# Comprehensive Environmental Inc.

## Study of Urban Non-Point Source Pollution

### Boire Field Brook Subwatershed

**PENNICHUCK WATER WORKS**
**SPRING 2000**

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**Figure Title**

# Summary of Project

This report contains information necessary to efficiently allocate resources for water supply protection. Based on a Watershed Management Plan, the Boire Field Brook subwatershed of the Pennichuck Water Works supply ponds was chosen for an intense field review to identify potential contaminant sources. Water quality threats from these sites were evaluated and Best Management Practices were proposed to minimize the threats.

This report and the results of the study have been structured to provide the reader with:

- A knowledge of the drainage patterns within the subwatershed studied.
- An understanding of the methodology used to identify water quality threats.
- A review of two sites in most need of water quality controls.
- Proposed conceptual Best Management Practices suitable for implementation at the identified sites.

Furthermore the prioritized nature of this study and its recommendations allows it to be useful to readers well after the proposed Best Management Practices have been implemented. Readers are referred to section 4 that contains short descriptions of other recommendations for this subwatershed.

Lastly, credit is to be given to the New Hampshire Department of Environmental Services and Pennichuck Water Works for their funding and interest in supporting this valuable study from which many New Hampshire citizens will benefit.

# 1.0 History of Project

From August to November 1999 Comprehensive Environmental Inc. (CEI) conducted a detailed review of an area of the Pennichuck watershed. This area is a 1000-acre subwatershed known as the Boire Field Brook (BFB) Subwatershed as identified in a 1998 *Watershed Management Report* (Comprehensive Environmental Inc., 1998)

Field information was gathered during the extremely dry conditions of late summer and also during a number of heavy rainstorms this fall. These unusual weather extremes provided a good range of conditions for observing the drainage of the BFB.

It appears that a significant amount of development has taken place since the original Watershed Management Plan was written only two years ago. New roads were built and now there are few vacant properties. Anytime there is demand to develop lands within a town, there is a unique opportunity for watershed managers to raise the bar for developers to minimize their impacts and eventual long term costs to society. Pennichuck's interest and technical assistance and the Nashua Conservation Commission's vigilance clearly have had an effect within the BFB subwatershed since many in-place BMPs were found during the study.

# 2.0 Drainage Areas

## 2.1 Site Selection Methodology

Because much of the development in this particular area has occurred recently, new techniques and performance standards for stormwater management can, and have, been required. During site walks many swales and detention ponds were observed. Much of the stormwater generated within this subwatershed must travel through these treatment structures. Because of the superior sediment trapping and water treatment that properly designed and operated detention ponds provide, an evaluation and prioritization of water quality threats must consider more than just impermeable areas, runoff volumes, and pollutant types and concentrations.

Because of the relatively good treatment that water from the BFB periphery receives, BMP site prioritization focused mainly on the areas closest to Pennichuck's water supply known as Harris Pond. While the distance that a contaminant must travel is often an important consideration in evaluating the threat from a source, in this subwatershed it became the overriding criteria in establishing the value of siting a BMP in one location as opposed to another. Therefore, while recommended locations of BMPs considered the interrelationships between many factors, site selection was ultimately based primarily on the proximity of the site to its eventual discharge into Harris Pond. A description of the drainage patterns within the BFB follows. The drainage schematic presented in Figure 2-1 (located at the end of Section 2) may be useful in visualizing these patterns.

## 2.2 Drainage Area Descriptions

In general much of the stormwater generated in the western and northwestern portion of this subwatershed flows through a series of detention ponds before it crosses under Somerset Parkway in the vicinity of the Exit 8 intersection. This stormwater is represented as a green arrow on Figure 2-1. Stormwater from the Boire Airfield appears to flow southward out of the BFB and is represented by a light blue arrow on Figure 2-1. Stormwater from the southeastern portion of the watershed is represented by an orange arrow on Figure 2-1. Stormwater generated in the northeastern corner of the watershed flows southerly and joins the other flows in Pennichuck Brook. It is shown as a red arrow on figure 2-1

### 2.2.1 Western and Northwestern Drainage Area (Green flow)

In the western edge of the BFB, runoff generated just east of Deerwood Drive flows through a combination of ditches to wetlands in the vicinity of the railroad tracks and behind the Building 19 property. The water in the wetlands flows to Birch Pond and eventually to the detention ponds that front on Somerset Parkway. A portion of stormwater from the large Kessler Farm development flows through a series of swales (Figure 2-2) and small detention devices before it crosses under Amherst Street to a detention pond (Figure 2-3) series in front of the Building 19 parcel. The Building 19 ponds act as a retention system that retains stormwater, except during large storm events when this and other adjacent parking lot drainage spills over a raised outlet to another pond know as Birch Pond (Figure 2-4). This water then flows to the series of detention ponds fronting on Amherst Street before heading northerly under Somerset Parkway.

Stormwater from the southern aspect of the Kessler Farm development and access drive does not benefit from as long a detention time as it short circuits the flow path seen in green on Figure 2-1 and instead discharges directly into the last detention pond (Figure 2-5) before crossing under Somerset Parkway.

### 2.2.2 Boire Airfield (Blue flow)

Drainage modifications appear to have altered natural drainage patterns on the airfield property with the result being that the majority of surface water generated on this site flows southeasterly toward the Nashua River. A grassed area east of the airstrip may have a subsurface influence (and likely surface influence during high groundwater and heavy rainstorms) toward the railroad bed in the vicinity of the Building 19. The extent of the influence is unclear due to the fact that a culvert under the rail grade appears to be collapsed and there was no evidence of recent surface water conveyance through the pipe. Groundwater elevation records were sought, but no representative records for the area of our concern were found.

### 2.2.3 Southeastern Drainage Area (Orange flow)

Stormwater from the southeastern portion of the BFB is shown in orange on figure 2-1. Most of the stormwater originates in and around Somerset Plaza and to a lesser extent from the Compaq Computer Area.

