FINAL REPORT

SPRAGUES COVE/FRONT STREET

STORMWATER REMEDIATION PROJECT

MARION, MA

IN COOPERATION WITH

THE TOWN OF MARION

DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF WATERSHED MANAGEMENT

ENVIRONMENTAL PROTECTION AGENCY

PLYMOUTH COUNTY CONSERVATION DISTRICT

PREPARED BY

BUZZARDS BAY PROJECT

AND

THE NATURAL RESOURCES CONSERVATION SERVICE

SEPTEMBER 1995

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Executive Summary

The Spragues Cove storm water remediation project began in 1990 when the town of Marion submitted a mini-grant proposal to the Buzzards Bay Project (BBP). The town entailed the remediation of the Front Street stormdrain system. The existing 24 inch stormdrain flowed directly into a stormdrain channel which, in turn, discharged into Spragues Cove. Stormwater which overflowed or bypassed the Front Street storm drain pipes would discharge onto the town's only full-facility beach, Silvershell Beach. Water quality monitoring of the stormdrain channel indicated elevated counts of fecal coliform bacteria during rain events. The town's primary concern was the impact the fecal coliform bacteria was having on the receiving waters. The area of Spragues Cove adjacent to the stormdrain channel outfall had already been closed to shellfishing by the Division of Marine Fisheries. Silvershell Beach also borders Spragues Cove. Even though the beach had never been closed, it was suspected the beach also experienced high fecal coliform levels following rain storms, resulting in a potential risk to human health.

Due to limited finances, the Buzzards Bay Project was unable to provide the necessary funds to remediate the Front Street stormwater discharge. In 1991, the Buzzards Bay Project assisted the Town of Marion in applying to the Department of Environmental Protection, Office of Watershed Management for a S.319 Nonpoint Source Pollution grant. The town entered into a contract with the Office of Watershed Protection in 1993 to undertake this storm water remediation project.
The Buzzards Bay Project requested planning and technical assistance from the Natural Resources Conservation Service (formerly the Soil Conservation Service) for the Spragues Cove Project. NRCS requested that the BBP and the town conduct some additional water quality monitoring to confirm the source and type of pollution being discharged into Spragues Cove. The Front Street stormdrain system, being the largest (64 acres) and most residential drainage area contributing to Spragues Cove, was determined to be the major source of fecal coliform bacteria to the Cove.

Several alternatives to reduce the coliform loads from the Front Street were considered. A constructed wetland system was selected as the most feasible solution. A review of monitoring data from other wetland systems designed to treat storm water runoff indicated a high pollutant removal rate, including fecal coliform. Also, due to the high groundwater situation throughout the Marion "lower village" area and the availability of a base flow of water from the stormdrain system, it was determined that a wetland system would be the most effective alternative.

To assist in the design of this wetland system, NRCS requested technical advice from several NRCS's specialists, the U.S Fish and Wildlife Service, the MA Division of Fisheries and Wildlife, MA Department of Environmental Protection's Division of Wetlands and Waterways, the Buzzards Bay Project, and several town representatives. The objective of the final design was to maximize the pollutant removal capabilities of the wetland system within the area donated by the town. The design went through several reviews and revisions. The final design was completed in August, 1993. Utilizing design criteria from the Florida Development Manual, the wetland system was sized to store one inch of stormwater runoff and have an average detention time of 14 days. The components of the wetland system included a sediment (or settling) basin, two shallow marshes located on both sides of a deep pool and a stone-lined channel.

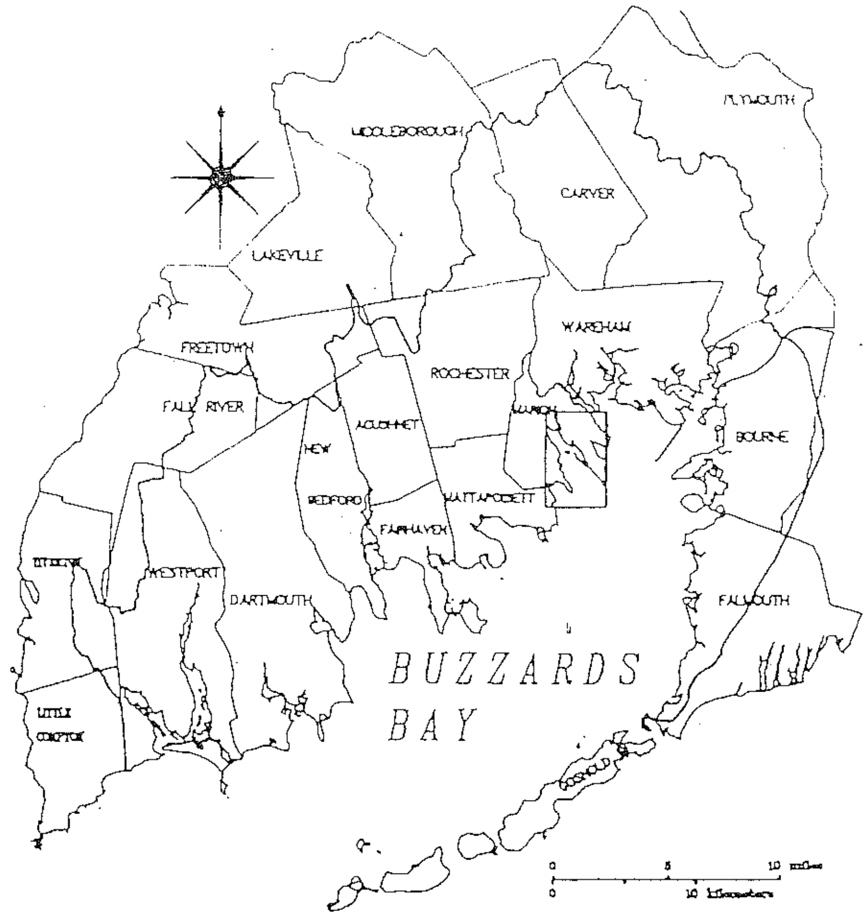
Introduction

In 1993, the town of Marion received through the Department of Environmental Protection-Office of Watershed Management, an Environmental Protection Agency funded 319 Nonpoint Source Pollution competitive grant. The proposal for this 319 grant was prepared by the Buzzards Bay Project, National Estuary Program, on the towns' behalf. The town sought this funding to reduce the amount of storm water pollutants being discharged into Spragues Cove (location map - figure 1). These pollutants (primarily fecal coliform bacteria) were contributing to shellfish closures and also represented a potential threat to the town swimming beach. A constructed wetland system was selected as the best alternative to treat the first flush (which for this project is the first inch) of storm water runoff. Construction of this storm water wetland system was completed in June 1995. As part of 319 contract, the Office of Watershed Management has requested a final report on the Spragues Cove Project. This final report describes the processes leading up to and through the construction phase of the Spragues Cove Project. The monitoring phase of this project has not be completed due to the lack of rain. This final report will be amended once the monitoring is completed.

Background/History

The Spragues Cove storm water remediation project began in 1990 when the town of Marion submitted a mini-grant proposal to the Buzzards Bay Project (BBP). The town requested financial and technical assistance from the BBP to remediate the storm water discharge located at the end of Front Street. The town's primary concern was the impact of elevated coliform levels to both Silvershell Beach and Spragues Cove. Water quality monitoring indicated the high levels of pollutants (especially fecal coliform bacteria) were being flushed into Spragues Cove following rain storms. The Marion Department of Public Works also expressed a concern about inadequate drainage in the area. In the past, the Front Street discharge has been submerged thereby reducing its effectiveness for carrying storm water.

Due to limited finances, the Buzzards Bay Project was unable to provide the necessary the funds for this project. The Buzzards Bay Project did, however, feel the proposal had merit and wanted to see it proceed forward. In 1991, the Town of Marion and the Buzzards Bay Project jointly applied for and received funding from the Departmental of Environmental Protection (the Department) 319 Nonpoint Source program to reduce nonpoint source pollution from the Front Street stormdrain system. The town entered into a contract with the Department in 1993 to undertake this project. The funding was designated to treat the pollutants associated with the "first flush" of storm water runoff prior to discharging into Spragues Cove.


PLYMOUTH
MIDDLEBOROUGH
CARVER
LAKEVILLE
WAREHAM
FREETOWN
ROCHESTER
FALL RIVER
ACUSHNET
MARION
BOURNE
NEW
BEDFORD
MATTAPOISETT
FAIRHAVEN
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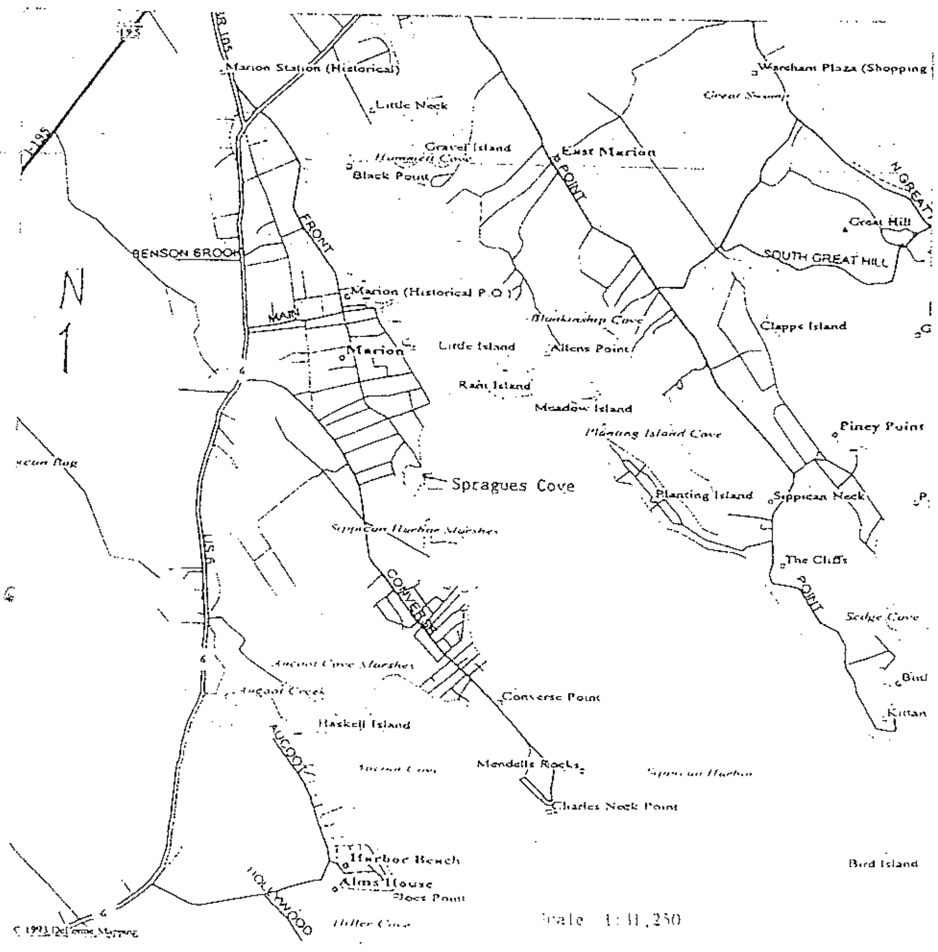

Marion Station (Historical)
Wareham Plaza (Shopping
Little Neck
Gravel Island
East Marion
Black Point
POINT
N GREAT
Great Hill
BENSON BROOK
FRONT
SOUTH GREAT HILL
N
Marion (Historical P.O.)
MAIN
Clapps Island
Marion
Little Island
Allens Point
Ram Island
Meadow Island
Planting Island Cove
Piney Point
Sprague's Cove
Planting Island
Sippican Neck
Sippican Harbor Marshes
The Cliffs
CONVERSE
POINT
Sedge Cove
Aucoot Cove Marshes
Aucoot Creek
Converse Point
Haskell Island
AUCOOT
Aucoot Cove
Mendells Rocks
Sippican Harbor
Charles Neck Point
Harbor Beach
Alms House
Joes Point
HOLLYWOOD
Hiller Cove
Bird Island
Scale 1:31,250

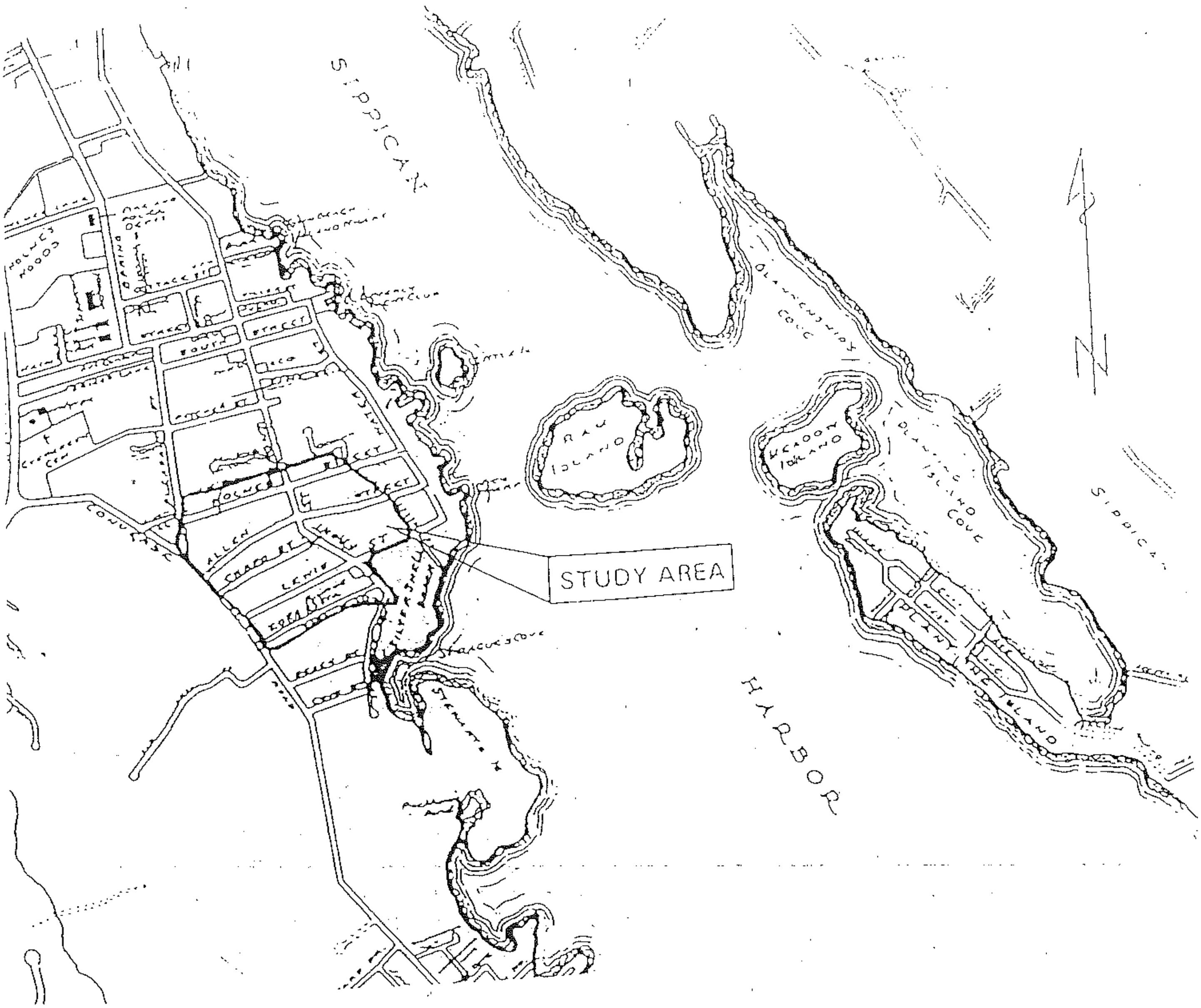
"Best Management" Alternatives

The Buzzards Bay Project submitted a request to the Natural Resources Conservation Service (formerly the Soil Conservation Service) for planning and technical assistance for the Spragues Cove Project. The Natural Resources Conservation Service (NRCS) put together an interdisciplinary team (including engineers, biologists, soil conservationists, a geologist and a soil scientist) to work with BBP and town representatives on identifying and selecting alternatives. NRCS requested that the Project and the town do some additional water quality monitoring to confirm the source and type of pollution being discharged into Spragues Cove. The Front Street stormdrain system, being the largest (64 acres) and most residential drainage area (See figure 2) contributing to Spragues Cove, was determined to be the major source of fecal coliform bacteria to the Cove. On one date, fecal coliform counts as high as 20,000 fecal coliform per 100 milliliters water were recorded.

Several alternatives, both mechanical and physical, to reduce the coliform loads from the Front Street were discussed. Mechanical alternatives, such as chlorination, UV lights, etc., were not considered feasible due to the high initial cost plus high post-construction expenses. Physical alternatives considered were infiltration structures, vegetative swale and settling basin, and constructed wetland. Due to the nature of the soils (high water table and poorly drained) in the watershed, infiltration structures were not considered feasible. A vegetative swale along with a settling basin would have been somewhat effective in removing the coarse sediments from the storm water runoff, but this combination of practices would not, however, be highly effective in removing fecal coliform bacteria.

The selected alternative - the constructed wetland - was considered to be the most feasible solution. Monitoring data from other wetland systems (note: monitoring data was available only for storm water wetland systems outside of Massachusetts) indicated a high pollutant removal rate (including fecal coliform) within wetland systems. Also, due to the high groundwater situation throughout the Marion "lower village" area and the availability of a base flow of water from the stormdrain system, it was believed that a wetland system could be supported. A planning document describing the water pollution problem, the watershed conditions, the proposed alternatives and the selected alternative, was prepared in June 1992 by the Natural Resources Conservation Service (See Appendix A).

The location of the proposed wetland system was on town-owned land at the end of the Front Street stormdrain pipe. Old aerial photos (pre-1950's) have indicated that this land was once a salt marsh. The marsh was filled during the 1950's with dredge material from Sippican Harbor. Prior to the fill placement, the salt marsh probably acted as a natural filtering mechanism for the road runoff. The fill placement disrupted the drainage patterns in the area. A stormdrain channel was created to take both the pipe and surface runoff from Front Street and directly discharged it into Spragues Cove.



SCALE: 1:19,200

Figure 2

Resource Area

To assist in the planning of this wetland system, NRCS requested input from a NRCS wetlands specialist, US Fish and Wildlife Service, MA Fish and Wildlife, and MA Department of Environmental Protection-Division of Wetlands. In order to maximize the effectiveness of a wetland system, the planning group felt as much land as possible should be utilized. The original planning concept (See figure 3) included a pre-treatment settling basin and marsh for the first inch of surface runoff from Front Street. The Front Street stormdrain pipe would discharge into a separate settling basin. Both the surface and pipe runoff would then flow into a shallow marsh, through a deep pool, into another shallow marsh and eventually discharging into a stone-lined channel and back into the stormdrain channel. In discussing this concept with several of the town boards (Selectmen, Health, and Recreation), a public health issued was raised pertaining to pollutants being discharged into the surface runoff settling basin and marsh (2A and 2B in Figure 3). Because of these public health concerns, the decision was to eliminate 2A and 2B from the wetland system.

Once the planning concept was agreed to by the town, the design phase began. The design went through several reviews and revisions - with input being sought from several NRCS disciplines (engineers, biologists, botanists, etc.). Several meetings were held with town representatives prior to producing the final design. The design was finalized in August 1993 (See Figure 4). The wetland system was designed on average to have a 14-day detention for one inch of runoff. The components of the system include the following:

1. A sediment (or settling) basin - a collection area for sediments from the street surface and the pipe, plus provided an open outlet for the existing stormdrain system. The basin was designed to be cleaned out on occasion - usually once every five to ten years.

2. Two shallow marsh on either side of the deep pool - the vegetative component providing the physical and biological processes necessary to treat and remove the pollutants associated with the storm water. The shallow marshes would be planted with salt-tolerant vegetation - softstem bulrush, narrowleaf cattail, and pond sagoweed. The depth of the marshes would range from 0 to 2 feet deep.

3. A deep pool - a six foot basin to provide not only additional cleansing plus also a fish habitat for mosquito control.

4. A stone-lined waterway - a final treatment mechanism of aeration prior to the discharge back into the stormdrain channel.

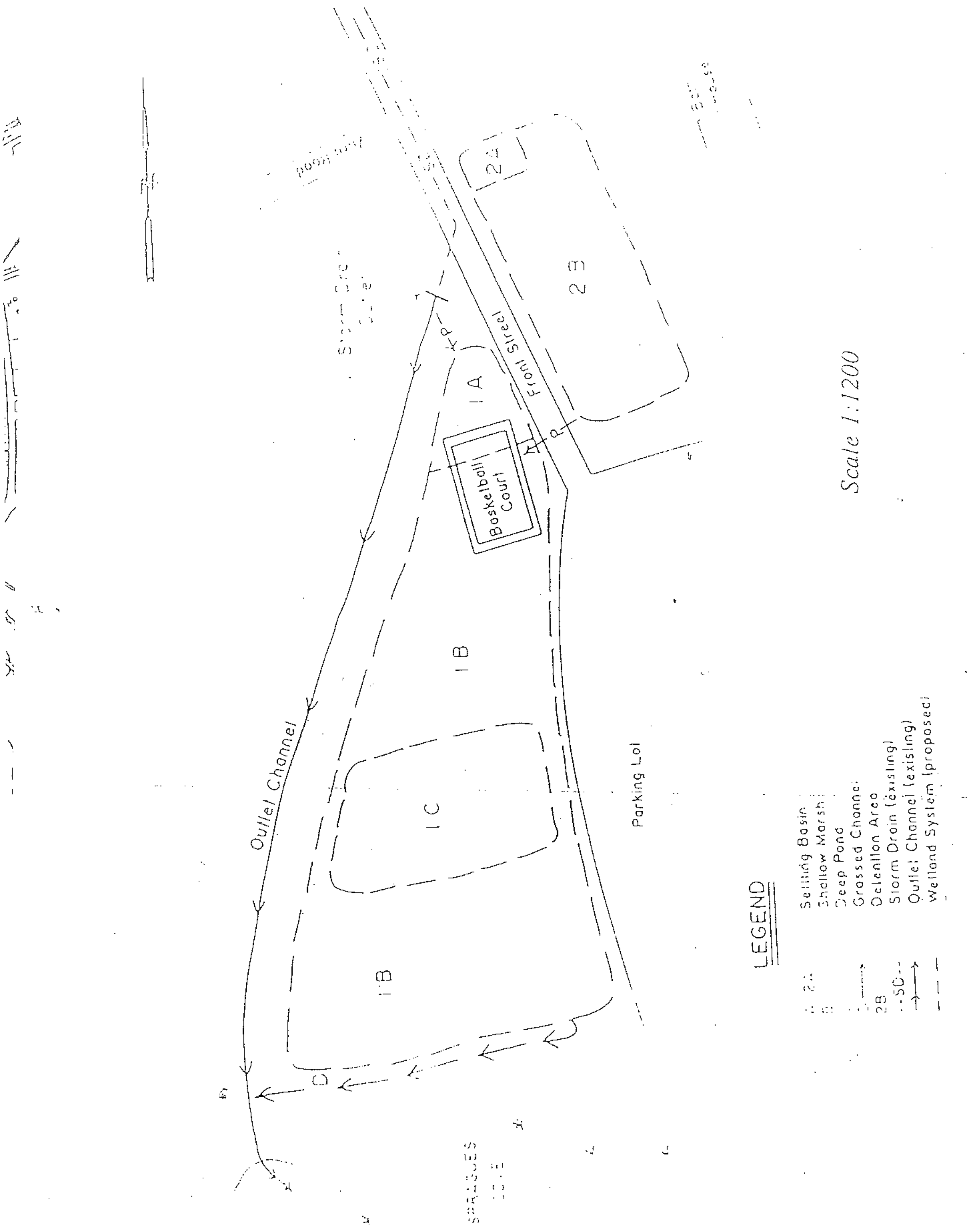
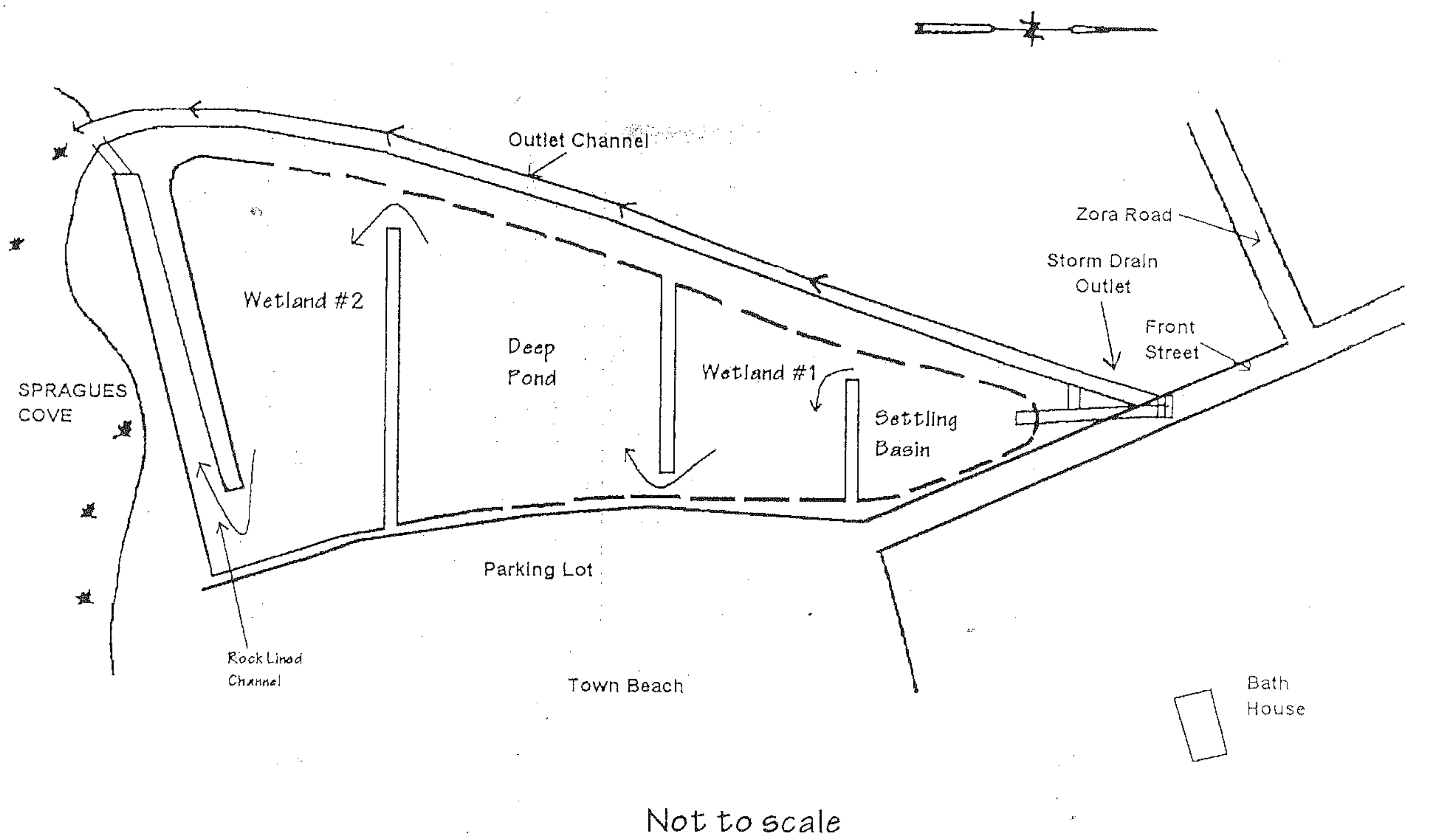


Figure 3 - Schematic of Planning Concept



Schematic of Final Design

Permitting

The permitting process began early in the planning phase of this project. At this stage, the Buzzards Bay Project and Natural Resources Conservation Service were aware that at least two wetland permits needed to be obtained - one from the local Conservation Commission and one from DEP-Division of Wetlands and Waterways -because the proposed site was within the wetland buffer zone and the coastal flood plain (land subject to coastal storm flowage). Both of these agencies were asked to review and comment on the plan and design concept. In March 1992, the Division of Wildlife Natural Heritage and Endangered Species Program was also contacted. The Spragues Cove Project was to be located in an area identified as habitat for the Diamondback Terrapin. It was the opinion of the Natural Heritage Program that this project would not significantly impact the Diamondback Terrapin.

