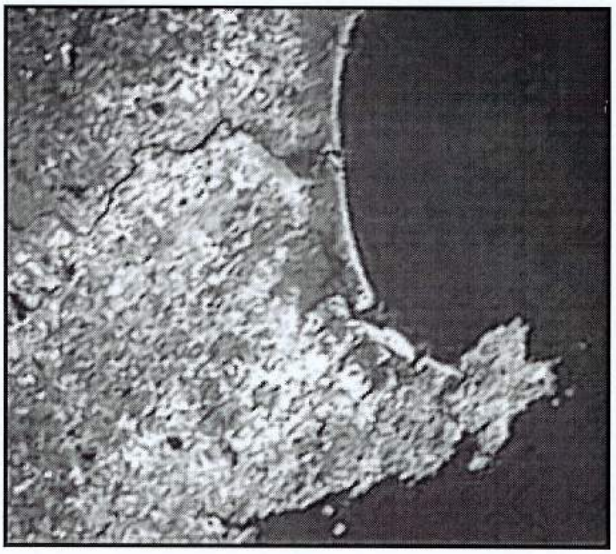
Tidal Crossings Inventory and Assessment

SUMMARY REPORT: UPPER NORTH SHORE, MASSACHUSETTS



Prepared for the Eight Towns and the Bay Committee

December 19, 1996

Parker River Clean Water Association

P.O. Box 823
Byfield, MA 01922

The **Tidal Crossings Inventory and Assessment Report** (December, 1996) details tidal restrictions in the eight communities within the Eight Towns and the Bay region (Salisbury, Newburyport, Newbury, Rowley, Ipswich, Essex, Gloucester, and Rockport). This work was made possible by funding from the Massachusetts Bays Program and by the tremendous efforts of the Parker River Clean Water Association.

Funding from the Massachusetts Office of Coastal Zone Management has allowed for a second printing of the report, which is now available in three versions:

- Summary Report (56 pages)
- Full Report (492 pages)
- Municipal Reports (contain data for single 8T&B communities)

For more information about this project, please contact:

The Parker River Clean Water Association
P.O. Box 823
Byfield, MA 01922
(508) 465-6280

or

The Eight Towns and the Bay Committee
c/o Merrimack Valley Planning Commission
160 Main Street
Haverhill, MA 01830
(508) 374-0519

For information about tidal restrictions in this and other areas of the state, please contact:

The EOEA Wetlands Restoration and Banking Program
One Winter Street
Boston, MA 02108
(617) 272-5986

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INTRODUCTION

Project Summary

The Eight Towns and the Bay Committee as part of the Massachusetts Bays Program, chose the Parker River Clean Water Association (PRCWA) to prepare a comprehensive report on tidal restrictions. The primary goal of the project is to complete an inventory and assessment of all the tidal restrictions in the eight town region, excluding the Ipswich to Newburyport MBTA railroad line. The results of this report are intended to be used by local highway departments, conservation commissions and various state agencies in order to ensure that specific solutions for correcting restricted tidal flows are incorporated into future road and maintenance plans.

The PRCWA is an independent organization dedicated to promoting the restoration and protection of the ecological integrity of the Parker River, its tributary streams and its adjacent lands. The purpose of the Association is to increase citizen involvement in projects designed to address the area's environmental problems.

The PRCWA Tidal Restriction Project encompasses the entire Great Marsh area which spreads along the coast from Cape Ann to New Hampshire. Assessment of crossings in tidal areas in the communities of Essex, Gloucester, Ipswich, Newbury, Newburyport, Rockport, Rowley, and Salisbury have been completed, and their various impacts on tidal flow have been evaluated. Crossings which cause significant restriction have been given special attention. A unique aspect of the Tidal Restriction project was the integration of volunteers who participated in the "Turn the Tide Day", involving local citizens in the evaluation of tidal restrictions in their community. The data collected was used to quantify the impact of the crossings on tidal flow, in order to identify which crossings are severely impacting salt marsh habitat. Recommendations were then formulated for each of the most restrictive crossings on means of improving tidal flow.

Project Background

The restriction of tidal flow can dramatically alter the productivity of a salt marsh by changing its natural habitat composition through the introduction of invasive species, which favor the less saline conditions created upstream. Productivity of the upstream and downstream wetlands is also effected by flooded soils resulting from poor drainage, poor maintenance of the culverts and bridges, and bank erosion.

The National Research Council has recently identified habitat modification as one of the major factors threatening the integrity of coastal ecosystems. The impact of human activities on coastal ecosystems has become a topic of great concern due to the closing of shellfish beds and the decline of New England's marine fisheries. Salt marshes provide important spawning and nursery areas as well as plant food for species crucial to the commercial and recreational fish and shellfish industries. An estimated 71% the dockside value of fish landed in the United States is derived from fish species that depend directly or indirectly on coastal wetlands.

In conclusion, habitat modification caused by tidal restriction is a threat that endangers the eight town region, and as the project summary illustrates, roughly one-fifth of all the sites restrict tidal flow. The need to address the problems caused by restrictive crossings is great, especially if the health of the Great Marsh is to be sustained.

Project Scope

Within the eight town region; Salisbury, Newburyport, Newbury, Rowley, Ipswich, Essex, Gloucester and Rockport; 125 tidal crossings were evaluated. The railroad line from Ipswich to Newburyport was not included in this study. The following is a breakdown of the sites for each town. The crossings have been categorized by phase, each phase representing a distinctly different quantitative analysis which is explained, in detail, in the methodology section of this report. Phase I indicates the total inventory of 125 sites. Phase II comprises 59 sites that have been assessed as potentially restrictive, and Phase III focuses on the 25 sites that are the most restrictive.

Phase I		**Phase II**		**Phase III**	
Salisbury:	20	Salisbury:	11	Salisbury:	6
Newburyport:	5	Newburyport:	1	Newburyport:	1
Newbury:	28	Newbury:	14	Newbury:	5
Rowley:	3	Rowley:	3	Rowley:	1
Ipswich:	14	Ipswich:	8	Ipswich:	3
Essex:	15	Essex:	6	Essex:	2
Gloucester:	30	Gloucester:	15	Gloucester:	7
Rockport:	10	Rockport:	1	Rockport:	0

A tidal crossing is defined as a culvert or bridge that crosses a tidal river, creek or ditch. Many crossings skirt the transition zone between salt marsh and upland, and these sites were not considered within the scope of this project. Causeways or road embankments in the salt marsh without culverts were also not considered.

Thirteen of the twenty five Phase III sites received a high priority rating. Priority was based on the amount of wetland potentially effected by the reestablishment of a proper tidal flow, the positive effects that reestablishment of tidal flow would have on nearby development, and on the cost of improvement vs. the benefit that increased tidal flow would have on the surrounding wetlands.

Methodology

The major goal of the Tidal Restriction Project was to identify those crossings which impede tidal flow and require further quantitative evaluation. To properly identify these crossings, the PRCWA broke the project into three phases.

Phase I

The assessment methods in Phase I were adapted from the shoreline survey methodology used

by our stream teams. A ranking scheme based on a simple 1-5 scale (5 being most problematic) was used to assess one biological and two physical indicators of tidal flow restriction.

Crossing Ratios (Physical)

Crossing Ratio refers to the relationship of stream channel width at the culvert to the diameter of the culvert or to the width of the crossing opening. The ratios were estimated for each crossing and the upstream and downstream ratios were recorded.

Bank Erosion (Physical)

If a crossing is restrictive, then the water velocity will be increased as it passes through the restriction. When this high velocity flow enters the natural channel, turbulent eddies result. This increased turbulence can accelerate bank erosion in the immediate vicinity of the restriction resulting in increased channel width or a pool adjacent to the crossing. The degree of bank erosion and pooling associated with the turbulent flow was recorded.

Vegetation Comparison (Biological)

When the tidal range is reduced, the upstream habitat may no longer be dominated by salt marsh grasses, but instead may contain less salt tolerant species such as Common Reed (*Phragmites australis*) or freshwater species such as cattails (*Typha sp.*). In extreme cases, the habitat may evolve into shrub or forested swamp, and the former wetland may be invaded by upland species. The habitat both upstream and downstream was assessed visually, and any difference in indicator plant species frequency was recorded.

For each crossing an individual labeling system was developed on a town by town basis, where each restriction is labeled within the total amount of restrictions located in the town. (For example: NB 5, would be the fifth restriction studied in the city of Newburyport)

Phase II

From the classification of this information, a sum of ratings was calculated for each site. For the crossing ratio and the bank erosion classifications the upstream and the downstream were rated separately and the rankings for each were given equal weight. For the vegetation comparison one overall ranking was given for the upstream and the downstream. If the rating was above 14, the site was evaluated further in Phase II. (The Phase I ranking also includes an overall score calculated when the vegetation comparison category is doubled and it is listed as the second number on the Phase I templates overall score category)

Two distinct studies were made in Phase II: the first measured tidal range on both sides of the crossing during one tide cycle; the second, comprised a quantitative analysis of vegetation composition.

