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(2008) Northwood Stomwater Technologies and Town of Northwood Buffer Ordinance

TTG Environmental Consultants, LLC

NORTHWOOD STORMWATER TECHNOLOGIES

A Final Report to

The New Hampshire Estuaries Project

Submitted by:
The Water Resources Sub-Committee
Town of Northwood, NH

Prepared by:
TTG Environmental Consultants, LLC
Concord, NH

November 13, 2008

This project was funded in part by a grant from the New Hampshire Estuaries Project as authorized by the U.S. Environmental Protection Agency's National Estuary Program.

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November 13, 2008

Water Resources Sub-Committee
Planning Board
Town of Northwood
818 First NH Turnpike
Northwood, NH 03261

Dear Sub-Committee Members:

TTG Environmental Consultants, LLC (TEC) is pleased to submit this final report on Northwood Stormwater Technologies to the Water Resources Sub-Committee at the Northwood Planning Board. This report has been prepared under contract to the NH Estuaries Project, administered by the University of New Hampshire, and funded in part by a grant from the U.S. Environmental Protection Agency. Although under contract to the NH Estuaries Project, this report is primarily the product of a cooperative effort of the Northwood Water Resources Sub-Committee of the Planning Board and TEC.

This report is divided into a number of sections addressing such issues as the need for stormwater management, stormwater management concepts, and stormwater management controls, addressing both quantity and quality issues. Although numerous stormwater management technologies were reviewed, Low Impact Development (LID) technologies are the technologies receiving the most attention and are the preferred technologies included in this report.

I would like to thank the Sub-Committee and the NH Estuaries Project for the opportunity to work on this project. I look forward to presenting the findings of this report to the full Planning Board. If you have any questions, please contact me at (603) 228-1122, ext. 131.

Sincerely,

TTG ENVIRONMENTAL CONSULTANTS, LLC

James T. Spaulding, P.E.
Vice President

JTS/sai

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INTRODUCTION

TTG Environmental Consultants, LLC (TEC), under contract to the New Hampshire Estuaries Project and in conjunction with the Northwood Water Resources Sub-Committee, has prepared this report on stormwater technologies appropriate for the Town of Northwood, NH. This report is divided into two (2) main sections with a number of subsections. The first section describes the need for stormwater management, and the second section describes stormwater management technologies that are appropriate for Northwood.

Stormwater management has been evolving for many years, from a need to convey stormwater away from or through a developed site, to the realization that land development has a significant impact on the rate, volume, and quality of stormwater runoff, and that these impacts to the runoff leads to corresponding impacts on downstream properties and receiving water bodies. Much of this increased awareness has been growing since the 1970's with the passage of the Federal Clean Water Act in 1972, and subsequent revisions. It is now understood that stormwater runoff is one of the leading causes of water quality violations in many of our water bodies.

The State of NH has had an evolving stormwater program for more than 25-years, the NH Department of Environmental Services, Alteration of Terrain program (AOT). The latest iteration of this evolution is evident in the proposed program rules. The revisions to the rules, expected to be implemented late this year (2008) will create a state-of-the-art stormwater management program and address many of the current issues associated with stormwater from land development. It should be noted that the AOT program only regulates larger developments.

In addition to the Alteration of Terrain program, the University of New Hampshire has a very active Stormwater Center at its Durham campus. The Center, funded by various grants, performs research and education on many of the various stormwater treatment technologies in use today. According to the Center's 2005 report, the "Center… evaluates the effectiveness of different stormwater treatments in a side-by-side setting, under strictly controlled conditions. It is the only testing facility of its kind in the nation."

The Town of Northwood Water Resources Sub-Committee, understanding the importance of adequate stormwater management, and wishing to address these issues on a local level, has instituted this report. This report will attempt to explain the need for proactively dealing with stormwater issues, and describe the various technologies currently available to address these needs. One of the major thrusts of this report is to identify stormwater management practices suitable for a rural/suburban community such as Northwood.

NEED FOR STORMWATER MANAGEMENT

Land development has a number of impacts upon stormwater runoff. These impacts are well documented, and it is not the purpose of this report to detail them. However, a brief overview is presented as an introduction to the subject of stormwater technologies. These impacts can be divided into two (2) broad categories; hydrologic impacts and water quality impacts.

Hydrologic Impacts

A typical development removes much of the natural vegetation from a site and replaces it with buildings, pavement and landscaped areas. These changes tend to create a site that is substantially less pervious and hydrologically more efficient than the undeveloped site, which is to say that the site sheds water more quickly and retains less. This decrease in pervious surfaces and increase in hydrological efficiency increases both the rate and volume of runoff, resulting in a number of impacts including:

- Reduced infiltration of stormwater.
- Decrease in time to peak runoff rate.
- Reduced groundwater recharge.
- Reduced stream base flow (Dry weather flow).
- Increase in stream channel size.
- Increase in downstream flooding.

The U.S. Environmental Protection Agency publication "Low Impact Development Hydrologic Analysis" states:

> *Changes in Existing Hydrologic Balance. Both the annual and seasonal water balance can change dramatically as a result of development practices. These changes include increases in surface runoff volume and decrease in evapotranspiration and groundwater recharge. For example, eastern hardwood forests typically have an annual water balance comprised of 40% evapotranspiration, 50% subsurface flows and less than 10% surface runoff volume. Development, depending on its size and location in a watershed, alters the existing hydrologic balance by increasing surface flow volumes up to 43%, reducing subsurface flows to 32%, and reducing evapotranspiration rates to 25%. All this results in major changes to the local hydrology."*

These impacts manifest themselves in a number of ways:

a. Decreased groundwater recharge due to reduced infiltration of stormwater.
b. Reduced stormwater infiltration results in decreased water volume available to streams during dry periods.
c. To accommodate higher rates of runoff, stream channels increase their capacity by becoming larger through erosion.
d. Higher rates of runoff will increase both the frequency and size of flooding events.

As a result of b. and c. above, perennial streams in areas without proper stormwater management have been known to become seasonal streams, dry for portions of the year even as their channels become larger.

