.01 Culvert	45.00	LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00	EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall			9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D- DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall		11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate		31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00 LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading								
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00 DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00 DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.06 Vegetate Disposal Area								
09.01.99.06.02 Hydroseed Upland Disposal Area	24000.00 SY	12,000	1,000	2,000	1,000	1,000	17,000	0.71
TOTAL Vegetate Disposal Area	24000.00 SY	12,000	1,000	2,000	1,000	1,000	17,000	0.71
09.01.99.07 Rip Rap at RR Opening								
09.01.99.07.01 Machine Placed Rip Rap	35.00 CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00 CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water								
09.01.99.08.01 Install Weir near RR Opening	30.00 LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00 LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream								
09.01.99.09.01 Allowance for Access over RR		1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream		1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup								
09.01.99.12.02 DeMob Veh & Remove stage area		12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup		12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items		1,109,000	60,000	234,000	84,000	119,000	1,606,000	

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D- DC	S & A	TOTAL COST	UNIT COST
TOTAL Channels			1,109,000	60,000	234,000	84,000	119,000	1,606,000	
TOTAL Channels and Canals			1,109,000	60,000	234,000	84,000	119,000	1,606,000	
90 Vegetating Marsh Area (Fed&Vol)									
90.01 Federal Planting Oversight	2.00	WK	9,000	0	2,000	0	0	11,000	5693.22
90.02 Purchase Plantings for Marsh	78800.00	SY	158,000	9,000	33,000	0	0	199,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)			167,000	9,000	35,000	0	0	211,000	
91 Monitoring									
91.01 Monitoring			9,000	0	2,000	0	0	11,000	
TOTAL Monitoring			9,000	0	2,000	0	0	11,000	
92 Real Estate			95,000	0	0	0	0	95,000	
95 Feasibility Study Costs									
95.01 Feasibility Study Costs			177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs			177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase									
96.01 Plans & Specifications Phase			120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase			120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 5			1,676,000	76,000	296,000	84,000	119,000	2,252,000	

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
09. Channels and Canals											
09.01. Channels											
09.01.99. Associated General Items											
09.01.99.01. Mobilization and Site Prep											
TOTAL Mob Vehicles & Set-up stage area					0	0	0	0	12,000	12,000	
09.01.99.01.02. Silt Fence & Haybales (USER)											
USR AA < > Haybales					0.00	0.00	0.00	0.00	1.70	1.70	
	6000.00	LF		0.00	0	0	0	0	10,200	10,200	1.70
Cost based on historical data. Assumed roughly 6000 LF to get around the site. Includes removal and disposal.											
MIL AA <02266 1120 > Erosion control, w/7.5' posts, silt fence, 3' high, polypropylene					0.05	1.57	0.00	0.67	0.00	2.24	
	6000.00	LF	ALABCLAB2	43.75	274	9,418	0	4,020	0	13,438	2.24
TOTAL Silt Fence & Haybales	6000.00	LF			274	9,418	0	4,020	10,200	23,638	3.94
09.01.99.01.03. Establish Utility Haul Road											
L AF AA < > Clearing, brush w/dozer & brush rake, heavy brush					5.00	179.47	237.00	0.00	0.00	416.47	
	3.20	ACR	CODTB11A	0.40	16	574	758	0	0	1,333	416.47
120' wide x 1150' long (area of gravel road) = 138000 SF = 3.2 acres											
Small area, therefore cut production rate in half.											
MIL AA <02243 D100 > Base, prepare & roll sub-base, large areas over 2500 SY					0.01	0.32	0.38	0.00	0.00	0.70	
	9000.00	SY	COFGB32	462.50	77	2,855	3,447	0	0	6,302	0.70
Per Civil Engineering: 81000 SF/9= 9000 SY											

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
M AF AA <02244 1530 >	Base course, gravel, bank run, compacted, 6" D, large areas	3000.00	CY	COFGB36C	104.38	0.05 144	1.75 5,259	2.28 6,845	10.00 30,000	0.00 0	14.03 42,104	14.03
	81000 SF x 1' deep (per Civil Eng & Geotech)/27 = 3000 CY											
	Already high enough for the 2.6 ft NGVD Mean Tide per current information, but added 1 foot bearing surface which was minimum assuming some consolidation.											
	Assume $10/CY average historical material cost for bank run gravel.											
TOTAL	Establish Utility Haul Road					237	8,688	11,050	30,000	0	49,738	

09.01.99.01.04. Establish Parking Area (USER)
Size as shown on concept drawings and per civil and geotech. The total qty of material for the parking area and the utility road beside it are covered in two line items and total 2200 CY.

B MIL AA < >	Crushed 3/4" stone, compacted, 12"D, small areas Decreased production rate since such a small area. Lowered to assume about 4 hours of work.	1770.00	SY	COFGB36C	150.00	0.03 59	1.22 2,159	1.59 2,810	4.00 7,080	0.00 0	6.81 12,049	6.81
	Assumed Southwest corner of site at end of berm at approx. 50 ft wide x 300' long area x 1 foot deep or 15000 SF = 1770 SY = 550 CY											
	Used material price of $4.00 based on historic data.											
L MIL AA < >	Base, prepare & roll sub-base, small areas to 2500 SY	1770.00	SY	COFGB32A	100.00	0.03 53	1.09 1,934	0.83 1,476	0.00 0	0.00 0	1.93 3,410	1.93
	Decreased production rate from 187 to 100 since a really small area.											