Most runoff generated south of Amherst Street in the vicinity of the Compaq computer facility flows to a detention pond (Figure 2-6.) and then northerly towards Somerset Plaza into the same swale (Figure 2-7) and detention pond series previously mentioned on Somerset Parkway. Some of the runoff generated north of the Compaq facility does not have the advantage of treatment in the Compaq pond although all flows are picked up by the aforementioned swale and pond series.

Stormwater generated north of Amherst Street, and inclusive and west of Sullivan Tire (Figure 2-8) flow westerly in one of two swales that surround and pick up flows from Somerset Plaza.

A portion of Trafalgar Square Road and a portion of the parking lot drainage north of Pfieffer Vacuum flows to the swale on the northern perimeter of Somerset Plaza (Figure 2-9). The water in these perimeter swales flows to the detention ponds fronting on and eventually crossing underneath Somerset Parkway with discharge into Pennichuck Brook.

All of the stormwater from the above-mentioned areas is treated to some degree as it flows through various stormwater treatment structures. All stormwater must flow through at least one of the detention ponds located in front of Crowne Plaza hotel (Figure 2-10). Because of the excellent treatment that detention ponds provide, Pennichuck water supply is not as vulnerable to direct contamination from stormwater from these outlying drainage areas as it is from other areas within the watershed that are closer to Harris Pond that produce stormwater that does not flow through a detention pond.

Therefore the focus for finding high priority BMP sites shifted further down the watershed (note area of focus shown in Figure 2-11) to areas that generate runoff that does not have the benefit of flowing through multiple treatment structures.

### 2.2.4 Area of Focus (Red flow)

This area of focus is represented as a red arrow on Figure 2-1, but also includes flows generated in the eastern edge of those represented in orange on Figure 2-1.

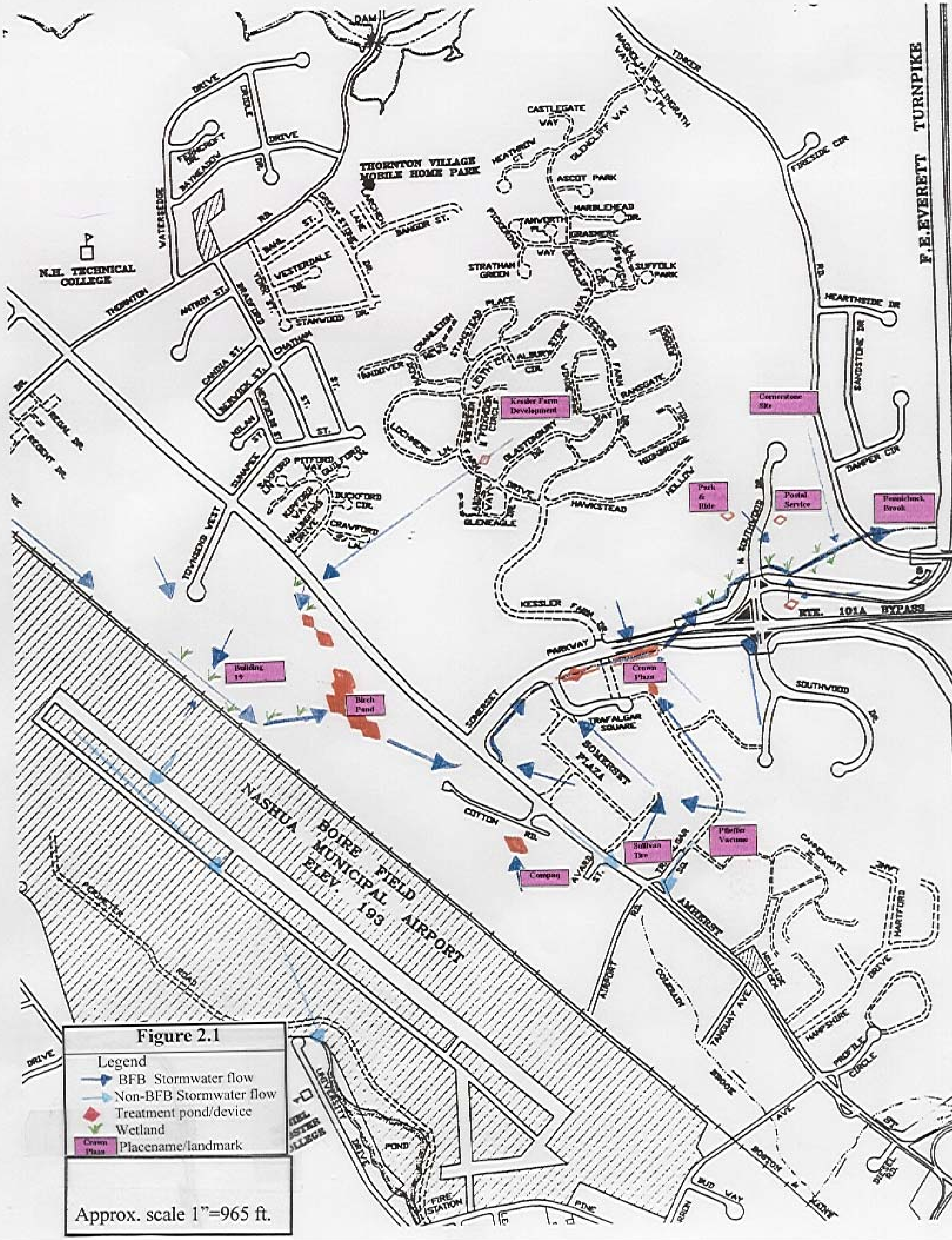
As seen in Figure 2-1 the red arrow depicts stormwater generated in the Northeastern  portion of the BFB that discharges into Pennichuck Brook. This area encompasses the remainder of the watershed and is typified by onsite treatment structures such as those located at the *Park and Ride* lot (Figure 2-12) and the Postal Service property (Figure 2-13).

Water from these and other adjacent areas discharges to Pennichuck Brook, which flows under Tinker Road, through a controlled outlet, under the Everett Turnpike to another controlled outlet (Figure 2-14) that discharges to Harris Pond.