In the summer of 1992, NRCS requested preliminary meetings with the Army Corps of Engineers and DEP-Division of Wetlands and Waterways to discuss the Spragues Cove Project and the application processes to obtain the necessary permits. The Army Corps indicated that due to the location of the final discharge pipe out of the constructed wetland, both a Federal Wetlands permit (404) and a State of Massachusetts Water Quality Certification (401) would have to be obtained. Also, the entire site of the Spragues Cove Project was on filled tidelands which would require a Chapter 91 permit from DEP-Division of Wetlands and Waterways.

While the draft designs were being developed (winter and spring 1993), the BBP and NRCS were also gathering the information needed to obtain the necessary permits. In June of 1993, the Buzzards Bay Project and the Natural Resources Conservation Service submitted permit applications to the following agencies:

Permit	Permitting Agency
Wetlands (404)	Army Corps of Engineers
Wetlands	DEP-Division of Wetlands and Waterways
Wetlands	Marion Conservation Commission
Water Quality Certification (401)	DEP-Division of Wetlands and Waterways
Chapter 91	DEP-Division of Wetlands and Waterways

Along with the permit applications, copies of the draft design were submitted with a letter explaining that the final design would be sent upon completion. The final designs were forwarded to the permitting agencies in August.

In addition to the above permits, this project also required a variance from the Marion Board of Health under the 1990 Marion Sanitary Code (See Appendix B). A public hearing was held to discuss the project. Several issues were brought up - some of which were unrelated to public health. The BBP and NRCS addressed all the health-related issues to the satisfaction of the Board and a variance was granted. A public hearing was also held by the Marion Conservation Commission prior to the issuance of the wetlands permit. Results of these public hearings and other public comments are discussed under the public participation section of this final report.

One of the major concerns of this project, was the ability of the town to obtain all the necessary permits in an acceptable timeframe to meet the completion schedule. To help expedite the process, site visits were conducted with several of the state and federal permitting agencies. The Buzzards Bay Project also requested assistance from the Department of Environmental Protection-Office of Watershed Management in obtaining a Chapter 91 license. At the time of the Spragues Cove application, the permitting agency for Chapter 91 (DEP-Division of Wetlands and Waterways) was accepting permit applications for their amnesty program. This amnesty program allowed for previously unauthorized waterfront structures to become licensed. Due to the number of applications received, The Division of Wetlands and Waterway were unsure of the timeframe to process the Spragues Cove application. The Department requested from the Division of Wetlands and Waterways that the Chapter 91 process be expedited for this project in order to meet the grant deadline. The Chapter 91 license was received in December, 1993. All the other permits had been received prior to this date.

Public Participation

During the preliminary design phase of the Spragues Cove Project, The BBP and NRCS attended several Board of Selectman meetings to keep the Selectman and other interested groups informed about the progress of the project. A brochure describing the project was developed by the BBP and made available at these meetings. Once the draft design was completed, several meetings, including onsite visits, were held with the Selectman, the Board of Health, the Recreation Committee, the Conservation Commission, the Marine Resources Committee, the Department of Public Works, the Shellfish Warden, and the Harbormaster. All these meetings were advertised and open to the public. Meetings were also held with the abutters to obtain their input.

Several questions about public health and safety were raised by many of the local boards. The first sediment basin and shallow marsh were to be placed in an area with high recreational use. The boards were concerned about the impact the pollutants (especially bacteria and viruses) could have on children playing in the area after a rain storm. The decision was to redesign the project - eliminating this first basin and marsh and utilizing other methodologies to enhance the pollutant removal capabilities of the remaining wetland system (See Figure 4).

Other public health and safety issues discussed were mosquitos and fencing. It was felt that the creation of this wetland would provide additional breeding habitat for mosquitos. Mosquitos are not only considered a public nuisance, but also a potential public-health risk. The BBP and NRCS discussed ways to reduce the threat of mosquitos with several experts. A deep pool had already been planned in the center of the wetland to provide a winter habitat for mummichugs (mosquito-eating fish). In addition to the mummichugs, the experts suggested minimizing the amount of shallow areas (less than one foot) and having a base flow through the wetland system. Groundwater seepage and sump pump discharges into the storm drain system provides enough water to have dry weather flows (base flow) throughout the year. The Plymouth County Mosquito Control Board also offered to monitor the wetland system and provide advice to the town. A copy of the design was sent to the Mosquito Control Board for their files.

Several discussions were held pertaining to the need for and, if necessary, the type of fence the town should install. The proposed side slopes going to the bottom of the wetland were steep - two to three feet horizontal to every 1 foot vertical. In order to maximize the area for pollution treatment, the side slopes needed to be steep. Several of the abutters had small children and were concerned for their safety. Also, one side of the wetland would be along side the Silvershell Beach parking lot. Since the fence would not impact the integrity of the wetland design, it was decided that the town and the abutters would come to a consensus about the fence, and inform the BBP of their decision. The agreement was to install a split-rail fence along the parking lot edge and plant a "living" edge (Rosa rugosa) between the wetland and the split-rail fence.

The Recreation Committee also had concerns about the loss and the funding for replacement of the basketball court. The court was in poor condition and had been slated for replacement, although the location of the new court had not been determined. It was decided that the Recreation Committee, the Selectman, and the Conservation Commission (since wetlands were an issue) would decide on the location and the funding of a new basketball court.

Public participation was also sought in order to acquire additional town funding for this project and to assist in the planting of the wetland vegetation. The public participation for town funding is discussed in detail in the funding section below; the volunteer planting effort is described in the construction section

Funding

In addition to the Department of Environmental Protection-Office of Watershed Management/Environmental Protection Agency 319 Nonpoint Source Pollution competitive grant, grant monies were also obtained through the United States Fish and Wildlife Service ($10,000) and the Marion Cove Trust ($10,000). Thus the total amount of grant monies awarded to the town for the Spragues Cove Project was $45,000.

Once the final design was completed, the town prepared a budget estimate of $80,000 to complete construction of this project. This budget was based on putting the construction, including fill removal, out to bid. Originally, the town planned for the Marion Department of Public Works (DPW) to install the wetland system utilizing their own equipment. Due to the magnitude of the project (primarily the amount of material to be excavated and removed offsite), the DPW did not have the time nor the manpower to accomplish the construction. In order to complete the Spragues Cove Project, the town would have to raise an additional $35,000 to meet the $80,000 estimate. The Board of Selectmen decided to request this additional funding at the Marion Special Town Meeting scheduled for October 25, 1994.

The Buzzards Bay Project and the Marion's Executive Secretary met with the town of Marion Finance Committee to discuss the request for funding. Based on previous financial discussions with the Selectmen concerning the Spragues Cove project and the proposed budget as submitted, the Finance Committee decided it could not support the original request for funding request. The Committee, however, felt the project had merit and suggested a revised budget be submitted for their consideration. This budget should have more detailed cost estimates and, if possible, a reduction in the funding request.

Following the Finance Committee meeting, the Buzzards Bay Project and the town worked together to develop a more realistic budget and to reduce the total cost of the project. Since the major expense of the project was the cost of moving the excavated material offsite, several alternatives were explored to lessen these costs. One suggestion was to utilize the top three to four feet (originally dredge spoil from Sippican Harbor) to expand Silvershell Beach. The beach is adjacent to the Spragues Cove site and the cost of placing the material on the beach would be minimal. The permitting agencies (state, federal, and local) were contacted to determine feasibility and time frame for permits. The Silvershell Beach Project would be allowed provided all the permit applications were filed and the fill material was tested for contaminants. The Buzzards Bay Project paid to have the soil tested and the material was found to be acceptable for placement on the beach.

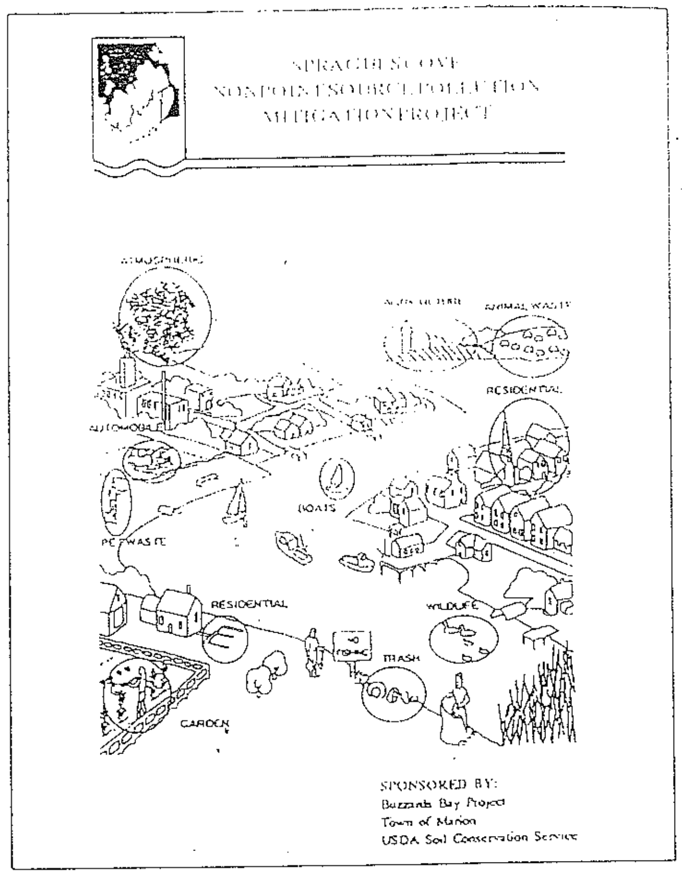
In addition to the beach nourishment project, other town boards and private contractors expressed an interest in utilizing the spoil material at Spragues Cove. The Marion Conservation Commission needed similar material to repair Planting Island Causeway. The permits for the causeway had been previously obtained and funding for trucking material to the causeway had been allocated . The Marion Recreation Committee also needed some fill material to create another recreational field in Washburn Park. Although the town would still have to pay the hauling costs to the park, it would eliminate the expense of purchasing fill in the future. The Buzzards Bay Project also contacted several private contractors in the area. Several stated they would be willing to haul the material away (and stockpile for future use) provided a loader with an operator could be onsite to load material on their trucks. The town was willing to supply the loader and operator.

Based on the revised cost estimates to remove the spoil material, plus some design modifications, the Buzzards Bay Project submitted an amended budget of $64,000 to the Finance Committee. The amount of funding to be requested at Special Town Meeting would be reduced from $35,000 to $19,000. As a result of the amended budget, plus some additional town benefits - improved water quality in Spragues Cove, an expanded town beach, and a recreational field - the Finance Committee voted to support the Spragues Cove Project at the Special Town Meeting.

In order to generate public support for the Spragues Cove Project, the Coalition for Buzzards Bay (the Coalition) and the Buzzards Bay Project initiated an intensive public information campaign. The Coalition mailed at least four hundred Spragues Cove Project brochures (See Figure 5) to Coalition members residing in Marion, Sippican Land Trust members, current and former members of Save Our Seas, and to the sixth grade at the Sippican School for their class on

Figure 5

Spragues Cove Brochure



Dear

URGENT-PLEASE ATTEND

Special Town Meeting - Tuesday, October 25, 7:30 p.m.

Sippican School Auditorium

Your YES vote is needed on Article S3 - the stormwater remediation project at SILVERSHELL BEACH

A YES vote will bring us

- *Cleaner water at Silvershell Beach, Marion's most frequented bathing beach*
- *Cleaner water at Spragues Cove, an accessible family permit only shellfish area*
- *An additional 160 ft. of beach at Silvershell*
- *Vastly reduced costs on a future soccer field at Washburn Park*
- *An improved beach at Planting Island Causeway*

I am for this project - please join me in voting YES on Article S3

Figure 6

Notice of Special Town Meetir

current events. The brochures had been revised to reflect the final design. One coalition member sent out four hundred postcards (See Figure 6) to Marion citizens requesting support of the Project. This member also invited several key citizens (supporters, nonsupporters, and "on-the-fence") to attend informal breakfast meetings to discuss the project. Save Our Seas, a local water quality monitoring group, mailed out one hundred and twenty letters of support. Press releases and supporting articles were also forwarded to the local newspapers.

In conjunction with the efforts of the Coalition and Save Our Seas, the Buzzards Bay Project built a scaled model (1 inch = 20 feet) of the constructed wetland. Included in the model were all the components of the proposed wetland, the existing stormdrain pipe and channel, and the beach parking lot. The model became a visual tool not only to explain the functioning of the constructed wetland system, but also how the project would look when completed. This model, along with the brochure and final design, was used extensively to generate public support for the Spragues Cove Project prior to the Special Town Meeting.

The Special Town Meeting was held on October 25th, 1995. Copies of the brochures and the postcards, plus the model of the project, were made available at the meeting. Joseph Costa, Executive Director of the Buzzards Bay Project, made a brief presentation describing the Spragues Cove Project to the audience. Several Marion citizens, including the Chairman of the Board of Health, spoke in favor of the project. Two people spoke against the project - the primary objections being potential cost overruns and public health concerns. The majority of the citizens of Marion believed that the concerns had been adequately addressed and voted overwhelmingly to appropriate the additional funds to construct the Spragues Cove Project.

Construction/Implementation

Once the funding for the Spragues Cove Project was appropriated, the town of Marion and the Buzzards Bay Project began preparing for construction. The town started putting together a bid package for contractors interested in bidding on the project. The Board of Selectmen appointed Christina Brokow as the town of Marion's Project Manager for the Spragues Cove Project. As Project Manager, Ms. Brokow worked in conjunction with the Buzzards Bay Project staff to coordinate the implementation phase of this project.

Prior to beginning construction, the town needed to finalize the plans for the Silvershell Beach nourishment project. As discussed previously, the town wanted to place some of the excavation material from the Spragues Cove Project to expand the beach. To accomplish this, the town needed to obtain the appropriate permits. The town contracted with a private engineering firm to draft the plans for the beach and then submitted the permit applications. All the permits for the beach were received before construction began on the constructed wetlands.

The town and the Buzzards Bay Project also needed to decide on the types and amounts of plant materials to be purchased. All the plant materials had to meet specific site requirements. The wetland vegetation had to tolerate a range of saline conditions due to potential for salt water intrusion into the wetland. Also, because the constructed wetland was designed to have a variable depth, the deep pool being six feet deep, while the shallow marshes six inches to three feet deep,- the selected wetland vegetation had to meet the depth requirements.

In contrast to the wetland vegetation, the upland vegetation had to be drought resistant. Previous soil test pits indicated a high percentage of sands and gravels on the project site. Both the perimeter and the low flow dikes would be constructed with this soil material. Also, a minimal amount of topsoil was expected to be available for the tops of the finished dikes. The selected seed mixture and the resulting vegetation needed the ability to succeed under stressful conditions, droughty soils, low nutrients, low pH and minimal maintenance.

The type of plant materials and the methodology for planting (seed, plugs, or live plants) were carefully researched by the Buzzards Bay Project and the Project Manager. This research included consultations with several nurseries throughout the United States. Very important in the selection process (especially with the wetland vegetation) was the number of years of growth required for 100% coverage. Normally the most expensive planting methodology (live plants) required the least number of years for 100% coverage and the least expensive (seeds) required the most number of years. A combination of seeds and live plants was eventually selected.

The total cost of plant materials plus soil amendments had to stay within the allocated budget. The budget did not allow for hiring labor to do the planting and seeding. This work had to be accomplished by volunteer labor.. Several presentations were made to the local schools and organizations to promote the project and to generate interest in volunteering. Postcards were also mailed out to project supporters requesting assistance with the planting. The supporters were asked to check off availability (April/May, weekday/weekend) and then return the postcard to the Buzzards Bay Project. Lists of available volunteers were compiled for future mailings.

The town awarded the contract for the Spragues Cove Project to the lowest bidder - Geotech Construction. To prevent interference with the beach traffic, the contractor agreed to finish construction by the end of May. This completion date also included the Silvershell Beach expansion and the removal of any excess material off the beach parking lot. The contractor expected to begin construction at the end of February. On February 16, 1995, town representatives, NRCS, and BBP met onsite with the contractor to discuss the construction schedule for both the Spragues Cove Project and the beach expansion. The Project Manager for the town was expected to be onsite every day to address any concerns and to coordinate the day-to-day activities. The Project Manager needed to ensure that the beach expansion be accomplished as planned and the removal of stockpiled material be coordinated with the town, private haulers, and the contractor. Any questions or concerns pertaining to the wetland design or construction would be directed to the Buzzards Bay Project or NRCS.

The town held a groundbreaking ceremony on February 27, 1995. Several federal, state and local officials were invited to attend. The first full day of construction began on the 28th. The contractor started by removing the top three to four feet of material and stockpiling it for the beach project. Once this material was all removed, the individual wetland sections were excavated. Throughout the construction, the contractor used a pump to control the water level. The first section to be constructed was the second shallow marsh. The peat material from this marsh was removed and stockpiled. The marsh was brought down to grade and then the peat was spread on the bottom. The deep pool was the second section to be constructed followed by the first marsh, the sediment basin, and finally the stone-lined channel.

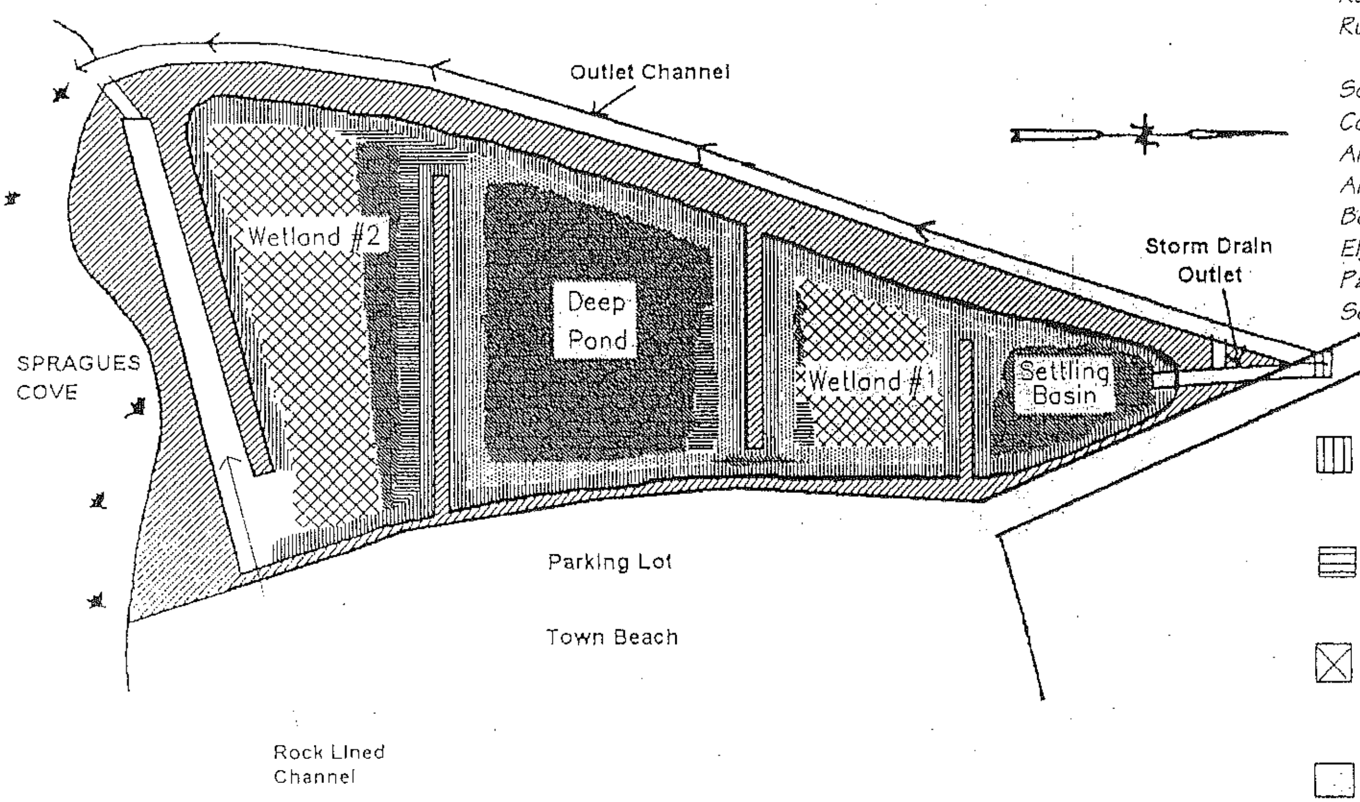
While the Spragues Cove Project was under construction, the Project Manager was also instrumental in bringing an osprey nest to the project site. The Project Manager contacted "osprey expert" Gil Fernandes to solicit advice on building an osprey platform and nest. Mr. Fernandes visited the site and provided a sketch of a platform and nest. Over the period of two days, the platform and nest were built using volunteer labor. To minimize interference during the wetland construction, the proposed location was discussed with the contractor. Inquiries were made to Commonwealth Electric about the feasibility of installing a telephone pole as a base for the platform. Commonwealth Electric not only donated the pole, but also supplied the truck and manpower to install the pole.

At the same time as the wetland excavation, the expansion of Silvershell Beach was also proceeding. The dredge spoil from the top layers of the project site was placed and then spread on the beach. Once the beach was complete, the excavated material was separated into large piles on the beach parking lot. Included in the excavated material were several large stones. Most of these stones were found in the first shallow marsh and the sediment basin. Removing all these stones, however, proved to be too difficult and the decision was made to leave them in the shallow marsh. By leaving the stones in place, the shallow marsh looks more aesthetically pleasing (more "natural"). The stones also help to dissipate the flow of stormwater through the marsh.

As discussed previously, all stockpiled material (soil and stones) except for the peat material had to be transported offsite, either by the town for town-related projects or by private contractors. A bucketloader and an operator to load the material onto trucks were supplied by the town. The removal of the stockpiled material was coordinated by the Project Manager.

The Project Manager also coordinated the planting of the wetland vegetation and the seeding of the upland dikes (see Figure 7). Once the construction of the deep pool was underway, planting of the already constructed shallow marsh began. Postcards were mailed out announcing the first day of planting, April 22nd (also Earth Day). Approximately 50 volunteers showed up and were given instructions on planting both the narrowleaf cattail and the softstem bulrush. In less than two hours, all the wetland vegetation had been planted in the designated areas. Lunch (chowder and sandwiches) was donated by a local restaurant.