Water Quality Impacts

Runoff from snowmelt, rainfall and other sources such as irrigation has the potential to pick up and carry away whatever is on the surface of the landscape. This is not a significant concern in natural areas, as the overland runoff flow rates and velocities are much lower than in developed areas. The runoff from natural areas is more diffuse and for many storms, infiltrates prior to reaching surface waters. In addition, the amount of pollutants present on the ground surface available for transport to surface waters in natural areas is much less than in developed areas. Developed areas tend to have a significant percentage of impervious area, which is much more hydrologically efficient, allowing the runoff to pick up and transport surface pollutants. Developed surfaces have much higher pollutant loads on them because of human activity. These pollutants may include trash, sediments, oils and grease, pet droppings, pesticides, fertilizers, and anything else that can be deposited by human and animal activity. Runoff will flush many of these pollutants to other, often undesirable locations. Some of the documented impacts of unmanaged runoff to surface waters include:

- Bacteriological contamination.
- Toxicity impacts from ammonia, metals, organic compounds, pesticides and other contaminants.
- Nuisance algal growth from nutrients.
- Reduced dissolved oxygen levels due to the presence of oxygen-demanding substances in runoff.
- Increased temperature from runoff passing over surfaces with elevated temperature levels, such as parking lots.
- Contamination from runoff exposed to chemicals, such as road salt.

STORMWATER MANAGEMENT CONCEPTS

Stormwater management has been a concern of human society for thousands of years. However, it is only in recent decades that attempts have been made to mitigate the impacts to surface water from stormwater runoff. As the technology has progressed over recent decades, stormwater management has progressed from heavily engineered practices to more natural practices that attempt to mimic pre-development drainage patterns and strategies, although the engineered practices are often the only viable option in many circumstances. An overview of how the natural systems manage stormwater runoff is useful in understanding how the built environment should also address these issues.

ITEM	NATURAL SYSTEM RESPONSE
Runoff Rate	Runoff travel time tends to be longer than over developed areas because runoff velocity is lower as a result of surface roughness, surface storage and longer runoff paths.
Runoff Volume	Runoff volume is reduced by infiltration, diffuse and concentrated surface storage, and evapo-transpiration.
Pollutant Loading	There is a limited potential for surface loading of many pollutants common in developed areas; many nutrients that are present are reduced or eliminated by cycling through natural systems, including uptake and incorporation into the plant biomass, and being tied up in the soil matrix.

The state of the art practice in stormwater management is to apply a natural response to the extent practical in the built environment. Accomplishing this leads to more diffuse stormwater management, i.e., managing the stormwater closer to its source verses at the end of the pipe. The creation of Low Impact Development (LID) strategies in recent years is a direct result of attempting to implement natural stormwater management solutions and replicate natural outcomes. The Unified Facilities Criteria, Design of Low Impact Development Manual, US Department of Defense provides the following excellent definition of LID:

> *LID is a stormwater management strategy concerned with maintaining or restoring the natural hydrologic functions of a site to achieve natural resource protection objectives and fulfill environmental regulatory requirements. LID employs a variety of natural and built features that reduce the rate of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground. By reducing water pollution and increasing groundwater recharge, LID helps to improve the quality of receiving surface waters and stabilize the flow rates of nearby streams.*
>
> *LID incorporates a set of overall site design strategies as well as highly localized small-scale, decentralized source control techniques know as Integrated Management Practices (IMPs). IMPs may be integrated into buildings, infrastructure, or landscape design. Rather than collecting runoff in piped or channelized networks and controlling the flow*

downstream in a large stormwater management facility, LID takes a decentralized approach that disperses flows and manages runoff closer to where it originates.

Two of the main concepts at the core of LID stormwater management are disconnected impervious areas and diffuse stormwater management. Traditional stormwater management practices include all the impervious areas, such as roofs and pavement, in the central stormwater collection system. This creates high peak flows and limits the ability of the stormwater to infiltrate on site. The LID approach disconnects the impervious areas, which allows runoff from impervious areas to flow over pervious areas. LID design can take many forms, such as directing roof runoff over lawn or landscaped areas or into infiltration drip zones, and allowing parking areas to flow onto perimeter landscape areas. LID design aims to maintain existing drainage features and patterns where possible.

The most cost effective and often ignored method of addressing stormwater quality concerns is pollution prevention. Pollution prevention can be addressed though a number of means such as good housekeeping (litter disposal), limiting the use of fertilizers, public education, street sweeping, etc. These methods are usually overlooked, but offer very cost effective solutions as it is easier to prevent pollution than it is to treat it. LID concepts will be emphasized in this report, but more heavily engineered practices will also be discussed.

STORMWATER MANAGEMENT TECHNOLOGIES APPROPRIATE FOR NORTHWOOD

While it is impossible to know every future circumstance that will require stormwater management, it is expected that most future development will be similar to past types. This assumption will allow for the selection of typical stormwater treatment practices suitable for Northwood. This report considers two (2) broad categories: that of a typical residential development with relatively low density and that of a commercial/industrial site, with a significant percentage of impervious areas. Secondary criteria will be the restrictions imposed by the site itself, such as slope, existing wetlands, soils and receiving water.

The low-density development is ideal for LID practices. There is typically sufficient land available to site diffuse practices, disconnected impervious areas, and open stormwater conveyance measures. Detention facilities can be small and spread throughout the development. Curb and gutter closed drainage systems should be avoided. This type of design will create a complete stormwater management system, which will diffuse throughout the site and attempt to replicate the natural system.

The higher density sites present additional challenges, but are by no means unsuitable for LID practices. Diffuse stormwater management is possible in landscaped areas, within parking lot aisles, around the pavement perimeter, at grassed panels between pavement and walks, and in many other pervious areas. In addition, infiltration can be accomplished in subsurface detention systems to reduce the outflow to surface water. Even in soils not conducive to large amounts of infiltration, a significant amount of groundwater recharge can be achieved on an annual basis with properly designed subsurface detention systems.

The following table shows the suitability of particular practices for various land uses and lot constraints. Following sections of this report provide more information specific to each practice. However, this report is not intended to be a design manual, and the reader is referred to other sources, such as those in the reference section, for more information.