Some of the stormwater in this area flows through grass treatment swales before it enters the main stem of the Pennichuck Brook. The discharge pipes in this area are quite large (Figure 2-15), presumably to handle the stormwater from development of the presently vacant lands. Although two of the grass swales appear to be intact and functioning properly, there was little evidence to suggest that either had experienced high flows.

Another treatment swale located downstream, however, showed signs of extreme sedimentation (Figure 2-16) to the point of almost complete blockage. This swale handles stormwater from the Cornerstone Computer site located on north Southwood Drive. Much of the beneficial vegetation in this grass treatment swale has been choked by sand. The remaining vegetation consisted of small woody plants typical of disturbed soils. These plants offer little treatment of stormwater beyond their minor energy dissipating qualities.

This discharge site (Figure 2-17) and an upstream collection junction (Figure 2-18) were picked for installation of BMPs and are described in greater detail in section 3.1.



DAM
THORNTON VILLAGE MOBILE HOME PARK
N.H. TECHNICAL COLLEGE
TINKER
CASTLEGATE WAY
ASCOT PARK
MARBLEHEAD DR.
GRASMERE
STRATHAM GREEN
SUFFOLK PARK
HEARTHSIDE DR
SANDSTONE DR
DAMPER CIR
FIRESIDE CIR
F.E.EVERETT TURNPIKE
BANGOR ST.
VESTERDALE DR.
STANWOOD DR.
ANTRIM ST.
CHATHAM
THORNTON
WATERSEDGE
TOWNSEND WEST
SUNAPEE
CRAWFORD LN
DUCKFORD CIR.
LOCHMERE LN.
GLASTONBURY DR.
GLENEAGLE
HAWKSTEAD
HOLLOW
HIGHRIDGE
RAMSGATE
KESSLER FARM DR.
PARKWAY
Kessler Farm Development
Cornerstone Site
Park & Ride
Postal Service
Pennichuck Brook
RTE. 101A BYPASS
Crown Plaza
SOUTHWOOD DR.
SOMERSET
TRAFALGAR SQUARE
SOMERSET PLAZA
Building 19
Birch Pond
COTTON RD.
Company
Sullivan Tire
Pfeiffer Vacuum
AVARD ST.
TRAFALGAR SQ.
AMHERST
AIRPORT RD.
CANONGATE
HARTFORD
DRIVE
HAMPSHIRE
PROFILE CIRCLE
TANGUAY AVE.
BROOK
BOSTON & MAINE
BUD WAY
PINE
FIRE STATION
POND
UNIVERSITY DRIVE
PERIMETER ROAD
NASHUA BOIRE FIELD MUNICIPAL AIRPORT ELEV. 193
Legend
BFB Stormwater flow
Non-BFB Stormwater flow
Treatment pond/device
Wetland
Crown Plaza
Placename/landmark
Approx. scale 1”=965 ft.


Figure 2.1

Figure 2-2. Kessler Farm Swale

Figure 2-3. Building 19 Detention Pond

**Figure 2-4. Birch Pond**

**Figure 2-5. Stormwater Discharges to Crowne Plaza Detention Pond**

**Figure 2-6. Compaq Detention Pond**

**Figure 2-7. Somerset Plaza Wet Swale**

**Figure 2-8. Sullivan Tire Runoff**

**Figure 2-9. Northern Perimeter Swale**

**Figure 2-10. Crowne Plaza Detention Ponds**

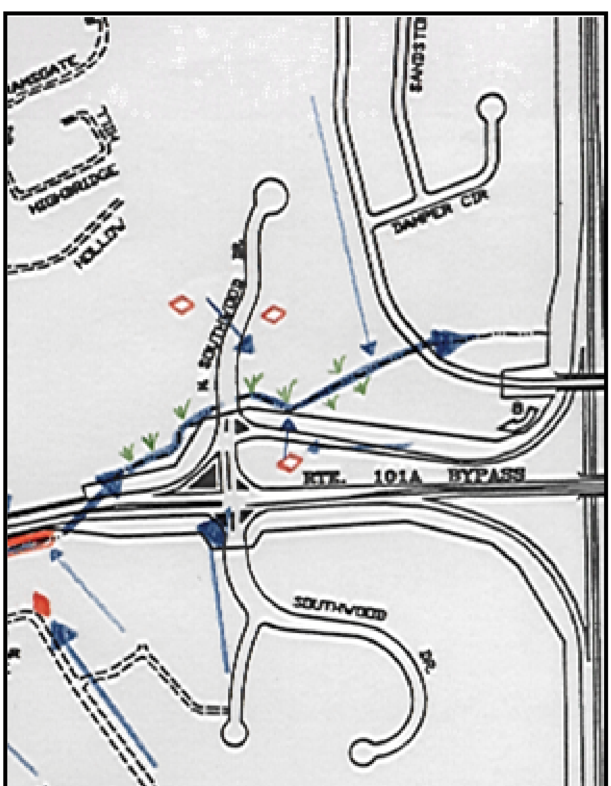



**Figure 2-11. Area of Focus**

**Figure 2-12. Onsite Detention at Park and Ride Lot**

**Figure 2-13. Postal Service Detention**

**Figure 2-14. Controlled Outlet to Harris Pond**

**Figure 2-15. Large Discharge From North Southwood Drive**

**Figure 2-16. Cornerstone Discharge Blockage**

**Figure 2-17. Existing Grass Swale**

**Figure 2-18. Stormwater Collection Junction for the Cornerstone Site**

# 3.0 Sites Recommended for Improvement

Within the BFB, there are two general observations that relate to water quality: sediment and associated phosphorus transport can be improved, and public education is needed to reduce bacteria and sediment inputs.

While the existing stormwater treatment structures will remove some of the sediments suspended in the stormwater flow, efforts to control the entrianment of these particles and thus phosphorus should be made. This will add both longevity and treatment effectiveness to the existing stormwater treatment structures. Sediment management is needed in the watershed to control sources such as erosion, and in some cases to remove sediment once suspended in storm flows. Reducing these loadings should lessen the need to clean out detention ponds and other stormwater treatment devices that currently appear to be overtaxed.