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	Assumed Southwest corner of site at end of berm at 200 ft wide x 400' long area or 8000 SF = 890 SY											
L MIL AA < >	Clearing, machine load spoils, .5 mi haul to on-site disposal area.	280.00	CY	COEIB17	44.00	0.09 25	3.08 861	1.38 386	0.00 0	0.00 0	4.46 1,247	4.46
	Top 6" of material removed first for a better foundation. 15000 SF x .5'/27= 280 CY											
L AF AA < >	Clearing, brush w/dozer & brush rake, heavy brush	0.34	ACR	CODTB11A	0.40	5.00 2	179.47 61	237.00 80	0.00 0	0.00 0	416.47 141	416.47
	Approx. 50' wide x 300' long = 15000 SF= .34 acres Small area, therefore cut production rate in half.											
M AF AA <02244 1530 >	Base course, gravel, bank run, compacted, 6" D, large areas 50 ft wide x 300' long area x 2 foot deep = 30000 CF/27 = 1100 CY	1100.00	CY	COFGB36C	104.38	0.05 53	1.75 1,928	2.28 2,510	10.00 11,000	0.00 0	14.03 15,438	14.03
	From Geotech appendix, assumed gravel put down (this 2 ft) for staging area, will eventually consolidate enough so that adding 1 foot stone surface at end of job will create parking/viewing area. The 1 foot final layer is covered in the crushed stone item above.											
	Assume $10/CY average historical material cost for bank run gravel.											
TOTAL	Establish Parking Area	15000	SF			192	6,943	7,262	18,080	0	32,285	2.15

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
09.01.99.01.05. Utility Road Beside Parking											
L AF AA < > Clearing, brush w/dozer & brush					5.00	179.47	237.00	0.00	0.00	416.47	
rake, heavy brush	0.11	ACR	CODTB11A	0.40	1	20	26	0	0	46	416.47
Small area, therefore cut production rate in half.											
MIL AA <02243 0100 > Base, prepare & roll sub-base,					0.01	0.32	0.38	0.00	0.00	0.70	
large areas over 2500 SY	900.00	SY	COFGB32	462.50	8	285	345	0	0	630	0.70
M AF AA <02244 1530 > Base course, gravel, bank run,					0.05	1.75	2.28	10.00	0.00	14.03	
compacted, 6" D, large areas	550.00	CY	COFGB36C	104.38	26	964	1,255	5,500	0	7,719	14.03
81000 SF x 1' deep (per Civil Eng & Geotech)/27 = 3000 CY											
Already high enough for the 2.6 ft NGVD Mean Tide per current information, but added 1 foot bearing surface which was minimum assuming some consolidation.											
Assume $10/CY average historical material cost for bank run gravel.											
TOTAL Utility Road Beside Parking					35	1,269	1,626	5,500	0	8,395	
TOTAL Mobilization and Site Prep					738	26,318	19,938	57,600	22,200	126,056	
09.01.99.02. Excavate/Restore Wetlands											
09.01.99.02.05. Clear Brush from Wetland Area											
L AF AA <02110 0600 > Clearing, brush w/dozer & brush					2.50	89.74	118.50	0.00	0.00	208.23	
rake, heavy brush	23.50	ACR	CODTB11A	0.80	59	2,109	2,785	0	0	4,894	208.23
Area to be restored per Civil Engineering = 1025000 SF = 23.5 acres											

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	TOTAL Clear Brush from Wetland Area	23.50	ACR			59	2,109	2,785	0	0	4,894	208.23
09.01.99.02.07. Strip Top 6" of peat/fragmites												
L MIL AA <	> Excavating, bulk, dozer, 300 HP, large area, open site, rough Decreased Production rate since working in the wet from 300 CY to 150 CY/HR with assumed LGP vehicle. 15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed done first prior to other excavation of the site to seperate fragmites material in it's own location in disposal area.	19000	CY	CODTB10M	150.00	0.01 190	0.36 6,918	0.93 17,750	0.00 0	0.14 2,660	1.44 27,328	1.44
L CIV AA <	> Excavate & load, hydr excavator, 3.5 CY, medium matl Decrease Production rate from 162.5 CY/hr to 81.25 CY/hr to allow for working in the wetland. 15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed similar for hydraulic excavators. Assume this top 6 " removed first and piled in one location, loaded into trucks with this line items and hauled to disposal area for topsoil/fragmites.	19000	CY	CODEB12D	81.25	0.02 467	0.84 15,916	2.31 43,846	0.00 0	0.35 6,650	3.50 66,413	3.50
	TOTAL Strip Top 6" of peat/fragmites	19000	CY			657	22,834	61,596	0	9,310	93,740	4.93

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
09.01.99.02.10. Excavate Channel/Wetland Area (USER)												
L CIV AA <	> Excavate & load, hydr excavator, 3.5 CY, medium matl Decrease Production rate from 162.5 CY/hr to 81.25 CY/hr to allow for working in the wetland. 15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed similar for hydraulic excavators.	49300	CY	CODEB12D	81.25	0.02 1,213	0.84 41,299	2.31 113,770	0.00 0	0.35 17,255	3.50 172,323	3.50
L MIL AA <	> Excavating, bulk, dozer, 300 HP, large area, open site, rough Decreased Production rate since working in the wet from 300 CY to 150 CY/HR with assumed LGP vehicle. 15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed done for each CY to assist in excavation process and as a leveling/shaping effort after excavating complete.	49300	CY	CODTB10M	150.00	0.01 493	0.36 17,950	0.93 46,056	0.00 0	0.14 6,902	1.44 70,908	1.44
TOTAL	Excavate Channel/Wetland Area	49300	CY			1,706	59,249	159,826	0	24,157	243,231	4.93
09.01.99.02.30. Hauling To D.A or to Dewater (USER) D.A. = Disposal Area												
L MIL AA <	> Hauling, hwy haulers, 16.5 CY, 1 mi round trip 4 loads/hr Assumed 3.5 CY excavator fills it in approx. 5 passes.	75100	CY	CTDHB34C	60.00	0.02 1,254	0.59 44,136	0.83 62,108	0.00 0	0.00 0	1.41 106,244	1.41