PLANTING GUIDE



Alium cernuum - Nodding Onion
Asclepias tuberosa - Butterfly Weed
Cassia Fasciculata - Partridge pea
Desmodium canadense - Showy Tick Trefoil
Euphorbia corollata - Flowering Spurge
Heliopsis helianthoides - Early Sunflower
Lespedeza capitata-Round-headed Bush Clover
Monarda fistulosa - Wild Bergamot
Penstemon digitalis - Foxglove Beardtongue
Ratibida pinnata - Yellow Coneflower
Rudbeckia hirta - Black-eyed Susan
Rudbeckia subtomentosa-Sweet Black-eyed Susan
Solidago rigida - Stiff Goldenrod
Coreopsis lanceolata - Sand Coreopsis
Andropogon gerardi - Big Bluestem
Andropogon scoparius - Little Bluestem
Bouteloua curtipendula - Side-oats Grama
Elymus canadensis - Canada Wild Rye
Panicum virgatum - Switch Gras
Sorghastrum nutans - Indian Grass

Juncus effusus - Soft Rush

Nuphar luteum - cow lily

Typha angustifolia - Narrow-leafed Cattail
Scripus validus - Soft-stemmed Bullrush

Potamogeton perfoliatus-Redheaded Grass
Elodea canondensis - Waterweed
Potamogeton pectinatus - Sago Pondweed

Iris versicolor - Blue Flag
Hibiscus palustrus - Swamp rose mallow
Lobelia cardinalis - cardinal flower

Not to scale

As the construction of the individual wetland sections were finished, local school groups and classes assisted in the planting and seeding. Student interest in volunteering for the Spragues Cove Project was generated from the various presentations made in the local schools. One student from Tabor Academy, Tom Lovett, selected the Spragues Cove Project for a senior project and helped coordinate volunteer activities. The student groups were first given a tour of the project and a copy of the Spragues Cove Project brochure. During the tour, the Project Manager (or BBP staff member) would explain the purpose of the project and how each basin would function in the wetland system. The areas selected to be planted or seeded were based on the age of the volunteer school group. The elementary school children (Sippican School) were allowed to toss seeds from the top of the dikes to the water edge. The students from Tabor Academy (High School) planted the vegetation in the shallow marshes. Some of the Tabor students also assisted in hand-placing the stone in the stone-lined channel.

Once construction was near completion, local volunteers assisted in the planting of the deeper sections of the wetlands and seeding the dikes. In order to plant the submergent vegetation (waterlilies, waterweed, etc.), the adult volunteers walked into the water, dug a hole by hand or with stakes, and then pushed the roots into the soil. The children were given the responsibility of tossing the pond sagoweed from the lowflow dikes. The pond sagoweed were weighted allowing them to sink to the bottom of the wetland.

The seeding of the dikes and other disturbed areas was completed in sections. A team of volunteers limed and seeded individual sections by hand. Unfortunately, the lime had been exposed to rain and was very difficult to spread. The lime and seed were then raked into the soil. The seed was a drought-resistant mixture of grasses and wildflowers. To hold the seed in place, a thin layer of mulch hay was spread on each section.

Once the planting was completed, the Project Manager stenciled all the catch basins contributing to the Front Street storm drain system. The stencils and paint were donated by the Coalition for Buzzards Bay and the Buzzards Bay Action Committee. Approximately 30 catch basins were stenciled with the following message:

DON'T DUMP

SAVE

SPRAGUES COVE

The final phase of construction was the installation of the 24" concrete pipe into the sediment basin. The design required the placement of a concrete structure at the end of the existing stormdrain system. The new 24" pipe would then extend from the concrete structure to the sediment basin. A 24" overflow pipe would discharge back into the existing stormdrain channel. In order to install the overflow pipe, the contractor needed to excavate a short section of the stormdrain channel. The Spragues Cove wetlands permit from the Marion Conservation Commission, however, did not include any channel excavation. To complete the excavation, the town had to request an amended Order of Conditions from the Conservation Commission.

At this time, the contractor also realized that the installation of the concrete structure in the stormdrain channel would be difficult. The channel was filled in with sediment and water was above the outlet of the stormdrain pipe. The contractor met with NRCS and the town to discuss the problem. It was decided to relocate the pipe from an existing manhole (located under Front Street) to the sediment basin. A "Y" would be placed in the pipe to allow for the installation of an overflow pipe. The overflow would then discharge back into the stormdrain channel.

Once the 24" pipe was installed and the area was graded, volunteers came back to finish the seeding. In addition to the seeds, six beach plum purchased by the town and several other donated shrubs and plants were planted. Also, between the wetland and the Silvershell Beach parking lot, volunteers also planted a row of donated Rosa rugosa. Once the construction was finalized and the excavated material removed from the parking lot, a split rail fence was placed between the roses and the parking lot.

Monitoring

As part of the Nonpoint Source Pollution (319) grant awarded to the town of Marion, the effectiveness of the Spragues Cove Storm Water Project in removing storm water pollutants (primarily fecal coliform) must be measured. Previous (preconstruction) water quality monitoring by the Division of Marine Fisheries (DMF) and the town had indicated that the Front Street storm drain system was impacting the shellfish beds in Spragues Cove. High levels of fecal coliform bacteria were detected at the end of the storm drain pipe and at the outlet of the storm drain channel. A permanent shellfish bed closure had been instituted by DMF in the area of the storm drain channel discharge as a result of fecal coliform contamination. The town was also concerned that the fecal coliform bacteria could impact swimming at Silvershell Beach. The constructed wetland system was designed, through biological and physical treatment, to reduce the fecal coliform (and other pollutants) loading into Spragues Cove. Monitoring the fecal coliform levels before and after treatment should demonstrate the effectiveness of this wetland system in removing fecal coliform bacteria from storm water runoff, and potentially, the impact of this removal on the waters of Spragues Cove.

On August 16th, approximately two months after construction completion, the Buzzards Bay Project began monitoring the water quality of the wetland system. By this time, the wetland vegetation had become established and was actively growing. This was a dry weather sampling, it had not been rained for several days prior to monitoring. A total of seven sites were monitored (see Appendix C) six sites were located within the wetland system (stations 1-6) and one next to the 6" pipe discharging into the storm drain channel (station 7). The seven samples were sent to Barnstable County Department of Health and the Environment (BCDHE) for analysis. The Buzzards Bay Project requested the analysis of both fecal coliform and fecal streptococci levels from each sample.

In discussing the monitoring results with the Senior Sanitarian from BCDHE, the Buzzards Bay Project decided not to continue monitoring fecal streptococci levels except at the Front Street discharge pipe (Station 1). The ratio of fecal streptococci to fecal coliform is an experimental index that some investigators use to determine whether the source of fecal coliform bacteria is human or from other warm-blooded animals. BCDHE, however, informed the Buzzards Bay Project that this index is unreliable in water samples taken from wetlands. Fecal streptococci bacteria found in wetland samples can be from sources other than warm-blooded animals (i.e. insects) and these sources can influence this fecal streptococci to fecal coliform ratio.

The fecal streptococci levels at the Front Street discharge pipe can still provide useful information pertaining to the source of fecal coliform bacteria. Since this water sample is taken prior to treatment (and therefore unaffected by fecal streptococci levels in the wetland), the fecal streptococci to fecal coliform ratio may indicate if the source is human. If a human source is suspected, the town is expected to recheck the storm drain system for any sewage cross-connections.

After reviewing the first monitoring data (see Appendix C), the Buzzards Bay Project also decided to add two new monitoring stations (stations 8 & 9). These stations are located in the waters of Silvershell Beach. To determine the level of salt water intrusion in the individual wetland sections, salinity is also being measured at all the stations.

Following our first sampling date, the second and third samples were on September 7 and September 18, 1995. The second sampling was also dry weather sample also. September 18th was a wet weather sampling day with approximately 2.5" of rain falling the night before. The results of these samples have not been received. The Buzzards Bay Project plans to monitor the water quality every two to three weeks during the fall. Limited monitoring will be done in the winter. Water quality monitoring will resume in the spring on a regular basis. At least two of these sample dates will include monitoring for hydrocarbons and metals.

Although the construction of the Spragues Cove Project has been completed, the monitoring of this project is ongoing. The Buzzards Bay Project will monitor the water quality (pre- and post-treatment) of the both wetland system and Silvershell Beach. The results of the testing will be shared, as a minimum, with the Marion Selectman and Board of Health and the Department of Environmental Protection-Office of Watershed Management.

Operation and Maintenance

As results from the water quality monitoring are obtained, specific components may need to re-adjusted to improve the effectiveness of the wetland system. Any changes to the constructed wetland will be made jointly by the Buzzards Bay Project, the Natural Resources Conservation Service, and the Town of Marion and will be appended to future reprintings of this report.

The operation and maintenance component of the wetland system is the responsibility of the Town of Marion (See Appendix D). The Operation and Maintenance Plan included the inspection and, if needed, the repair or replacement of any structural components of the wetland system. The design and the operation and management plan was submitted as part of the permit application to the Marion Conservation Commission as part of the wetlands permit application. Any maintenance to the wetland system, therefore, should not require an additional wetland permit.

The Buzzards Bay Project has already inspected the structural components of this wetland on several occasions including during and after rain storms. The Town has been made aware of our inspection results (See Appendix D). One of the maintenance concerns the Buzzards Bay Project expressed to the town was the establishment of Phragmites on the perimeter and low flow dikes. Phragmites is a an aggressive and invasive plant species, which, if left uncontrolled, will outcompete the existing wetland species. In response to these concerns, the town has mowed the dikes and has sought additional information on phragmites control. The Buzzards Bay Project has received advice from US Fish and Wildlife Service and has forwarded this information to the Board of Selectmen and the DPW.

Conclusions

The post-construction interest generated by of the installation of the Spragues Cove Project has not been limited only to the local town boards. As a result of the local presentations, public meetings, brochure distributions, and the citizen mailings made by the Buzzards Bay Project, the town of Marion, and the Coalition for Buzzards Bay, many of the local citizens have become more aware of the impacts untreated storm water runoff can have on sensitive resources. The Spragues Cove Project is located in a highly visible area, and is adjacent to two sensitive resources - the cove itself and Silvershell Beach. Untreated storm water runoff from the Front Street discharge had already caused a permanent shellfish closure in Spragues Cove. Also during rainstorms, surface runoff from Front Street would flow across the Silvershell Beach parking lot and directly discharge into the beach. Due to the limited testing of the beach following rainstorms, it was not clear what the exact impact the runoff was having on the beach. But once the correlation between stormwater and pollution was made, the potential human health risks from pollution acknowledged. Only through heightened public awareness of stormwater pollution and the need for stormwater treatment, was the appropriation of town funds to implement the Spragues Cove Project allowed.

During construction, several individuals, school groups, and other interested organizations were given tours by the Project Manager (Christina Brokow). The ability of the town to provide a Project Manager onsite on a daily basis not only increased public awareness of the project, but was also instrumental in soliciting volunteers to assist with planting and seeding. The Project Manager also kept the local newspapers informed of the construction progress and provided press releases on the planting dates. Many of the volunteers who assisted with the planting, have "adopted" the Spragues Cove Project. In addition to the plant materials supplied by the town, many of these volunteers have donated (and planted) flowers and shrubs to enhance the project, for example, the Rosa rugosa that died from the 1995 summer drought are gradually being replaced by volunteers.

The Spragues Cove Storm Water Remediation Project was installed to demonstrate the effectiveness of constructed wetlands in removing pollutants from stormwater runoff. Due to the limited amount of post-construction monitoring completed on this project, the effectiveness of this wetland system has not yet been demonstrated at this time. The Buzzards Bay Project will continue to monitor the water quality of the constructed wetland and submit the results to the Department of Environmental Protection-Office of Watershed Management. This report will be amended as long term monitoring data is obtained and the effectiveness of the wetland system can be demonstrated.

Even though the monitoring of the Spragues Cove Project has not been completed, several local communities have expressed an interest in utilizing constructed wetlands for managing storm water in their communities. The Town of Marion has given tours of the project - explaining how the constructed wetlands function and what results are expected. The town is willing to share the water quality monitoring results and continue to provide tours of the project to other Buzzards Bay communities.

The Buzzards Bay Project and Natural Resources Conservation Service will continue to provide technical assistance to the town and the local volunteers on the operation and maintenance on this wetland system. To ensure the future success of the Spragues Cove Project, and provide improved water quality to Spragues Cove, the town, the Buzzards Bay Project, and the local volunteers must continue their cooperative efforts to manage and maintain the constructed wetland system.

Appendix A

Planning Document

Spragues Cove

Stormwater Remediation Project

SPRAGUES COVE/FRONT STREET

STORMWATER REMEDIATION PROJECT

MARION, MA

IN COOPERATION WITH

THE TOWN OF MARION

THE BUZZARDS BAY PROJECT

THE PLYMOUTH CONSERVATION DISTRICT

PREPARED BY

THE SOIL CONSERVATION SERVICE

AUGUST 1992

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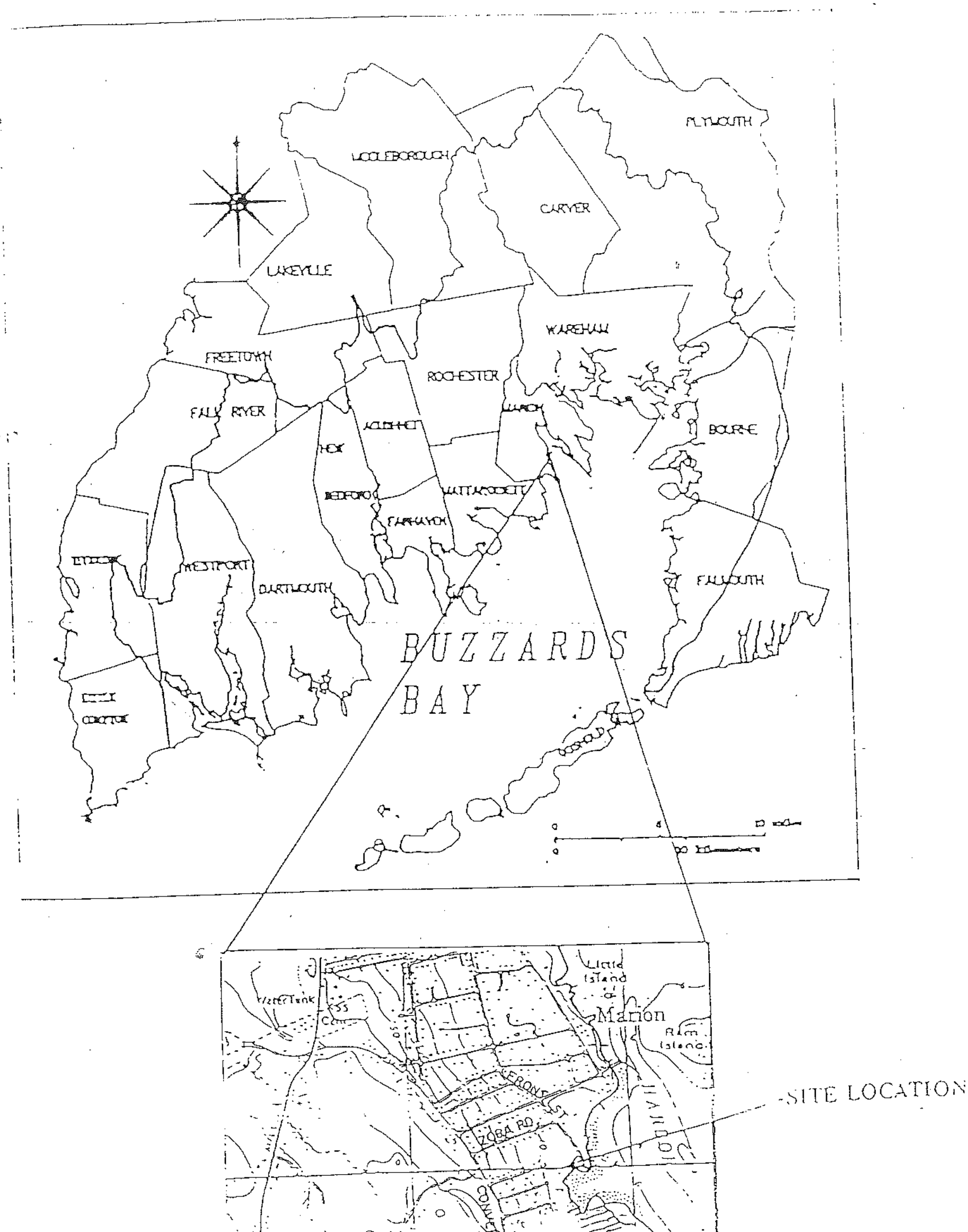
FIGURES

APPENDIX

FIGURE 1

LOCATION MAP



I. INTRODUCTION

The Buzzards Bay Project (BBP) was established in 1985 in order to characterize and assess water quality problems in Buzzards Bay and make recommendations based upon sound technical information. These management recommendations are stated in the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP). One of the major concerns identified in the CCMP is the continued degradation of water resources resulting from stormwater discharges.

To address this concern, the BBP assisted in the funding of municipal and county health laboratories in order to support the Massachusetts Division of Marine Fisheries (DMF) and the local communities efforts to complete their shellfish sanitary survey. This survey identified specific point and nonpoint sources which contribute pollutants into the waters of Buzzards Bay. Spragues Cove in Marion was one of the areas surveyed by DMF.

Spragues Cove is a relatively small shallow embayment on the western shore of Sippican Harbor. Currently this three acre area of valuable shellfish beds is closed for shellfishing because it exceeds both the state and federal standard (14 fecal coliform per 100 milliliters of water) for shellfishing. The sanitary survey identified stormwater runoff as a major contributor of fecal coliform bacteria in Spragues Cove. Adjacent to the cove is Silvershell Beach which is the only town-owned, full facility bathing beach in Marion. The beach is heavily used in the summer.

In 1990, The BBP, in conjunction with the Town of Marion (the project sponsors), submitted a proposal for funding under the Massachusetts Department of Environmental Protection's (DEP) 319 Nonpoint Source (NPS) program to reduce the pollution loading into Spragues Cove. The funding ($25,000) will be used to install a stormwater remediation project to treat runoff from the Front Street drainage system. This drainage system is a contributor of stormwater runoff to the cove.

As part of the project, the sponsors requested planning and technical assistance from the Soil Conservation Service (SCS). An SCS interdisciplinary team (including an engineer, geologist, biologist, soil scientist, and soil conservationist) met with BBP representatives and town sponsors to discuss the existing problems and objectives of the sponsors. Assistance was also provided by an SCS wetlands specialist, US Fish and Wildlife Service, MA Fish and Wildlife, and MA Department of Environmental Protection-Division of Wetlands. Since that time, members of the interdisciplinary team have worked to identify environmental concerns and to discuss potential treatment measures.

II. RESOURCE AREA

1. Landuse Description

The resource area (See Figure 2) is approximately 70 acres in size and encompasses the "lower village" section of Marion. It is primarily a residential watershed (64 acres) with house lot size averaging one-half acre. Some of the houses were built on previously filled marshland. All of the homes in this area are serviced by town sewer and water. The remaining 6 acres are town owned recreation land and includes the town beach, parking lot, a bath house, and open space. This recreational land was "created" by filling in a saltmarsh during the 1950's.

2. Water Quality

According to DMF's 1990 Sanitary Survey, there are currently two inputs of road runoff into Spragues Cove. One input is from the Front Street storm drain. The outlet consists of a 24 inch pipe which discharges into a 700 foot long channel leading into Spragues Cove. For the sanitary survey, DMF sampled the mouth of this channel six times and obtained fecal coliform counts ranging from 14 to 1600 fecal coliform (fc)/ 100 milliliters (ml) of water. According to DMF, recent cold weather tests have consistently exceeded the scale of their testing procedure with results greater than 64 fc/100 ml.

At the request of SCS and the BBP, the town sampled the water quality at the outlet of the pipe and the end of the channel during base flow conditions and storm events. In addition to fecal coliform, other water quality parameters were tested. The water quality data from these tests indicate that pollutants such as heavy metals and nutrients are not a problem. Fecal coliform bacteria, however, continues to be a problem during storm events. Measurements of fecal coliform and fecal strep bacteria indicate that the source of the bacteria is not from a human source. Currently, water quality sampling to monitor fecal coliform in the channel is ongoing. For water quality monitoring information see Appendix 1.

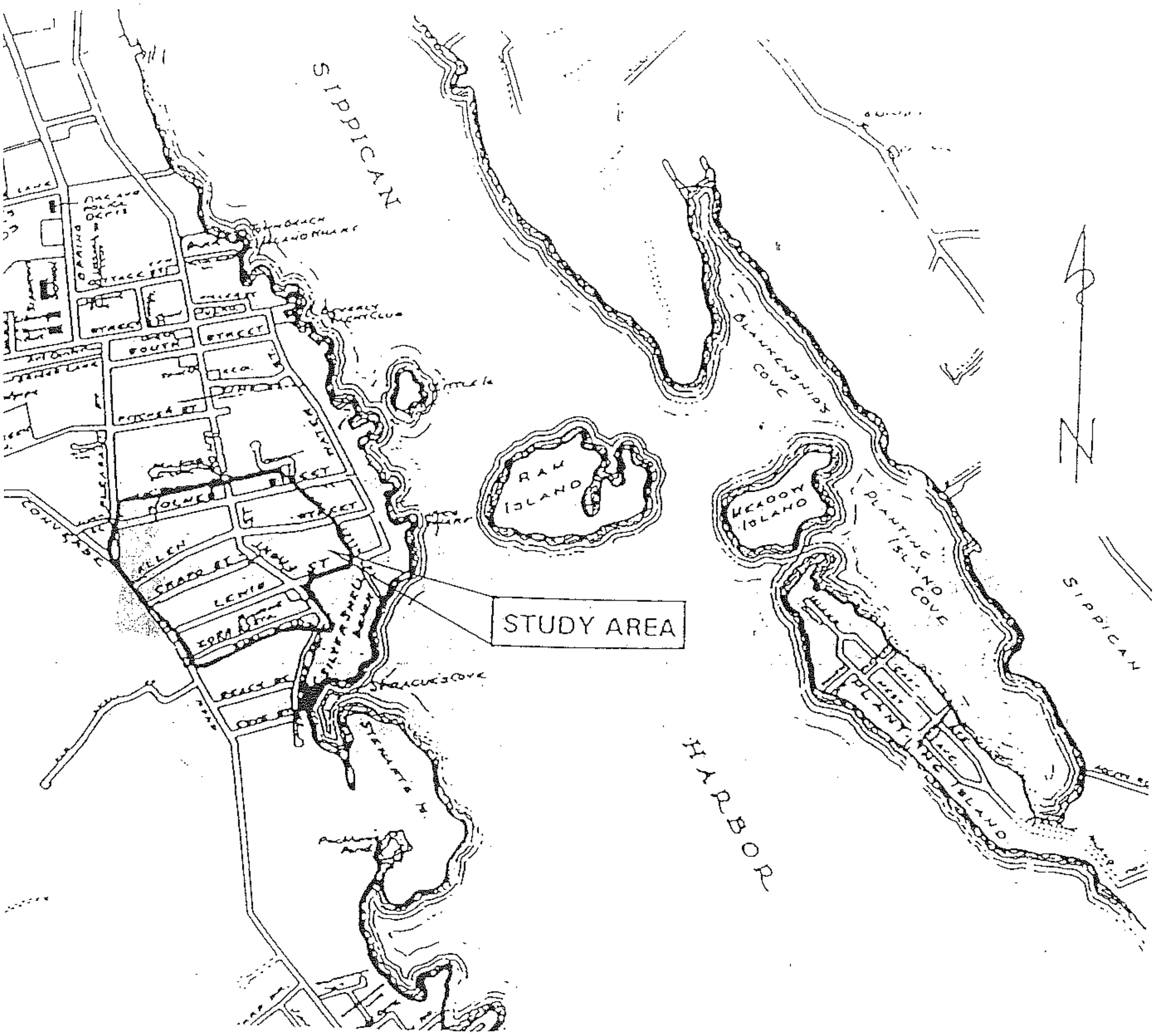
3. Topography and soils

The majority of the resource area is flat with only the upper reaches of the western watershed boundary being moderately sloping.

According to the Plymouth County Soil Survey, the majority of the soils are mapped either Norwell sandy foam or Scituate sandy loam. The Norwell soil is located around the lower end of Front Street. The soil description indicated that the soil is poorly drained with a fragipan within 2 feet of the surface. Most of these houses have been built on fill material and have wet basements throughout the year. The Scituate soil is described as a moderately well drained soil formed in compact glacial till. It is seasonally wet during the spring and after heavy rains.