Bacteria of many forms are present in nature, and a large chain pond system such as Pennichuck's can be expected to have a certain amount of bacterial contributors even in its supply waters. However in the BFB subwatershed, unnaturally high concentrations of waterfowl produce large amounts of fecal matter containing fecal bacteria. Because this unnaturally large population of waterfowl relates to human feeding, public education that discourages feeding allows citizens to have direct control over the quality of the quality of source water.

A blend of structural and behavioral BMPs were selected to address the water quality problems at two sites.

## 3.1 Cornerstone Site.

The Cornerstone site can be seen as a landmark site in Figure 2-1. The three BMP components proposed for this site are described below in section 3.13.

### 3.1.1 Identification of Problem.

Stormwater generated on the impervious surfaces at the Cornerstone Computer Facility receives some treatment from an existing grass treatment swale before it enters Pennichuck Brook. However, the grass treatment swale has been choked with sand and sediments contained in the stormwater and possibly the side slopes of the swale itself. While some infiltration exists in the sandy soils that underlie the swale, it appears that high velocity stormwater flows down through the swale as noted by the settling (Figure 3-1 located at the end of this section) of large particles quite a distance from the pipe's discharge.

Because of the large volume of sand and sediment contained in the stormwater, the pipe's discharge has become clogged. The source of sand and sediment found in the existing grass swale was traced to a developed site that discharges rooftop and parking lot runoff onto a steep slope before entering the conveyance system. Stone has been placed on top of fabric on the receiving slope of this upstream site in an attempt to protect the slope from erosion (unfortunately the stone that has been used is relatively flat and does not have the many faceted, angular structure required to function as riprap). The stone has slid down the fabric and the unprotected lateral walls have slumped and eroded (as seen in Figure 2-19). Much of this eroded material has been carried through the storm pipe and discharged onto the existing grass swale.

### 3.1.2 Water Quality Threat.

The water quality threat from this site is from sediment and the associated phosphorus transport to Pennichuck Brook. Some of this phosphorus in its dissolved form may reach Harris Pond. Sediments that settle in the brook occupy the valuable space and thus volume that slows the rate of flow in the brook. A slower rate of flow allows the finer silts and sediments high in nutrients to settle out. The natural settling that occurs in the brook and the metered outlets are the last line of defense before stormwater enters Harris Pond.

### 3.1.3 Method of Correction/Treatment.

To eliminate sediment transport to the existing swale two measures should be taken; slope stabilization and sediment collection. Once the erosion and sediment transport problems have been dealt with at the upstream end of the conveyance system, the problems in the existing swale at the outlet should be lessened dramatically. However this existing grass treatment swale should be reconditioned and two checkdams should be added. These three BMP components: eliminating erosion, collecting sediments, and reconditioning the existing grass swale are described conceptually below in the three respective sub-sections sections.

### Slope Stabilization

First, the slope receiving the runoff should be stabilized. The stone and fabric should be removed from the bank receiving the sites runoff. This area should be re-contoured in a shallow swale configuration so as to maximize the floor area of the swale (see Figure 3-2-A). The swale should be stabilized with a turf reinforcement material (see Figure 3-3), loamed and seeded with grass that will establish quickly. A flat longitudinal slope will allow a more shallow sheet flow to occur, thereby using the energy dissipating qualities of the grass to slow the velocity of water on the slope.

### Sediment Collection

The second feature needed at this site is a sediment forebay (see Figure 3-2-B) to trap stormwater sediments. The forebay should be excavated upstream of the existing headwall and lined with the stone removed from the slope. A baffle structure (which could be in the form of flutes or a short gabion wall) placed within the perimeter of the forebay to intercept incoming water from the slope could be employed to enhance sediment-settling rates. Finally, a box outlet structure tied into the existing headwall made with gabions will force water upwards and/or through the pore space of the stone. This will have the effect of adding sediment storage space, lengthening the stormwater travel time and preventing short-circuiting the system.

Once the erosion and sediment transport problems have been addressed at the upstream end of the conveyance system, the sedimentation problems in the existing grass treatment swale at the outlet should be reduced dramatically. However the existing grass treatment swale is in need of some improvements to fully utilize its treatment abilities.

### Reconditioning Existing Grass Swale

The third BMP component is the reconditioning of the existing grass swale so that it polishes stormwater from the above two components prior to its entrance to Pennichuck Brook. Reconditioning should consist of some minor regrading, re-vegetation and bank stabilization, and the addition of two check dams. These three efforts are described below.

The swale is in need of some minor regrading to re-establish its original design slope (See figure 3-4). Cleaning accumulated sediments from the pipes discharge (as shown in Figure 2-16) should be done at this time.

Although some woody vegetation is thriving in the disturbed soils of the swale, the bare stalks do little to break up the velocity of water. A coarse type of vegetation tolerant of sandy soils should be seeded on the floor of the swale to slow stormwater flow, and to help maintain the infiltration capacity of the swale's floor. Although the direct phosphorus removal by this vegetation is typically nominal unless intensely harvested, the physical characteristics of a healthy stand of dense vegetation are worth employing. This need not be done for the entire length of the swale floor as some of the vigorously growing established vegetation at the downstream end of this swale supports complementary treatment functions.

A grass, vetch or sedge known for its bank stabilization properties could be seeded on the sandy side slopes.  This should be done an as-needed basis either in areas where the bank has slumped or eroded.

Adding two check dams near the toe of the swale slope would encourage water to infiltrate into the sandy soils present on the site. Any stormwater generated from low intensity storm events is probably infiltrating into the sandy soils of the swale without the aid of the check dams, but higher intensity events likely exceed the capacity of the natural soils to infiltrate the portion of runoff associated contaminant transport. Adding checkdams to the swale will allow this portion of water greater time to infiltrate. Enhanced groundwater recharge and storage also has the advantage of staggering the release of water from the watershed so that water is available to the supplier over a greater period of time.

### 3.1.4 Estimated Cost to Construct.

It is estimated that costs to install these BMPs would range from $15,000 to $20,000 depending on whether all of the options components mentioned above are implemented.