1. *Tidal Range Measurement*

At each crossing, a reference point was defined on the both upstream and the downstream side of the bridge or culvert. The reference points chosen were near the middle of the channel, and were marked with a small spot of paint. A weighted tape-measure was used to measure distance (in inches) between the water surface and the reference point for both reference points at each crossing. A total of 6 measurements timed approximately 2 hours apart were collected during a single tide cycle.

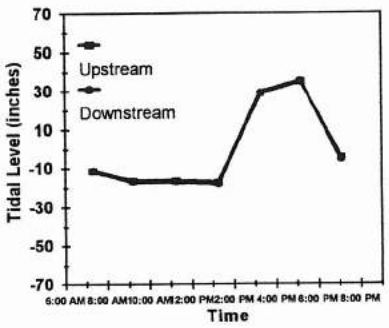


Figure 1- Unrestrictive Site -Unnamed Creek, Causeway St., Gloucester

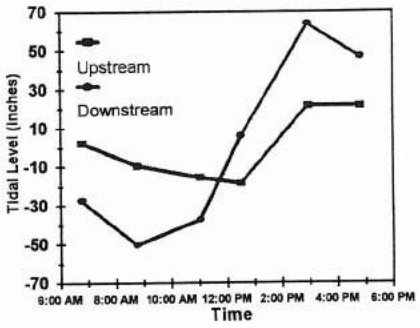


Figure 2 - Restrictive Site - Jones River, Long Wharf, Gloucester

The data were entered into a spreadsheet template which computes the water-level change for each reference point. Data visualized by graphing both upstream and downstream water-level changes for each crossing on the same axes. The peak-to-peak level changes (tidal range) were computed, as well as the ratio of the upstream to downstream level changes. If the crossing creates no restriction, then the upstream and downstream curves should lay over each other and the measured peak-to-peak upstream and downstream level changes will be within 1-2 inches of each other (see Figure 1). If there are significant differences between the curves and the peak-to-peak flows, then the crossing is altering the tidal flow (see Figure 2).

2. *Vegetation Analysis*

A series of four vegetation profiles, or transects, was completed for each side of the tidal crossing. These profiles started at the creek edge and continued to the upland, or to a designated distance. Forty-four different plant species were recorded along a tape measure which was staked at either end. The width of the profile was approximately one foot. The percentage of specific plant species was estimated in five foot intervals and then the data accumulated for each plant type was entered into a spreadsheet to give a profile of plant composition for each transect (see Figure 3 and 4).

The first set of profiles was taken at or near the crossing, on either side of the creek. The distance from the crossing depended on specific conditions

and accessibility. These profiles ran roughly parallel to the road bank and started at the creek edge.

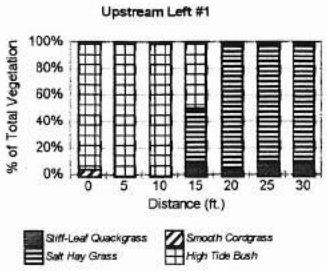


Figure 3 -Upstream Transect, Unnamed Creek, Rt. 1A, Rowley

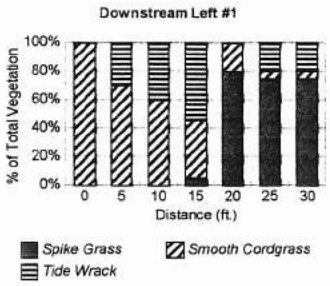


Figure 4- Downstream Transect, Unnamed Creek, Rt. 1A, Rowley

A second set of profiles was conducted approximately parallel to the first transect. The distances varied depending on each site but for most sites were kept the same for the upstream and the downstream for each individual site.

Phase III

From the data accumulated in Phase II a list of the crossings which significantly restrict tidal flow was developed according to a tidal differential of more than five inches between the upstream and the downstream sides of the crossing. Vegetation analysis was used as a supporting factor in the determination of Phase III status. Recommendations for crossing remediation were developed with attention to the physical limitations of the crossing (e.g. the amount of road cover), economic limitations, social limitations (e.g. flooding), benefits to wetland productivity, and overall feasibility. These recommendations were developed with the assistance of Scott Patrowicz, P.E.

It should be emphasized that further study will be necessary to quantify the engineering aspects of the recommendations. Prior to implementation of the recommendations, final engineering documents, including plans and specifications, will be required, and permits from the appropriate local and state agencies will be needed. Of special note: An Order of Conditions obtained through local conservation commissions, to allow for the implementation of the following recommendations, may be readily obtained if the project is identified as a "limited project" under the Massachusetts Wetlands Protection Act, which defines the routine maintenance of a drainage way a "limited project".

Acknowledgments

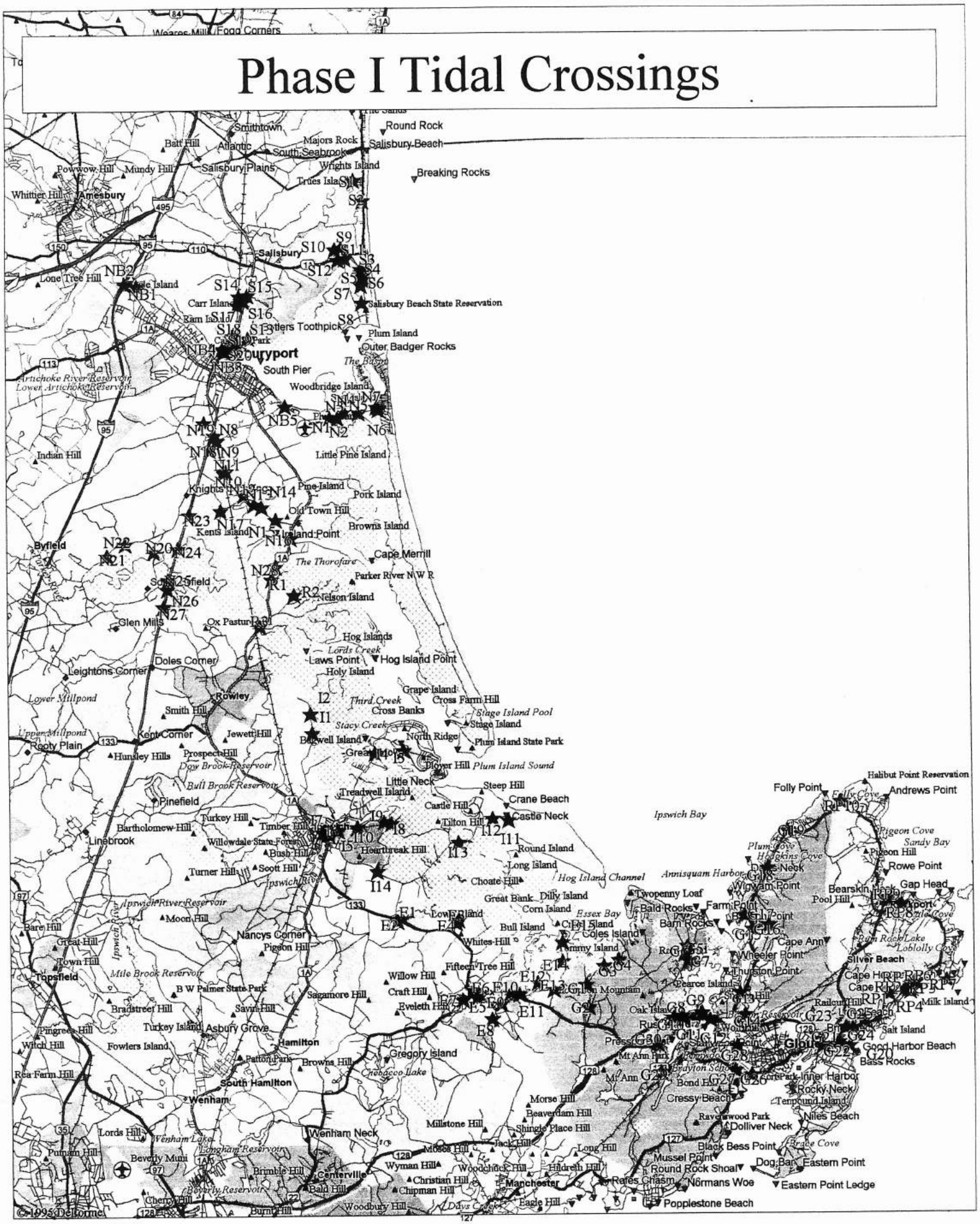
Special thanks must be given to Lisa Nicol and the members of the Eight Towns and the Bay

Committee, all of whom made their indelible stamp on the project and Scott Patrowicz, Professional Engineer, Patrowicz Land Development Engineering,

Special thanks as well to the volunteers: Joe Pecoraro, Bob Guthro, Chuck Slama, Chris Menard, Brigham Cox, Lee Wheeler, Morton Wheeler, Frederick Tarr, Barbara Bereman, David Mountain, Debra Baker, Linda Gutherie, Geoff Wilson, Rob "Swifty" Stevenson, Don Stein, Lane Williamson, David Stickney, Jane Nyman, Janet Pillion, Gus Harrington, Kate Benashski and Tim Purinton.