PRACTICE	LID Y/N	Suitable Low Density Residential Y/N	Suitable High Density Comm/Ind Y/N	Preferred Soil Type NRCS/HSG See Note 7	Suitable High Groundwater	Suitable Steep Slopes
QUANTITY CONTROL						
Detention Basin	[1]	Y	Y	All[8]	Y[8]	N
Subsurface Detention	[1]	N[4]	Y	All[8]	Y[8]	N
Infiltration	Y	Y[5]	Y	A, B & C	N	Y[10]
QUALITY CONTROL						
Stormwater Ponds	[1]	Y[6]	Y	B, C, & D[9]	Y[9]	N
Stormwater Wetlands	[1]	Y[6]	Y	B, C, & D[9]	Y[9]	N
Infiltration	Y	Y[5]	Y	A, B, & C	N	Y[10]
Surface Sand Filter	Y	N[4]	Y	A, B, & C	N	Y[10]
Subsurface Wetland	Y	N[4]	Y	All	Y[9]	N
Bioretention	Y	Y	Y	All	Y	Y
Tree Box Filter	Y	Y	Y	All	Y	Y
Vegetated Buffers	Y	Y	Y	All	Y	Y
Permeable Pavement	Y	Y[6]	Y	All	N	N
Treatment Swales	[2]	Y	Y	A, B, & C	Y	Y
Manufactured Products	[3]	N	Y	All	Y	Y

NOTES:

1. Not normally a LID practice but frequently used with LID practices as part of an overall stormwater management system.
2. Not a LID practice but frequently used as part of LID design for water conveyance and pre-treatment.
3. Pre-treatment practice only, particularly for subsurface systems or treatment system in retrofit of existing sites.
4. Not generally suitable for low-density residential developments due to cost and maintenance responsibilities.
5. Infiltration in low-density residential should be limited to those practices that achieve it as part of overall functionality. Infiltration practices require maintenance not normally available in these types of developments.
6. These practices not normally cost effective except in large developments.
7. Development on Group D soils should be limited.
8. These practices in high groundwater soils may have continuous discharge during portions of the year.
9. These practices require base flow of water typically from groundwater.
10. Slope will limit size and surface breakout of water must be considered during design.

QUANTITY CONTROL

Quantity Control Requirements in Northwood

The Northwood Site Plan Review Regulations contain extensive requirements for the control of both the volume and rate of stormwater runoff. These regulations require as a minimum the following:

> The two-year, 24-hour post-development peak flow rate shall be (a) less than or equal to 50 percent of the two-year, 24-hour pre-development peak flow rate and (b) less than or equal to the one-year, 24-hour pre-development peak flow rate.
>
> The post-development total runoff volume shall be equal to 90 to 110 percent of the pre-development total runoff volume (based on two-year, 10-year and 25-year, 24-hour storms).
>
> Except where prohibited, stormwater management designs shall demonstrate that the annual average recharge volume for the major hydrologic soil groups found on-site are maintained.

These regulations require the designer to consider the use of infiltration practices as well as other measures, such as limiting impervious surfaces, utilizing porous pavements, disconnected impervious areas, and other measures to properly manage stormwater. Stormwater detention facilities may be incorporated into an overall stormwater management system, but typically not the sole method of managing stormwater quantity control.

Detention Basins

Detention basins are one of the most common stormwater management measures in use today. The basic detention basin is storage pond designed for either one particular storm, or a series of storm events with sufficient volume to reduce the rate of runoff to some predetermined outlet rate. Detention basins reduce the rate of runoff, but are not typically capable of reducing the volume of runoff. An extended detention basin is a variation of the standard detention basin designed to detain runoff for longer periods of time, typically 24-hours or more. This longer detention time allows time for settling of a portion of the suspended solids.

Advantages	Disadvantages
• Least costly practice to address both quality and quantity issues. • When designed as Extended Detention with sediment forebays can remove significant amounts of sediment and the absorbed pollutants. • Less hazard potential as compared with practices that have a permanent pool.	• Minimal runoff volume reduction. • Minimal removals of soluble pollutants. • Requires relatively large land area. • Potential warming of stormwater. • Resuspension of sediments during large storm events has been reported. • Potential for insect vector problem if basin creates a pool of standing water.

Detention ponds are one of the most common stormwater management measures, and are appropriate under many circumstances for use in Northwood. They are not a LID practice and should be used where LID practices are not feasible or to augment LID practices.