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
09.01.99.03. Build Berm From Existing Mat'l Assume this quantity was stockpiled in southwest corner for dewatering versus placed in disposal area. Assumed cost to haul it to this location is included in cost to go to disposal area (assumed same distance). This is for spreading for dewatering, loading from spread stockpile, hauling, dumping and compacting to create the berm.												
09.01.99.03.01. Spread Material for dewatering Assumes plenty of room to dry a few days worth of material and that no rain/snow falls.												
L MIL AA <	> Dewatering, bulk, dozer, 300 HP, large area, open site, rough Decreased Production rate since working in the wet from 300 CY to 150 CY/HR with assumed LGP vehicle. This is assumed to allow for dewatering of material to be used to build the berm and is assumed spreadout in an on-site location. Assumed 20% more than quantity desired to allow for drying out/consolidation and including 10% bulking in trucks. 15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes).	21200	CY	CODTB10M	150.00	0.01 212	0.36 7,719	0.93 19,805	0.00 0	0.14 2,968	1.44 30,492	1.44
TOTAL	Spread Material for dewatering	21200	CY			212	7,719	19,805	0	2,968	30,492	1.44
09.01.99.03.02. Loading on truck from pile												
L CIV AA <02232 0160 >	Excavate & load, hydr excavator, 3.5 CY, medium matl Decrease Production rate from 162.5 CY/hr to 125 CY/hr to allow for working in near the wetland with somewhat wet heavy material even after drying.	17700	CY	CODEB12D	125.00	0.02 283	0.54 9,638	1.50 26,550	0.00 0	0.23 4,071	2.27 40,259	2.27

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	Assumed disposal area is about .5 miles average from all excavations. Assumed a 10% swell from in place quantity when loaded into truck. Berm quantity goes to dewatering spot assumed similar distance.											
	Berm quantity needed is 17,700 in place CY. Assumed need 10% more than that for drying and 10% more than that for bulked in truck or 20% or 21200 CY of this trucked amount goes to the dewatering spot.											
TOTAL	Hauling To D.A or to Dewater	68300	CY			1,254	44,136	62,108	0	0	106,244	1.56
09.01.99.02.40.	Grading to Assist Backfill D.A. (USER) D.A. = Disposal Area											
L MIL AA < >	Excavating, bulk, dozer, 300 HP, large area, open site, rough Decreased Production rate since working in the wet from 300 CY to 200 CY/HR (slightly less wet) with assumed LGP vehicle.	53900	CY	CODTB10M	200.00	0.01 404	0.27 14,720	0.70 37,768	0.00 0	0.14 7,546	1.11 60,034	1.11
	15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes).											
	This is done at the disposal area to shape and grade material as it is dumped. Excludes 21200 CY going to the berm, but uses the bulked CY quantity coming from the trucks.											
TOTAL	Grading to Assist Backfill D.A.	50600	CY			404	14,720	37,768	0	7,546	60,034	1.19
TOTAL	Excavate/Restore Wetlands	68300	CY			4,080	143,048	324,082	0	41,013	508,143	7.44

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed similar for hydraulic excavators.											
TOTAL	Loading on truck from pile	17700	CY			283	9,638	26,550	0	4,071	40,259	2.27
09.01.99.03.03. Hauling .5 mile to Berm area												
L MIL AA <	> Hauling, hwy haulers, 16.5 CY, 1 mi round trip 4 loads/hr					0.02	0.59	0.83	0.00	0.00	1.41	
		19500	CY	CTDHB34C	60.00	326	11,460	16,127	0	0	27,587	1.41
	Assumed 3.5 CY excavator fills it in approx. 5 passes.											
	Assumed berm area is about .5 miles average from where material will be passively dewatered with dozer. Assumed a 10% swell from in place quantity when loaded into truck.											
TOTAL	Hauling .5 mile to Berm area	19500	CY			326	11,460	16,127	0	0	27,587	1.41
09.01.99.03.04. Backfilling Berm												
L MIL AA <	> Backfill, strl, 6" lifts, w/dozer, no compaction					0.01	0.31	0.54	0.00	0.05	0.90	
	Assumed a dozer spreading 6" lifts will be used for building berm.	19500	CY	CODTB11R	175.00	168	6,086	10,563	0	975	17,624	0.90
	Decreased production rate by 100 CY/hr since working with damp clay still.											
	15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). That's the type of vehicle on site whether it is needed for this or not.											