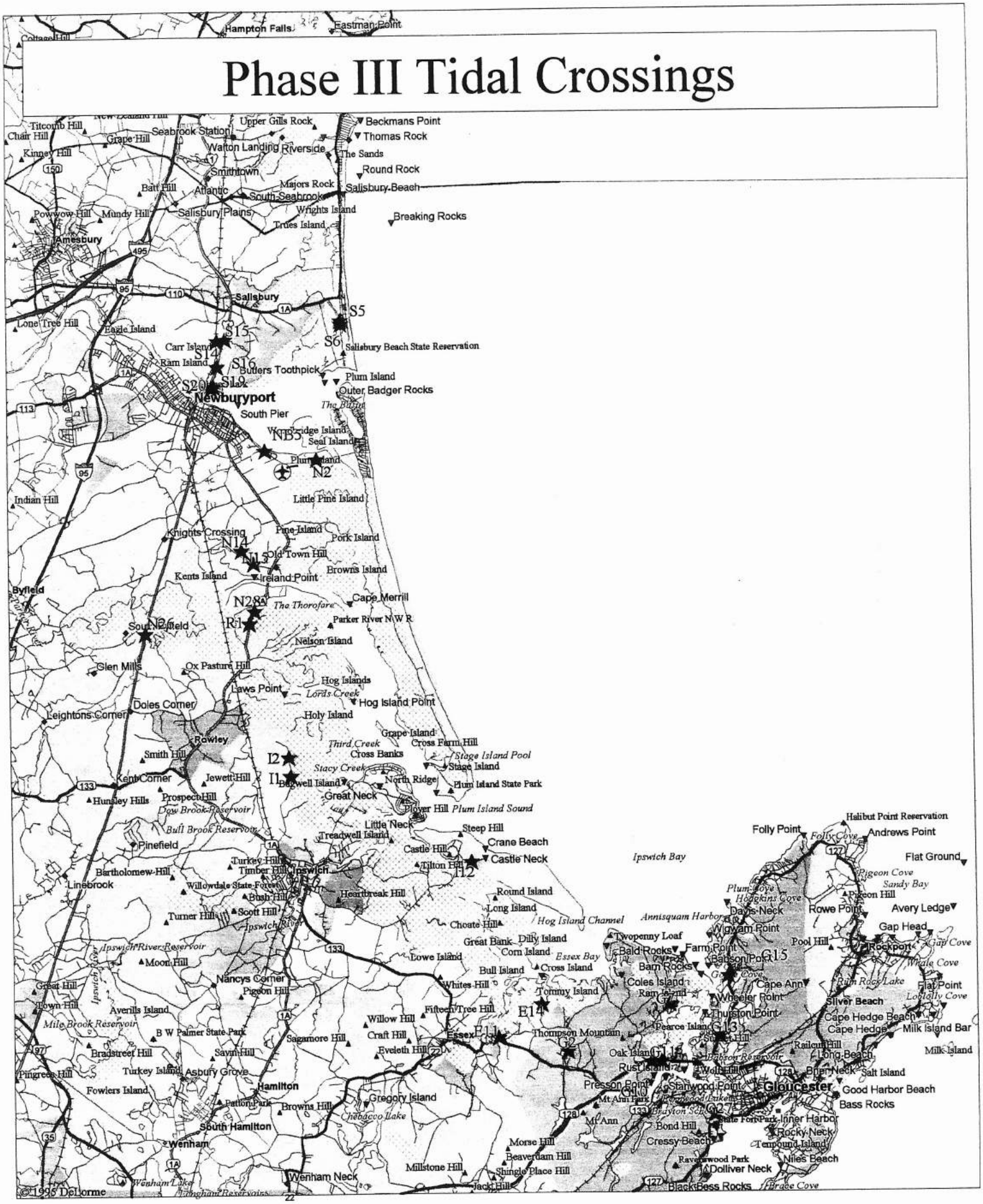
MAPS

Phase I Tidal Crossings



Phase II Tidal Crossings

Phase III Tidal Crossings



PHASE III SUMMARIES

Phase III Summary

Crossing Identification:

Site Number: S5 **Town**: Salisbury

Location: Unnamed Creek - Salisbury Beach State Reservation

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 36" Diameter

Approximate Acreage of Wetlands Impacted: .25

Phase I Restriction Rating: 14/19

Phase II Tidal Range Difference **Percentage**: 51% **Inches**: 28

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Heavy Residential Activity (One home is ~25' from the culvert to the east, directly abutting the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 12.5' from the creek edge

Downstream Average: 16.7' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: The wetland has been converted into private lawn, only approximately a 10' square area of wetland plant species remains, as well *Phragmites australis* (Common Reed) is present along road bank.

Downstream: A large growth zone of *Phragmites australis* exists along the creek and isolated growth patches are present in the marsh approximately 200 yards to the west.

General Impacts on the Function of the Wetlands: The upstream wetlands have been filled and the productivity of the marsh has been destroyed. The productive transition zone from the upland to wetland, downstream, has been overtaken by *Phragmites australis,* adversely affecting overall productivity.

Recommendations:

1. Do not increase the size of the culvert due to concerns of flooding.
2. Clean the sediment deposits and debris in stream bed adjacent to the culvert.
3. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: S6 **Town:** Salisbury

Location: Unnamed Creek - Salisbury Beach State Reservation

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 36" Diameter

Approximate Acreage of Wetlands Impacted: 2.8

Phase I Restriction Rating: 16/19

Phase II Tidal Difference **Percentage:** 70% **Inches**: 23

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Heavy Residential Activity (Nearest home is ~ 50' from the culvert to the east, ~20' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 18.75' from the creek edge

Downstream Average: Beyond the 25' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: A large growth zone of *Phragmites australis* (Common Reed) exists 100 yards to the south of the culvert. Overall this is a brackish marsh which gets limited tidal flushing.

Downstream: This is an area of healthy salt marsh with the exception of a large growth zone of *Phragmites australis* 100 yards to the south of the culvert.

General Impacts on the Function of the Wetlands: In the upstream more brackish conditions exist which can foster the spread of *Phragmites australis* which reduces the productivity of the salt marsh by introducing a monotypic species habitat. Otherwise diversity of plant species is good. The productive transition zones from upland to wetland are not gradual in the upstream because of the encroaching development and due to the existing bank configuration.

Recommendations:

1. Do not increase the size of the culvert due to concerns of flooding of the local the residences.
2. Clean sediment deposits and debris in stream bed adjacent to the culvert.
3. Improve stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:
Site Number: S14 **Town**: Salisbury
Location: Town Creek - RR Tracks

Crossing Characteristics:
Type of Crossing: Granite Bridge/Culvert **Size of Opening:** Upstream: 5' x 5' Downstream: 6' x 4'
Approximate Acreage of Wetlands Impacted: 75
Phase I Restriction Rating: 22.5/26
Phase II Tidal Difference **Percentage**: 37% **Inches**: 42

Land Use:
Downstream Adjacent Land Use: Undeveloped
Upstream Adjacent Land Use: Sparse Commercial Activity (Businesses are ~250 yards from the culvert to the east along Rt. 1, ~10'-100' from the wetlands)

Vegetation:
First Occurrence of Salt-intolerant Species:
Upstream Average: Dominated by *Phragmites australis*
Downstream Average: 20.6' from the creek edge
Overall Impacts on the Wetland Vegetation:
Upstream: Brackish and fresh marsh replace former high salt marsh, invasive species are present as well as cattails.
Downstream: Brackish and fresh marsh replace former high salt marsh, invasive species are present as well as cattails.
General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced due to the invasion of *Phragmites australis* and *Lythrum salicaria* (Common Reed and Purple Loostrife). The productive transition zone from upland to wetland, downstream, has been overtaken by *Phragmites australis* which is adversely affecting the wetland. The large amount of wetlands upstream (75 acres) is secluded or "trapped" meaning there is limited tidal flushing. Turbulence of flow limits low marsh development by creating steeply cut banks. The high percentage of Narrow Leaved Cattail and Common Reed creates a monotypic species composition which reduces overall productivity.

Recommendations:
1. Remove the tidal gate to allow for the free passage of water.
2. Install a bridge or an arched culvert porportional to the creek width to allow for the free passage of water.
3. Bury the culvert into the stream bed to allow for a natural stream bed to form.
4. Drop the invert on the upstream and downstream to allow for the free passage of water.
5. Improve the stone revetment if applicable to reduce bank erosion and subsequent bank failure and culvert blockage.

Note: Further study is needed to determine the effect of improved tidal flow on the existing development upstream (e.g. flooding).