Small Detention Pond at an Industrial Facility

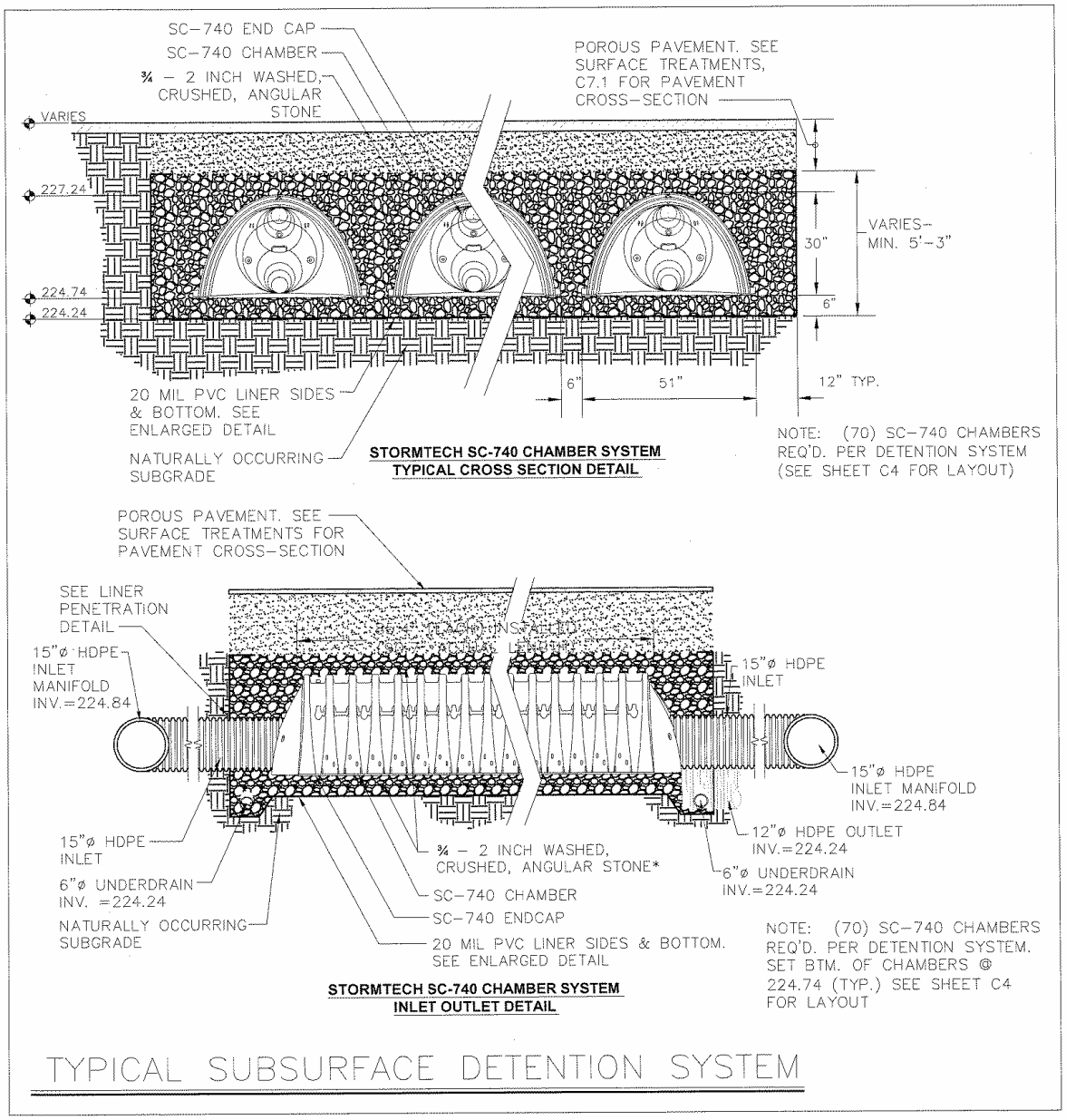
Subsurface Detention Facilities

With usable land becoming increasingly valuable, detention of stormwater in subsurface facilities is a common practice. These systems are commonly constructed under parking lots or other areas of the site outside of the building footprint. A typical subsurface detention facility is constructed by excavating an area to the required depth; lining with a geotextile fabric to prevent the surrounding soil from migrating into the system; installing perforated pipes or chambers; and backfilling with crushed stone. The crushed stone portion of the system has between 30 and 40% open volume available for storage of stormwater, in addition to that available in the pipes or chambers. There are several proprietary products that are designed to replace the pipe and stone and provide over 90% available storage in the total system. Unless these systems are designed as infiltration systems, no treatment of runoff is assumed to occur in the system.

Pretreatment of runoff is critical for these systems to prevent sediment from accumulating within. Depending on the surrounding soils, infiltration of a portion or all of the runoff may be possible (see Infiltration Practices). In areas where the groundwater may be contaminated, or where contamination from inflow into the system may be a concern, the system can be lined with an impervious liner.

Advantages	Disadvantages
• Makes maximum use of available land area. • No unsightly pond requiring screening and fencing. • Will not warm runoff as a surface detention pond can. • Will not create insect vector problem.	• High construction cost. • Minimal runoff volume reduction, unless also constructed as a subsurface infiltration system. • Difficult to maintain; in fact if not properly maintained it may have to be excavated to remove accumulated sediment.

Subsurface detention facilities are appropriate for use in commercial and industrial sites in Northwood; these practices are not LID practices. Refer to the following page for a typical example of a subsurface detention system.


SC-740 END CAP
SC-740 CHAMBER
¾ – 2 INCH WASHED, CRUSHED, ANGULAR STONE
POROUS PAVEMENT. SEE SURFACE TREATMENTS, C7.1 FOR PAVEMENT CROSS-SECTION
VARIES
227.24
224.74
224.24
30"
VARIES– MIN. 5'–3"
6"
6"
51"
12" TYP.
20 MIL PVC LINER SIDES & BOTTOM. SEE ENLARGED DETAIL
NATURALLY OCCURRING SUBGRADE
STORMTECH SC-740 CHAMBER SYSTEM
TYPICAL CROSS SECTION DETAIL
NOTE: (70) SC-740 CHAMBERS REQ'D. PER DETENTION SYSTEM (SEE SHEET C4 FOR LAYOUT)
POROUS PAVEMENT. SEE SURFACE TREATMENTS FOR PAVEMENT CROSS-SECTION
SEE LINER PENETRATION DETAIL
15"ø HDPE INLET MANIFOLD INV.=224.84
15"ø HDPE INLET
15"ø HDPE INLET MANIFOLD INV.=224.84
12"ø HDPE OUTLET INV.=224.24
6"ø UNDERDRAIN INV.=224.24
15"ø HDPE INLET
6"ø UNDERDRAIN INV. =224.24
NATURALLY OCCURRING SUBGRADE
¾ – 2 INCH WASHED, CRUSHED, ANGULAR STONE*
SC-740 CHAMBER
SC-740 ENDCAP
20 MIL PVC LINER SIDES & BOTTOM. SEE ENLARGED DETAIL
STORMTECH SC-740 CHAMBER SYSTEM
INLET OUTLET DETAIL
NOTE: (70) SC-740 CHAMBERS REQ'D. PER DETENTION SYSTEM. SET BTM. OF CHAMBERS @ 224.74 (TYP.) SEE SHEET C4 FOR LAYOUT
TYPICAL SUBSURFACE DETENTION SYSTEM

Infiltration Practices

Infiltration practices refer to any one of several measures designed to store and infiltrate a portion or all of a runoff event. The two broad categories of infiltration practices are infiltration trenches and infiltration basins.

Infiltration trenches, as the name implies, are trenches excavated into the ground with an available volume to store runoff for a sufficient period of time to allow its infiltration into the underlying soil. An infiltration trench is constructed and functions much like the subsurface detention system previously discussed. These systems are typically constructed with perforated pipe or chambers surrounded by crushed stone. Both the pipes and the void space in the stone provide storage of the runoff. The infiltration occurs at the interface between the crushed stone and soil surface. Pretreatment of runoff and maintenance of the pretreatment devices is critical to prevent clogging of the infiltrative soil surface.

Infiltration basins are similar to detention basins but are designed to store and infiltrate a portion of the runoff. Infiltration basins are generally excavated into natural soils with favorable permeability to infiltrate the stormwater over a predetermined period of time. Infiltration basins may be equipped with an outlet to discharge any runoff exceeding the infiltration design storm event.

Advantages	Disadvantages
• Significant reduction in runoff volume. • Provides groundwater recharge.	• Infiltration trench systems can be expensive to construct. • Requires pretreatment and regular maintenance to prevent clogging of infiltrative surface. • Potential for groundwater contamination. • Infiltration basins have potential to experience soil freezing problems.

Infiltration practices are appropriate for use in Northwood and their use should be encouraged. The proposed AOT rules in most circumstances require infiltration of a portion of the stormwater runoff. Infiltration practices are a LID practice and can serve as both quantity and quality controls of stormwater. A number of practices will be discussed in the Quality Controls sections which rely entirely or partially on infiltration for their function. Refer to the following page for an example of a subsurface detention system.

Large subsurface infiltration system under construction.

QUALITY CONTROLS

Stormwater Ponds
(Wet Ponds)

Stormwater ponds have a permanent pool of water to provide treatment of runoff. Stormwater ponds can also have storage above the permanent pool elevation to provide detention of stormwater. The pool creates an environment for the settling of sediments and provides some removal of soluble pollutants. The proposed AOT rules require a sediment forebay and a permanent pool at least equal to the water quality volume.