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Backfilling Berm	19500	CY			168	6,086	10,563	0	975	17,624	0.90
09.01.99.03.05. Compacting Berm Material											
MIL AA <02220 5900 > Compaction of backfill,					0.01	0.46	0.38	0.00	0.00	0.84	
structural, SP roller, 6" lift	19500	CY	COFCB10F	117.50	250	9,066	7,363	0	0	16,429	0.84
TOTAL Compacting Berm Material	19500	CY			250	9,066	7,363	0	0	16,429	0.84
09.01.99.03.06. Remove 6" Root Mat from Dike Fdn											
L AF AA <02110 0600 > Clearing, brush w/dozer & brush					2.50	89.74	118.50	0.00	0.00	208.23	
rake, heavy brush	2.30	ACR	CODTB11A	0.80	6	206	273	0	0	479	208.23
2200 LF berm x 45' wide = 99000 SF = 2.3 acres											
L MIL AA < > Excavating, bulk, dozer, 300 HP,					0.01	0.36	0.93	0.00	0.14	1.44	
large area, open site, rough	1800.00	CY	CODTB10M	150.00	18	655	1,682	0	252	2,589	1.44
Decreased Production rate since working in the wet from 300 CY to 150 CY/HR with assumed LGP vehicle.											
15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes).											
Assumed done to excavate the top 6" of material for disposing in on-site disposal area.											
L MIL AA < > Clearing, machine load spoils,					0.09	3.08	1.38	0.00	0.21	4.67	
.5 mi haul to on-site disposal	1800.00	CY	COEIB17	44.00	164	5,538	2,481	0	378	8,397	4.67
area											
Assume top 6 " removed first to establish better foundation per Geotech.											
2200 LF Berm x 45' wide x.5Ft											

09.01. Channels		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
	deep/27= 1850 CY											
	15% increase in equipment cost (shown in other) for a Low Ground Pressure vehicle, based on averages within equipment database (looking at D6 and D7 sizes). Assumed similar for all vehicles.											
TOTAL	Remove 6" Root Mat from Dike Fdn	1800.00	CY			187	6,400	4,435	0	630	11,465	6.37
09.01.99.03.07. Geotextile for Uniform Settling												
CIV AA <02250 2130 >	Geotextile fabric, 60 mil thick,					0.02	0.54	0.10	0.60	0.00	1.24	
	non-woven polypropylene	11000	SY	ULABA2	187.50	176	5,952	1,054	6,600	0	13,606	1.24
TOTAL	Geotextile for Uniform Settling	99000	SF			176	5,952	1,054	6,600	0	13,606	0.14
09.01.99.03.08. Topsoil and Seed												
MIL AA <02241 0705 >	Loam or topsoil, furnish &					0.09	3.36	1.68	15.37	0.00	20.41	
	place, imported, 4" deep	1200.00	CY	CODFB10S	16.25	111	4,034	2,016	18,444	0	24,493	20.41
	2200 LF Berm x 45' wide x .33' thick/27 = 1200 CY											
MIL AA <02932 0320 >	Seeding, athletic field mix,					4.26	133.79	74.27	549.50	0.00	757.56	
	mechanical seeding, 450#/acre	2.30	ACR	COELB66	0.24	10	308	171	1,264	0	1,742	757.56
	2200 x 45/43560 = 2.3 acres											
TOTAL	Topsoil and Seed	99000	SF			121	4,341	2,187	19,708	0	26,236	0.27
09.01.99.03.09. Shrubs to Keep People Off												
M MIL AA < >	Shrubs, 3' - 4', in prep beds,					0.75	26.00	0.00	20.00	0.00	46.00	
	rugosa rose	20.00	EA	ULABB1	4.00	15	520	0	400	0	920	46.00
	From Environmental: Qty and purchase price and type.											
TOTAL	Shrubs to Keep People Off					15	520	0	400	0	920	

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Build Berm From Existing Mat'l	17700	CY			1,737	61,181	88,084	26,708	8,644	184,617	10.43
09.01.99.04. Install Culvert and Flap Gate											
09.01.99.04.01. Culvert Structure w/Gate											
09.01.99.04.01.01. Culvert Assumed Corrogated Polyethlene as cheapest (as requested by PM) and 45 LF (Goes through Dike which is 45' at base).											
L CIV AA < > Piping, D&S, 20' sect, 24", corr					0.80	27.22	1.92	10.79	6.47	46.40	
polthn, type S, smooth wall	60.00	LF	CLABB14	7.50	48	1,633	115	647	388	2,784	46.40
For 42" culvert assumed 60% more cost (shown in other) of material than the 24" and same installation. Assumed need 60 LF since 20' sections and likely length of culvert is 45-50 feet. Since such small quantity assumed production rate that would equal 1 8-hour day.											
TOTAL Culvert	45.00	LF			48	1,633	115	647	388	2,784	61.86
09.01.99.04.01.02. Flap Gate Used unit price from 2001 Means UPB.											
CIV AA <05914 0140 > Hydraulic structures, flap					13.91	667.25	149.41	4594.48	0.00	5411.14	
gates, aluminum, 42" dia	1.00	EA	SIWSL5A	0.29	14	667	149	4,594	0	5,411	5411.14
TOTAL Flap Gate	1.00	EA			14	667	149	4,594	0	5,411	5411.14
09.01.99.04.01.03. Inlet Headwall/Wingwall Assumptions from information provided in Structural Appendix.											
RSM AA <03326 0200 > Concrete ready mix, regular					0.00	0.00	0.00	66.01	0.00	66.01	
weight, 3500 psi	22.00	CY	N/A	0.00	0	0	0	1,452	0	1,452	66.01
RSM AA <03217 0500 > Reinforcing in place, footings,					15.24	691.32	0.00	525.66	0.00	1216.98	
#4 to #7	0.60	TON	SIWRRODM4	0.26	9	415	0	315	0	730	1216.98
MIL AA <03217 0700 > Reinforcing in place, walls, #3					10.67	483.93	0.00	525.66	0.00	1009.59	
to #7	0.50	TON	SIWRRODM4	0.38	5	242	0	263	0	505	1009.59