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: S15 **Town:** Salisbury

Location: Town Creek - Rt. 1

Crossing Characteristics:

Type of Crossing: Double Concrete Culvert **Size of Opening:** 48" and 24" Diameter

Approximate Acreage of Wetlands Impacted: 45

Phase I Restriction Rating: 20/24

Phase II Tidal Difference **Percentage:** 21% **Inches:** 18.6

Land Use:

Downstream Adjacent Land Use: Heavy Commercial Activity (A parking lot and commercial property is ~400' from the culvert to the south, ~50' from the wetlands)

Upstream Adjacent Land Use: Heavy Commercial Activity (A commercial property and parking lot is ~200' to the north of the culvert, abutting the wetlands, another commercial property is ~200' from the culvert to the south, ~50' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: .25' from the creek edge

Downstream Average: 6.5' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: Brackish and fresh marsh replace former salt marsh, invasive species are present as well.

Downstream: Brackish species replace high salt marsh, with *Phragmites australis* (Common Reed) dominating the transition zones.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced due to the invasion of *Phragmites australis* and *Lythrum salicaria* (Common Reed and Purple Loostrife). The productive transition zone from the upland to the wetland, downstream, has been overtaken by *Phragmites australis* which is adversely affecting the wetlands. The upstream has adapted into a fresh water wetland system, for the watershed for this area is large and the tidal restriction traps the fresh water on the upland side of the crossing.

Recommendations:

1. Replace the existing culvert with a larger conventional culvert or double box culvert to allow for the free passage of water.
2. Bury the culvert into the stream bed to allow for a natural stream bed to form.
3. Place the culvert at the proper elevation to allow for the free passage of water.
4. Improve the concrete head wall to reduce bank erosion and subsequent bank failure and culvert blockage.

Note: Further study is needed to determine the effect of improved tidal flow on the existing development upstream (e.g. flooding). This site will need to improved if tidal flow is increased at crossing S14.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: S16 **Town:** Salisbury

Location: Vincent Creek - Rt. 1

Crossing Characteristics:

Type of Crossing: Granite Culvert **Size of Opening:** Upstream: 0" x 0" Downstream: 14" x 10"

Approximate Acreage of Wetlands Impacted: 22

Phase I Restriction Rating: 20/24

Phase II Tidal Difference **Percentage:** 21% **Inches:** 18.6

Land Use:

Downstream Adjacent Land Use: Heavy Commercial Activity (A parking lot and commercial property is ~100 yards from the culvert to the south,~50' from the wetlands)

Upstream Adjacent Land Use: Sparse Residential and Heavy Commercial Activity (A residence/commercial structure and parking lot is ~50' from the culvert to the north, abutting wetlands)

Vegetation:

First Occurrence of Salt-intolerant Species:

Upstream Average: 2.5' from the creek edge

Downstream Average: 11.9' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: Brackish and fresh marsh conditions replace former salt marsh, invasive species are present as well.

Downstream: Low salt marsh with brackish species replace high salt marsh, with *Phragmites australis* (Common Reed) dominating the transition zones.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced due to the invasion of *Phragmites australis* and *Lythrum salicaria* (Common Reed and Purple Loostrife). The productive transition zone from the upland to the wetland, downstream, has been overtaken by *Phragmites australis* which has negative effects on the wetland. The upstream marsh is secluded or "trapped" marsh because it is dependent on one source of tidal flow. These conditions make the upstream wetland susceptible to invasion by opportunistic species.

Recommendations:

1. Replace the existing granite culvert with a conventional culvert (24" or 36") to allow for the free passage of water.
2. Bury culvert into the stream bed to allow for a natural stream bed to form.
3. Place the culvert at the proper elevation to allow for the free passage of water.
4. Clean the sediment deposits and debris in the stream bed adjacent to the culvert.
5. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Note: Further study is needed to determine the effect of improved tidal flow on the existing development upstream (e.g. flooding). In this case the tidal range is only 5" so an improvement of tidal flow would probably not adversely threaten surrounding development. This site will need to improved if tidal flow is increased at crossing S14.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: S20 **Town:** Salisbury

Location: Unnamed Creek - 1st Street

Crossing Characteristics:

Type of Crossing: Metal Culvert **Size of Opening:** 20" Diameter

Approximate Acreage of Wetlands Impacted: .25

Phase I Restriction Rating: 17/21

Phase II Tidal Difference **Percentage**: 59% **Inches**: 24

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (A home is ~100 yards to the east, ~25' from the wetlands), Sparse Commercial Activity (A business is ~75' from the creek to the west, adjacent to the wetlands)

Upstream Adjacent Land Use: Sparse Residential Activity (A home is ~75' from creek edge to the east, ~25' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Dominated by *Phragmites australis*

Downstream Average: Dominated by *Phragmites australis*

Overall Impacts on the Wetland Vegetation:

Upstream: In this wetland *Phragmites australis* (Common Reed) replaces former high salt marsh, invasive species such as *Lythrum salicaria* (Purple Loosestrife) are present as well, indicating the brackish nature of the site.

Downstream: *Phragmites australis* and *Typha augustifolia* (Narrow Leaved Cattail) are encroaching on the high salt marsh. To the east a small portion of high marsh is present. Low marsh is limited to directly along the Merrimack River and along the creek edge.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced due to the invasion of the Common Reed and to a lesser extent Purple Loosestrife. The productive transition zone from the upland to wetland, downstream and upstream, has been overtaken by *Phragmites australis* which adversely affects the wetland. This site also gets tidal influence to the north from Mill Creek but not enough to abate the encroachment of *Phragmites australis*, upstream. The upstream is a very small area (.25 acres) of secluded marsh bound by March Street and crossing S19.

Recommendations:

1. Increase the size of the culvert to 36"+ to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and the road bed install multiple, side by side culverts.
3. Bury the culverts 12" into the stream bed to allow for a natural stream bed to form.
4. Clean the sediment deposits and debris in stream bed adjacent to the culvert.
5. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Note: Improvement of crossing S20 would require the same improvements to be completed on crossing S19 due to the proximity of the crossings and the nature of local hydrologic conditions.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: NB5 **Town:** Newburyport

Location: Unnamed Creek - Water Street

Crossing Characteristics:

Type of Crossing: Double Steel Culvert **Size of Opening:** 24" Diameter (Each)

Approximate Acreage of Wetlands Impacted: 4.1

Phase I Restriction Rating: 17/21

Phase II Tidal Difference **Percentage:** 29% **Inches:** 14

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (A home is ~75' from the creek to the west, raised above the wetlands), Sparse Commercial Activity (~10' from the culvert to the east, abutting the wetlands)

Upstream Adjacent Land Use: Sparse Residential Activity (A home is ~100 yards from the creek edge to the south,~90 yards from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 10.6' from the creek edge

Downstream Average: 11.6' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: Brackish marsh and fresh meadow border the poorly defined creek channel. It appears that the percentage of salt marsh has been reduced by the restrictive quality of the crossing and therefor is limited to a small area near the culvert.

Downstream: Although the crossing is only a few hundred feet from the Merrimack River the vegetation is comprised of invasive species such as the *Phragmites australis* and *Polygonum cuspidatum* (Common Reed and Japanese Knotweed). There is some evidence of healthy high/low marsh but this is evident as one progresses away from the crossing to the west and to the east.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has not necessarily been reduced in the transformation of the former salt marsh to a more brackish marsh, for species diversity is high and the transition zone is healthy. The downstream vegetation composition is disturbed due to the nearby parking lot and sand and gravel spoils which have raised elevations and changed soil types on the former salt marsh. There is also evidence of increased sedimentation on the downstream side from the erosion of the road bed as well as from parking lot runoff.

Recommendations:

1. Increase the size of the culvert to 36" to allow for the free passage of water or install a reinforced concrete box culvert.
2. Due to the shallow cover between stream bed and road bed install double, side by side culverts.
3. Bury the culverts into the stream bed to allow for a natural stream bed to form.
4. Drop the invert on the upstream and downstream to allow for the free passage of water.
5. Clean the sediment deposits and debris in the stream bed and in the marsh adjacent to the culvert.
6. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.
7. Install a Massachusetts Department of Public Works wingwall on the downstream side to prevent bank erosion

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: N2 **Town**: Newbury

Location: Unnamed Creek - Plum Island Turnpike

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 20" Diameter

Approximate Acreage of Wetlands Impacted: 5.5

Phase I Restriction Rating: 16/19

Phase II Tidal Difference **Percentage**: 54% **Inches**: 22.8

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (~100 yards from the culvert to the north and ~50' to the east, both are immediately adjacent to the wetlands.)

Upstream Adjacent Land Use: Sparse Residential Activity (~ 75' from the culvert to the west,~ 50' from the wetlands.)

Vegetation:

First Occurrence of Salt-intolerant Species:

Upstream Average: 13.3' from the creek edge

Downstream Average: 10' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: The upstream wetlands are healthy although there is evidence of water saturation in the high marsh and increased growth of *Spartina alterniflora* (Smooth Cord Grass). As well a high percentage of *Iva frutescens* (High Tide Bush) is growing in the high marsh, possible the result of a reduction in tidal range.