Advantages	Disadvantages
• Capable of removing sediment and soluble pollutants from runoff. • Capable of providing both quality and quantity control of runoff. • If properly designed and landscaped can be aesthetically pleasing.	• Requires a dependable base flow of water. • Potential to warm runoff. • Can require significant land area. • Will not normally provide significant reduction in runoff volume. • Safety and insect vector concerns.

The use of stormwater ponds in Northwood is only marginally appropriate, and it is not expected that they will be proposed, except in rare circumstances. Not normally considered a LID practice, it can, however, be incorporated in a site utilizing LID practices for additional volume reduction.

Photograph showing stormwater Pond City of Austin, Texas.

Stormwater Wetlands

Stormwater wetlands are wetlands constructed in upland areas that utilize natural wetland functions to remove pollutants by settling, filtering, and plant uptake. The term "Stormwater Wetlands" refers to a number of practices. The Massachusetts Stormwater Handbook lists the following five (5) basic types: shallow marsh systems, basin/wetland systems, extended detention wetlands, pocket wetlands, and gravel wetlands. For the purposes of this report, gravel wetlands will be discussed in a later section. The proposed AOT rules require that a stormwater wetland have a sediment forebay and a permanent pool similar to that of a stormwater pond.

Advantages	Disadvantages
• Capable of removing sediment and soluble pollutants from runoff. • Capable of providing both quality and quantity control of runoff. • If properly designed and landscaped can be aesthetically pleasing.	• Requires large land area. • Costly to construct. • Potential to warm runoff. • Requires a dependable base flow. • Will not normally provide significant reduction in runoff volume. • Safety and insect vector concerns.

The use of stormwater wetlands in Northwood, with the exception of gravel wetlands, although appropriate under many circumstances, are not generally cost effective. With the exception of gravel wetlands, stormwater wetlands are not generally considered a LID practice, although as with other practices, can be used in conjunction with LID practices.

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Infiltration Practices

As previously discussed, infiltration practices are both a quantity and a quality control practice, having many benefits under both categories. In addition to the practices discussed under this section, many of the other practices have an infiltration component. The general construction requirements of infiltration practices have already been discussed and will not be repeated. It will be difficult to meet the treatment standard in the proposed AOT rules without some infiltration component to stormwater management.

Advantages	Disadvantages
• Significant reduction or elimination of discharge to surface waters. • Excellent pollutant removal. • Will not increase water temperature. • Provides groundwater recharge. • Provides water for stream base flow.	• Infiltration trench systems can be expensive to construct. • Requires regular maintenance to prevent clogging of infiltrative surface. • Potential for groundwater contamination, including chloride contamination from deicing salts. • Infiltration basins have potential for soil freezing issues.

As is the case for quantity control, infiltration practices are appropriate for use in Northwood for quality control. Infiltration practices are critical in meeting the requirements of the proposed AOT rules. Infiltration practices are a LID practice.

Photograph of large infiltration practice which serves as both quantity and quality practice.

Filtering Practices

Filtering practices consist of a number of measures, all of which are LID practices, and should be considered for all developments.

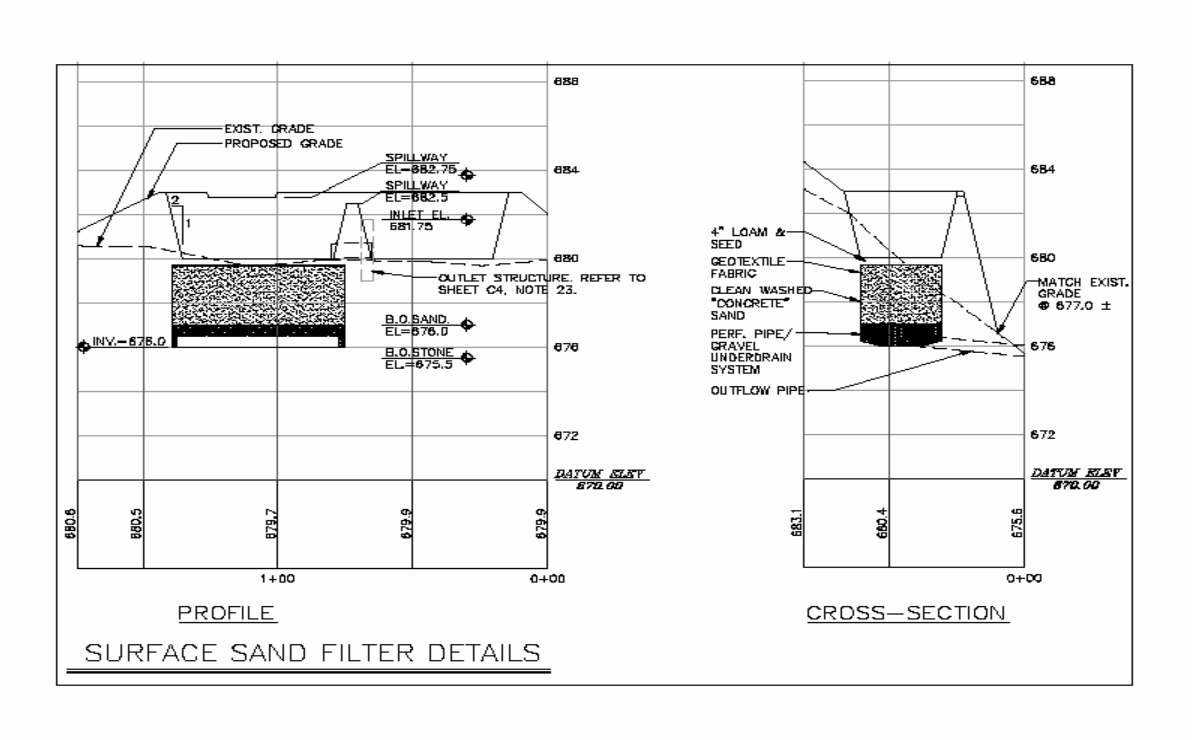
Surface Sand Filter

A surface sand filter is a basin with an underdrained sand bed. Water is introduced onto the surface of the sand bed and allowed to filter through the sand, where it is collected in the underdrain system. Sand filters improve water quality by settling pollutants on top of the filter surface and straining pollutants through the filter media. Sand filters can achieve good removal efficiencies. Sand filters should be preceded by pretreatment measures to prevent sediments from clogging the sand media. If the filter is not lined and the underdrains are set above the bottom of the bed, these practices can also achieve a measure of infiltration depending upon the permeability of the natural soils.