09.01. Channels

		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
MIL AA <03158 5050 >	Forms in place, footing, spread, plywood, 2 use	85.00	SF	ACARC1	46.38	0.09 7	3.38 287	0.00 0	1.01 86	0.00 0	4.39 373	4.39
MIL AA <03182 2052 >	Forms in place, walls, int, to 8' high, 2 use, job built plywood	380.00	SF	ACARC2	54.38	0.11 42	4.40 1,673	0.00 0	1.04 395	0.00 0	5.44 2,068	5.44
L MIL AA <03372 5050 >	Placing conc, walls, 12" thick, direct chute	10.00	CY	ULABC6	2.00	3.00 30	103.22 1,032	3.70 37	0.00 0	0.00 0	106.92 1,069	106.92
	Lowered production rate since such a small quantity.											
L MIL AA <03372 2600 >	Placing conc, footings, spread, over 5 CY, direct chute	12.00	CY	ULABC6	2.00	3.00 36	103.22 1,239	3.70 44	0.00 0	0.00 0	106.92 1,283	106.92
	Lowered production rate since small quantity.											
TOTAL	Inlet Headwall/Wingwall					130	4,888	81	2,511	0	7,481	

09.01.99.04.01.04. Outlet Headwall/Wingwall
Assumptions from information provided in Structural Appendix.

RSM AA <03326 0200 >	Concrete ready mix, regular weight, 3500 psi	27.00	CY	N/A	0.00	0.00 0	0.00 0	0.00 0	66.01 1,782	0.00 0	66.01 1,782	66.01
RSM AA <03217 0500 >	Reinforcing in place, footings, #4 to #7	0.60	TON	SIWRRODM4	0.26	15.24 9	691.32 415	0.00 0	525.66 315	0.00 0	1216.98 730	1216.98
MIL AA <03217 0700 >	Reinforcing in place, walls, #3 to #7	0.75	TON	SIWRRODM4	0.38	10.67 8	483.93 363	0.00 0	525.66 394	0.00 0	1009.59 757	1009.59
MIL AA <03158 5050 >	Forms in place, footing, spread, plywood, 2 use	85.00	SF	ACARC1	46.38	0.09 7	3.38 287	0.00 0	1.01 86	0.00 0	4.39 373	4.39
MIL AA <03182 2052 >	Forms in place, walls, int, to 8' high, 2 use, job built plywood	440.00	SF	ACARC2	54.38	0.11 49	4.40 1,937	0.00 0	1.04 458	0.00 0	5.44 2,395	5.44
L MIL AA <03372 2600 >	Placing conc, footings, spread, over 5 CY, direct chute	12.00	CY	ULABC6	2.00	3.00 36	103.22 1,239	3.70 44	0.00 0	0.00 0	106.92 1,283	106.92
	Lowered production rate since small quantity.											
L MIL AA <03372 5300 >	Placing conc, walls, 15" thick, direct chute	15.00	CY	ULABC6	2.00	3.00 45	103.22 1,548	3.70 56	0.00 0	0.00 0	106.92 1,604	106.92

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
Lowered production rate since small quantity.											
TOTAL Outlet Headwall/Wingwall					154	5,789	100	3,035	0	8,924	
TOTAL Culvert Structure w/Gate					346	12,977	446	10,789	388	24,600	
TOTAL Install Culvert and Flap Gate	45.00	LF			346	12,977	446	10,789	388	24,600	546.67
09.01.99.05. Survey Crew Final Grading											
This duration is based on that of final grading which will be continuous over sections of the project as they are completed for about 47 days (based on dozer grading a site at 300 SY/hour from Unit Price Book information). Survey is critical to wetland restoration. Added 3 days for misc. other surveys that will be needed for other features. Per Environmental Section, only 1 surveyor was necessary (equipment can be free standing or sit on a dozer). If someone else is needed to hold something, one of laborers on the job is assumed will do it.											
09.01.99.05.11. 1 Surveyor w/4x4 Suburban (USURA)											
FOP AA < > Surveyors					1.00	45.54	0.00	0.00	0.00	45.54	
	400.00	HR	FC-SURYR	1.00	400	18,216	0	0	0	18,216	45.54
MIL AA < > TRUCK, HWY 8,600 (3,901KG)GVW 4X2, 2 AXLE, 3/4T-SUBURBAN					0.00	0.00	12.13	0.00	0.00	12.13	
	268.00	HR	T50Z7300	1.00	0	0	3,252	0	0	3,252	12.13
USR AA < > Misc. Equipment Needed					0.00	0.00	100.00	0.00	0.00	100.00	
	50.00	DAY		0.00	0	0	5,000	0	0	5,000	100.00
MIL AA < > TRUCK, HWY 8,600 (3,901KG)GVW 4X2, 2 AXLE, 3/4T-SUBURBAN					0.00	0.00	2.37	0.00	0.00	2.37	
	132.00	HR	T50Z7300	1.00	0	0	313	0	0	313	2.37
TOTAL 1 Surveyor w/4x4 Suburban	50.00	DAY			400	18,216	8,565	0	0	26,781	535.62
TOTAL Survey Crew Final Grading	50.00	DAY			400	18,216	8,565	0	0	26,781	535.62
09.01.99.06. Vegetate Disposal Area											
09.01.99.06.02. Hydroseed Upland Disposal Area											
USR AA < > Hydroseed with Rye 10#/MSF Assumption from Environmental and costs from RSMeans, with escalation to 2001 dollars.					0.00	7.84	8.32	28.00	0.00	44.16	
	216.00	MSF		0.00	0	1,693	1,797	6,048	0	9,539	44.16
TOTAL Hydroseed Upland Disposal Area	24000	SY			0	1,693	1,797	6,048	0	9,539	0.40