Downstream: The upstream wetlands are healthy, although there is some erosion at the creek banks with a heavy accumulation of tide wrack which is blanketing and suffocating the high marsh.

General Impacts on the Function of the Wetlands: The productivity of the upstream and downstream wetlands is good, no invasive species are evident. Problems associated with the undersized culvert are localized. Although, as some sections of marsh are changing from high marsh dominated by herbaceous species to a high marsh dominated by woody species, these conditions may provide conditions suitable for the introduction and spread of *Phragmites australis* (Common Reed).

Recommendations:

1. Increase the size of the culvert to 36" to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install multiple, side by side culverts.
3. Drop the invert on the upstream and downstream to allow for the free passage of water.
4. Install energy dissipators in the form of large diameter stone in the stream bed upstream to reduce the damage from water velocity and to prevent bank scouring.
5. Bury the culverts 12" into the stream bed to allow for a natural stream bed to form.
6. Clean the sediment deposits and debris in the stream bed adjacent to the culvert.
7. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: N14 **Town**: Newbury

Location: Unnamed Creek - The Trustees of the Reservation Road

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 18" Diameter

Approximate Acreage of Wetlands Impacted: 3.7

Phase I Restriction Rating: 15/16

Phase II Tidal Difference **Percentage**: 76% **Inches**: 5.5

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Undeveloped

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Beyond the 30' Transect

Downstream Average: Beyond the 30' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: Overall this is a region of healthy high/low marsh with healthy wetland/upland transition zones. Sporadic *Spartina alterniflora* (Smooth Cordgrass) is evident in the high marsh perhaps indicating poorly drained soils. There are small patches of *Phragmites australis* (Common Reed) approximately 300 yards to the north at the upland transition zone.

Downstream: Overall this is a region of healthy high/low marsh. Sporadic *Spartina alterniflora* (Smooth Cordgrass) is evident in the high marsh perhaps indicating poorly drained soils.

General Impacts on the Function of the Wetlands: The productivity of the upstream and downstream wetlands is good, little invasive species are evident. Problems associated with the undersized culvert are localized and minor such as erosion and scouring. The upstream wetlands benefit by also receiving tidal flow from crossing N15.

Recommendations:

1. Increase the size of the culvert to 24" or 36" to allow for the free passage of water.
2. Bury the culvert 12" into the stream bed to allow for a natural stream bed to form.
3. Drop the invert on the upstream and downstream to allow for the free passage of water.
4. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: N15 **Town:** Newbury

Location: Unnamed Creek - Newman Road

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 48" Diameter

Approximate Acreage of Wetlands Impacted: 28.4

Phase I Restriction Rating: 19/21

Phase II Tidal Difference **Percentage:** 55% **Inches:** 33.5

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Undeveloped

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Beyond the 30' Transect

Downstream Average: Beyond the 30' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: Overall this is a region of healthy high marsh/low marsh with healthy wetland/upland transition zone. Sporadic *Spartina alterniflora* (Smooth Cordgrass) is evident in the high marsh perhaps indicating poorly drained soils. There are small patches of *Phragmites australis* (Common Reed) approximately 200 yards to the northwest at the upland transition. Problems associated to the crossing are localized such as wrack build up and bank erosion, which can harm low marsh development.

Downstream: Overall this is a region of healthy high marsh and low marsh. Sporadic *Spartina alterniflora* (Smooth Cordgrass) is evident in the high marsh, perhaps indicating poorly drained soils. Problems associated with the crossing are localized such as sedimentation caused by bank erosion and bank slumping from the turbulent water flow.

General Impacts on the Function of the Wetlands: The productivity of the upstream and downstream wetlands is good, and few invasive species are evident. Problems associated with the undersized culvert are localized such as bank erosion and scouring which is especially evident on the upstream side. The upstream wetlands benefit by also receiving tidal flow from crossing N14.

Recommendations:

1. Install a freestanding bridge or a double 48"+ box culvert to allow for the free passage of water.
2. Bury the box culverts into the stream bed to allow for a natural stream bed to form.
3. Install energy dissipators in the form of large diameter stone in the stream bed upstream and downstream to reduce the damage from water velocity and to prevent bank scouring.
4. Clean the sediment deposits in the stream bed adjacent to the culvert.
5. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: N26 **Town:** Newbury

Location: Unnamed Creek - Rt. 1

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 24" Diameter

Approximate Acreage of Wetlands Impacted: .9

Phase I Restriction Rating: 15.5/18

Phase II Tidal Difference **Percentage:** 51% **Inches:** 19

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Undeveloped , Sparse Institutional Activity (A parking lot for a school is ~100 yards to the northwest, ~50' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 0' from the creek edge

Downstream Average: 0' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: This is an area of brackish marsh dominated by *Typha augustifolia* (Narrow Leaved Cattail). The upland transition zone directly parallels the creek on the east and west sides, as well the road bank encourages the migration of upland species onto the high marsh.

Downstream: Overall this is a region of brackish marsh dominated by *Typha augustifolia*. Sporadic *Spartina alterniflora* (Smooth Cordgrass) growth is evident near the creek edges and within the creek. The brackish nature of the vegetation is not primarily due to this crossing, but is probably due to increased sedimentation upriver.

General Impacts on the Function of the Wetlands: The crossing although restrictive, has little effect on the upstream vegetation due to the proximity of the upland to the creek. Improved tidal flow would probably encourage the growth of cattails further upstream to the north where the creek widens. The monotypic vegetation ubiquitous to this site is far less productive than a healthy salt marsh but this is probably a result of large scale watershed factors rather than the tidal flow restriction at this crossing.

Recommendations:

1. Clean sediment deposits and debris in stream bed adjacent to the culvert.
2. Improve stone revetment/ head wall to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: N28 **Town:** Newbury

Location: Mud Creek - Rt. 1A

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 24" Diameter

Approximate Acreage of Wetlands Impacted: 32.1

Phase I Restriction Rating: 18/21

Phase II Tidal Difference **Percentage:** 86% **Inches:** 9

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Undeveloped

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 23.75' from the creek edge

Downstream Average: 41.25' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: This is an area of overall healthy high/low marsh. The upland transition zones show evidence of *Phragmites australis* (Common Reed) growth (approximately 100 yards to the west and approximately 200 yards to the northwest). Woody species such as the High Tide Bush and Red Cedar are encroaching onto the high marsh near the upland transition zone and in the high marsh. There is some evidence of increased *Spartina alterniflora* (Smooth Cordgrass) emerging in the high marsh in localized pockets near the culvert.

Downstream: This is an area of healthy high/low marsh. There is some evidence of increased *Spartina alterniflora* (Smooth Cordgrass) emerging in the high marsh, and the heavy accumulation of tide wrack has changed the vegetation composition. There is also a significant amount of bank erosion taking place along the creek banks, effecting the distribution of the low marsh.

General Impacts on the Function of the Wetlands: This crossing adversely effects the productivity of the downstream on a small, localized scale. Productivity of the salt marsh is also threatened by the limiting of tidal range which has perhaps encouraged the growth of *Phragmites australis* on the upstream transition zone and has allowed other woody species to migrate onto the high marsh. Overall productivity of the upstream and downstream, though, is high.

Recommendations:

1. Increase the size of the culvert to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install multiple, side by side culverts or a reinforced concrete box or arched culvert.
3. Bury the culverts into the stream bed to allow for a natural stream bed to form.
4. Install energy dissipators in the form of large diameter stone in the stream bed downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Drop the invert on the upstream and downstream to allow for the free passage of water.
6. Clean the sediment deposits and debris in stream bed adjacent to the culvert.
7. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: R1 **Town:** Rowley/Newbury

Location: Unnamed Creek - Rt. 1A

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 36" Diameter

Vegetation:

Approximate Acreage of Wetlands Impacted: 32.1

Phase I Restriction Rating: 17/20

Phase II Tidal Difference **Percentage**: 55% **Inches**: 26

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Residential Activity (A home is ~100 yards to the south, ~25' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 5' from the creek edge

Downstream Average: 16.25' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: This is an area of overall healthy high/low marsh. The upland transition zones show no evidence of *Phragmites australis* (Common Reed) growth. Woody species such as *Iva frutescens* (High Tide Bush) are encroaching onto the high marsh near the road and the creek perhaps indicating the crossing has affected the vegetation composition.

Downstream: This is an area of healthy high/low marsh. There is some evidence of increased *Spartina alterniflora* (Smooth Cordgrass) emerging in the high marsh, and the heavy accumulation of tide wrack changes the composition of the vegetation . There is also a significant amount of bank erosion taking place on the downstream, effecting the distribution of species in the low marsh.

General Impacts on the Function of the Wetlands: This crossing effects the productivity of the downstream on a small, localized scale but on the upstream the limiting of tidal range has encouraged the growth of *Iva frutescens* at the transition zone and has allowed other woody species to migrate onto the high marsh. Overall productivity of the upstream and downstream wetlands is high.