FIGURE 2

RESOURCE AREA



Scale: 1" = 1600'

In March 1991, three soil test pits were dug west of the Silvershell Beach parking lot. From the historical information provided by the Town Administrator plus information gathered from the test pits, this site is a filled salt marsh. The first three feet of the pits consisted of sand fill underlain by 1 to 2.7 feet of peat material. Below the peat is about 2 feet of sandy silt, then poorly graded sand with silt to the bottom of the test pits. Depth of the pits ranged from 6 to 10 feet. There was evidence of a perched water table at 3 feet and an apparent water table at 6 feet

4 Hydrology

One of the major concerns in any coastal community is the potential damage to structures (buildings, roads, storm drains, etc.) caused by flooding. According to the Marion Flood Insurance Study, part of the Marion lower village is within the 100-year flood plain zone. The flood elevation for the 100-year storm is 14.3 feet National Geodetic Vertical Datum (NGVD), for the 10-year storm, 8.1 feet (excluding wave action). Based on topographic surveys of the proposed site, the ground elevations range from 5 to 7 feet (NGVD). As a result, the site will be flooded by the
10-year storm.

The main storm drain for Marion lower village is located under Front Street. Several roads run perpendicular to Front Street and contribute stormwater to the drainage system through either connecting storm drains or surface runoff. Also the Town Executive Secretary has indicated there are approximately 11 sump pumps which contribute water to the sewer system. The estimated sump pump discharge is a maximum of 54,000 gallons/day (0.08 cfs). The town is considering tying the sump pumps into the storm drain system.

The hydrology of the Front Street storm drain watershed was calculated using the TR-55 computer program, the results of which are summarized below:

Landuse: 1/2 acre houselots   Drainage area: 64 acres

Storm frequency	Peak flow (cfs)	Runoff volume (in.)
1-year	36	0.9
2-year	66	1.6
10-year	144	2.6
100-year	205	4.7

In the Spragues Cove project however, the amount of stormwater runoff is not as much of a concern as is the water quality. Pollutants accumulate in the watershed between storm events. Once rain water begins to run off land surfaces, pollutants are "washed off" and, unless intercepted, can affect the quality of the receiving waters. This "first flush" of stormwater runoff is generally accepted to be the first inch or less of runoff. For the Front Street drainage, this runoff volume amounts to 5.33 acre-feet (1 inch over 64 acres) or 1.74 million gallons.

5. Natural Resources

According to the Natural Heritage and Endangered Species Programs' Atlas (1992 Edition), all of Sippican Harbor (including Spragues Cove) is mapped as an estimated habitat for rare wetlands wildlife. In accordance with the Wetlands Protection Act, the sponsors must notify the Natural Heritage Program if the project alters a wetland resource area or buffer zone within the boundaries identified on the atlas maps. The notification form is Appendix A to Notice of Intent (Form 3) and Abbreviated Notice of Intent (Form 4). In discussing this project with the Heritage staff, the resource area may contain habitat for the Diamondback Terrapin (Malaclemmys t. terrapin). The terrapin is known to inhabit coastal estuaries and tidal flats. The Heritage staff indicate that a stormwater remediation project in the resource area would not affect the habitat of the terrapin.

The natural resources in the watershed of the Front Street drainage system typifies many residential areas in Buzzards Bay. Lawns, shrubs, and trees (oaks, maples, and pines) and its associated wildlife (raccoons, songbirds, squirrels, etc.) are the predominant plant and animal species. The channel and its associated wetlands offer a greater variety of natural resources. The associated wetlands include two forested wetlands north of the pipe outlet, the riparian vegetation along both sides of the outlet channel and Spragues Cove itself. These habitats support a diverse community (both fresh water and estuarine) of wetland plant and animals. A more detailed report on the natural resources in the watershed is available with the supporting information.

6. Cultural Resources

According to the 1991 State Register of Historic Places published by the Massachusetts Historical Commission, there are no historic sites located on the project site. Since the project involves federal financial and technical assistance, the Town of Marion has submitted a letter to the State Historic Preservation Officer for a determination of the existence of cultural resources at the site.

III. PLANNING OBJECTIVES AND ALTERNATIVES

1. Sponsor Objectives and Problems

The Town of Marion has two primary concerns with the Front Street drainage system. These concerns are described below:

A. Water quality monitoring of the outlet of the storm drain system, the outlet of the channel, and Spragues Cove indicate a continued fecal coliform bacteria problem related to stormwater runoff. The town wants to reduce the bacteria loading into the Cove with the hopes of opening the area up for shellfishing.

B. Currently, the outlet to the storm drain is submerged and sediment has accumulated in the pipe. The reduced capacity has caused some minor flooding in the roads. By cleaning out the pipe and the channel, the capacity of the system will improve.

2. Alternatives

Several alternatives were considered for the treatment of stormwater from the Front Street drainage. Alternative A is no action. Alternative B consists of various methods of mechanical treatment. Alternative C consists of several methods of physical treatment.

Alternative A - No Action

Under this option, the Front Street storm drain system will continue to function as it has in the past. After storm events, high counts of fecal coliform bacteria will enter the outlet channel from both the road and the pipe and then discharge into Spragues Cove. The Cove will remain closed for shellfishing. Flooding will continue and will worsen as more sediment builds up in the discharge pipe and outlet channel.

Alternative B - Mechanical Treatment

Treatment discussed under this option include chlorination, ultraviolet light, ozone, and reverse osmosis. These treatments were not considered feasible due to the high initial cost plus post-construction expenses. Any mechanical method would need protective housing, a power source (electrical, battery, etc.,) and daily upkeep. Currently, mechanical methods are not "proven" technology to handle stormwater flows and its associated pollutants. Bacteria amounts in the stormwater are not significantly high to warrant mechanical treatment, such as in wastewater treatment. Some mechanical methods such as chlorination may actually have a negative impact on downstream waters - affecting shellfish and other aquatic habitat.

Alternative C - Physical Methods

The physical methods of treatment explored by the interdisciplinary team are described below:

1. Infiltration structure(s) - This method involves either installing a series of leaching chambers throughout the watershed or an infiltration basin at the end of the storm drain. An infiltration structure(s) collects stormwater runoff and infiltrates it into the soil. Although this method has been proven effective in treating fecal coliform, the location of such a structure(s) is very site specific and must be evaluated thoroughly before installation. The functioning of an infiltration structure is dependent on the drainage capabilities of the surrounding soil (well drained) plus depth to high water table and bedrock. The majority of the watershed has moderately to poorly drained soils and a high water table - both of which would impede the performance of infiltration practices. At the proposed site, there is very little elevation difference between the stormdrain outlet and the high water table.

2. Settling basin with a vegetative filter strip/swale - This allows for removal of the coarser sediments in the settling basin plus some other particulates (including fine sediment, heavy metals) in the vegetative filter. Pollutants are removed by filtration, deposition, and infiltration. The amount of removal depends on the contact or holding time within the system. Based on the calculated storm flows for the Front Street watershed, retention time in a vegetative filter is expected to be minimal. Vegetative best management practices (BMP) are not the most effective method for removing pollutants unless they are used in conjunction with other BMPs.

3. Constructed/restored wetlands - This system (see Figure 3) includes a settling basin, marshland vegetation, and an open deep-water pool. Base flow from the Front Street stormdrain pipe and road runoff enters the settling basin. The basin allows for coarse sediments and other particulates to settle out prior to entering the wetland treatment system. From the settling basin, water flows into the marsh vegetation as sheet flow. The physical and biological processes that normally occur in a wetland will treat and remove the pollutants from the water. The deep pool also provides a mechanism to reduce potential mosquito problems. The final phase of the system is a grassed channel which outlets back into the existing channel.

As an option, an additional settling basin and detention area could be installed to improve the pollutant removal capabilities of the wetland system. These components would be located across Front Street on town-owned recreational land (between the bath house and Front Street). This land currently consists of a mowed, low intensity recreational field. Initially surface water from Front Street would be diverted to this area, stored, and then released within a 24-hour period into the wetland treatment system.

The constructed wetland system would also provide the opportunity to remove accumulated sediment from the storm drain and outlet channel. This would increase the storm drain capacity and reduce road flooding.

IV. SELECTED ALTERNATIVE

The Town of Marion has reviewed the alternatives and decided that the constructed wetland system (Alternative C3) meets their objectives. A preliminary design for the constructed wetland system was completed and is described below. On July 7th, the Selectman voted to accept the preliminary design and to proceed with the project. SCS and the BBP will assist the Town in obtaining the necessary permits needed to construct the wetland system. The Town will also pursue avenues to remove any necessary fill material. Any permits required for placement of the excavated fill will be the responsibility of the Town.

System Description

The first flush (the first half inch) of road runoff will be diverted into a settling basin-2A (See Figure 3) and then into a shallow detention area (2B). The runoff will be piped into a shallow marsh (1B) within 24 hours. Any road runoff over the first inch will be diverted back into the existing outlet channel. The base flow and any storm flow from the storm drain system will be routed into a settling basin (1A). With the use of a level lip spreader, the water will discharge into the marsh (1B) as sheet flow and eventually into the deep pool system (1C). The water will flow back into the shallow marsh before being released into a grassed channel (1D), which will outlet back into the existing outlet channel. The deep pond (1C) will be 5 feet deep. The shallow marsh and detention area (1B and 2B) will range from 0.5 to 1.5 feet deep. The marshes will be planted to salt tolerant species such as narrow leaf cattail, softstem bulrush, and sago pondweed.

The shallow marsh and deep pool will be designed to store a permanent pool of water. As new stormwater runoff enters the wetland system, excess water in the permanent pool will be discharged through the control outlet and into the grassed channel. The pollution removal efficiency is related to the detention time of the stormwater runoff within the permanent pool and the total flow length within the system. The control outlet will be designed in order to maximize the distance between the system inlet and outlet. A minimum 3:1 length (between inlet and outlet) to width ratio is planned. Also, within the shallow marsh low dikes will be constructed to discourage short circuiting of the system and prevent the formation of dead storage areas. The planned wetland system has a hydraulic detention time of over 7 days.

The goal for this project is to reduce the fecal coliform levels into Spragues Cove and potentially open the area for shellfishing. Limited research on using wetlands to treat wastewater for fecal coliform indicate that at least 95 percent and in most cases greater than 99 percent is removed. The fecal coliform counts associated with stormwater from Front Street are significantly lower than the research levels.

Along with the water quality improvements, the restored wetlands system will enhance the fish and wildlife habitat in the area. Currently, the site has very little wildlife value - it is sparsely vegetated with low growing shrubs and grasses. This wetland system will be constructed where a salt marsh previously existed - the site was previously filled with dredge spoil from Sippican Harbor. It will offer a more diverse habitat with the combination of open water, marshland grasses and upland shrubs. The pond should be stocked with freshwater mussels, crayfish, and other native aquatic species. The mussels will enhance the effectiveness of the system by filtering the water.

Operation and Maintenance

In order for the wetlands system to function properly, it must be inspected on a regular basis. During the first year, the system should be inspected before, during, and after significant storm events. The wetland system will be inundated by higher storm tides; therefore, it should be checked for damage and proper operation after the water levels subside. If any problems or malfunctions occur, they must be reported to the proper town authorities and rectified immediately. Destruction and/or damage to large areas of wetland vegetation are to be replaced during the next growing season. Replacement of the vegetation may also include some surface regrading within the wetland system.

Both long- and short-term inspection and maintenance of the system is the primary responsibility of the Marion Conservation Commission. Any noxious vegetation that threatens the plant diversity within the wetlands (ex. Phragmites and purple loosestrife) must be controlled. Also, the accumulation of sediment and other debris in the sediment basins, the storm drain pipe, and the outlet pipes and channel must be removed at least once per year or more frequently, if needed.

Water Quality Monitoring

The water quality monitoring plan will be part of the Quality Assurance/Quality Control (QA/QC) plan required by the Environmental Protection Agency. The most frequent water quality parameter to be measured is fecal coliform, along with flow. Other parameters (fecal strep, BOD, suspended and settable solids, nitrogen, phosphorus, and metals) are to be measured occasionally. Sample collection will be accomplished by BBP staff, Marion Conservation Commission, and local citizen monitoring. Sample locations will be prior to the stormwater runoff entering the system (at the end of the 24 inch outlet pipe and other locations, if needed), after wetland treatment (at the control outlet), in the existing outlet channel (where the grassed channel discharges), and in Spragues Cove.

Funding Sources

The Town of Marion and the BBP have obtained funding for $25,000 through EPA's 319 grant program. The town offered an in-kind match of $35,000 to cover the cost of construction (equipment and labor). The town has also donated the land on which the wetland system will be restored (an estimated cost of $100,000 per acre). Approximately 2 to 3 acres of land will be utilized for the project at a total land value of $200,000 to $300,000.

The U.S. Fish and Wildlife Service has granted the Town of Marion $10,000 for this project under their Wetland Restoration Program.

APPENDIX 1

WATER QUALITY DATA

FECAL COLIFORM MONITORING SUMMARY

AMPLE DATE	PIPE OUTLET	CHANNEL OUTLET	RAINFALL (INCHES)	SAMPLER
28/89		>64		DMF
14/89		1600		DMF
22/89		49		DMF
31/89		14		DMF
05/89		33		DMF
04/89		>64		DMF
11/90		>64		DMF
11/90		4000		TOWN
20/90	<20	1300	0.41	TOWN
08/91		<20		TOWN
'09/91		41		DMF
'20/91	<20	130	0.26	TOWN
'28/91		23		DMF
'24/91		400		TOWN
/12/91	170	2200		TOWN
/16/91	5000	12000	1.95	TOWN
/17/91	830	800		TOWN
/09/91	<1	9		TOWN
/23/92	109	27	0.25	TOWN

MPLE DATE		12/09/91	1/23/92	
.INFALL (INCHES)		0	0.25	
		FECAL COLIFORM		
;TATION	7+00	<1	109	PIPE OUTLET
	6+40	9	100	
	5+20	<1	73	
	3+90	18	182	
	3+30	9	27	
	2+70	18	18	
	1+70	45	<1	BOARDWALK ACROSS CHANNEL
	0+50	36	27	
	0+00	9	27	OUTLET @ SPRAGUES' COVE

Appendix B

Florida Development Manual

Chapter 6 - Storm Water Basins

SW BMP 3.02

STORMWATER DETENTION BASINS

Definition

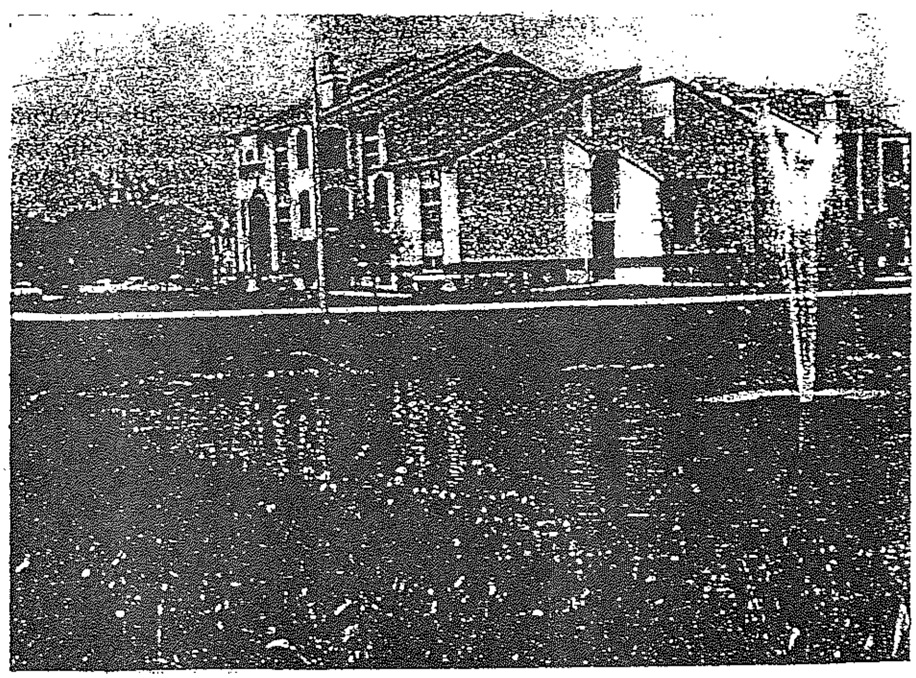
On-site detention refers to the temporary storage of excess runoff on the site prior to its' gradual release after the peak of the storm inflow has passed. Runoff is held for a short period of time and is slowly released to a natural or man-made water course, usually at a rate no greater than the predevelopment peak discharge rate.

Purpose

The objective of a detention facility is to regulate the runoff from a given rainfall event and to control discharge rates to reduce the impact on downstream stormwater systems, either natural or manmade. Generally, detention facilities will not reduce the total volume of runoff, but will redistribute the rate of runoff over a period of time by providing temporary "live" storage of a certain amount of stormwater. The volume of temporary "live" storage provided is the volume indicated by the area between the inflow and outflow hydrographs as shown in Figure 6-4.

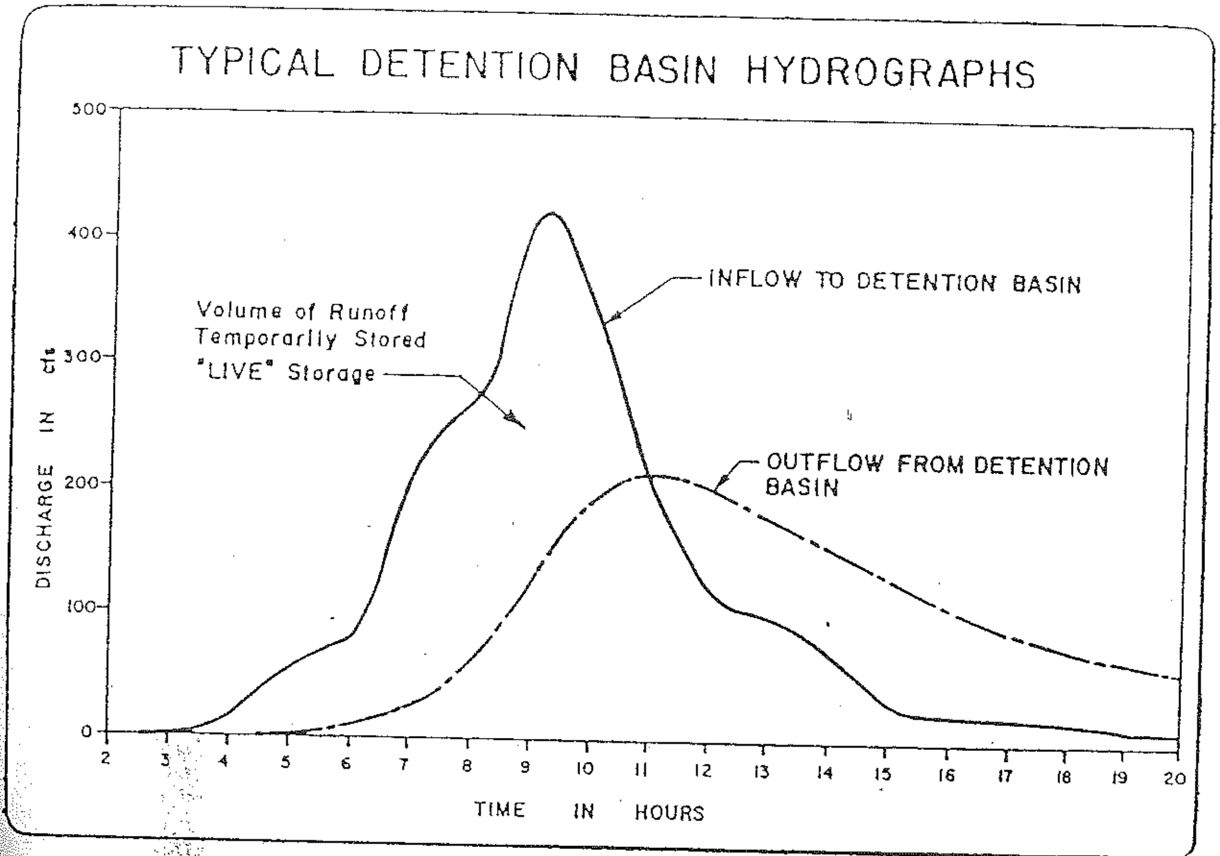
A major benefit derived from properly designed and operated detention facilities is the reduction in downstream flooding problems. Other benefits include reduced costs of downstream stormwater conveyance facilities, reduction in pollution of receiving streams and enhancement of aesthetics within a development area by providing the core of "blue-green" areas for parks and recreation.

Example of a Typical Wet Detention Basin for Stormwater Control



(Source: Photo courtesy of Mr. Will Miller, Aurora Inc. South)

Figure 6-4



Planning Considerations

Throughout the design process the designer should be committed to considering the potential impacts of the completed facility. Such impacts can be positive or negative and can be as broadly classified as social, economic, political and environmental. Designers can often influence the positive or negative aspects of these impacts by their careful evaluation of decisions made in the design process. Generally speaking, the completed facility should provide for safety to people as well as protection of real property, water quality and wildlife habitats.

Multiple Uses: Multi-purpose use of the facility and aesthetic enhancement of the general area should also be major considerations. Above all, the facility should function in such a manner as to be compatible with overall stormwater systems both upstream and downstream to promote a watershed approach to providing stormwater management as well as local flood control.

Water Quality Improvement: In planning new impoundments, it should be kept in mind that the goal of improved water quality downstream may conflict with certain desired uses of the impoundment. It is only logical that if the basin is used to remove pollutants, the water quality within the basin itself will be lowered, thus reducing the applicability for uses such as water supply, recreation and aesthetics. In planning the facility the engineer or planner should have a good knowledge of the runoff constituents and an understanding of the possible effects on the quality of the stored water.

Depending upon the impoundment design, downstream water quality may be improved for the following reasons:

1) Soil, sediment and other particulate pollutants settle out and are trapped to a degree.

2) Delayed release of runoff stretches out the loading to the receiving stream of runoff-borne sediment, organic materials, chemicals and bacteria thus reducing the "first-flush" or shock loading effects of stormwater effluent.

3) To some extent increased infiltration of runoff through the soil may occur so that the water is cleansed before reaching lakes, canals, or streams and the augmented groundwater volume later helps to sustain base flow.

4) Decreased runoff rates reduce stream channel erosion and subsequent sediment pollution.

5) Some amount of chemical transformation and biological uptake occurs which helps upgrade runoff quality while the water is detained in the detention pond. This upgrading process can be further enhanced through mechanical aeration and the use of aquatic plant species which can assimilate pollutants.

6) Downstream pollution by litter and debris is reduced to the extent that such pollutants are trapped within the impoundment area or pretreatment devices.

The exact level of treatment or pollutant removal which may be obtained from each or all of these mechanisms is difficult to predict. The efficiency of these systems has been shown to vary depending on a number of factors including the holding time, amount of littoral zone available, and the location of the inlet relative to the outlet of the facility, and the incorporation of other BMPs into an overall treatment train. Detention systems should be integrated with other BMPs such as swales, modified stormsewer inlets, etc. to reduce loading to the detention pond, especially if it will serve as an aesthetically pleasing "lake".

Stormwater detention impoundments can vary greatly in size and design. Until recently, the "dry pond" was often used. These structures impound water only during a storm and are designed to completely drain at an allowable release rate usually equivalent to predevelopment conditions. The primary purpose is to limit the peak rate of discharge. The entire storage volume is discharged within a matter of a few hours following an event. Consequently, in most instances little if any improvement (0% - 30%) in the quality of the water is likely to occur.

"Wet ponds" have been shown to function better for pollutant removal. Therefore, the information provided here is primarily associated with this type of installation. Such facilities are used extensively over much of south Florida and in low lying areas especially along the coast. These impoundments have a "normal water level" with additional capacity above the control elevation for runoff storage during storms. The structures are often designed with multiple uses in mind such as recreation, aesthetics, etc. Recent studies conducted in Florida as well as information collected during the National Urban Runoff Program (US EPA, 1982) demonstrate that these facilities are capable of providing a high level of pollutant abatement (80% or greater) for many constituents particularly nutrients.

Watershed-Wide Planning: The design of urban impoundments should be coordinated with a watershed-wide plan for managing stormwater runoff. In a localized situation an individual property owner can, of course, by his or her actions alone provide effective assistance to the next owner downstream if no other areas are contributing to that owner's problems. However, uncontrolled proliferation of impoundments within a watershed can severely alter natural flow conditions, causing compounded flow peaks or increased flow duration which can contribute to downstream degradation. In addition, upstream impacts due to future land use changes should be considered when designing the structure. Land use planning and regulation may be necessary to preserve the intended function of the impoundment.

Sediment and Debris: More often than not, detention ponds are expected to serve primarily as sedimentation basins during construction when erosion rates are particularly high. In and of itself this situation does not present a problem. Unfortunately, these facilities are often installed without the benefit of the designer having evaluated the capacity of either the initial or the final (post-construction) design configuration to perform this type of function.

In settlability analysis, removal by gravity settling is viewed to occur when the average velocity of flow through the pond is less than the settling velocity of the minimum size particles that the designer wishes to capture. Chemical flocculation, although expensive, can aid in this process as heavier sediments overtake and coalesce with the smaller lighter fractions to form still larger particulates. Consequently, the opportunity for settling fine textured collodial material which happen to absorb and carry many other pollutants is projected to be enhanced as the average velocity decreases and the residence time and depth of the pond increases.