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
TOTAL Vegetate Disposal Area	24000	SY			0	1,693	1,797	6,048	0	9,539	0.40
09.01.99.07. Rip Rap at RR Opening											
09.01.99.07.01. Machine Placed Rip Rap For riprap, assumed Water Control's value of D30 = 0.5 ft. Per Project Manager. If riprap is placed to line the inside face of each abutment and extended along the outlet headwall of Structural's conduit, assume, say a total of 100 LF. Assuming a section three feet high with a base six feet wide, quantity needed is conservatively 35 CY of riprap.											
B RSM AA < > Rip-rap, random, machine placed for slope protection	35.00	CY	UOEHB12G	4.37	0.46 16	15.58 545	8.96 314	32.00 1,120	0.00 0	56.54 1,979	56.54
Due to small quantity assumed cost of material at $32/CY. Also assumed a days work as a minimum due to small qty. Reasonable for small effort.											
TOTAL Machine Placed Rip Rap	35.00	CY			16	545	314	1,120	0	1,979	56.54
TOTAL Rip Rap at RR Opening	35.00	CY			16	545	314	1,120	0	1,979	56.54
09.01.99.08. Weir to Keep Open Water											
09.01.99.08.01. Install Weir near RR Opening Assume the weir will be a series of anchored railroad ties one tie deep placed across the inside of the 30-ft wide opening at the railroad bridge at the specified elevation. Rip rap will be placed on top of it.											
L MIL AA < > Railroad, ties, wood, pressure treated, 6" x 8" x 8'-6", CL lots	4.00	EA	CLABB14	1.00	6.00 24	204.13 817	14.40 58	28.25 113	0.00 0	246.77 987	246.77
Assume 4 to represent 30 LF need (part of it will likely be a removeable plastic stop log. Assume a 1/2 day effort, especially since a small qty.											
TOTAL Install Weir near RR Opening	30.00	LF			24	817	58	113	0	987	32.90
TOTAL Weir to Keep Open Water	30.00	LF			24	817	58	113	0	987	32.90

09.01. Channels	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
09.01.99.09. Access over RR to ExcavateStream											
TOTAL Allowance for Access over RR					0	0	0	0	1,000	1,000	
TOTAL Access over RR to ExcavateStream					0	0	0	0	1,000	1,000	
09.01.99.12. Demobilization and Site Cleanup											
TOTAL DeMob Veh & Remove stage area					0	0	0	0	10,000	10,000	
TOTAL Demobilization and Site Cleanup					0	0	0	0	10,000	10,000	
TOTAL Associated General Items					7,341	264,796	443,283	102,378	83,245	893,702	
TOTAL Channels					7,341	264,796	443,283	102,378	83,245	893,702	
TOTAL Channels and Canals					7,341	264,796	443,283	102,378	83,245	893,702	

90.01. Federal Planting Oversight	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
90. Vegetating Marsh Area (Fed&Vol)											
90.01. Federal Planting Oversight Federal Employee 2 weeks oversight at $4500 per week assumed.											
USR < > Federal Salary Planting Oversight	2.00	WK		0.00	0.00 0	4500.00 9,000	0.00 0	0.00 0	0.00 0	4500.00 9,000	4500.00
TOTAL Federal Planting Oversight	2.00	WK			0	9,000	0	0	0	9,000	4500.00
90.02. Purchase Plantings for Marsh (USER) Quantity and cost is from Environmental with cost being $2/plug. It is assumed that the $2 is a purchase cost to the government and that volunteers will pick them up and install plants at no cost to the project.											
USR < > Planting Plugs	78800	EA		0.00	0.00 0	0.00 0	0.00 0	0.00 0	2.00 157,600	2.00 157,600	2.00
TOTAL Purchase Plantings for Marsh	78800	SY			0	0	0	0	157,600	157,600	2.00
TOTAL Vegetating Marsh Area (Fed&Vol)					0	9,000	0	0	157,600	166,600	

91.01. Monitoring		QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
91. Monitoring												
	TOTAL Monitoring					0	0	0	0	8,500	8,500	
	TOTAL Monitoring					0	0	0	0	8,500	8,500	

	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
92. Real Estate											
Based on preliminary Real Estate Planning Report (6/13/2001)											
TOTAL Real Estate					0	0	0	0	95,000	95,000	
95. Feasibility Study Costs											
95.01. Feasibility Study Costs											
Cost from Project Manager.											
TOTAL Feasibility Study Costs					0	0	0	0	177,000	177,000	
TOTAL Feasibility Study Costs					0	0	0	0	177,000	177,000	

96.01. Plans & Specifications Phase	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	OTHER	TOTAL COST	UNIT COST
96. Plans & Specifications Phase											
96.01. Plans & Specifications Phase Cost from Project Manager, with 12% escalation to present (from 1997) cost estimate of $106,000.											
TOTAL Plans & Specifications Phase					0	0	0	0	120,000	120,000	
TOTAL Plans & Specifications Phase					0	0	0	0	120,000	120,000	
TOTAL Town Pond FS - ALT 5					7,341	273,796	443,283	102,378	641,345	1,460,802	

Town Pond FS - ALT 6
Town Pond (a.k.a. Boyd's Marsh)
Wetland Restoration
Portsmouth, Rhode Island

Designed By: CENAE-EP-DC
Estimated By: CENAE-EP-DE

Prepared By: Karen Schofield

Preparation Date: 06/12/01
Effective Date of Pricing: 06/12/01

Sales Tax: 0.0%

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This project is a portion of the Town Pond Feasibility Study. Several Alternatives for the Town Pond (previously called Boyd's Marsh) in Portsmouth, Rhode Island are being evaluated. The wetlands portion will consist of various configurations, depths, and disposal volumes which creates the differences between alternatives.