Recommendations:

1. Increase the size of the culvert to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install multiple, side by side culverts or a reinforced concrete box or arched culvert.
3. Bury the culverts into the stream bed to allow for a natural stream bed to form.
4. Install energy dissipators in the form of large diameter stone in the stream bed downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Drop the invert on the upstream and downstream to allow for the free passage of water.
6. Clean the sediment deposits and debris in the stream bed adjacent to the culvert.
7. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: I1 **Town**: Ipswich

Location: Unnamed Creek - Town Farm Road

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 24" Diameter

Approximate Acreage of Wetlands Impacted: 13.8

Phase I Restriction Rating: 17/21

Phase II Tidal Difference **Percentage**: 84% **Inches**: 5

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Residential Activity (A home is ~75 yards to the west, ~100' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 6.25' from the creek edge

Downstream Average: Beyond 30' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: This is an area of moderately healthy high marsh/low marsh. The upland transition zones show clear evidence of *Phragmites australis* (Common Reed) growth. Woody species such as *Iva frutescens* (High Tide Bush) as well as *Phragmites australis* are encroaching onto the high marsh near the road where erosion of the road bed has raised elevations.

Downstream: This is an area of healthy high/low marsh. There is some evidence of increased *Spartina alterniflora* (Smooth Cordgrass) emerging in the high marsh, and the heavy accumulation of tide wrack has changed the vegetation composition.

General Impacts on the Function of the Wetlands: This crossing effects the productivity of the downstream on a small, localized scale but on the upstream the limiting of tidal range has encouraged the growth of *Phragmites australis* at the transition zone and has allowed other woody species to migrate onto the high marsh. These are indicators of a secluded or "trapped marsh" that have only one source of tidal influence. "Trapped" marshes are especially susceptible to degradation associated with the growth of invasive species.

Recommendations:

1. Increase the size of the culvert to 36" to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install double, side by side culverts.
3. Drop the invert on the upstream and downstream to allow for the free passage of water.
4. Install energy dissipators in the form of large diameter stone in the stream bed upstream and downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Bury the culverts 12" into the stream bed to allow for a natural stream bed to form.
6. Clean the sediment deposits and debris in the stream bed and on the salt marsh adjacent to the culvert.
7. Improve the head wall to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: I2 **Town:** Ipswich

Location: Unnamed Creek - Town Farm Road

Crossing Characteristics:

Type of Crossing: Concrete and Corrugated Metal Culvert **Size of Opening:** 32" Diameter

Approximate Acreage of Wetlands Impacted: 13.8

Phase I Restriction Rating: 17/20

Phase II Tidal Difference **Percentage**: 60% **Inches**: 12.5

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Commercial Activity (A landfill is ~75 yards to the north, ~50' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 3.75' from the creek edge

Downstream Average: 8.25' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: This is an area of moderately healthy high marsh/ low marsh. The upland transition zones show clear evidence of *Phragmites australis* (Common Reed) growth (approximately 200 yards to the south and approximately 250 yards to the west). Woody species such as *Iva frutescens* (High Tide Bush) as well as *Phragmites australis* are encroaching onto the high marsh near the road where erosion of the road bed as well as ditch spoils has raised elevations.

Downstream: This is an area of healthy high/low marsh. There is some evidence of increased *Spartina alterniflora* (Smooth Cordgrass) emerging in the high marsh, and the heavy accumulation of tide wrack has changed the vegetation composition. *Phragmites australis* also is evident on the north edge of the road bank, dominating the transition zone between salt marsh and upland. Immediately to the north of the creek, heavy bank erosion has made the transition zone between high marsh/upland dramatic.

General Impacts on the Function of the Wetlands: This crossing effects the productivity of the downstream on a small, localized scale but on the upstream the limiting of tidal range has encouraged the growth of *Phragmites australis* at the transition zone and has allowed other woody species to migrate onto the high marsh. These are indicators of a secluded or "trapped" marsh that has only one source tidal influence, although as one progresses upstream the marsh gets some flooding by the creeks that flow under the rail road tracks.

Recommendations:

1. Increase the size of the culvert to 36" or install a 48" reinforced concrete box culvert to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install multiple, side by side 36" culverts.
3. Drop the invert on the upstream and downstream to allow for the free passage of water.
4. Install energy dissipators in the form of large diameter stone in the stream bed downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Bury the culverts into the stream bed to allow for a natural stream bed to form.
6. Clean the sediment deposits in stream bed adjacent to the culvert.
7. Improve the head wall to reduce bank erosion and subsequent bank failure and culvert blockage.

Note: Further study of current railroad bed improvements are needed to understand how improvements will effect the hydrology for this crossing

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: I12 **Town:** Ipswich

Location: Patterson Creek - Argilla Road

Crossing Characteristics:

Type of Crossing: Corrugated Metal Culvert **Size of Opening:** 32" Diameter

Approximate Acreage of Wetlands Impacted: 15

Phase I Restriction Rating: 21.5/26

Phase II Tidal Difference **Percentage:** 35% **Inches:** 22

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Institutional Development (Castle Hill is~750 yards from the culvert to the north west, ~ 400' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 9.75' from the creek edge

Downstream Average: Beyond the 30' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) dominates the former salt marsh along the east side of the creek and along the transition zones from the wetland to upland. Erosion from the road bed has changed the vegetation composition such that it favors invasive species. On the west side of the creek healthy salt marsh is evident.

Downstream: The salt marsh is healthy with only isolated growth patches of *Phragmites australis* along the road bank. At the crossing heavy tide wrack build up has altered vegetation composition.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced by the invasion of *Phragmites australis*. The productive transition zone from upland to wetland, upstream, has been overtaken by *Phragmites australis* adversely affecting the wetland.

Recommendations:

1. Increase the size of the culvert to 36" or install a reinforced concrete box or arched culvert to allow for the free passage of water.
2. Due to the shallow cover between stream bed and road bed install multiple (2 or 3), side by side culverts.
3. In the case of conventional culverts drop the invert on the upstream and downstream to allow for the free passage of water.
4. Install energy dissipators in the form of large diameter stone in the stream bed upstream and downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Bury the culverts into the stream bed to allow for a natural stream bed to form.
6. Clean sediment deposits in stream bed and road spoils adjacent to the culvert to increase channel width.
7. Improve stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.
8. Install a Massachusetts Department of Public Works wing wall to ensure bank stability

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: E11 **Town:** Essex

Location: Ebben Creek - Rt. 133

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 20" Diameter

Approximate Acreage of Wetlands Impacted: 55

Phase I Restriction Rating: 21/23

Phase II Tidal Difference **Percentage:** 80% **Inches:** 20.5

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (A home is ~100' yards to the east, ~ 20' from the wetlands, 300 yards to the west, ~100' from the wetlands), Sparse Commercial Activity (A restaurant is ~75' to the south, ~ 20' from the wetlands)

Upstream Adjacent Land Use: Sparse Residential Activity (A home is~50' yards to the west of the culvert, ~ 50' from the wetlands, another home is ~75 yards to the northeast of the culvert, ~ 50' from the wetlands, another home is~200 yards to the southeast of the culvert, ~50' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Beyond the 40' Transect

Downstream Average: Beyond the 40' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: Overall this area is a healthy salt marsh. The upland transition zones are gradual and show sporadic patches of *Phragmites australis* (Common Reed) growth, especially to the south. There is some evidence of *Spartina alterniflora* (Smooth Cord Grass)extending into the high marsh, but on a small scale. The localized effects of the crossing are more dramatic with heavy tide wrack buildup changing low marsh to mudflat, deep bank scouring, which limits low marsh development, and the associated sedimentation from turbulent water flow.

Downstream: Overall this area is a healthy salt marsh. The upland transition zones are gradual and show sporadic patches of *Phragmites australis* growth, especially to the west. There is some evidence of *Spartina alterniflora* extending into the high marsh but on a small scale. The localized effects of the crossing are more dramatic with heavy tide wrack buildup changing low marsh to mudflat, deep bank scouring, which limits low marsh development, and the associated sedimentation from turbulent flow.

General Impacts on the Function of the Wetlands: On a localized scale, this crossing has tangible, adverse effects on the productivity of the wetlands. These effects are the result of the accumulation of tide wrack, erosion and sedimentation. The presence of *Phragmites australis* along the transition zones could be a function of limited tidal range or because of specific land use practices. woody species seem to be encroaching onto the wetland but further study is needed to determine if this is the result of the tidal crossing.

Recommendations:

1. Replace the culvert with a bridge to allow for the free passage of water.
2. Install energy dissipators in the form of large diameter stones in the stream bed upstream to reduce the damage from water velocity and to prevent bank scouring.
3. Clean the sediment deposits and debris in the stream bed adjacent to the culvert.