### 3.1.5 Annual Maintenance Requirements

Maintenance needed for these two BMPs to function properly should be generally confined to the upstream sediment removal BMP. However, periodic inspection of the reconditioned swale is suggested.

Once vegetation has been established on the slope it should be mowed cross slope with a conventional push or walk behind mower. Grass should not be mowed to less than two and one half inches. Clippings should be collected if they are likely to smother the grass, however fine clippings may be allowed to disperse evenly on the slope. Removal of thatch in spring or fall should only be done if there is evidence that excessive thatch is causing water to channelize on the slope. An alternative to conventional grass is to use a “no mow” mix (dwarf fescues) and clover to minimize maintenance. Mowing is needed only once per year, but fall cleanup of leaves in required.

Sediment that is collected in the forebay should be removed periodically. The rate of accumulation will depend on many factors from winter sanding applications that may vary depending on the severity of the winter, and how well the vegetation establishes on the eroded slope. As a post-construction follow-up the depth of sediment in the forebay should be checked with a measuring stick quarterly and after big storms. Knowing the rate of accumulation will help in predicting when the foerbay will become full and in identifying problems upstream. Sediments should be removed prior to using all of the storage capacity (freeboard) in the forebay.

### 3.1.6 Funding Sources.

This project is eligible for grant funding under the New Hampshire Department of Environmental Protection’s Drinking Water Protection Program:

- *Local Water Protection Grants* –typically due by November 15th.
- *Drinking Water Protection Projects*-typically due by November 15th.

Application for design and construction of this project has been submitted under the 1999/2000 New Hampshire Department of Environmental Services' *Non-Point Source Local Initiative Grant Program*. Partial grant funding was awarded for the construction of the aforementioned BMPs.

### 3.1.7 Ownership.

The city of Nashua tax maps indicate that M n'D Properties LLC. is the owner of the upstream property in need of erosion and sediment control. They are located at 15 N. Southwood Drive in Nashua. The land containing the grass treatment swale near Pennichuck Brook is owned by Pennichuck Water Works.

### 3.1.8 Implementation Difficulty.

It is anticipated that the physical limitations of both BMP sites will present only low to moderate construction difficulties.

Initial investigations of the soil characteristics at both proposed BMP locations indicate that it may be droughty and contain little organic matter. This will present challenges to quick establishment of thick grass cover. Adding loam should hasten turf growth during the vulnerable establishment period. Thoroughly watering the established grass will encourage deep root growth if the topsoil to just above the root depth is allowed to dry. Access for construction equipment to both locations should be good, although contractors should be aware of water, gas, and other underground utilities near both locations. As always, DIG SAFE should be notified.

Landowner concerns are expected to be minimal for two reasons. First, one of the locations is owned by Pennichuck Water Works. Second, the other location is unsightly with visible degradation of the existing stone and fabric system. The proposed use of grass in its place will blend with the surrounding landscape far better than even a properly operating riprap structure. The gabion outlet structure should not be very noticeable.

## 3.2 Crowne Plaza Waterfowl

A behavioral BMP and several physical deterrents are proposed at the site shown in Figure 3-5 just North of the Crowne Plaza Hotel.

### 3.2.1 Identification of Problem

Waterfowl are present throughout the BFB subwatershed frequenting the various detention structures and adjacent grounds. Limiting waterfowl throughout the watershed would be a highly impractical goal, but deterring waterfowl from this critical location near the water source is a realistic objective. The focus of these efforts should be in the detention ponds to the North of the Crowne Plaza Hotel between the hotel and Somerset Parkway. These two connected ponds attract an unnaturally high concentration of waterfowl in ponds that are closest to the water supply.

There are a large number of waterfowl that frequent these ponds and it appears that the general public and guests of the hotel are feeding these ducks. The ducks should to be discouraged from these two ponds and their reliance upon public feeding must be stopped at this location due to the impact on water quality

### 3.2.2 Water Quality Threat

The abundance of waterfowl (see Figure 3-6) that defecate both in and along the banks of the Crowne Plaza detention ponds are a source for both bacteria and phosphorus. Currently, both bacteria and phosphorus pose the most significant threat to Pennichuck's water supply. The reasons for this are twofold.

First, water high in algal matter and bacteria place additional burdens (and therefore costs) on the treatment plants filtering and flocculation processes. Second, threats to Pennichuck's water supply relate to long-term reduction in storage capacity due to excess phosphorus inputs. Phosphorus-laden waters support enhanced flora and fauna production in the reservoirs. The yearly die off results in accumulation of biomatter within the reservoirs and the space that this biomatter occupies is not available for water storage. The likelihood of internal phosphorus cycling in the reservoirs from bottom sediments is also enhanced as a result of anoxic conditions that may form due to the increased decomposition of organic matter and associated oxygen demand.

### 3.2.3 Method of Correction

A multifaceted approach is necessary to control waterfowl. Public education in the form of signs around the pond and leaflets in the lobby of the hotel would be useful in explaining to guests the importance of not feeding ducks at this location. Articles in the paper and leaflets in the lobbies of the adjacent businesses will reach locals and employees who might otherwise spend a lunch hour feeding the ducks. If ineffective, an ordinance prohibiting the feeding activity may be needed. Three methods of deterrents and ordinance adoption are explained below.

### Educational Outreach

Educational materials should not only stress the water quality issues involved, but should also mention the detrimental effects on the waterfowl themselves. Ducks that are fed bread can develop metabolic bone disease and other nutritional diseases. Additionally ducks that migrate need not be fed, but feeding ducks leads to human dependency and increases the likelihood of diseases spreading through the flock due to the limited gene pool. Moreover high concentrations of ducks in close proximity to humans also presents possible public health threats. Duck feeding need not be the focus of all public education efforts; it could for example also occupy a portion of a leaflet or article on how the average citizen can make a difference in their community's water quality.