If a facility is to be used as the principal means to avoid having excessive levels of turbidity discharged from the site during construction, the engineer should evaluate the pond geometry in conjunction with the rate of outflow and grain size distribution of the soils. The application of a set of standards and specifications pertinent for flood control or even post construction water quality management can not necessarily be depended on to prevent excessive sediment delivery down stream. Adherence to typical predevelopment rate control criteria does not provide assurance that the average velocity of water moving through the detention basin will not exceed the settling velocity of the particulates that must be removed to avoid excessive levels of turbidity. Likewise, treatment schemes based on the control of small magnitude storms (i.e., one inch or less) as mandated by the statewide stormwater rule (17-25 F.A.C.) would not be expected to function properly since the major environmental damage that is likely to occur due to erosion and sedimentation would normally be associated with less frequent but greater magnitude storms (i.e., two inches or more in size). Consequently, a sizeable portion of major events that contribute to construction related problems would bypass the system practically untreated.

If a detention facility is to be used for sediment retention, the major objective should be to maximize sediment-trapping efficiency. One method of doing this is to maximize the hydraulic flow length within the basin. Long basins are generally more efficient than short wide ones, given equal depth.

Hydraulic flow length can be increased by installing a system of baffles within the basin which causes the flow to meander, allowing more time for sediment deposition to occur. See TEMPORARY SEDIMENT BASIN, (ES BMP 1.26) Appendix 1.26A, for recommendations pertaining to basins and baffles to promote improved sedimentation.

Marsh Establishment: Establishment of fresh water marshes in ponds can aid in water quality improvement. Marsh areas create a sink for many pollutants with a high degree of water treatment or purification possible, depending upon the runoff detention time and the availability of wetland plants and aquatic life which can assimilate pollutants.

Wetland associated plants will establish themselves naturally in a shallow, wet pond. It may be beneficial, however, to accelerate marsh establishment by planting appropriate native vegetation in shallow areas. Certain wetland plant species have a greater capacity for pollutant assimilation and are less maintenance intensive than others. The Center for Wetlands at the University of Florida, can help in the selection of appropriate species for the specific site conditions. The Nonpoint Source Management Section of the Department, the local FDER district office, or the regional Water Management District may also be of assistance. These agencies are good sources for information concerning private consultants and nurseries that can also be of assistance in restoration or revegetation of aquatic systems.

Marsh establishment for stormwater treatment is still in the experimental stages in Florida. However, preliminary indications show that such measures can be appropriate for the following applications:

1) At the perimeter of deep impoundments to filter direct sheet flow runoff from the adjacent drainage area.

2) On shallow sills or shelves separating inline tandem ponds or forebays to filter runoff before it enters the major impoundment from tributaries or stormsewer inlets.

3) At the edge or surrounding the outflow of detention facilities to promote assimilation of dissolved pollutants before water exits the primary impoundment.

Marsh establishment in facilities that also serve as temporary sediment basins may be difficult during construction due to frequently required cleanout of accumulated sediment. To continue functioning, marshes will require periodic sediment removal. Sediment should be removed from the deepest parts of the basin where vegetation is sparse. Heavily vegetated areas should be disturbed as little as possible. Overhead scooping equipment works well for dredging selected portions of marsh areas.

The presence of marshes in established urban areas is perceived by many people to be undesirable. They are often thought of as mud holes where mosquitoes and other insects breed. Actually, once a marsh becomes fully established, it can become a welcomed addition to an urban community. Created fresh water marshes provide miniature wildlife refuges to which ducks, songbirds, turtles, raccoons, fish, and other wildlife have migrated. While insect populations are increased, insect predators also increase, often reducing the problem to a tolerable level.

Fresh water marshes can greatly increase the pollution removal efficiency of urban ponds. For this reason, vegetated littoral zones are a necessary part of any wet detention system.

<u>Tandem Ponds and Forebays</u>: The multiple-use purpose of certain impoundments may be preserved by installing a smaller settling basin directly upstream of the major basin. The smaller pond would serve to remove a large portion of the particulate pollution and release higher quality water into the major impoundments. The term "tandem pond" refers to a settling basin and adjacent detention or retention basin both resulting from constructed embankments. A "forebay" is an excavated settling basin at the head of the primary impoundment. The efficiency of the smaller settling basins can be

increased through the use of chemical flocculants which causes small colloidal particles to settle at a faster rate. See STORMWATER STORAGE/TREATMENT SYSTEMS (SW BMP 3.09), for more information.

Heavy Metal Contamination: Studies have shown high accumulation rates of lead, zinc and copper on and near heavily traveled highways and streets. Therefore, runoff from highways and streets can be expected to carry significant concentrations of these heavy metals. If a significant portion of the drainage area into a pond consists of highways, streets, or parking areas or other known sources of heavy metal contamination, there is a potential environmental health hazard. In such cases the multiple use functions of the pond should be limited and accessibility should be restricted.

The increased construction of multi-purpose impoundments with controls for nonpoint source pollution could mean the accumulation of sediment contaminated with heavy metals or other toxic materials. This may require special disposal sites for sediment dredged out of the basins during maintenance cleaning. However, investigators of sediments removed from detention ponds to date have found that the pollutants are tightly bound with only a slight possibility of leaching. To be safe, sediments to be removed should be analyzed and elutriate tests performed to verify that the sediment can be safely disposed of by conventional methods.

Design Criteria

In urban or urbanizing areas, failure of an impoundment structure can cause significant property damage and even loss of life. Such structures should be designed only by professional engineers who are qualified and experienced in impoundment design.

Wherever they exist, local safety standards for impoundment design and construction should be followed. Where no such criteria exist, widely recognized design criteria such as those used by the USDA Soil Conservation Service or U.S. Army Corps of Engineers are recommended. The following are intended to supplement other acceptable design and safety criteria only. They apply to pollution control purposes the adherence to which should not be construed to satisfy other design objectives.

Wet Detention Systems

Presently there are numerous sets of standards which have been promulgated with the intent to maximize the treatment (pollutant removal) capacity of permanently wet detention facilities. Guidelines have been developed by several of Florida's five water management districts as well as the Department of Environmental Regulation. All are somewhat different. However, most if not all permitting authorities seem to agree that a sizeable littoral zone should be provided to encourage better assimilation. Planting, preferably with native aquatic species, is usually recommended. Some degree of dimensional criteria pertaining to storage volume, depth, width, length, and the orientation of the inlet and outlet are also common. Designs which maximize residence time, encourage reaeration, and discourage short circuiting are principal goals.

The current guidelines established by the Department for wet detention systems follow, along with a list of available plant species that are encouraged. Each is still subject to changes. Research into the performance of these systems and the mechanisms by which they may best function is still in its infancy. Designers are reminded that these requirements may be slightly different in areas of the state where stormwater quality permitting has been delegated to the local Water Management District.

Current Department of Environmental Regulation Criteria for Wet Detention Systems are listed as follows:

a) One inch of runoff storage above the control (bleed down) elevation of the permanent pool.

b) This volume is to be recovered at a slow rate. No more than one-half the volume may be discharged in the first sixty hours following an event.

c) The volume in the permanent pool must provide for a residence time of at least fourteen days. This volume may be determined by estimating 3.83% of annual average runoff. A more empirical approach sometimes used is calculated by taking two inches times the impervious acreage in the project plus one-half inch times the pervious acres. The value in cubic feet is determined through multiplication times the appropriate conversion factor (i.e., 3630).

d) A littoral shelf should be provided by extending and gently sloping the sides of the facility (6:1 or flatter) out to a point 2-3 ft. below the normal water level or control elevation. Facilities that are planned with sides that are steeper than 4:1 out to a depth of two feet below the level of the permanent pool must be fenced to restrict public access for purposes of safety (Ref. 17-25.025(6) F.A.C.)

e) No more than 70% open water is recommended. The remaining 30% (i.e., littoral shelf) typically is established with aquatic vegetation. A layer of muck (6" recommended) may be incorporated into the littoral area to promote establishment of wetland vegetation. Planting of native aquatic plant species is highly recommended. Lining the bottom and sides of these facilities with a layer of organic material such as muck appears to be an attractive alternative when potential groundwater contamination problems are apparent. However, the use of muck that has been transported to the facility from areas where cattails or willows are predominant can cause nusiance weed problems and should be avoided.

f) A maximum depth of 8-10 feet below the invert of bleed down device should be planned for the permanent pool.

g) Inlet structures should be designed to dissipate the energy of water entering the pond. Baffles are the most commonly used structures for such purposes. Inlets should not be located in close proximity to the outlet so as to prevent short circuiting.

h) Facilities that are potential sources for oil and grease contamination must include a skimmer or other mechanism to prevent these substances from leaving the facility.

i) Erosion and sediment control BMP's must be used to retain sediment on site during construction. BMP's must be shown on the design plans and the engineer must provide instructions for proper O & M. Sod all areas above the normal water level of ponds to prevent erosion and sedimentation of plantings.

j) If the facility is planned as a "real estate" lake to enhance property values and promote the aesthetic value of the land, pretreatment in the form of landscape retention areas or perimeter swales should be incorporated into the stormwater management facility. If possible, catch basins should be located in grassed areas. By incorporating the "treatment train" concept into the over-all collection and conveyance system, the engineer can prolong the utility of these permanently wet installations and improve their appearance. Any amount of runoff waters, regardless how small, that is filtered or percolated along its' way to the final detention area can remove oil and grease, metals, and sediment; as well as, reduce the annual nutrient load to prevent the wet detention lake from eutrophying. A credit against the required wet detention storage volume may be provided depending upon the amount of stormwater infiltrated. A notice should be posted warning residents of potential water borne disease that may be associated with body contact recreation such as swimming in these facilities.

Littoral Zone Planting Criteria: Specific conditions for projects involving wet ponds with vegetated littoral zones are very similar to requirements pertaining to wetlands replacement and restoration. In each instance, monitoring in the form of photographic documentation of percentage survival of plant species and coverage of naturally occurring or propagated vegetation is usually requested. Submittals of this information will usually be on a quarterly basis for the first year. The frequency declines to once or twice a year during the next two year period.

Most permitting agencies will ask that the applicant remove nuisance species (e.g., cattails) during the establishment period. An 85% survivorship guarantee is usually required for all planted species. Annual replanting will be required if survival falls below the 85% level.

Whenever possible, the Department (FDER) encourages the use of native vegetation for "aquascaping" around and within detention ponds. These species require less intensive maintenance and are not as likely to become a nuisance as some of the more notorious introduced varieties that are often used in Florida for nutrient assimilation and pollution control (e.g. water hyacinth). In the design of the planting it is important to consider the need for future access to high maintenance areas such as inflow and outflow structure and sediment sumps.

The following list of herbacious plants and trees and shrubs is intended to provide the reader with some background information pertaining to the various types of vegetation that may be acquired from nurseries for establishment in and along the shoreline of wet detention facilities. It is by no means an exhaustive list and other species may be used if more suitable. Most of the plants in the "trees and shrubs" category are primarily used for their wildlife enhancement value and for landscaping landward of in the zone of fluctuating water that is temporarily detained and stored above the normal pool elevation. The herbacious species shown have a wide range of growth habits and preferred environments. The table also provides an indication of pool and comments regarding other features of interest as well.

TABLE 6-2

NATIVE PLANT SPECIES SUITABLE
FOR LITTORAL ZONE PLANTINGS AND LANDSCAPING AROUND DETENTION PONDS

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE *	FEATURES
	<u>TREES SHRUBS AND PALMS</u>		
Acer rubrum	Red maple	1-2	Medium sized tree specimen known for its' attractive brilliant red fall color.
Betula nigra	River birch	1	Medium sized tree. Known for its' attractive bark. Prefers moist soils. Is often planted in clumps.
Carpinus caroliniana	American hornbean "Blue Beech"	1	Medium sized tree with attractive bark, and interesting form.

* Planting Zones:
1) + 0.5 feet or more higher than the normal level of the permanent pool.

2) + 0.5 feet above to - 1.0 feet below normal pool.

3) - 1.0 feet to - 3.0 feet below the control elevation of the permanent pool.

4) - 3.0 feet to - 5.0 feet below normal water level.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Carya aquatica	Water hickory	1-2	Large specimen. Leaves are relatively large. Fall color (bright yellow).
Cephalanthus occidentalis	Buttonbush	1-2	Large shrub up to 3m. (9.8 ft) tall with white flowers resumbling buttons. Buttonbush has a scrubby appearance owing to the dying of leader shoots leaving dead stumps.
Clethra alnifolia	Sweet pepper bush	2	Highlighter, shrub with attractive berries.
Crataegus spp.	Haw apple	1	Small tree with white flowers and attractive red fruit.
Fraxinus caroliniana	Popash	1-2	Large specimen with attractive foliage and deep furrowed bark.
Gordonia lasianthus	Loblolly bay	1-2	Medium to large tree. Large white flowers and attractive foliage.
Hypericum spp.	St. Johns Wort	2	Highlighter, shrub.
Ilex cassine	Dahoon holly	1	Small tree or shrub with prominent red berries and attractive evergreen foliage.
Ilex vomitoria	Yaupon	1	General landscape shrub with attractive red berries.
Illicium floridanum	Florida anise	1	Shrub with attractive aromatic foliage and purple flowers.
Liquidambar styraciflua	Sweetgum	1-2	Medium to large specimen. Attractive unusual shaped foliage and good fall color. Not tolerant of long term inundation
Liriodendron tulipifera	Yellow poplar "Tuliptree"	1	Large specimen; attractive large showy flowers and unusual shaped foliage.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
agnolia virginiana	Sweet bay	1	Medium sized tree with attractive foliage and white flowers.
yrica cerifera	Wax myrtle	1	Large shrub with attractive aromatic evergreen foliage. Bluish green berries in autumn and winter are eaten by many birds. Often used in groups for general landscaping and highlighting or accent around ponds.
yssa biflora	Blackgum tupelo	1-2	Glossy foliage turning bright red in autumn. Fruit matures in the fall; is consumed by many birds. Flowers are a source for honey.
trya virginiana	Hop hornbean "ironwood"	1	Slow growing small tree with fruit clusters resembling "beer" hops. Trunk looks like sinewy muscle. Nutlets and buds are eaten by wildlife.
rsea palustris	Swamp redbay	1-2	Attractive aromatic glossy evergreen foliage. Bitter fruit is eaten by wildlife. Does not do well in submerged locations.
ercus laurifolia	Laurel oak	1	Large tree with attractive nearly evergreen foliage. Acorns eaten by wildlife.
ercus nigra	Water oak	1	Large deciduous tree with small fine textured foliage. Acorns provide food for wildlife.
apidophyllum hystrix	Needle palm	1	Small to medium sized palm with attractive foliage used for providing tropical highlights. Sharp needles along the trunk lead to its' name.
bal palmetto	Cabbage palm	1	Large palm suited to all areas. Attractive tropical fan shaped foliage.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Taxodium spp.	Cypress "Bald" or "Pond"	1-2	Large aquatic deciduous conifer of picturesque form. Preliminary observation shows good survival and rapid growth of either species when used for storm-water enhancement purposes.

FRESHWATER AQUATIC PLANT SPECIES
(Herbs, Sedges, Grasses and Ferns)

Bacopa caroliniana	Lemon bacopa "Water hyssops"	2	Crushed leaves and stems lemon scented. Flowers blue.
Canna flaccida	Golden canna "Canna lily"	2	Very good highlighter. Used at fringe of ponds and lakes. Large showy yellow flowers.
Cladium jamaicense	Saw-grass	1-2	Coarse perennial sedge up to 3m (9.8 ft) tall. Grows equally well in water or several feet above water level. Long narrow and serrated leaf blades. Provides nesting, protection and food (seeds) for water fowl and other birds.
Coreopsis nudata	Tickseed	2	Short perennial herb with attractive "daisy shaped" lavender flowers. Prefers shallow water or wet soil at edge of ponds or lakes.
Crinum americanum	Swamp lily	2	Good highlighter at pond fringes. Showy white fragrant flowers. Stems usually less than waist high.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Cyperus odoratus	Umbrella sedge	1-2	Good accent plant usually grown in clumps at edge of ponds. Areas of fluctuating water provide good habitat but umbrella sedge can also survive in more upland areas. Its stems are usually less than 3 ft. tall with a conspicuous umbrella shaped foliage and brown seed head.
Diodia virginiana	Buttonweed	1-2	Wet soils along the border of ponds provides a good environment. Buttonweed is a relatively low growing perennial herb. Main branches are usually less than 8 dm (2.6 ft) long. Stems branch from the base and grow along the ground. Small white flowers are borne between the junction of the leaves and stem. Does not prefer submerged conditions.
Dryopteris ludoviciana	Southern shield "Leatherwood fern"	1-2	Suited to wet soils in the zone of fluctuation above the permanent pool of detention ponds.
Echinochloa crusgalli	Barnyard grass "wild millet"	1-2	Predominately suited to the margins of ponds and lakes. A common annual with stems up to 1.2 m (3.9 ft.) tall. Seeds are heavily used by waterfowl and songbirds.
Eleocharis spp.	Spikerushes	2	Suitable for establishing marshes along the coast. Slender, dwarf and water spikerushes may be submerged. Other varieties grow along the landward edge of ponds. Green leafless stems vary in thickness from thread to pencil size and from ankle to shoulder high. May be grown in clumps or as colonies depending on species.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Eriocaulon decangulare	Hat pins	2	Hat pins are a low growing plant with slender spikes arising from the base. The top is tipped with a small white "button". Provides a pleasing contrast when mixed into areas dominated by wetland grasses or sedge.
Hibiscus spp.	Marsh hibiscus	1-2	Normally used for accent at the periphery of ponds. Stems are waist high or slightly higher. Large flowers, 4" to 8" in diameter, white or pink, sometimes with a red center.
Hydrocotyle umbellata	Water pennywort	2	Numerous round partly to deeply lobed leaves centrally attached to a stem up to 12 inches in length. Grows well on the surface of the water or as a ground cover rooted along the margin of ponds.
Hymenocallis spp.	Spider lilies	1-2	Provides good ground cover or may be used for accent at the edge of ponds. Showy white flowers. Best on wet soils. Average height 3 ft.
Iris Hexagona	Anglepod blue flag	2	Prefers wet soils at the fringes of lakes and ponds. The average height is about 1 ft. Used extensively as highlighters, planted in groups at the edges of wetland vegetation due to it's showy blue flowers.
Iris virginicus	Southern Blue Flag Iris	2	Prefers similar habitat to the "Anglepod" variety. However, this species is more upright in its growth habit. The flowers are larger and borne at the ends of each stem. Although very showy, either species of iris will only flower briefly for several weeks in spring.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Nymphaea odorata	Fragrant water lily	4	Along with Canna lily, Sagittaria, and Pickerelweed this species will produce flowers throughout the spring, summer and fall months. It is the most commonly utilized water-lily for "aquascaping" in urban impoundments. It has a sweet scented, white showy flower. Nymphaea is installed in clusters of three to five plants every 25 feet.
Nymphoides aquatica	Floating hearts	2-4	Very similar to other water lilies. A cluster of small white flowers reaches just out of the water. Short thick roots sometimes are found dangling from the stalk just under the leaf.
Osmunda cinnamomea	Cinnamon fern	2	Attractive lush foliage these plants are primarily suitable for use in shaded areas internal to or approaching the periphery of cypress or other wooded wetlands.
Osmunda regalis	Regal fern	2	Similar in habit to the cinnamon variety where it is not already established this species may be used to add a "rain forest" like appearance to any deeply shaded area suitable for detaining run-off. Small depressions blended into a landscape such that the facility is over shadowed by large trees and tall buildings would represent one of the primary uses for either species in respect to stormwater enhancement purposes.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Juncus effusus	Soft rush	2	Very attractive plant with pale green hollow stems up to 4 ft. tall. Commonly used in large clumps scattered along the edge of ponds or lakes. However, soft rush is also used in large concentrated groupings in ponds and covering the bottom of wet swales. The seeds are utilized by waterfowl. Does not die back in winter making this plant a good choice in shallows between the outlet/control structure and the open pond area.
Nebumbo lutea	American lotus	3-4	This plant is an attractive large leafed rooted aquatic. The leaves are circular, up to 60 cm. (24 inches) across. The American lotus has very showy large yellow flowers. Dried seed pods are often used in flower arrangements. Similar to other "water-lilies", this species is planted along the outside of the littoral zone in groups spaced about 25 feet apart.
Nuphar luteum	Spatterdock	3-4	This "water-lily" has large oval or heart shaped leaves up to 40 cm (16 inches) long and 25 cm (10 inches) wide. Its flowers are small yellow and spherical shaped giving the appearance of a "bud" that hasn't completely opened. The rootstock provides spawning habitat for black crappie and shellcrackers in many of Floridas' artificial lakes and ponds.
Nymphaea mexicana	Yellow water lily	3-4	Similar in form and use as the other water lilies discussed previously. However, this species is distinguished by its attractive bright yellow flowers.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Panicum hemitomon	Maidencane	1-2	This grass has narrow stems usually between .5 and 1.0m (1.6 - 3.3 ft.) tall. It may be grown in relatively dry soils or with the bases in a foot or two of water. Maidencane will form dense colonies in wet areas and in the shallows of ponds. This species supplies valuable cover and spawning habitat around its roots. Its aggressive growth habit tends to overshadow its valuable characteristics.
Peltandra virginica	Green arum "Arrow-arum"	2	This perennial herb has arrow shaped leaves up to waist-high. The blades vary in size up to a foot wide and one and a half feet long.
Polygonum spp.	Smartweed	2	Smartweed is an annual or perennial herb with creeping stems that run along the ground. Most types have small narrow lance shaped leaves. At the end of the stems are spikes of small pink and white flowers. The seeds are heavily used by birds, waterfowl and small mammals.
Pontederia cordata	Pickerelweed	3	Pickerelweed forms the core of most littoral zone enhancement efforts in Florida relative to wet stormwater detention ponds. It has attractive, dark green lance shaped leaves. Each stem produces a spike of numerous violet blue flowers that is quite showy.

SCIENTIFIC NAME	COMMON NAME	PLANTING ZONE*	FEATURES
Sagittaria lancifolia	Arrowhead	3	Along with pickerelweed the "arrowheads" form the core of the mid-zone in most littoral shelf establishment efforts. Lancifolia has attractive narrow elliptical lance shaped leaves up to 2 ft. in length and 4 inches wide. It has small white flowers. Is not considered an important wildlife food source.
Sagittaria latifolia	Broadleaf arrowhead	3	This type of arrowhead is attractive with deeply lobed and arrow shaped leaves. They may be up to a foot long and slightly less wide. The species also has small white flowers extending above the leaves. Valued as a wildlife food source.
Scirpus californicus	Giant bulrush	2-3	Giant bulrush has blunt triangular stems up to 3m (9.8 ft.) tall. This sedge was introduced from California and is relatively common in Florida. It is similar in habit to "soft stem bulrush" but of larger stature.
Scirpus validus	Soft stem bulrush	2-3	The stems are cylindrical and may attain heights of 2.5m (8.2 ft.). Leaves are absent in bulrushes. Attractive brown spikelets are borne at the ends of the stem. The seeds are eaten by waterfowl and many marsh and songbirds. Soft stem bulrush will grow in mud or up to several feet of water.
Spartina bakeri	Sand cordgrass	1-2	This grass grows in stout rather large dense clumps up to several feet in diameter. It is quite suitable as an accent plant at the fringes of detention ponds in coastal areas. Cordgrass has long narrow wire like leaves. It's growth habit presents a thick fine textured broom like appearance. When flowering the plant has a reddish tinge at the periphery.

Nursery sources are recommended by the Department wherever possible. Small (2-4 inch) containers are encouraged to avoid transporting large amounts of potting soil to the pond. White roots and active basal budding indicate a healthy stock. Small pots seem to encourage active root growth when finally unconfined.

Most "aquascaping" specialists prefer to have someone on site during the construction phase to ensure that the littoral shelf is located and graded properly. Knowing exactly where the normal water level of the facility will reside after construction is absolutely essential to the success of this element of the system.

Bank erosion is often a significant problem during the initial stages of development. Stabilization with sod down to the normal pool and preventing undue sediment deposition is required for the planting to survive. There is no cheap way out. Costs typically run in the neighborhood of $2,000 - $10,000/acre. Therefore, it is important to do everything possible to ensure immediate success for both water quality and the sake of the client.

Storage Volume and Release Rate: Design of the storage volume and release rate of an impoundment depends upon the purpose for which the structure is built. Typical urban purposes which require different design strategies include flood control, stream channel erosion control, and consumptive uses (i.e., water supply, fire protection, irrigation, etc.). The purpose of pollution removal also requires a different design strategy. The following are some examples of typical design criteria for different impoundment purposes.

Flood Control: The design criteria for this purpose depends upon the level of flooding to be controlled. Usually, a locality will specify that stormwater runoff from a developing drainage area must be controlled so that the post-development peak runoff rate does not exceed the pre-development rate for a specific design storm. In some localities a ten year design storm is specified to protect downstream drainage structures. Other localities require protection from larger storms and specify that a fifty year or one hundred year storm must be detained and released at a reduced rate.

Stream Channel Erosion Control: In Florida, the criteria used to evaluate a stormwater discharge facility for this purpose is usually tied to the erosion potential of the area soils. The velocity associated with the peak rate of discharge expected from the design event (25 year/24 to 72-hour duration, typical) is compared to the maximum permissible rate (ft/sec), given the textural class of the substrate and a bare channel. Such information has been published by the Soil Conservation Service (USDA, S.C.S., 1974. pg. 4.18). Unless the local or regional permitting authority has established a lower set of limits, the maximum velocity allowed may be expected to range from 1.5 ft/sec for sands and sandy loam, to 2.0 ft/sec for sandy clay loam, and up to 2.5 ft/sec for clay.