Note: Further study is needed to assess the impacts of improved tidal flow especially in regard to the flooding of adjacent properties.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: E14 **Town:** Essex

Location: Unnamed Creek - Conomo Point Road

Crossing Characteristics:

Type of Crossing: Granite Culvert **Size of Opening:** Upstream: 8" x 22" Downstream: 12" x 16"

Approximate Acreage of Wetlands Impacted: 7.8

Phase I Restriction Rating: 16/21

Phase II Tidal Difference **Percentage:** 38% **Inches:** 16

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Residential Activity (A home is ~300 yards to the north of the culvert, ~ 100' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Dominated by *Phragmites australis* (Common Reed)

Downstream Average: 11.25' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* dominates the former salt marsh along the creek and the road bank on the upstream, where only small pockets of high marsh are located.

Downstream: The wetlands are healthy with only isolated growth patches of *Phragmites australis*. There is some evidence of pooling and sedimentation caused by the restrictive quality of the crossing. The upland is in close proximity to the creek edge, naturally limiting the buffer zone of salt marsh along the creek

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been greatly reduced due to the invasion of *Phragmites australis*. The productive transition zone, from upland to wetland, upstream, has been overtaken by *Phragmites australis,* adversely affecting the wetland. The upstream is a typical secluded or "trapped" marsh which receives limited water flow.

Recommendations:

1. Replace degraded granite culvert with a 48" reinforced concrete box or two 36" conventional culverts to allow for the free passage of water.
2. Due to the shallow cover between stream bed and road bed install double, side by side culverts or a box culvert.
3. Clean the sediment deposits and debris in stream bed adjacent to the culvert.
4. Drop the invert on the upstream and downstream to allow for the free passage of water.
5. Bury culverts into the stream bed to allow for a natural stream bed to form.
6. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: G2 **Town:** Gloucester

Location: Walker Creek - Walker Street

Crossing Characteristics:

Type of Crossing: Reinforced Concrete Box Culvert **Size of Opening:** 6' x 6'

Approximate Acreage of Wetlands Impacted: 16.5

Phase I Restriction Rating: 15/18

Phase II Tidal Difference **Percentage**: 71% **Inches**: 17

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (A home is ~100 yards to the southeast, ~50' from the wetlands)

Upstream Adjacent Land Use: Sparse Agricultural/Residential Activity (A farm is~ 200 yards to the northwest, ~100 yards from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 13.8' from the creek edge

Downstream Average: 18.5' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: This area has clearly defined zones of high marsh/low marsh. The upland transition zones show no evidence of *Phragmites australis* (Common Reed) growth but show some extension of woody species onto the high marsh. *Iva frutescens* (High Tide Bush) dominates the high marsh in high percentages. The low marsh is confined to the creek edges and creek bed. The upland extends to within roughly a 50-75' offset on either bank.

Downstream: This area has clearly defined zones of high marsh/low marsh. The upland transition zones show no evidence of *Phragmites australis* growth , although *Typha augustifolia* (Narrow Leaved Cattail) is evident approximately 100' to the east. *Iva frutescens* is evident in the high marsh. Low marsh is confined to the creek edges and creek bed. The upland extends to within roughly a 75-100' offset of the creek on either bank.

General Impacts on the Function of the Wetlands: On a localized scale, this crossing has tangible effects on the productivity of the wetlands. These effects are limited to the accumulation of tide wrack, and erosion along the creek edges which causes pooling and bank scouring. The lack of *Phragmites australis* on both the upstream and downstream transition zones is an indication of a healthy, well drained marsh. As well, the abundance of *Iva frutescens* perhaps reduces overall biodiversity although to what extent warrants further study.

Recommendations:

1. Bury box culverts 12" into the stream bed to allow for a natural stream bed to form and for the free passage of water.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: G7 **Town:** Gloucester

Location: Unnamed Creek - Long Wharf

Crossing Characteristics:

Type of Crossing: Pier **Size of Opening:** NA

Approximate Acreage of Wetlands Impacted: 21.1

Phase I Restriction Rating: 22/24

Phase II Tidal Difference **Percentage:** 35% **Inches:** 74

Land Use:

Downstream Adjacent Land Use: Sparse Residential Activity (A home is ~200 yards south of the wharf, ~ 75' from the wetlands)

Upstream Adjacent Land Use: Undeveloped

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Beyond the 50' Transect

Downstream Average: Beyond the 50' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) is present along the upland/wetland transition zone to the north approximately 300 yards. A majority of this marsh is healthy with undisturbed transition zones from the marsh to the oak islands. Bank erosion along the wharf has caused limited sedimentation. A large amount of *Spartina alterniflora* (Smooth Cord Grass) is evident in the high marsh along the creek banks perhaps indicating that the high marsh soils are poorly drained.

Downstream: A majority of this marsh is healthy with undisturbed transition zones from the marsh to the oak islands. Bank erosion along the wharf has caused limited sedimentation. A large amount of *Spartina alterniflora* is evident in the high marsh along the creek banks perhaps indicating that the high marsh soils are poorly drained. The accumulation of tide wrack has not changed vegetation types due to the vast expanse of mudflat bordering the wharf.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been slightly reduced due to the invasion of *Phragmites australis* at the transition zone. The extent of *Phragmites australis* growth is limited and is present only along the road bank of Atlantic Avenue. The upstream is a "trapped" marsh with only one incoming source of water, this incoming source is the water that seeps through the rip rap along approximately 200' of the wharf. A main culvert is not evident, or has been destroyed. Overall the upstream and downstream marsh is productive although the saturation of the high marsh, which encourages the expansion of low marsh, can reduce the over species diversity of the salt marsh system.

Recommendations:

1. Insert a double or triple 48" reinforced concrete box culvert to allow for the free passage of water.
2. Bury the culverts into the stream bed to allow for a natural stream bed to form.
3. Improve the stone revetment with existing stone to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: G10 **Town:** Gloucester

Location: Unnamed Creek - Rt. 128

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 42" Diameter

Approximate Acreage of Wetlands Impacted: 2.3

Phase I Restriction Rating: 20/24

Phase II Tidal Difference **Percentage:** 65% **Inches:** 29.5

Land Use:

Downstream Adjacent Land Use: (An old pier is immediately parallel to the creek to the west)

Upstream Adjacent Land Use: Sparse Commercial Activity (An office park and car dealership is ~100' to the west and ~100 yards to the east, both are ~25' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: Beyond the 35' Transect

Downstream Average: Beyond the 45' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) dominates the wetland/upland transition zone. A majority of this secluded marsh is healthy. Bank erosion near the culvert has caused sedimentation and altered low marsh composition. *Spartina alterniflora* (Smooth Cord Grass) is evident in the high marsh in small portions of the salt marsh.

Downstream: The downstream is not the typical creek formation but rather it is a cove. At high tide a vast portion of the area is under water and at low tide, it is mudflat.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been reduced due to the invasion of *Phragmites australis*. The productive wetland/upland transition zone upstream, has been overtaken by *Phragmites australis*. The upstream is a "trapped" marsh with only one incoming source of water so it is especially susceptible to degradation from the introduction of invasive species.

Recommendations:

1. Slightly increase the size of the culvert to allow for the free passage of water but not the subsequent flooding of nearby property.
2. Due to the shallow cover between stream bed and road bed install multiple, side by side culverts.
3. Bury the culverts 12" into the stream bed to allow for a natural stream bed to form.
4. Install energy dissipators in the form of large diameter stone in the stream bed upstream and downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Drop the invert on the upstream and downstream to allow for the free passage of water.
6. Clean the sediment deposits in the stream bed adjacent to the culvert.
7. Improve the stone revetment by increasing the diameter of the stones in the rip rap wall to 60" stone to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: G11 **Town:** Gloucester

Location: Unnamed Creek - Rt. 128

Crossing Characteristics:

Type of Crossing: Steel Culvert **Size of Opening:** 36" Diameter

Approximate Acreage of Wetlands Impacted: 16.5

Phase I Restriction Rating: 19/21

Phase II Tidal Difference **Percentage:** 66% **Inches:** 27.75

Land Use:

Downstream Adjacent Land Use: Undeveloped

Upstream Adjacent Land Use: Sparse Commercial Activity (A parking lot is ~200' to the west,~25' from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 22' from the creek edge

Downstream Average: Beyond the 35' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) is evident along the upland/wetland transition zone to the west. A majority of this secluded marsh is healthy. Bank erosion near the culvert has caused sedimentation and altered low marsh species composition. *Spartina alterniflora* (Smooth Cord Grass) is evident in the high marsh on a localized scale.

Downstream: The downstream has a well developed salt marsh which borders a cove. Bank erosion near the culvert has caused sedimentation and altered low marsh species composition. *Spartina alterniflora* is evident in the high marsh on a localized scale.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been slightly reduced due to the invasion of *Phragmites australis* at the transition zone. The upstream is a "trapped" marsh with only one incoming source of water, bounded by Rt. 128 and Causeway Street. Overall the upstream marsh is productive and healthy despite its continuity being severed by Causeway Street to the north.