### Structural Deterrents

Structural deterrents are numerous, but many are impractical for this compact urban setting. One method that has been used successfully once the human food source has been eliminated is to make a pond unattractive to ducks by suspending small diameter wire slightly above the water surface in a grid network . Purchase and installation of gridding can be expensive, but many variations of this deterrent idea are possible using cheaper materials or limiting its installation to only those areas preferred by ducks (see Figure 3-7). Grids for ducks should be five feet by five feet and heights may be from two inches to three feet off of the water.

### Feeding Deterrents

An option to deter ducks from these two ponds is the use of a natural substance found in grape flavoring. Some trials have shown this product (sold under the trade name of Bird Shield) to be effective at deterring ducks when applied to grass or water. Some users feel that the product must be re-applied too frequently to be of value when compared to other deterrents. The product is food grade and would impart a grape flavor to the water if applied directly on the water and therefore is not recommended for direct application to drinking water sources. Applying the product to the root zone of the grass surrounding the ponds would deter the ducks from eating it. The manufacturer claims that if properly applied with a high pressure (50 psi) injection-type boom sprayer the substance with its coalgulative properties tends to adhere to the roots and generally resists washoff. Again if this product is used it should be on a trial basis and only when human feeding of ducks has ceased and the ducks have taken to eating the grass surrounding the ponds.

### Ordinance Adoption

The use of the aforementioned deterrents will tend to encourage waterfowl to move into areas where citizen feeding of waterfowl still takes place and the waterfowl are not disturbed. Because of this the City of Nashua should consider adopting an ordinance against feeding waterfowl in and around waterbodies that flow to Pennicuck's water supply. Cities in many other areas have adopted ordinances that prohibit the feeding of wildlife to reduce the health risks to humans.

### 3.2.4 Estimated Costs

- Public education need not be costly if press releases are used. Generating and submitting a series of press releases would cost approximately $200 per release
- A rough estimate to produce and distribute three-fold brochure is $5,000.

- Signage can be done for about $100 per sign.
- Wire gridding to cover both detention ponds including installation would cost between $7,000 and $9,000.
- Bird Shield costs about $70 gallon with one gallon covering approximately 21,000 square feet. Bird Shield should be applied every three weeks or after mowing. Assuming four to six applications, material costs would be roughly $500. Application with a 50 psi boom sprayer is required.
- Adopting a town ordinance to restrict waterfowl feeding would not result in any out of pocket expenses, however enforcement of this ordinance would require up to one hour per day of a police officers time and it may be difficult to get the cooperation of the police considering the life and death nature of many of their other duties.

### 3.2.5 Annual Maintenance Requirements

Maintenance of the wire gridding would consist of periodically cleaning the wires of any unsightly debris that may have accumulated on them, and occasionally tightening any sagging wires. Specifying construction of the gridding with either stainless steel wiring or a UV stable product will limit the need for replacement to seven years to ten years.

### 3.2.6 Funding Sources

This project is eligible for grant funding under the New Hampshire Department of Environmental Services's Drinking Water Protection Program:

- *Local Water Protection Grants* – typically due by November 15th.
- *Drinking Water Protection Projects*-typically due by November 15th

### 3.2.7 Ownership

Crowne Plaza Site:
Sam Hospital Corp.
Continental Wingate
63 Kendrick Street
Needham, MA 02494

### 3.2.8 Implementation Difficulty

The major obstacle in implementing any of these deterrents is that feeding of the ducks must be stopped if any of the other strategies are going to be employed. Additionally, behavior modifications (for humans) represent not only the most important part in waterfowl deterrence, but will also require the most effort and persistence.

Signage around the detention ponds and literature in the form of leaflets should be implemented to help support and publicize efforts to reduce waterfowl concentrations. Later, a couple of articles in the local paper would help to reinforce the importance of this endeavor to those who ignore the postings and leaflets, and inform other citizens not exposed the direct efforts of postings and leaflets. Articles will in time create a social pressure where it is unacceptable to feed ducks. For some citizens, for example, this social pressure has worked well in preventing littering when signs warning of a $250 fine have not. Lastly, a local ordinance should be adopted and enforced to restrict those individuals not deterred by the aforementioned approaches

If substantial reductions in waterfowl are not noted despite successful public cooperation, a structural method of deterrent should be used. Gridding or another low cost option that has the effect of inconveniencing the waterfowl should be the next step. Lastly, Bird Shield or a similar product might be tried on the grass to make the grass surrounding the pond unpalatable to the ducks. The marketers of Bird Shield confirmed that Bird Shield is food grade, however, other manufacturers should be contacted to assure their products are drinking water compatible when applied to grass.

**Figure 3-1. Settling of Large Particles**

**NOTES:**

1. Remove existing Rip Rap swale lining and reuse as sediment forebay liner.
2. Widen and flatten swale to forebay.
3. Excavate forebay and install gabion outlet structure.
4. Reline swale with turf reinforcing material and seed.