Nonpoint Source Pollution Control: The primary design strategy for this purpose is to maximize the detention time of captured runoff. It is believed that basin drawdown times in excess of 60 to 120 hours will result in significant pollutant removal. However, the required storage volume is usually tied to the capture of the first, most pollutant laden, portion of a storm (i.e., the initial one inch of runoff).

Flow Routing: A stormwater detention basin acts as a constriction in the stream or conveyance system. A portion of the flow backs up and is temporarily stored. The procedure used to determine the volume of water which will be held behind the detention structure during a design rainfall event is known as flow or flood routing. In order to properly size a detention basin, a flow routing procedure must be used to determine the storage volume for a range of design storms given the maximum allowable release rate which is deemed to be necessary to satisfy the objective or objectives for which the structure is being designed.

Most flow routing procedures involve a trial and error process. The storage volume or outflow rate is varied depending on the desired depth, or space, and any number of other limitations. The basic premise is that the volume of runoff entering the detention basin minus the amount of water leaving over a given interval of time is equal to the required volume of storage. Consequently, flow routing can be extremely time consuming when done manually.

Rather than present a lengthy in-depth explanation or an over-simplified version of the subject of flood routing in this handbook, the reader is referred to the Soil Conservation Service, (SCS) National Engineering Handbook Section 4, Chapter 17. That reference provides a good explanation of flood routing for calculating detention storage volumes. The SCS TR-20 and DAMS 2 computer programs provide accurate methods of analysis. The Stormwater Management and Design Aid (SMADA) program developed for the Department by the University of Central Florida is also available on diskettes for use with IBM personal computers. These are just a few of the acceptable routing models recognized by regulatory authorities around the state.

Manual Method: A simpler, but less accurate method of estimating detention storage volume is the "Manual Method" outlined in SCS Technical Release No. 55, Chapter 6. It involves the use of a single graph which was developed based upon average storage and routing effects of many structures.

The primary advantage of this method is its simplicity and compatibility with SCS runoff calculation procedures described in Chapter 5 of this manual. It is particularly suited for small detention basin design, and estimating the required size of basins during the project planning phase.

A common application of the design procedure for the Manual Method is presented here, however, its use is subject to the following limitations:

1) The drainage area must be less than 2000 acres.

2) Failure of the structure must not result in loss of life or major property damage.

3) The procedure should not be used to perform final design if an error in storage of 25% cannot be tolerated. The SCS design aid is biased to prevent undersizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and routing will often pay for itself through reduced construction costs.

The following design procedure will only determine the required storage volume of the basin. The design of an appropriate discharge structure, which will maintain the allowable release rate at the design storage elevation, should also be done by a qualified engineer.

In Florida the discharge control structure for a detention pond intended to satisfy both water quantity and water quality objectives would be a two stage device. In most instances the first stage is regulated by a small orifice (usually round) that is designed to provide intended storage for treatment of the first inch of runoff from the contributing area. The water is released at a very slow rate. The required storage volume (Vs1) in cubic feet is determined by simply multiplying the drainage area (A) in acres times one inch of runoff (R) times the appropriate conversion factor (3630).

During the design process for flood routing the volume is viewed as static since its rate of release is so relatively slow. Moreover, this volume of storage is normally required in addition to that established for peak discharge control. Many local governments or water management districts responsible for flood control have determined that a sizeable portion of this storage could be taken up and therefore be rendered unavailable by smaller magnitude storms that may occur nearly daily during the period of the year when larger events approaching the design conditions for peak discharge control have the highest probability of occurring. Consequently, the most common application of these procedures is a two fold process. The storage volume for water quality control (Vs1) is first determined. Part two involves an estimate of the additional storage volume (Vs2) which must be provided to meet peak discharge limitations. The SCS manual method of flow routing described in TR-55 may be used for these purposes subject to the previously discussed limitations.

DESIGN PROCEDURE

Step 1 - Determine the storage volume (Vs1) to satisfy water quality control objectives.

Input Requirements and Procedures

The most frequent application is to estimate storage volume (Vsl) for situations where the drainage or contributory area is equal to the project area. The required inputs are the drainage area (A) in acres and the required "runoff" depth (R) to be stored as specified by the appropriate regulatory agency. This depth may range from a minimum of 0.5 inch to 1 inch or more depending on jurisdiction. The value Vsl in cubic feet is calculated as follows:

Vsl = A (ac) x R (in.) x 3630 (conversion factor acre inches to cubic feet)

Example:

A 75-acre medium to high density residential development is planned to discharge through a single outlet into an existing drainage canal designed for present land use conditions. No off-site drainage will be delivered by the project's conveyance system. How much storage (Vsl) will be required above the seasonal high water table elevation (10 ft NVGD) to meet the state's water quality treatment criteria? Assume that the project is required to provide for the first inch of runoff (R) stored above the level of the permanent pool. What is the invert elevation of the facility so as not to lower the existing water table? What is it's average size (square feet) assuming the depth of storage is limited to one foot?

The storage equation is:

$$Vsl = AR\ (3630)$$

where:

A = Watershed Area (75 acres)
R = Runoff Treatment Depth Criteria (1 inch specified)

$$Vsl = (75)\ (1)\ (3630) = 272{,}250 \text{ cu.ft.}$$

The facility's size may be determined since the maximum depth of the detained water is specified. Use the following equation:

$$a = Vsl/d$$

where:

a = average size of detention pond (square feet)

Vsl = storage volume (272,250 cu.ft.)

d = depth of storage (1 ft. specified)

therefore:

$$a = 272,250 \text{ ft}^2 \text{ or } 6.25 \text{ acres}$$

The invert elevation of the discharge control structure orifice must be set equal to or above the seasonal high water table elevation to avoid changing the existing conditions as specified. Therefore, the bottom of the bleed down orifice should be no lower than 10 feet NVGD as stated by the information given.

Step 2 - Determine the size of the device needed to limit the rate of drawdown for the first stage to satisfy state or local criteria.

Input Requirements and Procedures

In Florida, the most commonly used means of metering the first stage of detention facilities is accomplished by cutting or drilling one or more small round openings (i.e., orifices) at the appropriate elevation along the barrel of a riser pipe, through a weir, or through the face of a concrete box drop inlet spillway. The required inputs for estimating the size of the orifice required is average depth of storage or head (h) effecting the orifice during the drawdown period considered and the desired release rate. The storage volume Vsl and the minimum drawdown time are usually required to determine the allowable rate of release.

The orifice equation is modified to solve for A (area of orifice) as follows:

$$Q = CdA(2gh)^{1/2}$$

$$A = \frac{Q}{Cd(2gh)^{1/2}}$$

where:

Q = rate of discharge (cfs)
A = orifice area (ft^2)
g = gravitational constant (32.2 ft/sec^2)
h = depth of water above the flow line (center) of orifice (ft)
Cd = orifice coefficient (usually assumed = .6)

By setting "h" equal to the average depth between two stages and calculating the average rate of drawdown during the interval, the designer can calculate the orifice area required. The average rate of discharge is determined by dividing the volume of storage available between the intervals of elevation by the time period of concern in seconds. Using the existing state guidelines for these systems would stipulate that the device must limit outflow to no more than .5 Vsl over the first 60 hours. This translates to a value of 2.315×10^{-6} Vsl cfs as the controlling rate of discharge. The entire solution for the previous example is shown below.

Example:

Given the 75 acre residential project mentioned previously, what is the orifice area required to limit drawdown to one-half the storage volume over a sixty (60) hour period? Recall that the storage required to meet water quality criteria (i.e., Vsl) is equal to 272,250 cubic feet. Also recall that the depth of storage was specified to be one foot.

Rearrange the orifice equation and solve for (A)

$$A = \frac{Q}{Cd(2gh)^{1/2}}$$

Substitute the following values in the equation:

$Cd = .6$
A = orifice cross section area (ft^2)
$g = 32.2\ ft/sec^2$
$Q = 272{,}250\ ft^3\ (2.315 \times 10^{-6}) = .63\ cfs$
$h = \frac{1.0\ ft + .5\ ft}{2} = .75\ ft$

(NOTE): This is the average depth of storage during the drawdown period where one-half the storage volume is presumed to be recovered.)

Therefore:

$$A = .63\ cfs/.6\ [(2)(32.2\ ft/sec^2)\ (.75\ ft)]^{1/2}$$

or;

A = .15 sq.ft.

To determine the diameter of a circular orifice rearrange the equation for the area of a circle and solve for D (diameter) as follows:

Eq. for area of a circle; $A = \frac{\pi D^2}{4}$

Rearrange and solve for D

$$D = (4A/\pi)^{1/2}$$

Substituting A = .15 sq.ft. from above,

$$D = [4(.15)/3.1416]^{.5} = .44 \text{ ft.}$$

Use a 5 inch diameter orifice

Step 3 - Use Figure 6-5 to estimate Vs, storage volume for peak discharge control.

Input requirements and procedures

Figure 6-5 may be used to estimate storage volume (Vs) required or peak outflow discharge (q_o). The most frequent application is to estimate Vs, for which the required inputs are runoff volume (V_r), q_o, and peak inflow discharge (q_i). To estimate q_o, the required inputs are Vr, Vs, and q_i.

Estimating V_s

To estimate the storage volume required, use the following procedure:

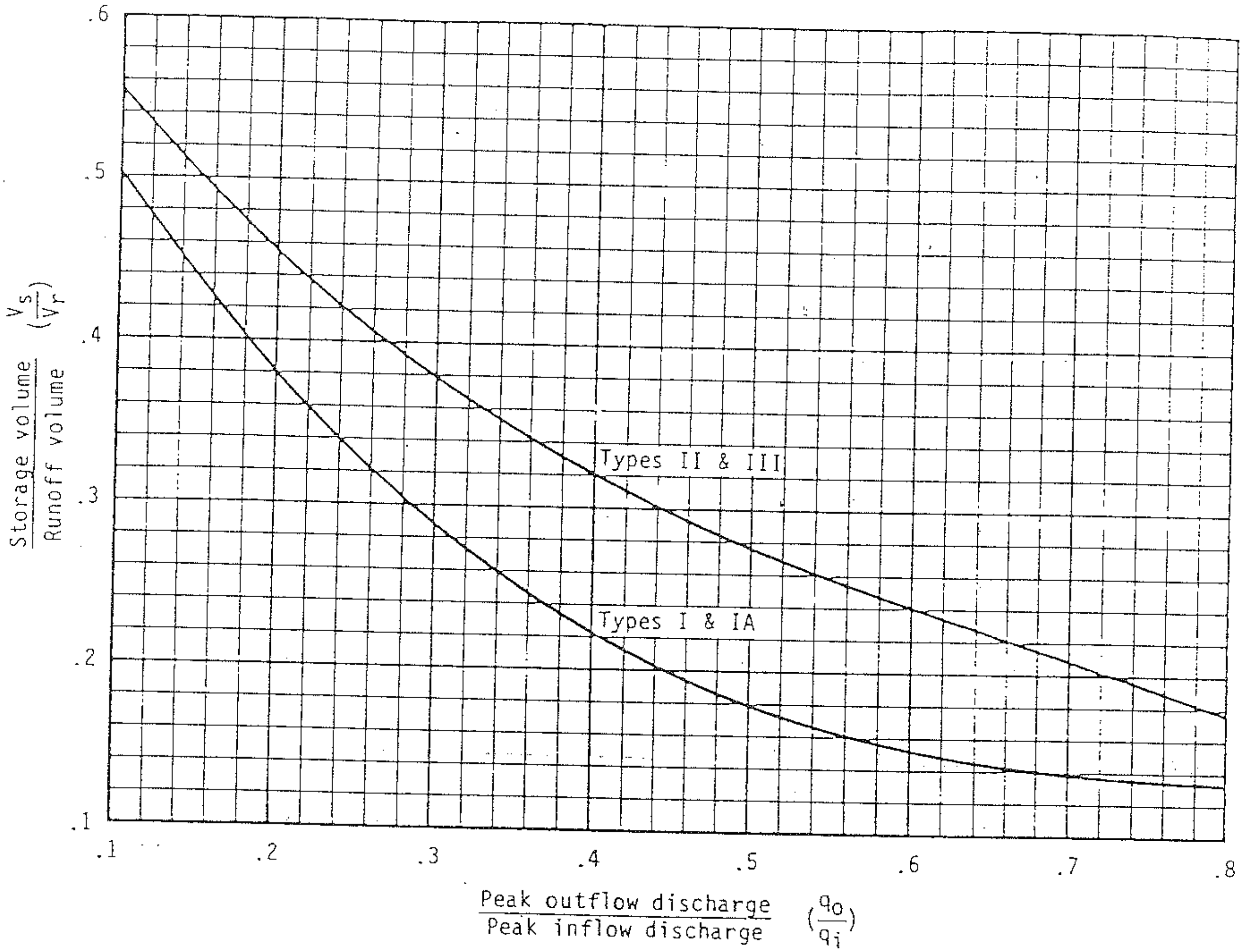
a) Determine q_o. Many factors may dictate the selection of peak outflow discharge. The most common is to limit downstream discharges to a desired level, such as predevelopment discharge. Another factor may be that the outflow device has already been selected.

b) Estimate q_i by procedures outlined in chapters 4 or 5 of TR-55, Second Edition published by SCS, June 1986. Do not use peak discharges developed by any other procedure. When using the Tabular Hydrograph method to estimate q_i for a subarea, only use peak discharge associated with $T_t = 0$.

c) Compute q_o/q_i and determine V_s/V_r from Figure 6-5.

FIGURE 6-5

APPROXIMATE DETENTION BASIN ROUTING FOR RAINFALL TYPES I, IA, II AND III



U.S.D.A. Soil Conservation Service, 210-VI-TR-55,
Second Ed., June 1986.

d) Q (in inches) is determined when computing q_i in step b above. However it must be converted to the units in which V_s is to be expressed - most likely, acre-feet or cubic feet. To convert Q to V_r expressed in acre-feet:

$$V_r = .083\ Q(A)$$

where:

V_r = runoff volume (acre-feet),
Q = runoff (in),
A = drainage area (ac.) and
.083 = conversion factor from acre-inches to acre-feet.

e) Use the results of steps c and d to compute V_s:

$$V_s = V_r \frac{V_s}{V_r}$$

where V_s = storage volume required (acre-feet).

The stage in the detention basin corresponding to V_s for stage 1 plus stage 2 must be equal to the stage used to generate q_o.

Example

Going back to the situation mentioned earlier, recall that a 75-acre development is being planned that discharges into an existing channel designed for present conditions. Assume the watershed is in the type II storm distribution region. Suppose that the present channel capacity, 180 cfs, was established by computing discharge for the 25-year-frequency storm by the Graphical Peak Discharge method (Chapter 4 SCS, 210 VI - TR-55, Second Edition, June 1986.) Further presume that the developed-condition peak discharge (q_i) computed by the same method is 360 cfs, and runoff (Q) is 3.4 inches. Since outflow must be held to 180 cfs, a detention basin having the maximum outflow discharge (Q_o) will be built at the watershed outlet.

How much storage (V_s) will be required to meet the maximum outflow discharge (Q_o) of 180 cfs, and what will be the approximate dimensions of a rectangular weir outflow structure? Figure 6-6 shows how SCS TR-55 worksheet 6a is used to estimate required storage (V_s stage 2 = 5.9 acre-feet) and maximum stage (E_{max} = 12.0 feet).

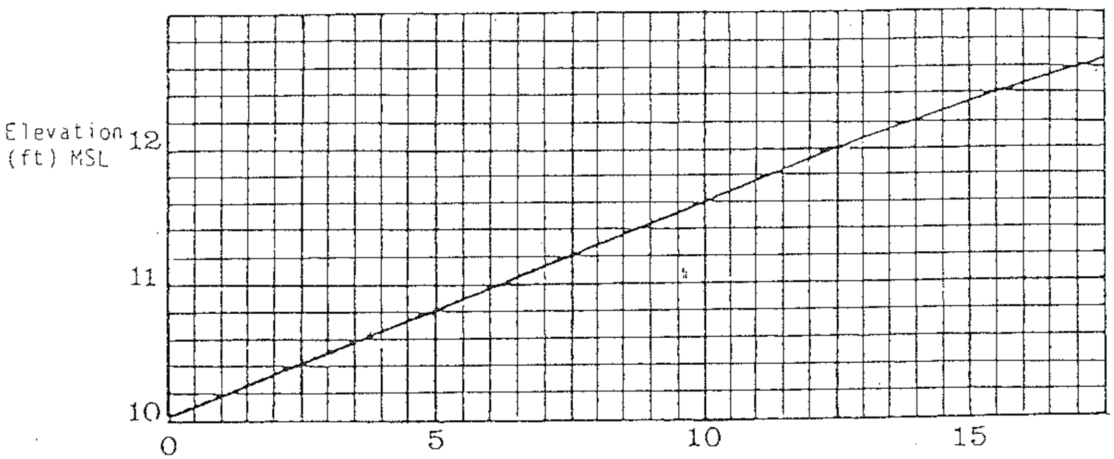
FIGURE 6-6

Worksheet: Detention basin storage above permanent pool, peak outflow discharge (q_o) known

Project Coastal Flatwoods Estates By JC Date 2/3/88

Location Canal County, Florida By EHL Date 2/5/88

Circle one: Present **[Developed]** 2 - stage structure



1. Data:
   Drainage area .... A = 75 ac.
   Rainfall distribution type (I, IA, II, III) = II

	1st stage	2nd stage
2. Frequency ...... yr	NA	25
3. Peak inflow discharge, q_i ... cfs From worksheet 4 or 5b	NA	360
4. Peak outflow discharge, q_o ... cfs [1/]	.7	180
5. Compute $\frac{q_o}{q_i}$	NA	0.50
6. $\frac{V_s}{V_r}$ .... (Use $\frac{q_o}{q_i}$ with figure 6-5)	NA	0.28
7. Runoff, Q ....in (From worksheet 2 TR-55)	NA	3.4
8. Runoff volume, V_r ....ac-ft (V_r = QA 0.083)	NA	21.1
	2/	3/
9. Individual storage volume,	6.25	5.9
10. Total storage volume, V_s ac.ft.	6.25	12.15
11. Maximum stage, E_{max} (From plot)	11.0	11.95

1/ 2nd stage q_o includes 1st stage q_o.

2/ Computed in the Step 2 Example

3/ $(V_s = V_r (\frac{V_s}{V_r}))$

After USDA Soil Conservation Service Worksheet 6a.

The rectangular weir was chosen for its simplicity; however, several types of outlets can meet the outflow device proportion requirement. Most hydraulic references, along with considerable research data that are available, provide more guidance on variations of outlet devices than can be summarized here.

An outlet device should be proportioned to meet specific objectives. A weir is suitable here because of the low head. The weir crest elevation is 11.0 feet.

Figure 6-6 also shows how SCS TR-55 worksheet 6a may be slightly modified and used to record the storage volume (V_s) of 6.25 acre-ft and elevation (E^{max}.) of 11.0 ft. MSL for the first stage of the control structure. The invert or crest elevation of the second stage weir to be used for peak discharge control corresponds to the maximum storage elevation (11.0 ft. MSL) for the first stage device. Recall that these values were determined in the example for "Step-2" of this analysis.

The datum of the stage one control device is the center or flow line of the five-inch diameter circular orifice. Consequently, the invert or ultimate control elevation of the structure would be slightly (i.e., 2.5 inches) below the mean high groundwater elevation (10.0 ft. MSL). If this small deviation cannot be tolerated, the designer may still use the procedure to establish the minimum orifice required. Setting the invert elevation at datum when the structure is installed would not present a problem. While stage one would not optimize the allowable bleed down capacity, the structure would remain in compliance with state criteria since the end result would be a reduction in the actual rate of discharge and a concurrent increase in drawdown time.

The second stage is proportioned to discharge the correct amount at 12.0 ft. (Figure 6-6, step 11). However, the maximum allowable rate of discharge for the second stage equals the total discharge minus discharge through the first stage. Consequently, the designer must first compute the discharge through the first stage for elevation 12.0 ft. using the orifice equation.

$$Q = C_d A \, (2gh)^{1/2}$$

where:

- Q = Discharge (cfs)
- A = Orifice Cross-Sectional Area (ft^2)
- g = Gravitational Constant (32.2 ft/sec^2)
- h = Head over Orifice (ft.)
- C_d = Orifice Discharge Coefficient (.6 usually presumed)

h and A are determined as follows:

$$h = E_{max} - \text{Flowline Elev. of Orifice}$$
$$= 12.0 - 10.0 = 2.0 \text{ ft.}$$

Since A was established equal to 0.15 sq.ft. during the "Step 2" analysis, the equation may be solved for Q

$$Q = .6\ (.15)\ (2 \times 32.2 \times 2)^{.5}$$
$$= 1.0 \text{ cfs}$$

As may be seen, in this instance the contribution associated the maximum allowable discharge (180 cfs) specified on the worksheet for the second stage device (Figure 6-6, step 4). In this instance the first stage can be ignored and the required weir crest length (Lw) for the second stage may be determined as though the control structure was a single stage device.

Using the total storage V_s = 12.15 acre-ft (Figure 6-6, step 10) and the elevation-storage curve, the maximum stage (E_{max}) is approximately 12.0 ft.

The rectangular weir equation is

$$q_o = 3.2\ L_w {H_w}^{1.5}$$

where:

q_o = peak outflow discharge (cfs),
L_w = weir crest length (ft, and
H_w = head over weir crest (ft).

H_w and q_o are computed as follows:

$$H_w = E_{max} - \text{weir crest elevation}$$
$$= 12.0 - 11.0 = 1.0 \text{ ft.}$$

Since q_o is known to be 180 cfs, solving the weir equation for L_w yields;

$$L_w = 3.2\ H_{w1.5}$$

$$= \frac{180}{3.2\ (1.0)^{1.5}} = 56 \text{ ft.}$$

In summary, the outlet structure is a rectangular weir with crest length of 56 ft, H_w = 1.0 ft, and q_o = 180 cfs corresponding to a V_s = 12.15 acre-ft. of which 6.25 acre-ft. is associated with the stage one water quality criteria.

If the width of the control structure (weir) exceeds either the physical capacity of the site or the owners pocket-book the designer may wish to increase the depth of storage (H) associated with stage one. In this example, an increase in the depth of the first stage to 1.5 ft. or elevation 11.5 MSL and a corresponding increase in H_w to slightly less than 3.0 ft. (E_{max} = 13.0 ft. MSL) would result in a sizeable reduction in crest length L_w = 30.6 ft. However, the designer should be aware that fluctuations in the design depth of stage one exceeding one foot can make the selection of plantings difficult and drastically influence the possibility of success in the establishment of a viable littoral zone. Recent reports seem to support the findings that nuisance species such as cattails and willows will out compete the preferred native aquatic species in these situations.

Pollutant Removal Parameters

There are several parameters that will determine the pollutant removal efficiency of a wet pond. These parameters include the pond geometry, wet pond depth, the area ratio, and the volume ratio. These parameters are discussed in detail in the following sections.

Pond Geometry

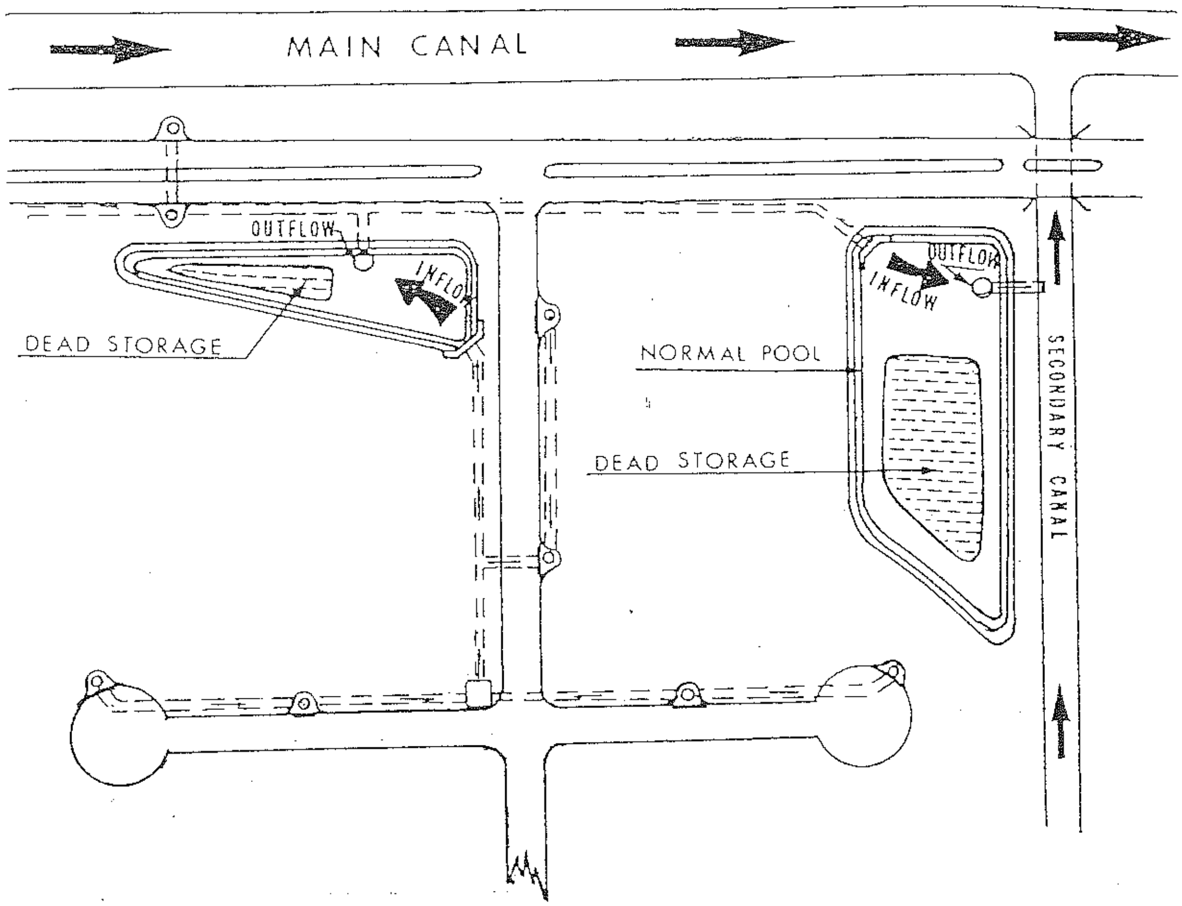
Most experts agree that the pond geometry has a strong influence on how effectively the permanent pool volume is used to remove pollutants. In some cases, there are areas of the pond that are ineffective in providing any pollutant control. This occurs in dead storage areas where inflow is bypassed without mixing. Figure 6-7 shows several examples of reservoir shapes which have large dead storage volumes and are to be avoided.