The project involves a restored wetland area with channels and plantings, a berm assumed to be built from excavated on-site silty clay material which has a high moisture content (requires dewatering prior to use), a 15000 SF parking area, restore/create haul road to utility poles through site, and an on-site disposal area. Other items include an assumed 42" 45 LF corr poly culvert through the dike with an inlet and outlet headwall and flap gate, rip rap at the RR opening and a weir of RR ties across the RR opening.

One general contractor is assumed to do the all the work.

Construction Sequence/Method Assumptions:
Basic crew size is assumed to be one 3.5 CY excavator, one LGP Dozer, two 16.5 CY trucks, a labor, and a surveyor.

First, mob vehicles, set up a staging area, and put silt fence/haybales around the entire site. Assume a quick pass to clear/mow the area is done with the dozer over the entire area. The utility haul road will be built up with an assumed 1' of bank run gravel and will include turnouts at each utility pole. The parking area will be cleared and prepared to then be used as part of the dewatering area for building the berm. It is assumed that the southwest corner of the site (at the end of berm) will be large enough for drying several days worth of material at a time and that no rain/snow falls to hamper the process.

Then the top 6" of peat and fragmities would be stripped and disposed of in one corner of the on-site disposal area. Then the excavator and dozer would excavate, grade, and load clay material right into the trucks. The trucks would haul and dump material at the on-site disposal area or the dewatering area (probably doing some switching off to allow drying). The dozer would also spend some of it's time grading and shaping the disposal area and some time dewatering the material for the berm.

At the future berm location, 6" of peat will be stripped and disposed of on-site to create a better foundation for the structure. A layer of geotextile will be placed to help with uniform settling per geotech. Then dried material will be loaded and hauled to the berm area and backfilled in lifts and compacted. The cross section is assumed to be 5' high, 45' at the bottom and 15' at the top when completed. Topsoil and seed was assumed added to the berm per geotech and 20 shrubs are to be placed along it to help keep people off it for safety.

The culvert, flap gate, and headwalls as described previously will be installed when appropriate. The same applies for the 30 LF of weir assumed to be made from RR ties to a height to hold pool at 0 ft NGVD and the 35 CY of rip rap around the railroad bridge opening as erosion control.

In order to excavate the stream on the other side of the RR bridge, a cost

allowance was assumed for some inexpensive method of access (piling up material?)

At the end of the job, a final grading with dozer will be done at the site and will include one surveyor at that time which is critical to wetland restoration work. Then hydroseeding is assumed applied to the upland/on-site disposal area.

Plantings for the marsh area are assumed to be bought by the government directly, loaded into volunteer vehicles and planted over a two week period by volunteers with federal oversight by one experienced person. Monitoring of the site was assumed to be $10,000.

For all estimates, labor rates are based on Davis Bacon General Decision Number RI010001, Modification 2, dated 18 May 2001. Escalation is assumed from May 2001 to Feb 2003 (mid point of construction) and is based on Civil Works Construction Cost Index System (CWCCIS), EM1110-2-1304, dated March 2001. Work is assumed to start in October 2002 and last 8 months.

Contingency is assumed at 20% since this is for the feasibility phase: quantities are based on three transects across the marsh, unit prices are mostly based on unit price book rates and some historical data, and design/assumptions are at a conceptual level. Engineering and Design During Consutrction is assumed at 6% and Construction Supervision and Administration is assumed at 8%.

This Cost Estimate also includes costs provided by Project Manager for this Feasibility Study, the Plans and Specifications Phase of the work (with escalation from 1997), and Real Estate.

6/13/2001
Note: Plans and Specifications estimate still needs updating and vegetation quantities need another review from environmental prior to issuing in Final Feasibility Report.