Recommendations:

1. Increase the size of the culvert to allow for the free passage of water.
2. Due to the shallow cover between the stream bed and road bed install multiple, side by side culverts.
3. Drop the invert on the upstream and downstream to allow for the free passage of water
4. Install energy dissipators in the form of large diameter stone in the stream bed upstream and downstream to reduce the damage from water velocity and to prevent bank scouring.
5. Bury culverts 12" into the stream bed to allow for a natural stream bed to form.
6. Clean the sediment deposits in stream bed adjacent to the culvert.
7. Improve the stone revetment to reduce bank erosion and subsequent bank failure and culvert blockage.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: G13 **Town:** Gloucester

Location: Mill Creek - Washington Street

Crossing Characteristics:

Type of Crossing: Metal Culvert and Concrete Spillway

Size of Opening: Downstream: 9' x 14'6"(arch) Upstream: Opened: 3.5' x 6' Closed: 5.5' x 6'

Approximate Acreage of Wetlands Impacted: 13.8

Phase I Restriction Rating: 23/26

Phase II Difference **Percentage**: 60% **Inches**: 38

Land Use:

Downstream Adjacent Land Use: Sparse Commercial Activity, Heavy Residential Activity (A restaurant parallels the creek ~100' to the east and residences are ~200' west of the culvert, abutting wetlands)

Upstream Adjacent Land Use: Residential Activity (Homes closely paralleling creek ~100 yards to the southwest, abutting wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: No Vegetation

Downstream Average: 38.75' from the creek edge

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) is evident along the upland/wetland transition zone and at salt marsh elevations. This area has been disturbed by the alteration of the nearby wetlands and from dense residential development along the shoreline.

Downstream: This area has been disturbed by the alteration of the nearby wetlands and from residential and commercial development directly along the shoreline. The amount of salt marsh is limited by the land use and the existing geology.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been reduced due to the invasion of *Phragmites australis* at the transition zone and in the marsh. The extent of *Phragmites australis* has been exacerbated by land use practices. The upstream area forms a "trapped" marsh with only one incoming source of water. Conditions have been exacerbated by the water management practices at the crossing (IE: Closing of the sluice gate in the winter for the formation of a skating pond).

Recommendations:

1. Completely remove concrete spillway/outlet control structure to allow for the free passage of water.

Note: Special study should be preformed to ascertain the effects of increased tidal flow and it's effect on development (e.g. flooding).

Improvement Priority Rating: High

Phase III Summary

Crossing Identification:

Site Number: G15 **Town**: Gloucester

Location: Goose Cove - Washington Street

Crossing Characteristics:

Type of Crossing: Bridge **Size of Opening:** ~22' x 26'

Approximate Acreage of Wetlands Impacted: 5.5

Phase I Restriction Rating: 21/22

Phase II Tidal Difference **Percentage**: 63% **Inches**: 39

Land Use:

Downstream Adjacent Land Use: Heavy Residential Activity (A home is parallel to the creek ~ 20' to the north and 100' west of the culvert, both abut wetlands)

Upstream Adjacent Land Use: Heavy Residential Activity (Homes closely parallel the creek, the closest is ~100' to the north, abutting wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: No Vegetation

Downstream Average: No Vegetation

Overall Impacts on the Wetland Vegetation:

Upstream: This area has been disturbed by the dense residential development along the shoreline. The lack of salt marsh is also a function of geologic conditions which form sharp transition zones from the upland to the wetland.

Downstream: This area has been disturbed by the dense residential development along the shoreline. The lack of salt marsh is also a function of geologic conditions which form sharp transition zones from the upland to the wetland.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been reduced by the historic land use of the area, where artificial sea walls replace the natural shoreline. Many of the natural transitions zones are too sharp to encourage expansive salt marsh development. *Phragmites australis* (Common Reed) is not a problem in the upstream or in the downstream wetlands.

Recommendations:

1. Increase the size of the bridge to allow for the free passage of water.

Note: The benefits of improved tidal flow on the upstream and downstream salt marsh is difficult to gauge and requires further study especially in the regard to the impacts on development that increased tidal flow could have.

Improvement Priority Rating: Low

Phase III Summary

Crossing Identification:

Site Number: G27 **Town:** Gloucester

Location: Unnamed Creek - Essex Avenue

Crossing Characteristics:

Type of Crossing: Steel and Concrete Culvert **Size of Opening:** 36" Diameter

Approximate Acreage of Wetlands Impacted: 10.1

Phase I Restriction Rating: 21/26

Phase II Tidal Difference **Percentage:** 31% **Inches:** 69

Land Use:

Downstream Adjacent Land Use: Sparse Commercial Development (Marina is ~100 yards to the west, abutting wetlands)

Upstream Adjacent Land Use: Sparse Commercial Development (Water Pollution Control Facility is ~100 yards to the east, ~50 from the wetlands, a movie theater is ~250 yards to the northwest, ~150 yards from the wetlands)

Vegetation:

First Occurrence of Salt In-Tolerant Species:

Upstream Average: 7.5' from the creek edge

Downstream Average: Beyond the 50' Transect

Overall Impacts on the Wetland Vegetation:

Upstream: *Phragmites australis* (Common Reed) is evident along the upland/wetland transition zones and at salt marsh elevations. This area has been disturbed by the alteration of the nearby wetlands and from parking lot and commercial development.

Downstream: A majority of this marsh is healthy. *Spartina alterniflora* (Smooth Cord Grass) is evident in the high marsh to the east indicating that the high marsh soils in this area are poorly drained. *Phragmites australis* can be found to the west along the upland edge.

General Impacts on the Function of the Wetlands: The productivity of the upstream wetlands has been reduced due to the invasion of *Phragmites australis* at the transition zones and in the marsh. The extent of *Phragmites australis* has been exacerbated by historical land use which includes a diversion of the natural creek into the nearby water treatment facility. The upstream area forms a "trapped" marsh with only one incoming source of water. The downstream marsh is healthy although the high marsh is saturated in some places, which encourages the expansion of low marsh and can reduce overall species diversity.

Recommendations:

1. Increase the size of the culvert to allow for the free passage of water.
2. Bury the culverts into the stream bed to allow for a natural stream bed to form.
3. Install energy dissipators in the form of large diameter stone in the stream bed downstream to reduce the damage from water velocity and to prevent bank scouring.
4. Drop the invert on the downstream to allow for the free passage of water.
5. Clean the sediment deposits and debris in stream bed adjacent to the culvert.

Note: This crossing needs further study especially in identifying the configuration of the culvert in relation to the water quality treatment plant. Study should also be done in regard to potential flooding of upstream properties with increased tidal flow.

Improvement Priority Rating: Low

PLANT SPECIES LIST

Tidal Crossings Inventory and Assessment Project

Complete Vegetation Species List

Common Name	Latin Name
Narrow-leaved Cattail	*Typha augustifolia*
Broad-leaved Cattail	*Typha latifolia*
Stiff-leaf Quackgrass	*Agropyron pungens*
Reed Canary Grass	*Phalaris arundinacea*
Spike Grass	*Distichlis spicata*
Red Fescue	*Festuca rubra*
Switchgrass	*Panicum virgatum*
Common Reed	*Phragmites australis*
Seashore Alkali Grass	*Puccinellia maritima*
Smooth Cordgrass	***Spartina alterniflora***
Big Cordgrass	*Spartina cynosuroides*
Salt Hay Grass	*Spartina patens*
Slough Grass	*Spartina pectinata*
Olney Three-square	*Scirpus americanus*
Common Three-square	*Scirpus pungens*
Salt Marsh Bulrush	*Scirpus robustus*
Spike-rush	*Eleocharis palustris*
Baltic Rush	*Juncus balticus*
Black Grass	*Juncus gerardii*
Bushy Knotweed	*Polygonum ramosissimum*
Marsh Orach	*Atriplex patula*
Common Glasswort	***Salicornia europaea***
Perennial Glasswort	***Salicornia virginica***
Sea Blite	*Suaeda linearis*
Water Hemp	***Amaranthus cannabinus***
Silverweed	*Potentilla anserina*
Sea Milkwort	*Glaux maritima*
Sea Lavender	*Limonium nashii*
American Germander	*Teucrium canadense*
Seaside Gerardia	*Agalinis maritima*
Mudwort	***Limosella subulata***
Seaside Plantain	*Plantago maritima*
New York Aster	*Aster novae-belgii*
Perennial Salt Marsh Aster	*Aster tenuifolius*
Sea Myrtle	*Baccharis halimifolia*
High Tide Bush	*Iva frutescens*
Seaside Goldenrod	*Solidago sempervirens*
Riverbank Quillwort	***Isoetes riparia***
Pygmyweed	*Crassula aquatica*
Poison Ivy	*Toxicodendron radicans*
Purple Loosestrife	*Lythrum salicaria*
Ragweed	*Ambrosia artisiifolia*
Common Morning-Glory	*Ipomoea purpurea*
Japanese Knotweed	*Polygonum cuspidatum*

Highlighted Plants are the Least Tolerant of Saline Conditions
Bold Plants are Generally Considered "Low Marsh" Species