To avoid dead storage areas where mixing and settling of inflow pollutants do not occur, the length to width ratio should be no less than 3:1. In addition, a wedge shaped reservoir with the inlet located at the narrow end will maximize inflow mixing. If dead storage areas of flow are unavoidable based on topographic conditions, the effective length of flow can be increased by adding diversion barriers in the pond. These barriers may be created by a small island, a peninsula, or some sort of baffle.

Wet Pond Depth

Selecting the wet pond depth is dependent on the intended use of the pond. If the pond is to be a multiple purpose facility, the depth of the permanent pool will vary to provide water quality enhancement, wildlife benefits, and recreational uses.

Figure 6-7
EXAMPLES OF DEAD STORAGE AREAS IN WET PONDS



A shallow marsh habitat or wetlands environment can be created by a wet pool depth ranging from 1/2 to 2 feet. The shallow depth will allow emergent aquatic vegetation to be established which is very beneficial in removing nutrients and other attached pollutants from the water column. A shallow marsh area also provides an excellent environment for wildlife (Godfrey, 1985).

Florida Game and Freshwater Fish Commission has specified that optimum fish production will normally be achieved given a 6 to 8 feet deep pool over at least 1/3 of the surface area. A minimum surface area of 1/4 acre is also recommended for pond management purposes by some agencies such as the Soil Conservation Service.

With respect to water quality enhancement, a pond containing areas of both shallow depths (less than 2 feet) and deep depths (greater than 3 feet) may be the most beneficial. The emergent aquatic vegetation in the shallow areas will reduce nuturient loads into the pond which will prevent excessive algae growth. The deeper areas of the pond will provide pollutant removal by gravity settling during and after storm events.

Wet ponds should generally be limited to a maximum depth of 8-10 feet. Ponds that are deeper are envisioned to present a greater possibility for contributing toward potential groundwater contamination. Likewise, the creation of anaerobic conditions over large areas of the lake bottom is also seen as more likely under these circumstances. Consequently, the solublization of pollutants (e.g., metals and phosphorus) normally bound in the sediment and their release to the overlying water column is perceived to be probable by many regulatory agencies including the Department of Environmental Regulation.

Area and Volume Parameters of Wet Ponds

There are two important area and volume parameters that effect the pollutant removal efficiency of wet ponds. These parameters are the area ratio (A/A_s), and the volume ratio (VB/VR).

The area ratio (A/A_s) is determined by dividing the drainage area (A) by the wet pool surface area (A_s). For an example, an area ratio of 40 represents a 2 acre basin surface area serving an 80 acre drainage area.

Adherance to state guidelines that were discussed pertaining to the temporary storage and slow release of the first 1 inch of runoff will result in an area ratio of 18 or lower provided the depth of stage one is limited to no more than 18 inches. A basin surface area with a percentage of the contributing catchment area of 5 or more will maximize pollutant removal for most standard parameters including solids, traffic related metals, and nutrients (EPA, 1987). An area ratio of 18 or lower translates to a value of 5 percent or more in terms of the EPA criteria. Consequently, it may be concluded that the state criteria indirectly result in a maximization of design in this particular respect.

The volume ratio (VB/VR) is equal to the wet pool volume (VB) divided by the mean runoff volume (VR). The mean runoff volume (VR) can be estimated by multiplying the mean rainfall depth times the rational runoff coefficient (C), the drainage area of the basin, and the appropriate conversion factor.

In regard to (VB), for purposes of maximizing the assimilation of pollutants in wet ponds, particularly nutrients, the following statements were offered to the Department (CDM, 1985):

"Since the major biological mechanisms (e.g., algal uptake) for pollutant removal in a wet detention basin are essentially lake eutrophication processes, eutrophication modeling theory can be used to adequately size the permanent pool" .... A residence time of 2 weeks is considered to be the minimum duration that ensures adequate opportunity for algal growth."

The consultant goes on to state:

> "A design residence time of about 2 weeks is in the same order of magnitude as the residence times achieved by several of the wet pond BMPs monitored under the EPA NURP Study ... As may be seen, these recommended permanent pool storage volumes are equivalent to approximately 2.0 inches per impervious acre plus 0.5 inches per pervious acre."

In the consultants opinion, based on field experience, adherence to this simple to apply empirical approach will result in a detention basin wet pool volume (VB) sufficient to ensure that a hydraulic residence time approaching 2 weeks is achieved. The facility would also be expected to perform well from a water quality perspective. Consequently, it may be concluded that the basin volume to runoff volume ratio (VB/VR) determined by estimating VR and VB as discussed above is appropriate. However, it may be seen that the proper ratio will be highly variable. Its' value will depend on the average rainfall per event per region, the runoff coefficient, and the amount impervious area.

A slightly more rigorous approach to confirm that the appropriate basin volume to runoff volume is achieved, incorporates the average interval between storms into the previous assessment. In this procedure, VR is calculated as before. The value of VR is then multiplied times fourteen (14) days and divided by the average interval (days) between events to determine the volume of the basin permanent pool (VB).

For example, consider a 75-acre project, as discussed before, with an associated coefficient of runoff (C=.4), located in Tallahassee where the mean storm volume (P) is .65 inches. Rainfall statistics recorded at the airport show that the average interval between events equals 86 hours or 3.6 days. The appropriate basin volume (VB) in acre feet is determined as follows:

VB (Ac.Ft.) = [VR(A) (14 days)/(Days interval between events)] x CF (.083)

where:

VR = Coeffficient of runoff (C) x mean storm volume (P) inches. Watershed area (acres)
CF = Conversion factor ac-in. to ac.ft. (.083)

The equation can be solved, assuming that the watershed area (A) is equivalent to the project area (75 acres) given the values of (C) and (P) that were specified above and an interval of 3.6 days.

VB (Ac-Ft.) = .083 (.4) (.65) (75) (14/3.6)
= 6.3 Ac.Ft.

The mean runoff volume VR would equal:

VR = CF (C) (P) (A) or
VR = .083 (.4) (.65) (75)
= 1.6 Ac.Ft.

Therefore the appropriate volume ratio in this example is VB/VR = 6.3/1.6 = 3.9.

Planning and Design Considerations

Emergency Spillway: In Florida designers often fail to provide for the occurence of catastrophic events. These oversights are not advisable. In any circumstance where damage to downstream property or public safety is jeopardized impoundment structures should be provided with emergency spillways which, as a minimum, can pass runoff from the one hundred year frequency storm without damage to the impoundment structure.

Discharge Structures: Discharge control devices may be either single-stage multi-stage devices. They should be designed such that the permissible release rate is not exceeded at the highest water level. The control structure should be adequately designed to prevent failure and resultant property damage and loss of life. Due consideration should be given to preventing the plugging of the discharge structure by debris. High intensity landuse areas with significant percentages of impervious surfaces should include provisions to prevent hydrocarbons (oil and grease) from exiting the discharge facility.

The outlet of the discharge device shall be protected from scouring. Riprap, plunge pools, energy dissipators or other acceptable means should be used for this purpose.

Sediment: Probable quantities of sediment from the drainage area should be estimated for the expected life of the pond taking into consideration future development trends. The structure should include capacity for sediment storage and provisions for periodic sediment removal if necessary.

Shoreline Protection: The shoreline of large impoundments should be adequately protected from littoral currents or wave action which can cause shoreline erosion.

Draining: Provisions should be made for completely draining wet ponds to allow periodic cleaning, inspection and maintenance. Drain facilities may be an integral part of the flow control structure or a separate structure. However, these features invite misuse. Permitting authorities have begun to require that gate valves for this purpose be locked. Keys are supplied only in the appropriate circumstances.

Multi-Purpose Ponds: Permanent ponds designed for multiple use should meet the specific requirements of the uses intended in addition to the stormwater management requirements stated herein.

Safety: Ponds which are readily accessible to populated areas should incorporate all possible safety precautions. Steep side slopes at the perimeter should be avoided or fenced and dangerous outlet facilities should be protected by enclosure. Warning signs for deep water and potential health risks associated with body contact recreation should be used wherever appropriate.

Aesthetics: A storage facility is an integral part of the environment and therefore should serve as an aesthetic improvement to the area if possible. Use of good landscaping principles is encouraged. The planting and preservation of desirable trees and other vegetation should be an integral part of the storage facility design.

Construction Specifications

Widely acceptable construction standards and specifications such as those developed by the USDA - Soil Conservation Service or the U.S. Army Corps of Engineers for embankment ponds and reservoirs should be followed to build the impoundment. Attention to details of construction and adherence to specifications are as important as adequate investigations and safe design. A safe design can be ruined by poor construction.

Chapter 17 of the SCS Engineering Field Manual provides guidance on construction methods for the various elements of a pond or reservoir. Specifications for the work should conform to methods and procedures for installing earthwork, concrete, reinforcing steel, pipe, watergates, metalwork, woodwork and masonry, that are applicable to the site and the purpose of the structure.

Maintenance

Maintenance is of primary importance if urban impoundments are to continue to function as originally designed. A local government, a designated group such as a homeowners' association, or some individual must accept the responsibility for maintaining the structures and the impoundment area. A specific maintenance plan should be formulated outlining the schedule and scope of maintenance operations.

Debris removal in detention basins can be achieved through the use of trash racks or other screening devices.

Maintenance of sediment and debris basins is extremely important. Plans should include provisions for sediment removal when a certain storage elevation is reached. Debris should be removed from the basin following each storm.

Design with maintenance in mind. Good maintenance will be crucial to successful use of the impoundment. Hence provisions to facilitate maintenance operations must be built into the project when it is installed. Maintenance must be a basic consideration in design and in determination of first cost.

A permanent easement at least fifteen feet in width should be provided around the perimeter of an impoundment to allow for maintenance and to provide a buffer from encroachment. The easement should be measured from the maximum elevation of the storage pool. An easement also must be provided for access to the impoundment location.

The following are some items which should be considered in formulating a maintenance plan:

Sediment: Sediment deposition should be continually monitored in the basin. The maintenance plan should specify a specific point or elevation at which the sediment should be removed. Owners, operators, and maintenance authorities should be aware that significant concentrations of heavy metals (e.g., lead, zinc., and cadmium) as well as some organics such as pesticide, may be expected to accumulate at the bottom of these treatment facilities. Testing of sediment (EP Toxicity) especially near points of inflow should be conducted to determine the leaching potential and level of accumulation of hazardous material before disposal via landspreading or filling is prescribed.

Inlets: Pipe inlets should be inspected after each major storm, and accumulated debris and sediment should be removed each year.

Outlets: During each year of operation pipe outlets should be inspected after each storm to determine whether outflow is causing erosion. Wherever such erosion is detected, effective measures should be taken to stabilize and protect the affected area. These precautions are particularly important during the immediate post construction phase of the project.

Vegetation: Trees and shrubs should be kept off of dam and emergency spillway areas. Should these plants die from disease, lighting or other causes, their large and decaying root system can seriously reduce the stability of an embankment. Vegetation should be maintained for critical area stabilization as specified in vegetative practices contained in this handbook.

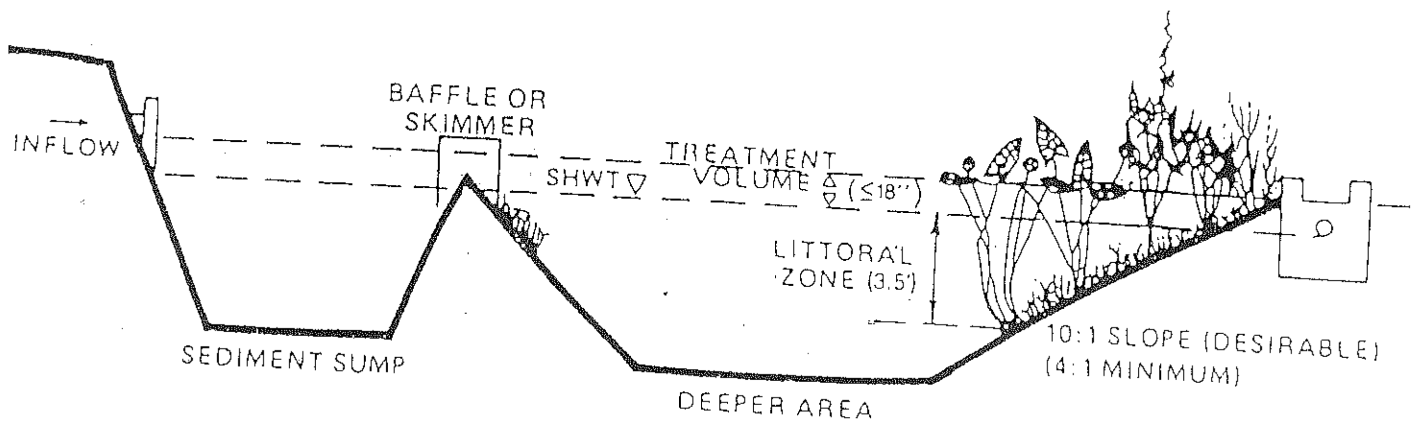
Insects: Precautions should be taken to minimize the production of fast-breeding insects in and around the ponded area. Possible control measures include controlling the growth of grass at shorelines, varying the water depth every few days, and stocking the pond with larvae-eating fish.

Safety Inspections: All permanent impoundments should be inspected periodically by a qualified professional engineer to insure that they remain structurally sound and mechanically efficient. An annual safety inspection is ecommended where the potential for downstream damage and loss of life due to impoundment failure is high. All structures should be inspected following major storms as well.

FIGURE 6-8

WET DETENTION SYSTEM

POND CONFIGURATION - A

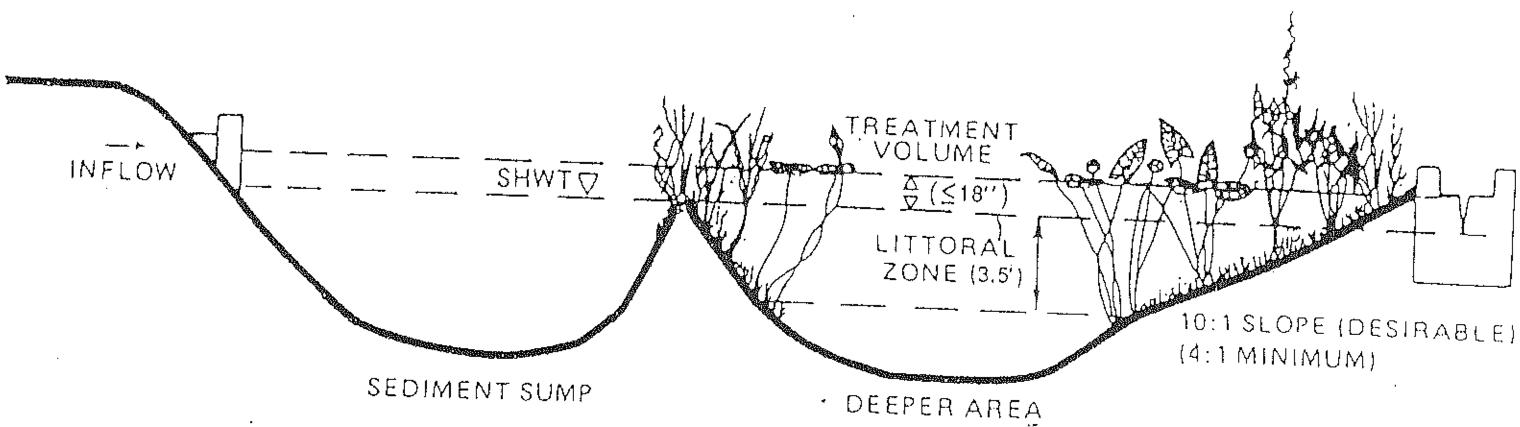


Source: Southwest Florida Water Management District Management and Storage of Surface Waters, Permit Information Manual, Vol.I, March 1988.

FIGURE 6-9

WET DETENTION SYSTEM

POND CONFIGURATION - B



Source: Southwest Florida Water Management District
Management and Storage of Surface Waters, Permit Information
Manual, Vol.I, March 1988.

Appendix C

Communications

Spragues Cove

Stormwater Remediation Project

File SC

MEMO

TO: John Rockwell, Buzzards' Bay Project
Bernie Taber, U. S. Soil Conservation Service

FROM: Ray E. Pickles, Executive Secretary

RE: Sprague's Cove project

DATE: January 11, 1995

At a regularly scheduled meeting held January 10th, the Marion Board of Selectmen accepted your recommendations and has appointed Ms. Christina Brokaw to serve as project manager on the Sprague's Cove project. It is our understanding that she will serve at an intern position to the Buzzards' Bay Project while performing these duties. We look forward to meeting her.

If you need any additional information, please do not hesitate to contact me.

REP/hac

TOWN OF MARION
2 SPRING STREET
MARION, MASSACHUSETTS 02738

TO: Community Leaders

FROM: Dennis Luttrell
Chairman
Marion Conservation Commission

DATE February 3, 1994

RE: Sprague's Cove Project

The Town of Marion in conjunction with the Buzzards Bay Project, the U.S. Fish and Wildlife Service, Coalition for Buzzards Bay and the Buzzards Bay Action Committee, have embarked on a project to improve the water quality of Sprague's Cove. It is hoped, that as a result of the project, that the area currently closed to the harvesting of shellfish, may once again be available to town residents for clamming. This area is adjacent to Silver Shell Beach and the project will also serve to protect the water at the beach.

One component of the project is to stencil the catch basin openings of the storm drains with a picture of a fish with the words "DON'T DUMP! DRAINS TO BAY". This aspect will later be expanded for all of the town's storm drains.

Other Towns will be participating in similar stenciling projects, in fact, it has already begun in New Bedford with Governor William Weld painting the first drain.

We hope that your organization would like to participate in this community project to protect our town's natural resources.

For further information please call me at 748-3600. Thanks!

Marion Board of Health
Minutes
September 28, 1993

Members Present:
Davis Gallison, M.D., Chairman
Elizabeth Dunn, Vice-Chairperson
Albin R. Johnson III, Clerk

Others Present:
Karen Walega, Regional Sanitarian, M. P. H.
Sherman Briggs, 1132 Point Road
Raymond P. Curan Jr., 21 Spring Street
Bernadette Taber, Buzzards Bay Project
Joseph Costa, Buzzards Bay Project Manager
Dorothy Coykendell, 59 Lewis Street
Dorothy Drolett, 72 Main Street, PO 264
Gregory Koss, 32 Beach Street
Ray Pickles, Executive Secretary
Lori Schaefer, Selectman
Lisa Roderick, The Sentinel Reporter
Hod Kenney, Conservation Commission
Helene Craver, Board of Selectman Secretary
Marilyn E. Winters, 106 Main Street
Beverly Wareham, 27 Beach Street
Albert Winters, Selectman
Shelby Tripp, 1010 Point Road
James S. Dougall, Board of Selectmen Chairman
Kenneth J. Souza, The Wanderer Reporter
Dan Durand, Standard Times Reporter
Sarah Miquelle, 9 Shellheap Road
Claude Miquelle, 9 Shellheap Road
Margaret McKim, 20 Front Street
Clark Streeter, 31 Beach Street
Ruth C. Streeter, 31 Beach Street
David Anderson, 88 Converse Road
Lee Craver, 71 Old Knoll Road
Dennis Luttrell, Conservation Commission

1. Commencement. The Meeting began at 7:00 P.M.

2. Minutes. The Minutes of the September 14 Meeting were approved as written; motion - Vice-Chairperson Dunn, second - Clerk Johnson, unanimous - Chairman Gallison.

3. Schedule Change. The Meeting of October 12 was changed to October 19 due to the October 12 Town Meeting; motion - Chair Gallison, second - Clerk Johnson, unanimous - Vice-Chair Dunn.

4. Intern. The draft intern job description was introduced by Dr. Gallison and distributed to members for review.

5. Late Meetings. A memo from the Board of Selectmen concerning meetings going past 10:00 PM was noted.

6. Tobacco. Regional Sanitarian Walega distributed several Massachusetts town regulations concerning tobacco/smoking by-laws. Chairman Gallison stated that he would like to ban cigarette machines in Marion before the calendar year ends. Members agreed to discuss further at next meeting.

7. Correspondence. Members reviewed other incoming mail.

8. Bill. The Board approved the bill to MPG for the advertisement of the Hearing that was being conducted this evening; motion - Clerk Johnson; second - Chairman Gallison; unanimous - Vice-Chair Dunn.

9. Healthy Hints. Chair Gallison reported that he called the Sentinel to have an entry concerning lead screening advise for parents with small children. Vice-Chair Dunn stated that she has only seen one of the Board of Health "hints" published thus far. It was noted that the paper said they would publish them on a space available basis.

10. Recess. The regular meeting was recessed at 07:30 to hear the Town of Marion variance request. The regular meeting reconvened at 09:10 PM.

11. Adjournment. The regular meeting was adjourned immediately following the variance hearing - at 09:13 PM.

12. THE NEXT TWO MEETINGS ARE OCTOBER 19 (UPSTAIRS CONFERENCE ROOM) AND OCTOBER 26 (MAIN CONFERENCE ROOM).

Respectfully submitted,

Albin R. Johnson III

ALBIN JOHNSON III
Clerk

1 Attachment
Variance Hearing Minutes

MA

Marion Board of Health
Minutes
September 28, 1993

Variance Hearing

Town of Marion
South End of Front Street
Silvershell Beach

Marion Sanitary Code 6.30.1
Marion Sanitary Code 6.30.2
P16, L95 and 96; P17, L 30

Sprague's Cove Stormwater Remediation Project

Members Present: D. Gallison, E. Dunn, A. Johnson
Others Present: K. Walega, S. Briggs, R. Curan, B. Taber, J. Costa, D. Coykendell, D. Drolett, G. Koss, R. Pickles, L. Schaefer, L. Roderick. H. Kenney, H. Craver, M. Winters, B. Wareham, A. Winters, C. Streeter, R. Streeter, D. Anderson, L. Craver, D. Luttrell

At 07:30 PM, The Hearing began with the reading of the public notice and the July 28 variance application by Chairman Gallison.

Clerk Johnson then read abutter Shelley I. Keith's letter dated September 15, 1993.

Buzzards Bay Project Manager, Dr. Joseph Costa, stated that the system was designed to treat the drainage and pollution problems of Spragues Cove. He also stated that changes are proposed in order to compliment the natural plant environment and to not impair the fish environment. He noted that a fence would be installed around the pool to ensure the safety of the children. Dr. Costa said that they would be diverting the flow of the tidal pipe/ditch for stormwater drainage. Dr. Costa said that no sewerage ran into that pipe; he stated that the coliform count is not high when there is no rain and that is a clear indication to that fact.

Chair Gallison said that he could smell sewerage from that area and thought that it came from the pipe.

Once again, Dr. Costa said that there was no waste water draining into the pipe. He said that sewerage does not have an odor and that the coliform count does not indicate fecal coliform in the water.

Executive Secretary Pickles, spokesperson for the Town, stated that eventually all towns will be forced by regulation to do exactly what this project sets out to do. He said that this was an ideal "demonstration project". It is considered a demonstration project, not because it is the first of its kind, but that it is a conglomerate effort on the part of several different government agencies. Mr. Pickles said that the Town is requesting two variances - one to construct the basin in a velocity zone and the other to waive the deep hole test.

Chairman Gallison noted that Silvershell Beach was tested weekly throughout the summer and that the coliform count was consistently below twenty - with the exception of one week. The Chairman stated that if the count is found to be over 200 the beach is closed. He thanked the efforts of those involved with the testing.

Mr. Ray Pickles also stated that the Town would be requesting from the Conservation Commission that an amendment to the order of conditions be issued to allow for maintenance dredging. Mr. Pickles stated that the dredging has not been conducted for the past ten years due to orders from the Conservation Commission.

Buzzards Bay Project Specialist Bernie Taber, on loan from the Soil Conservation Service, stated that she concurred with Dr. Costa and Mr. Pickles that the project was a worthy one. She also said that the work thus far was substantial and that the work to be done is also substantial. She was unable to provide a cost estimate.