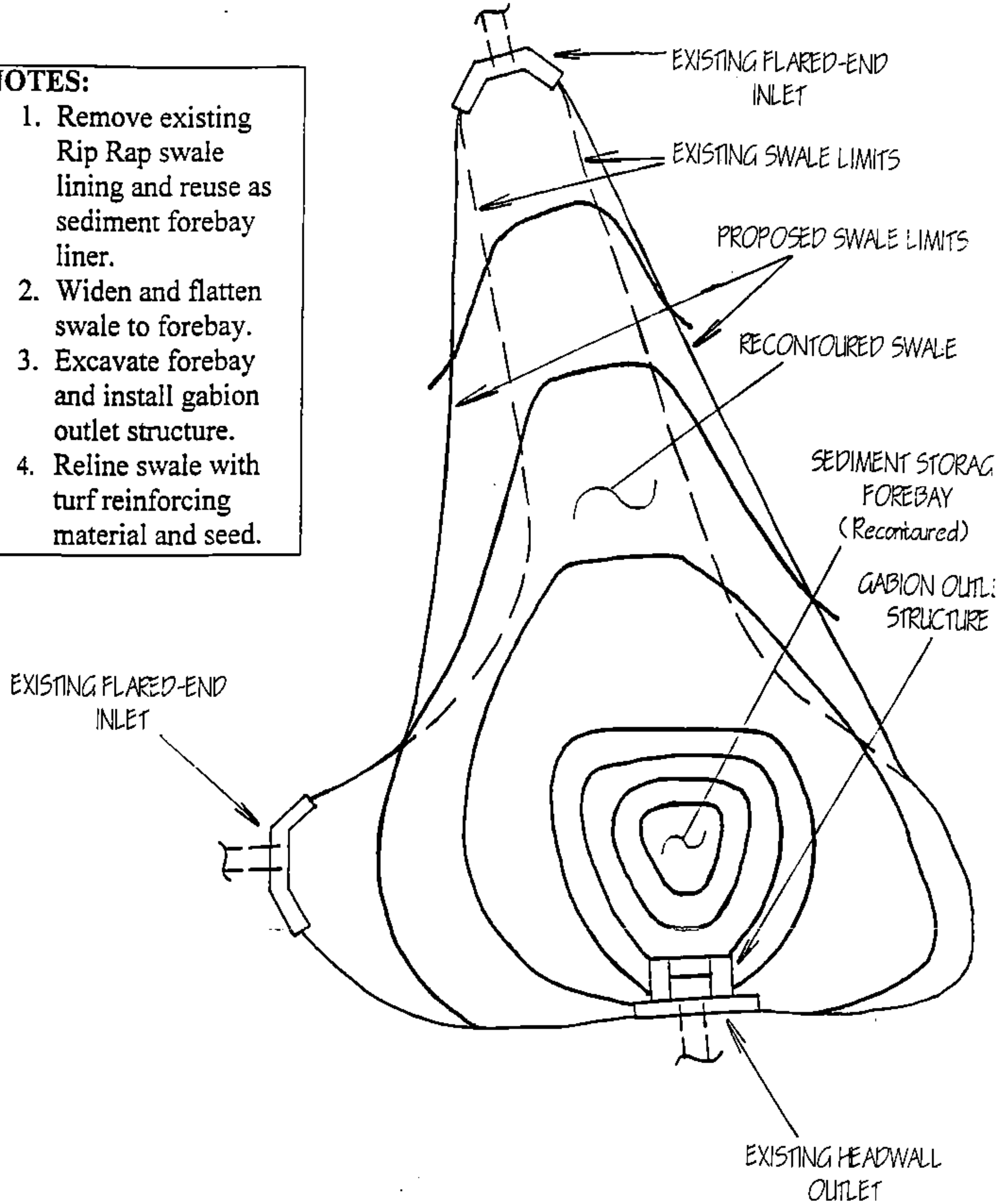



Figure 3-2-A
Conceptual Slope
Stabilization Plan

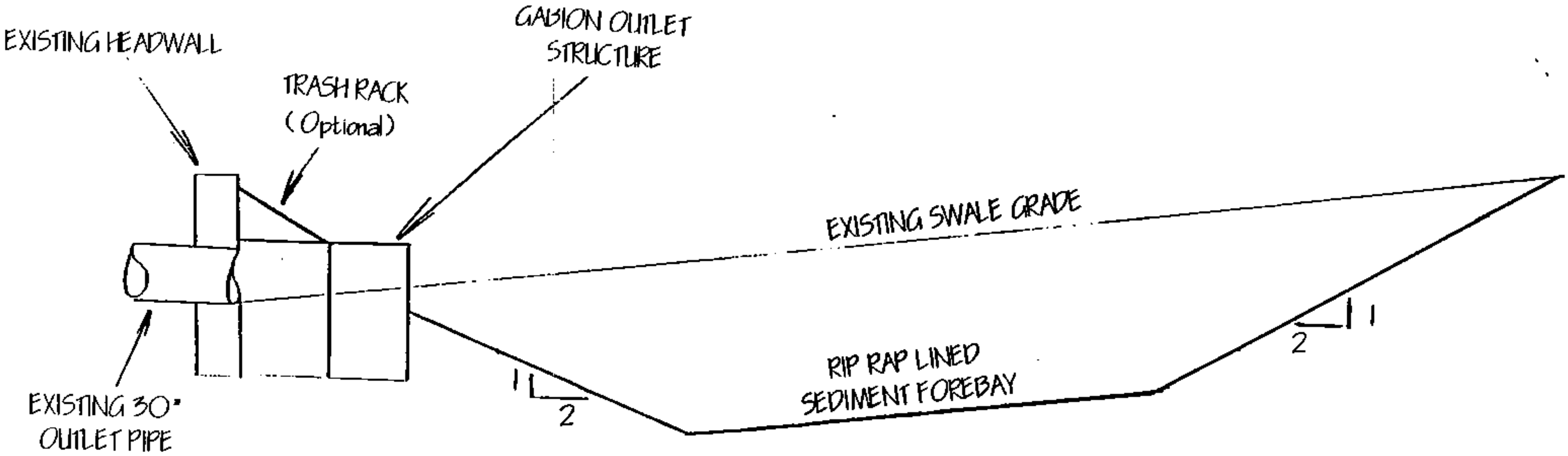



Figure 3-2-B
Sediment Forebay
Detail
Not to Scale

Figure 3-3. Turf Reinforcement Material

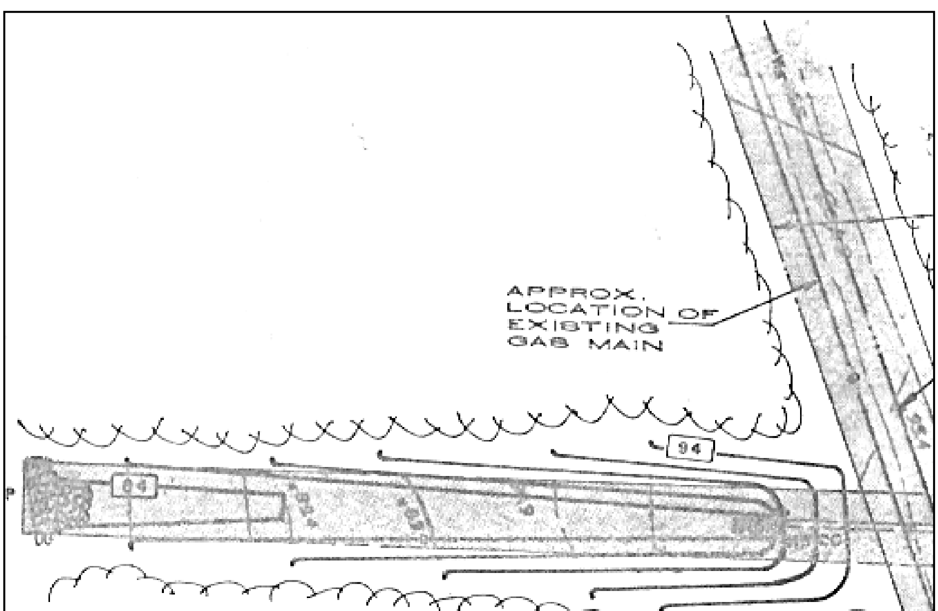



Figure 3-4. Original Swale Design

**Figure 3-5. Crowne Plaza Detention Ponds**

**Figure 3-6. Typical Waterfowl Concentrations in Crowne Plaza Pond**

**Figure 3-7. In both winter and summer, ducks preferred this narrow pond. Installation of physical deterrents here are less costly.**

# 4.0 Other recommendations

Based on days spent in the field (most of which were during rainstorms), a number of issues were noted. While alone, single acts or practices may not represent as significant or directs threat to water quality as those mentioned for BMP implementation, the consistency with which many of these issues were found deserves attention.

The following presents a short description of six of the most important issues and brief recommendations.

## 4.1 Maintenance/Overuse of Detention Ponds

Many detention ponds throughout the subwatershed appear to be working well. The accumulation of sediment within the ponds shows that they work. While a detailed review of design criteria for these ponds was not conducted, the accumulated volume of sediment may soon be affecting the treatment efficiencies due to significantly shortened detention times. Whether this accumulation is from lack of maintenance or other users tying into the pond is unclear.

It is recommended that developers proposing water quality structures in the future be required to submit and adhere to a thorough Operations and Maintenance Plan (O&M Plan). Provisions in the design and plan should allow the lay person (such as a Conservation Commission Member) to be able to check compliance with such a plan. For example placing a permanent measuring gauge or rod in the sedimentation pond that can be read from the shore would enable the owner or enforcing individual to easily recognize the need for maintenance or compliance with the O & M Plan. Provisions allowing either the Nashua Department of Public Works or Pennichuck Water Works to perform maintenance and back charge the landowner should also be included to address the issue should the owner refuse to perform required routine and special maintenance. Lastly, bylaws should empower an entity to fine for violations of the O & M Plan.

## 4.2 Aesthetics of Detention Ponds and Other Structures

The accumulation of trash and garbage in many of the water quality structures should be removed by the property owners. While this refuse may not be a direct threat to water quality, it gives the general public a bad impression about the effectiveness of stormwater treatment devices. In fact detention ponds and swales can blend in and even enhance the visual appearance and character of a development. Developers are far more likely to go beyond just the minimum requirements when designing and constructing stormwater treatment devices if their clients view them as an asset to the appearance and landscaping design.