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09 Channels and Canals								
09.01 Channels								
09.01.99 Associated General Items								
09.01.99.01 Mobilization and Site Prep								
09.01.99.01.01 Mob Vehicles & Set-up stage area		15,000	1,000	3,000	1,000	2,000	22,000	
09.01.99.01.02 Silt Fence & Haybales	6000.00 LF	29,000	2,000	6,000	2,000	3,000	42,000	7.08
09.01.99.01.03 Establish Utility Haul Road		62,000	3,000	13,000	5,000	7,000	89,000	
09.01.99.01.04 Establish Parking Area	15000.00 SF	40,000	2,000	8,000	3,000	4,000	58,000	3.87
09.01.99.01.05 Utility Road Beside Parking		10,000	1,000	2,000	1,000	1,000	15,000	
TOTAL Mobilization and Site Prep		156,000	9,000	33,000	12,000	17,000	227,000	
09.01.99.02 Excavate/Restore Wetlands								
09.01.99.02.05 Clear Brush from Wetland Area	23.50 ACR	6,000	0	1,000	0	1,000	9,000	374.27
09.01.99.02.07 Strip Top 6" of peat/fragmites	19000.00 CY	116,000	6,000	25,000	9,000	12,000	168,000	8.87
09.01.99.02.10 Excavate Channel/Wetland Area	80800.00 CY	495,000	27,000	104,000	38,000	53,000	716,000	8.87
09.01.99.02.30 Hauling To D.A or to Dewater	99800.00 CY	193,000	10,000	41,000	15,000	21,000	279,000	2.80
09.01.99.02.40 Grading to Assist Backfill D.A.	82100.00 CY	122,000	7,000	26,000	9,000	13,000	177,000	2.16
TOTAL Excavate/Restore Wetlands	99800.00 CY	932,000	51,000	197,000	71,000	100,000	1,350,000	13.53
09.01.99.03 Build Berm From Existing Mat'l								
09.01.99.03.01 Spread Material for dewatering	21200.00 CY	38,000	2,000	8,000	3,000	4,000	55,000	2.59
09.01.99.03.02 Loading on truck from pile	17700.00 CY	50,000	3,000	11,000	4,000	5,000	72,000	4.09
09.01.99.03.03 Hauling .5 mile to Berm area	19500.00 CY	34,000	2,000	7,000	3,000	4,000	50,000	2.54
09.01.99.03.04 Backfilling Berm	19500.00 CY	22,000	1,000	5,000	2,000	2,000	32,000	1.62
09.01.99.03.05 Compacting Berm Material	19500.00 CY	20,000	1,000	4,000	2,000	2,000	30,000	1.51
09.01.99.03.06 Remove 6" Root Mat from Dike Fdn	1800.00 CY	14,000	1,000	3,000	1,000	2,000	21,000	11.45
09.01.99.03.07 Geotextile for Uniform Settling	99000.00 SF	17,000	1,000	4,000	1,000	2,000	24,000	0.25
09.01.99.03.08 Topsoil and Seed	99000.00 SF	33,000	2,000	7,000	2,000	3,000	47,000	0.48
09.01.99.03.09 Shrubs to Keep People Off		1,000	0	0	0	0	2,000	
TOTAL Build Berm From Existing Mat'l	17700.00 CY	229,000	12,000	48,000	17,000	25,000	332,000	18.75
09.01.99.04 Install Culvert and Flap Gate								
09.01.99.04.01 Culvert Structure w/Gate								
09.01.99.04.01.01 Culvert	45.00 LF	3,000	0	1,000	0	0	5,000	111.19
09.01.99.04.01.02 Flap Gate	1.00 EA	7,000	0	1,000	1,000	1,000	10,000	9725.58
09.01.99.04.01.03 Inlet Headwall/Wingwall		9,000	1,000	2,000	1,000	1,000	13,000	

	QUANTITY	UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
09.01.99.04.01.04 Outlet Headwall/Wingwall			11,000	1,000	2,000	1,000	1,000	16,000	
TOTAL Culvert Structure w/Gate			31,000	2,000	6,000	2,000	3,000	44,000	
TOTAL Install Culvert and Flap Gate	45.00	LF	31,000	2,000	6,000	2,000	3,000	44,000	982.54
09.01.99.05 Survey Crew Final Grading									
09.01.99.05.11 1 Surveyor w/4x4 Suburban	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
TOTAL Survey Crew Final Grading	50.00	DAY	33,000	2,000	7,000	3,000	4,000	48,000	962.68
09.01.99.06 Vegetate Disposal Area									
09.01.99.06.02 Hydroseed Upland Disposal Area	33500.00	SY	17,000	1,000	3,000	1,000	2,000	24,000	0.71
TOTAL Vegetate Disposal Area	33500.00	SY	17,000	1,000	3,000	1,000	2,000	24,000	0.71
09.01.99.07 Rip Rap at RR Opening									
09.01.99.07.01 Machine Placed Rip Rap	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
TOTAL Rip Rap at RR Opening	35.00	CY	2,000	0	1,000	0	0	4,000	101.61
09.01.99.08 Weir to Keep Open Water									
09.01.99.08.01 Install Weir near RR Opening	30.00	LF	1,000	0	0	0	0	2,000	59.14
TOTAL Weir to Keep Open Water	30.00	LF	1,000	0	0	0	0	2,000	59.14
09.01.99.09 Access over RR to ExcavateStream									
09.01.99.09.01 Allowance for Access over RR			1,000	0	0	0	0	2,000	
TOTAL Access over RR to ExcavateStream			1,000	0	0	0	0	2,000	
09.01.99.12 Demobilization and Site Cleanup									
09.01.99.12.02 DeMob Veh & Remove stage area			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Demobilization and Site Cleanup			12,000	1,000	3,000	1,000	1,000	18,000	
TOTAL Associated General Items			1,415,000	77,000	298,000	107,000	152,000	2,050,000	

	QUANTITY UOM	CONTRACT	ESCALATN	CONTINGN	E&D - DC	S & A	TOTAL COST	UNIT COST
TOTAL Channels		1,415,000	77,000	298,000	107,000	152,000	2,050,000	
TOTAL Channels and Canals		1,415,000	77,000	298,000	107,000	152,000	2,050,000	
90 Vegetating Marsh Area (Fed&Vol)								
90.01 Federal Planting Oversight	2.00 WK	9,000	0	2,000	0	0	11,000	5693.22
90.02 Purchase Plantings for Marsh	21700.00 SY	43,000	2,000	9,000	0	0	55,000	2.53
TOTAL Vegetating Marsh Area (Fed&Vol)		52,000	3,000	11,000	0	0	66,000	
91 Monitoring								
91.01 Monitoring		9,000	0	2,000	0	0	11,000	
TOTAL Monitoring		9,000	0	2,000	0	0	11,000	
92 Real Estate		95,000	0	0	0	0	95,000	
95 Feasibility Study Costs								
95.01 Feasibility Study Costs		177,000	0	0	0	0	177,000	
TOTAL Feasibility Study Costs		177,000	0	0	0	0	177,000	
96 Plans & Specifications Phase								
96.01 Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Plans & Specifications Phase		120,000	7,000	25,000	0	0	152,000	
TOTAL Town Pond FS - ALT 6		1,868,000	87,000	337,000	107,000	152,000	2,551,000	