Advantages	Disadvantages
• Can be used in small drainage areas. • Has few site constraints. • Can be used in highly developed sites. • Can be used in areas with low soil permeability.	• Require care until site is stabilized to prevent clogging of sand media with construction related sediments. • Low peak flow reduction, unless incorporated into a detention basin. • May be considered unsightly. • Potential soil freezing issues.

Surface sand filters are appropriate for Northwood and are a LID practice. They can be of any size and placed at various locations within a site. This allows for a diffuse stormwater management system, and although not a quantity practice, a diffuse system will extend the time of concentration of runoff, thereby decreasing its rate.

Surface Sand Filter Under Construction.
Note Detention Pond in Background.



Detail of Surface Sand Filter in Photograph.

Subsurface Wetland

A subsurface wetland is a wetland constructed in a bed or channel which contains an engineered media. The media supports the growth of common wetland plants, such as cattails. The flow is introduced below-grade through a distribution system at the upstream end of the wetland. It flows through the media to a collection system at the downstream end. These systems are typically designed to allow the flow to pass through it below the ground surface. Treatment is accomplished in two ways: through filtration to surrounding soil as the flow passes through the media, and also through absorption as the plant roots uptake some of the water and pollutants. These systems require a nearly continuous supply of water to keep the plants alive, and may not be suitable for dry, well drained sites.

Advantages	Disadvantages
• Can be used in small or large drainage areas. • Provides effective treatment. • Can be used in highly developed sites. • Can be used in areas with low soil permeability. • Insect vectors are not a problem.	• Require care until site is stabilized to prevent clogging of media with construction related sediments. • May be considered unsightly. • Potential soil freezing issues. • Potential anoxic discharge. • Requires continuous water base flow to sustain vegetation.

Subsurface wetlands are appropriate for Northwood, but may have limited application. Subsurface wetlands are a LID practice.

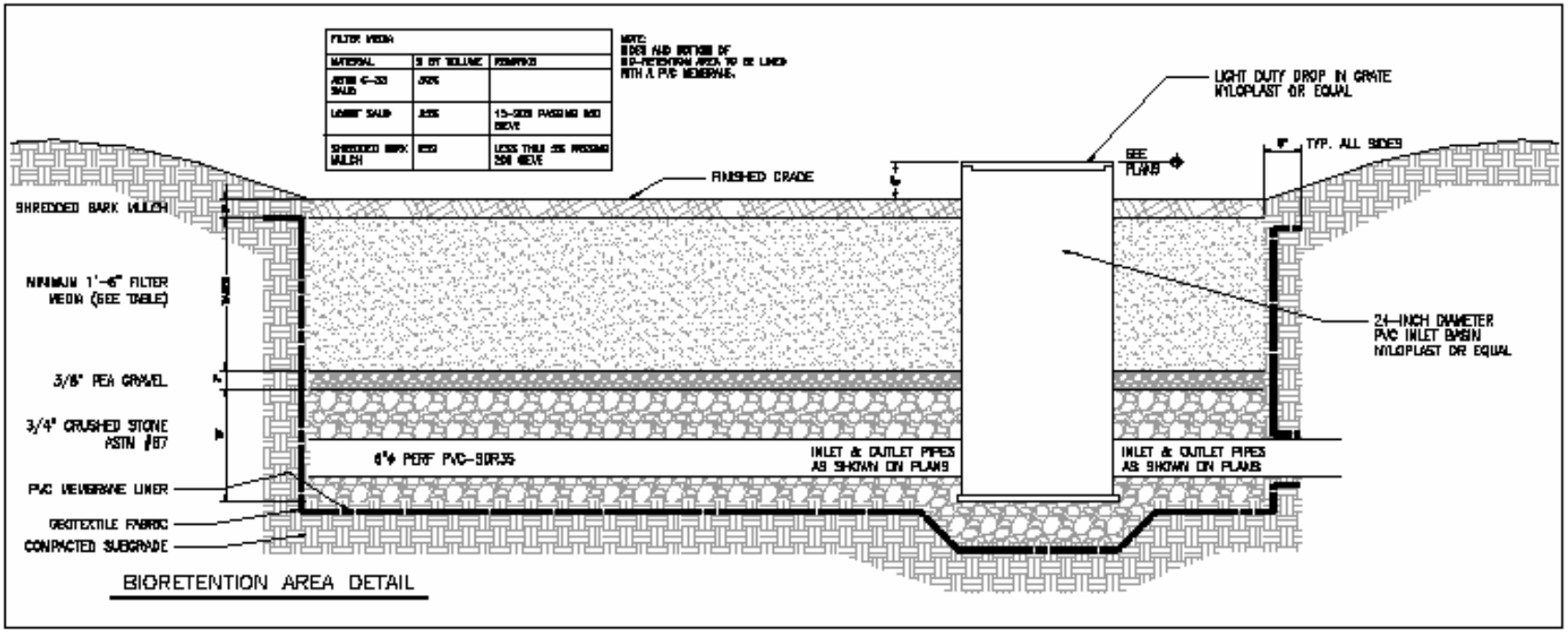
Bioretention Systems

Bioretention systems are the most common LID practice. They can function as a filtering practice or as a filtering and infiltration practice, depending on their construction and the natural soils. Bioretention systems consist of vegetated basins with a filtering media and an underdrain system. The filtering media can be sand or a media containing sand and organic material for better pollutant removal. Bioretention systems can and should be scattered throughout the site. Doing so allows them to be used in smaller areas such as landscape islands, and as with surface sand, filters helps create a diffuse stormwater management system.

Advantages	Disadvantages
• High pollutant removal ability. • Can be used in large or small drainage areas. • With proper sitting and landscaping will blend into the site. • Have few site constraints. • Can be used in highly developed sites. • Can be used in areas with low soil permeability. • Potential for peak flow reduction.	• Require care until site is stabilized to prevent clogging of filter media with construction related sediments. • Potential soil freezing issues.

Bioretention areas are appropriate for Northwood and are a LID practice. They can be of any size and placed at various locations within a site. This allows for a diffuse stormwater management system, and although not a quantity practice, a diffuse system will extend the time of concentration of runoff, thereby decreasing its rate.

Bioretention Area Within a Parking Lot.



Cross-section through Bioretention Area

Tree Box Filter

A tree box filter is a small, specialty bioretention system. It typically consists of a concrete vault with an underdrained, bioretention soil mix, and planted with vegetation, which can consist of shrubs or a small tree. The tree box filter is constructed immediately behind the curb with a break or inlet in the curb to allow the runoff to flow into the tree box filter. They also serve as catch basins. Tree box filters make maximum use of landscape spaces particularly on highly developed sites with a high percentage of imperviousness. Pollutant removal efficiencies are similar to bioretention areas.