## 4.3 Storage and Disposal of Street Sweepings

Sweeping parking lot sediments saves catch basin cleaning costs and is beneficial to water quality. However a common practice in this watershed is to pile the sweepings uncovered near the corner of a parking lot or worse, in and on the slopes of drainage swales. Most owners and contractors may not be sweeping parking lots to prevent sediment entrainment in stormwater during rainstorms. Therefore contractors should be educated about proper storage and disposal of these sediments if their sweeping efforts are to have substantial water quality benefits. This should also be discussed by the Nashua Public Works Department.

## 4.4 Sullivan Tire Runoff

There is a significant ponding problem that occurs on the northeastern portion of the Sullivan Tire property (see Figure 4-1. at the end of this section). Currently runoff from the northeastern portion of the Sullivan Tire parking lot travels to the northern perimeter swale that flows around the Somerset Plaza. However sediment in the swale and curbing along the Sullivan lot prevent efficient drainage of the site. The resulting ponding that occurs both on the Sullivan parking lot and in a grassy area to the northeast can be six to eight inches deep.

Simply cleaning out the accumulated sediments would solve the ponding problem, however from a water quality standpoint, the frequent appearance of a petroleum sheen (Figure 4-2.) on the surface of the water indicates that the ponding "problem" may, in the short term, act to help treat the water. The ponding that occurs now detains the water and thus gives the floatable material a chance to degrade.

A long-term solution to eliminate the source of this petroleum should be sought. If the source is intermittent or diffused and inherent for this auto service facility, a floatables hood could be installed in the downstream catchbasin once the ponding problem on the grass has been eliminated.

## 4.5 Paint Disposal in Catchbasin

During field review of drainage, a painting contractor was spotted dumping paint or paint thinner into the storm drain (Figure 4-3.). Although this was an isolated instance, it highlights the need to effectively educate the general public of the connection between the drainage system and the water supply.  Catchbasin templating programs might be helpful. Some towns enlist the efforts of The Boy Scouts or other volunteer groups to go out and paint a brief warning on the pavement surrounding a catch basin that the water entering the basin drains to the river or reservoir. Annual repainting can become an educational project of great benefit.

## 4.6 Scum Found on Stormwater Near Bank

On one occasion a thick black floating scum (Figure 4-4.) was seen floating on the water at a stormwater discharge pipe near the Bank Boston drive thru. The scum looked similar to that found at wastewater discharges. A sewer manhole was quite close to this location however no surface evidence of linkage between the two was found. This area should be tested for bacteria under various weather conditions. This maybe able to be incorporated into Nashua's Phase II stormwater program.

**Figure 4-1. Ponding Problem at Sullivan Tire**

**Figure 4-2. Petroleum Sheen at Sullivan Tire**

**Figure 4-3. Paint Thinner Being Dumped in Catchbasin**

**Figure 4-4. Scum Found at Stormwater Discharge Near Bank Boston**