Dr. Costa said that the dredging would have to be done every five to ten years.

Selectman Lori Schaefer stated that there was a large {drainage} problem in the Spragues Cove area, but that the Town is trying to deal with it as naturally as possible. She said that the benefits of the people and the wildlife were the Town's main concern. She said she was in favor of the request.

Ms. Tabor said that the shallow marsh would harbor a variety of plants - specifically salt tolerant vegetation.

Abutter Koss said that he did not see how a treatment plant with a 15 day cycle would benefit the property owners.

Abutter Miquelle said that he was dismayed because the state had notified him prior to the Town notifying him. He said he first heard of the project through a Conservation Commission Meeting about one year ago and has heard nothing since. He stated that originally the plan was to have the whole area a reconstructed wetland. Since that time - a year ago - the area to be changed has been reduced. He suggested that the proposal be altered to be half the original proposed area. Mr. Miquelle said that another concern he had was that he thought the standing water would promote mosquito breeding. He said that the mosquitoes would probably not be healthy for the summer residents. Another concern stated by Mr. Miquelle was that a lot of the run-off comes from Front Street - and also Cove and Beach. He said that a lot of pollution comes from other areas. He said he did not feel the project would solve the problem. He asked that figures concerning the pollution on Front/Cove/Beach Streets be provided the area residents. He said that the key question was whether or not the project would actually solve the problem. He said that there is already a lot of standing water on Beach Street. He gave the board a picture. He said that environmental factors have not been discussed. He said he would like to see a projected plan. He said that the preliminary engineers over designed the whole project. He said again that he would like to see some data. He said that it "seems that the project may be detrimental, not an improvement". He said that he thought the project may be "worthless" and that there may be other ways of solving the problem.

Soil Conservation Engineer Ray Curan said that the stream would not dry up and that there will be a valve to adjust and maintain the flow.

Abutter Miquelle said that a storm surge should obliterate every plant and some soil along the area. He also said that fecal material would be spread through out the area.

Abutters McKim and Streeter agreed with the fecal material spreading about the area.

Engineer Curan stated that the cost of the project was $75,000 to $100.000 and was funded by grants. He also noted that if the cost exceeds the grant amounts, that the town must vote their approval/disapproval of the money.

Dr. Costa assured the abutters that the salt tolerant marshes tend not to get wiped out when they are submerged as in the case of a surge.

He also said that the coliform count would decrease with this proposal.

Dr. Gallison asked how many residents had basement sump pumps. He said that the town was built on a swamp and that the pumps are often necessary. Dr. Gallison also said that 30% of the town is sewered and the abutters are part of this 30%.

Abutter Clark Streeter said that Beach Street floods after every rain. He asked if the quality of life would not be better improved if all the sewerage was pumped up to a leeching field.

Chairman Gallison explained that the quality of the water will be improved under this proposal. He said that the project is involved with stormwater - not wastewater. He said the pumping of the stormwater into a leeching field does not improve the health of residents.

Abutter Miquelle said that the general thrust {of the abutters} is not so much that the project will treat the run off. He said that people have used the beach without this project for years. He asked what would happen if the project does not work. He said that he was concerned with flooding, property values, and odors. He said that there is odor that comes from the ditch. He said that there is more to this than pollution control.

Engineer Curan said that the town was limited as to land area or they would have used more area to solve the problems.

Abutter Koss said he felt the project was too big and that a smaller size would be better.

Dr. Gallison said that this project does not hinder the abutters, but improves the health of the immediate abutters.

Dr. Costa said that the coliform count will be reduced. He explained that reducing the coliform count will open up shell fishing and keep the beach open.

Abutter Drolett was concerned about how deep the water would get once it rains. She said she was concerned how long it would remain after the rain.

Ms. Taber said that this project will probably not address those that have flooding water problems in that area.

Mr. Pickles, speaking as an abutter, said that a home on 32 Beach Street has made matters worse. When the home was originally built, abutters were told that Beach Street drainage would not be affected. Mr. Pickles said that is not true. Since the house, the standing water increases when it rains.

Ms. Taber reiterated that this project would probably not have any impact on already standing water problems on Beach Street.

Front Street drainage problems were briefly mentioned. Dr. Gallison said that there was definitely a problem on Front Street.

Again Ms. Taber said that this proposal would have no impact on the flooding of Front Street.

She also said that the tidal ditch should flow better once it is cleaned, as they have proposed.

Abutter Koss once again brought up the issue of size. He said that the town needs to consider reducing the project by 50%.

Engineer Curan said that the town has already reduced the project by 16,000 square feet. He noted that the project is designed to treat the water from 64 acres of land.

Dr. Costa said it was not possible to accomplish the job with half the land.

Abutter Miquelle asked if outside engineers were contacted for comment.

Regional Sanitarian Walega stated that the town does not just have anybody off the street working on this. She said that she was quite confident that this was a good plan. She said the plan was reviewed by Defeo and Waite and also DEP.

Clerk Johnson said that this variance hearing concerns some very technical Marion Sanitary Code issues and that the board may have to consider the Code, as presently written, at a later date. He said he felt the request to be a valid one.

Abutter Anderson asked if the decision made concerning this request would set a precedent.

The Chairman told him "No".

Conservation Commission Representative Luttrell said that he concurred with Clerk Johnson and he recommended that the board approve the request for a variance.

Vice-Chair Dunn noted that the issue was not just to open the shellfish beds.

The Hearing was closed at 09:10 PM.

{No decisions were made at this hearing. The request will be further discussed at the next regular meeting.}

Buzzards Bay Project

September 23, 1993

Dear Abbutter to the Spragues Cove Stormwater Remediation Project:

As you are aware, the Town of Marion and The Buzzards Bay Project have proposed to install a constructed wetland adjacent to Spragues Cove. The constructed wetland is designed to reduce nonpoint source pollution associated with stormwater runoff from Front Street. Currently, the pollution from the road runoff directly impacts the use of Silvershell Beach and the shellfish resource of Spragues Cove. According to the Division of Marine Fisheries Sanitary Survey, this road runoff is the major contributor of fecal coliform bacteria to the Cove resulting in shellfish closures.

This stormwater remediation project began in 1990 when the town of Marion submitted a mini-grant proposal to the Buzzards Bay Project. The town requested financial and technical assistance from the BBP to remediate the stormwater discharge located at the end of Front Street. The town's primary concern was the impact of elevated coliform levels to both Silvershell Beach and Spragues Cove. The Marion Department of Public Works also expressed a concern about drainage in the area. Throughout most of the year, the Front Street discharge is submerged thereby reducing its effectiveness for carrying stormwater.

Due to limited finances, the Buzzards Bay Project was unable to provide the necessary the funds for this project. The Buzzards Bay Project did, however, feel the proposal had merit and wanted to see it proceed forward. The Project submitted a request to the Soil Conservation Service (SCS) for some planning and technical assistance. SCS put together an interdisciplinary team (including an engineer, geologist, biologist, soil scientist, and soil conservationist) to work with BBP and town representatives on identifying and selecting alternatives. Assistance was also provided by an SCS wetlands specialist, US Fish and Wildlife Service, MA Fish and Wildlife, and MA Department of Environmental Protection-Division of Wetlands.

In 1991, the Project and the town of Marion jointly applied for and received funding from the Departmental of Environmental Protection 319 Nonpoint Source program to reduce nonpoint source pollution from the Front Street stormdrain system. The funding is designated to divert the "first flush" of stormwater runoff into a constructed wetland system. Pollutants deposited on impervious surfaces (roads, driveways, patios) throughout the watershed are carried into receiving waters during the initial flush of runoff. This first flush, therefore, contains the highest pollution levels during a rain event.

The proposed project site is located on town-owned land. This land was once a salt marsh. The marsh was filled during the 1950's with dredge material from Sippican Harbor. Prior to the fill placement, the salt marsh probably acted as a natural filtering mechanism for the road runoff. The fill placement disrupted the drainage patterns in the area and created instead a direct discharge for the road runoff (the ditch) into the cove. Sediment deposited within the stormdrain system and the ditch plus a backflow of water from the ditch into the stormdrain has reduced the capacity of the stormdrain system. During rain events, runoff that should normally flow into the stormdrain system instead flows across Silvershell parking lot and into the beach.

The wetland system consists of a sediment basin, a shallow marsh, a deep pool, and a stone-lined waterway. The sediment basin is designed to provide a collection area for sediments plus provide an open outlet for the existing stormdrain system. The sediments will have to be cleaned out of the basin - usually once every five to ten years. The shallow marsh contributes the physical and biological processes necessary to treat and remove the pollutants associated with the stormwater. The deep pool is an additional cleansing mechanism plus it provides a fish habitat for mosquito control. The final treatment mechanism is the stone-lined waterway which provides aeration prior to the discharge back into the ditch. To deter access from the Silvershell beach, a fence will be installed between the wetland and the parking lot. The town may wish to expand the fencing to include the area along side the ditch.

This project is a result of a cooperative effort from several state, local, and federal agencies including the Buzzards Bay Project, Soil Conservation Service, Buzzards Bay Action Committee, Marion Conservation Commission, US Fish and Wildlife Service, and MA Division of Fish and Wildlife. Funding to construct this project has been provided not only by DEP ($25,000) under Section 319 Nonpoint Source Pollution competitive grant program (discussed above) but also US Fish and Wildlife ($10,000) under their Partnerships for America Program.

The Buzzards Bay Project has become aware that some of the abutting landowners to Spragues Cove have some concerns pertaining to the proposed stormwater remediation project. Hopefully, this letter and the enclosed materials will clarify further the goals and objectives that the Buzzards Bay Project and the town wish to accomplish with the constructed wetland.

The Buzzards Bay Project is committed to resolve any environmental or health concerns raised in relation to this project. Other concerns, such as beach access, landscaping, etc. should be brought to the attention of the Selectman. If we can be of any more assistance, please do not hesitate to call.

Sincerely,

Joseph E. Costa, Ph.D.
Project Director

cc: Board of Selectman
Board of Health
Ray Pickles

MARION RECREATION DEPARTMENT
MARION TOWN HOUSE
2 SPRING STREET
MARION, MASSACHUSETTS 02738

August 15, 1993

Board of Selectmen
Marion Town House
2 Spring Street
Marion, Massachusetts 02738

Dear Madam and Gentlemen:

At the recent recreation committee meeting held on August 11, 1993, there was a lengthy discussion of the Spragues Cove Nonpoint Source Pollution Mitigation Project proposed for the Silvershell Beach area.

The committee is in favor of this project in principle. The members of the recreation committee voted unanimously to urge the Buzzards Bay Project and the Board of Selectmen to relocate the proposed #1 drainage pool. If this simple request could be accomplished all town residents could continue to enjoy Silvershell Beach.

Respectfully submitted,

Jonathan E. Dickerson
Chairman
Recreation Committee

Bernie

United States Department of Agriculture
Soil Conservation Service
451 West Street
Amherst, MA 01002
Tel. (413) 253-4367

April 17, 1992

Mr. Robert S. Scheirer
U. S. Fish and Wildlife Service
22 Bridge Street
Concord, NH 03301

Dear Bob:

Enclosed is the planning information for the stormwater management project in Marion. We are planning to rehabilitate the filled marsh by utilizing a constructed wetland to treat the runoff. This will improve the water quality before entering Sprague's Cove, reduce the affects on the shellfish beds, and improve wildlife habitat. We will be preparing a preliminary design for the constructed wetland.

Thanks for attending the team meeting on March 16 and 17. You provided valuable information on the project with cooperation between several agencies. We look forward to further assistance on planning and implementing this project.

If you have any questions or need additional information, feel free to contact me or Bernie Taber in Marion.

Sincerely,

Dennis

Dennis A. Verdi
Civil Engineer

Enclosures

Commonwealth of Massachusetts

Division of Fisheries & Wildlife

Wayne F. MacCallum, *Director*

14 May 1992 NHESP File No. 92-184

Richard Fike
Soil Conservation Service
451 West Street
Amherst, MA 01002

Re: Constructed wetland
Marion, MA

Dear Mr. Fike:

Thank you for contacting the Natural Heritage and Endangered Species Program regarding rare species and ecologically significant natural communities in the vicinity of the constructed wetland as described in your letter of 6 March 1992.

At this time, we are not aware of any rare and endangered species or ecologically significant natural communities within the vicinity of the proposed project.

Please note that this determination is based on the most recent information available in the Natural Heritage database, which is constantly being expanded and updated through ongoing research and inventory. Should new rare species information become available, this determination may be reconsidered. This evaluation does not consider the potential impacts to inland fisheries. To receive such an evaluation contact Richard Keller, Field Headquarters, Division of Fisheries and Wildlife, Route 135, Westborough, MA 01581.

Please contact Jay Copeland, Environmental Reviewer, if you have any questions.

Sincerely,

Patricia Huckery
Assistant Environmental Reviewer

Natural Heritage & Endangered Species Program

TOWN OF MARION
2 SPRING STREET
MARION, MASSACHUSETTS 02738

March 24, 1992

Ms. Judith McDonough
State Historic Preservation Officer
Mass. Historical Commission
80 Boylston Street
Boston, Mass. 02116

Dear Ms. McDonough:

The Town of Marion, with Section 319 grant assistance from the Environmental Protection Agency and technical assistance from the U. S. D. A. Soil Conservation Service, is undertaking the reclamation of a wetland, which will involve excavation in the areas shown on the enclosed map. We understand that, since this work involves federal assistance, your office must be contacted for a determination of the existence of cultural resources.

The proposed project will involve the removal of dredged fill that was dumped in this tidal wetland some thirty years ago. In addition, excavation below the old wetland surface will take place to depths of approximately four feet.

At present, the site is an open spoil area with sparse vegetation. A basketball court stands at the north end of the project area. The enclosed map shows the area. The site has been walked many times by SCS employees. No obvious indicators of cultural resources have been found to date. Actual construction is anticipated in the Fall of this year.

Thank you for your anticipated cooperation in this matter. Should you have any questions, I may be reached at (508) 748-3550.

Very truly yours,

Ray E. Pickles
Executive Secretary

/hac

Enclosure

Appendix D

Marion Sanitary Code - Section VI

Marion Board of Health

THE MARION SANITARY CODE

for

The Protection of Public and Environmental Health

1990 CONFORMED DRAFT

The Conformed Draft represents a consolidation of the current Marion Sanitary Code with draft regulations yet to be adopted and potential regulations yet to be considered for review by the Board of Health. The purpose of the Consolidated Draft is to allow the Board of Health and the public to view current and potential regulations in a coherent manner in order to evaluate both as to their value and potential effectiveness.

The current Marion Sanitary Code regulations are printed in Chicago type face and have the dates of adoption and revisions, if any, in parentheses following each major regulation (mm/dd/yy; Rev:mm/dd/yy). The current regulation number will be shown in parenthesis if it differs from the number shown in the conformed draft.

Draft regulations that have been through preliminary review and are ready for Board of Health consideration and the public hearing process are printed in New York type face with a "&" shown in front of the regulation number. Where applicable the source of the draft regulation is indicated in brackets {.....}.

Preliminary draft regulations that are <u>not</u> ready for the Public Hearing process and which require further Board of Health study are shown in Monaco type face with a '?' in front of the regulation number. Where applicable the source of the draft regulation is shown in brackets {....}.

MARION BOARD OF HEALTH
2 Spring Street
Marion, Mass. 02738
(508) 748-250

1989, et seq., the Board of Health may permit the placing part of a dwelling's septic system on another lot, or the placing elements of more than one septic system on the same lot.

a) If more than one leaching area are to be placed on the same lot all leaching area perimeter set-back distances applicable to septic systems are to be increased by 50%.

i) The Board of Health will grant no variance to these setback requirements.

b) Any proposal to place more than one septic system leaching area on one lot under MSC 5.20.1 may be required by the Board of Health to submit an Environmental Health Impact Report (EHIR) if any portion of the lot falls within an AE Zone as depicted on the FEMA maps of Marion. If the combined flow of the leaching areas is greater than two thousand gallons (2,000) per day an EHIR will be required.

c) Any proposal to place more than one septic system leaching area on one lot will include a maintenance plan for the lot and the leaching areas which includes appropriate mechanisms to guarantee its implementation.

d) Ownership of and responsibility for maintenance of each leaching are shall be accepted on the deed of the dwelling which it serves unless otherwise approved by the Board of Health.

e) Any lot of land selected to be the site of more than one septic system leaching area under the provisions of MSC 5.60.1 shall not be built upon, but shall serve as a site for the leaching areas only. The lot size must accommodate reserve areas.

f) Ownership of, and responsibility for the maintenance of the lot within which the leaching fields lie shall be apportioned by percent shares equal to each dwelling's percent contribution to total design capacity discharge unless otherwise approved by the Board of Health.

g) No portion of a lot used to site more than one septic system leaching area shall be in a VE Zone.

f) The Board of Health shall require a percolation rate of not less than one (1) inch in four (4) minutes, or more than one (1) inch in twenty (20) minutes for any leaching area installed under MSC 5.60.1.

g) Each dwelling shall have a separate septic tank which is sized in conformity with the Marion Sanitary Code.

h) All other applicable provisions of the Marion Sanitary Code shall apply to any application made under MSC 5.60.1.

SECTION VI: Storm Water Drainage

6.10: No direct discharge of untreated storm water run-off from impervious surfaces including, but not limited to, roadways, parking lots, driveways, and roofs to a wetland or watercourse will be permitted. (12/6/88)

6.20: Subdivision drainage plans will be designed to allow no greater quantity of storm water to be transferred out of the subdivision than was transferred out prior to the construction of any drainage system. (3/13/90)

6.30: Detention and infiltration basins shall be constructed to allow a minimum of two feet of naturally occurring pervious material between the bottom of the basin and the probable level of maximum high groundwater elevation, as determined in conformity with The Marion Sanitary Code. (See MSC 4.10.3) (3/13/90)

6.30.1: Deep hole tests must be dug within the location of the proposed basin. (3/13/90)

6.30.2: Detention and infiltration basins may not be located within the VE Zone as depicted on the FEMA National Flood Insurance Program maps of the Town of Marion, dated 2/17/88, as amended. (3/13/90)

6.30.3: In the case of a repair to, or an emergency expansion of an existing drainage system, the Marion Board of Health may grant a variance allowing the calculation of probable maximum high groundwater.(3/13/90)

6.40: Wet ponds (retention basins) may not be constructed without a permit from the Board of Health. (3/13/90)

6.40.1: Design, construction and maintenance program criteria of wet ponds shall be in conformity with the guidelines articulated in Controlling Urban Runoff. (3/13/90)

SECTION VII: Marine Sanitary Regulations

?7.10: The following portions of the Coastal waters of the Town of Marion are No Discharge Zones:

a) Aucout Cove, North of a line from Centerboard Shoals to Nyes Ledge.

b) Sippican Harbor, North of a line from Bird Island Bell to Centerboard Shoals to Nyes Ledge.

c) Wings Cove & Weeweantic River, North of a line from the Bird Island Bell to Little Bird Island.

7.10: Any owner of a boat, or person in charge of a boat, moored in Marion waters, docked at a marina for more than fourteen (14) days, or passing through Marion waters, shall maintain that boat's sanitary waste disposal system (MSD), if it is fitted with such a system, so that sewage is not discharged into Marion waters. (12/6/88; Rev. 3/13/90)

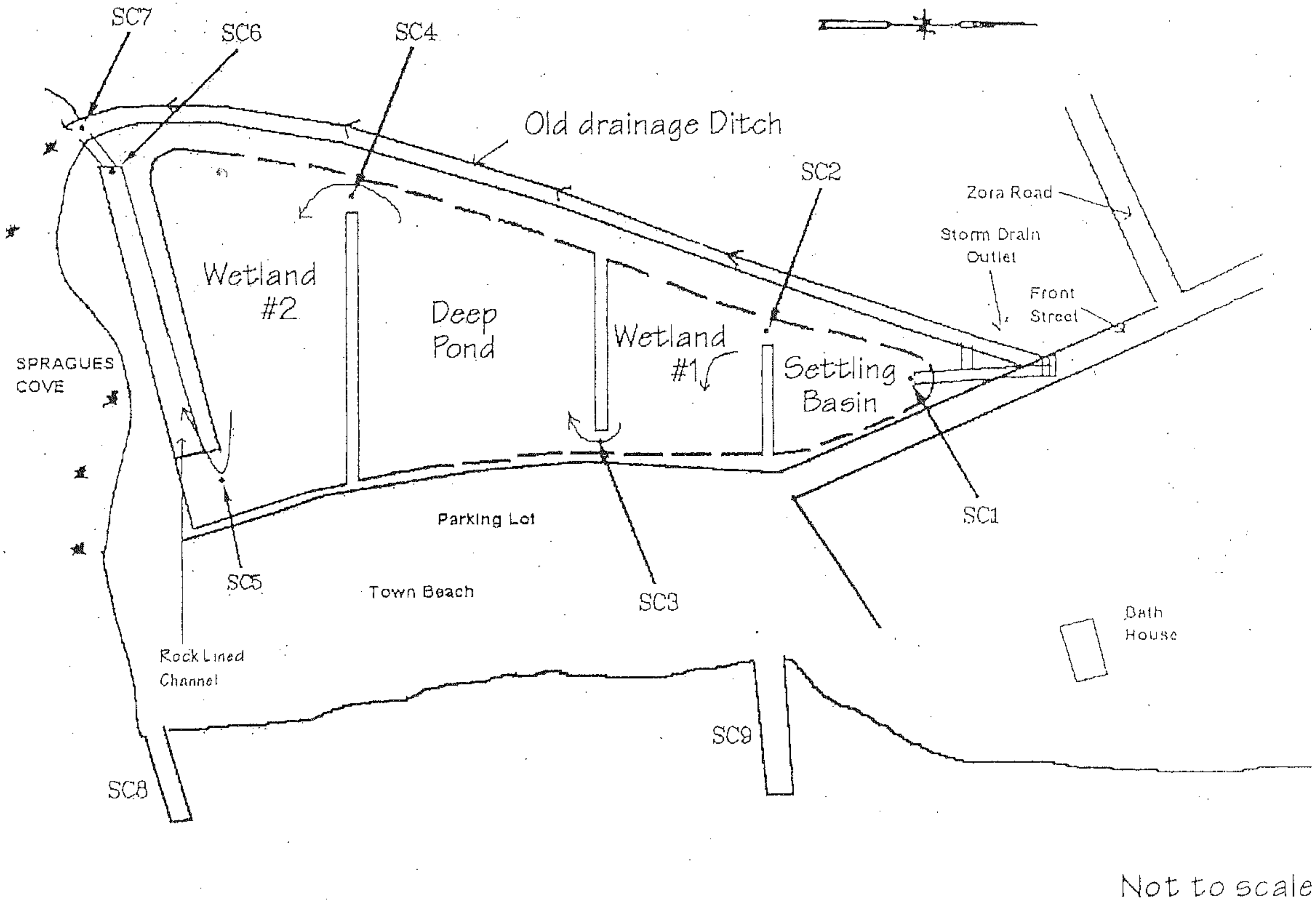
?7.10.1: Any vessel which is to be permitted to moor in Marion Waters by the Marion Harbormaster must have its MSD inspected by a certified

Appendix E

Monitoring Data

Spragues Cove

Stormwater Remediation Project



praques Cove Monitoring Sites

Town Buzzards Bay [illegible]

Collector Tracey

Location: Spragues Cove

Date of Collection [illegible]

Analyst Brian [illegible]

LOCATION	TC *	FC	FS
SC #1	(TNTC)	10	230
SC#2	(TNTC)	< 10	310
SC #3	(TNTC)	< 10	80
SC #4	(TNTC)	10	1090
SC #5	(TNTC)	1250	270
SC #6	(TNTC)	160	200
SC #7	(TNTC)	40	19500
AG #1	(TNTC)	20	16000

* High background levels prevented the enumeration of total coliform colonies.

BARNSTABLE COUNTY
DEPARTMENT OF HEALTH, HUMAN SERVICES AND THE ENVIRONMENT

Joseph Costa
Marion Town Hall
Spring Street
Marion MA 02738

Date of Collection: September [illegible] 199[illegible]

Buzzards Bay Project

Analyst: Brian [illegible]

or: Tracey Warner

on: Buzzards Bay

SAMPLE		FECAL COLIFORM/100ml	FECAL STREP/100ml			
SC1		150	110			
SC2		<10				
SC3		50				
SC4		<10				
SC5		10				
SC6		<10				
SC7		30				
SC8		<10				
SC9		<10				

Appendix F

Inspection and Operation and Maintenance

Spragues Cove

Stormwater Remediation Project

[illegible] COVE STORMWATER [illegible]

Operation & Maintenance Plan

Inspect the wetland system before, during and after significant storm events. The inspection must include the following items:

1. All inlet and outlet pipes, structures, etc.

2. Level spreaders (gabions).

3. Low flow dikes.

4. All fill and excavated slopes.

5. Plant viability.

If any damage to the above items is noted, replace and/or repair to meet the original design specifications.

Other maintenance items:

1. Maintain fence or other barrier between parking lot and wetland system.

2. Mow detention basin on the same schedule as surrounding recreational area.

3. Remove accumulated sediment from sediment basin, storm drains and detention areas.

4. Keep deep pool stocked with indigenous fish, crayfish and freshwater clams/mussels. Control algae and mosquitoes as much as possible with biological control.