Tree box filters should be designed to treat the water quality volume with an overflow bypass for larger runoff events.

Advantages	Disadvantages
• High pollutant removal ability. • Can be used in very small drainage areas. • Can replace catch basins. • With proper planning will complement the landscaping. • Have few site constraints. • Can be used in highly developed sites. • Can be used in areas with low soil permeability. • Serve as part of the stormwater collection system.	• Require care until site is stabilized to prevent clogging of filter media with construction related sediments. • Potential soil freezing issues. • Plantings will require periodic maintenance and long term may require replacement.

Tree box filters are appropriate for Northwood and are a LID practice. They can be placed at various locations outside of the curbing within a site.

Vegetated Buffers

Vegetated buffers are, as the name implies, vegetated areas between a developed site and the resource that is being protected. A vegetated buffer is typically a vegetated area, either planted or left natural, between a small parking area and a wetland or watercourse. Vegetated buffers should be designed to receive sheet runoff only. Vegetated buffers remove sediment and nutrients from runoff through sedimentation, filtration and infiltration. Important design considerations are slope and length. The proposed AOT Rules contain sizing criteria that vary the required buffer length depending on slope, soil type, and type of vegetated cover. The rules also state that the use of vegetated buffers should be limited to low-density residential development, developed areas with less than 10% imperviousness, and small impervious areas.

Advantages	Disadvantages
• Modest pollutant removal. • Can be aesthetically pleasing. • If maintained as a natural area can provide wildlife habitat. • Can be used as a pretreatment measure for other treatment practices.	• Does not provide significant flow rate control. • Can only function under conditions of sheet runoff. • Require significant land area.

Vegetated buffers are appropriate for Northwood and are a LID practice. They can be placed at various locations around the perimeter of a site or as a pretreatment measure for other practices.

Buffer and Grass Treatment Swale.

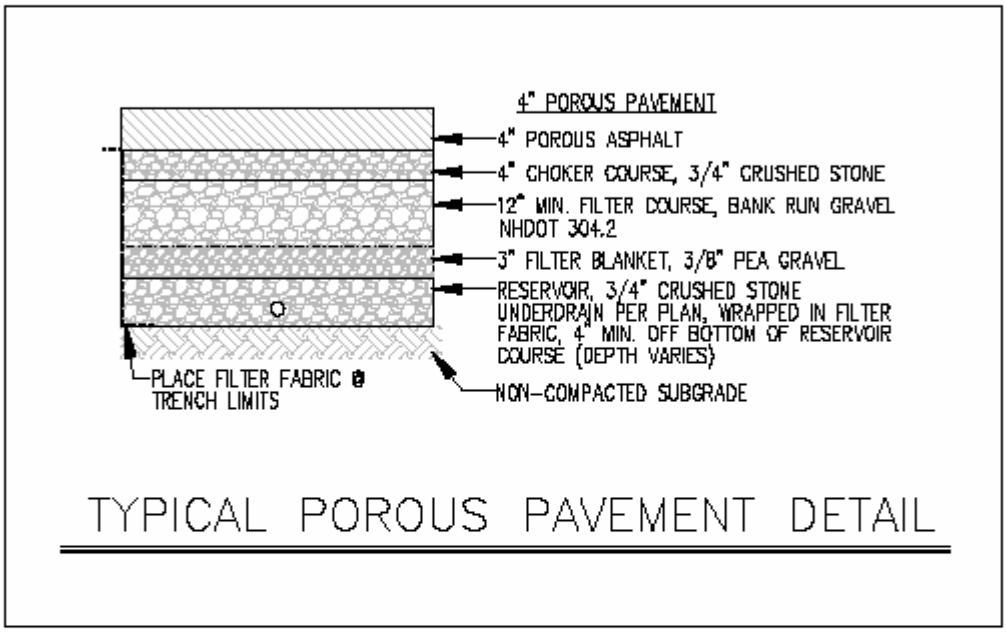
Permeable Pavements

Permeable pavements can consist either of asphalt - typically referred to as porous asphalt, or Portland cement concrete - typically referred to as pervious concrete. In each case the pavement is manufactured with an open-graded aggregate that permits substantial amounts of water to pass through the pavement and into a subbase intended to provide storage and facilitate infiltration. With a properly designed and constructed subbase, pavement manufactured in this manner will have little to no runoff during most storm events. A typical application will have the following cross section or layers:

- Permeable pavement layer.
- Crushed stone layer to provide structural support and remove the water from the immediate subgrade.
- Sand/gravel filter layer; this is the treatment layer.
- A storage/infiltration layer; this layer will vary in size and provides detention storage until the stormwater infiltrates into the surrounding natural ground or is released to the underdrain drainage system in a controlled manner. This layer is typically constructed of crushed stone with or without chambers or pipes to provide enhanced void space.

Advantages	Disadvantages
• Do not increase development footprint, i.e., they use the same land area already being used for an impervious surface. • Provide both quantity and quality management functions. • If used as a detention practice with discharge to surface water will not increase water temperature. • Tests have shown that permeable pavements require less winter maintenance.	• Requires routine vacuuming of surface to maintain effectiveness. • Concerns have been expressed regarding spills of hazardous material on the surface infiltrating through the system and contaminating the groundwater. • Future owners/managers of the site may not be aware of the need to maintain the surface and may perform seal coating, not realizing the negative impact to the system.

Permeable pavements are appropriate for Northwood and are a LID practice.


4" POROUS PAVEMENT
4" POROUS ASPHALT
4" CHOKER COURSE, 3/4" CRUSHED STONE
12" MIN. FILTER COURSE, BANK RUN GRAVEL NHDOT 304.2
3" FILTER BLANKET, 3/8" PEA GRAVEL
RESERVOIR, 3/4" CRUSHED STONE UNDERDRAIN PER PLAN, WRAPPED IN FILTER FABRIC, 4" MIN. OFF BOTTOM OF RESERVOIR COURSE (DEPTH VARIES)
PLACE FILTER FABRIC @ TRENCH LIMITS
NON-COMPACTED SUBGRADE
TYPICAL POROUS PAVEMENT DETAIL

Treatment Swales

The grass treatment swale has long been a widely used stormwater treatment practice in New Hampshire and nearly every other state. The original designs used in New Hampshire were based upon studies performed at the University of New Hampshire and elsewhere. In recent years, this method has been shown to be less effective than other available methods. The proposed AOT rules classify vegetated swales as pretreatment devices. Treatment swales of and by themselves cannot be considered a LID practice due to their low performance. However, they can be used in an overall LID design.

Advantages	Disadvantages
• Require a limited area. • Can function as a stormwater conveyance features. • Relatively inexpensive. • Widely accepted.	• Limited pollutant removal. • Pollutants removed during small storms may washout during large storms.

Treatment swales are appropriate for Northwood and although not a LID practice, they can be utilized as both runoff conveyance and pretreatment in an overall LID design.

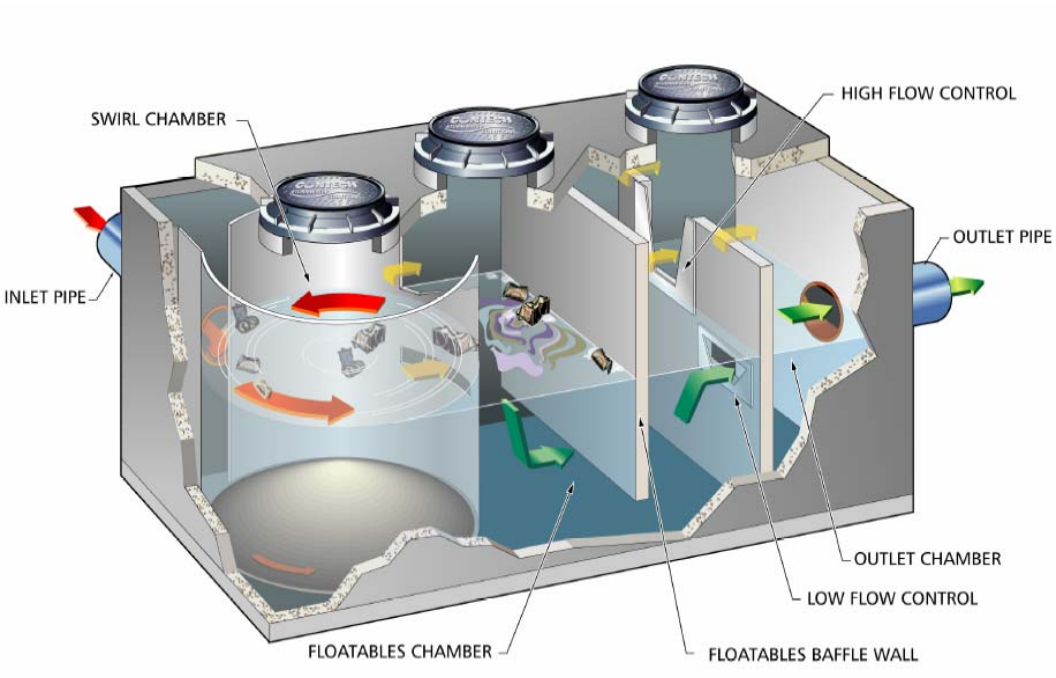
Grass Treatment Swale at Edge of Parking Area.

Manufactured Practices

The market place contains scores of factory-manufactured devices for the treatment of stormwater. A number of these devices have been subject to independent performance testing, but many more have not. These devices tend to be flow-through devices and do not offer flow rate reduction benefits. Common devices include hydrodynamic separators, filter devices with manufactured filter media, and water quality units. Currently these devices are only accepted as pretreatment devices to remove larger particles when implemented with other practices.

Manufactured practices are not LID practices.

Advantages	Disadvantages
• Requires limited land area. • Can be installed under paved areas. • Can be retrofitted into existing drainage system.	• Limited pollutant removals. • Not generally approvable as stand-alone treatment.



Vortechs System graphic courtesy of Contech Construction Products.

LIST OF REFERENCES

1. Alteration of Terrain Rules, Initial Proposal, April 9, 2008, NH Department of Environmental Services.
2. Contech Construction Products, Marketing information.
3. Low Impact Development Center, Beltsville, Maryland, various fact sheets.
4. Massachusetts Stormwater Handbook, Volume 2, February 2008.
5. National Association of Home Builders, Research Center, various fact sheets.
6. NH Stormwater Management Manual DRAFT Copy, May 2007, NH Department of Environmental Services.
7. Northwood Development Ordinance, as amended through March 11, 2008.
8. Northwood Site Plan Review Regulations, as modified 2008.
9. Northwood Subdivision Regulations, revised July 2004.
10. Roseen, et al, Storm Water Low-Impact Development, Conventional Structural and Manufactured Treatment Strategies for Parking Lot Runoff, 2005, UNH Stormwater Center.
11. Stone Environmental, Review of Northwood's Stormwater Management Regulations, Draft Copy, July 12, 2007.
12. TTG Environmental Consultants, various project related information.
13. University of New Hampshire Stormwater Center, numerous publications and fact sheets.
14. US Department of Defense, Unified Facilities Criteria, Design: Low Impact Development Manual, 25 October 2004.
15. US EPA Low-Impact Development Hydrologic Analysis, January 2000.
16. US EPA, Low-Impact Development Design Strategies an Integrated Design Approach, January 2000.
17. US EPA, Wastewater Technology Fact Sheet, Wetlands: Subsurface Flow, September 2000.
18. Vermont Stormwater Management Manual Volume I, Stormwater Treatment Standards, April 2002.

APPENDIX

Summary of Review of Relevant Documents

Note: Publication/revision dates of documents reviewed noted, more recent documents may exist.

Summary of Review of Relevant Documents

July 2008

This review was undertaken as the first item of the project Scope of Work for the Northwood Stormwater Technologies report. This report is being prepared by TTG Environmental Consultants, LLC (TEC) on behalf of the Town of Northwood under contract to the NH Estuaries Project.

The first section of the project scope required the review of relevant Northwood documents, as well as those of the NH DES and the UNH Stormwater Center. In addition, a review of representative documents in the library of TTG Environmental Consultants, LLC (TEC) was performed.

The following documents were reviewed:

I. Northwood Subdivision Regulations, Revised July 2004.
II. Northwood Development Ordinance, Amended March 11, 2008.
III. Northwood Site Plan Review Regulations (2008 Edition).
IV. Draft copy of review of "Northwood's Stormwater Management Regulations," by Stone Environmental, dated July 12, 2007.
V. NH Department of Environmental Services, April 9, 2008, Initial Proposal, Alteration of Terrain (AOT) Rules.
VI. Draft copy of "NH Stormwater Management Manual – Stormwater Management Techniques to Achieve Pollutant Load Reductions for New or Retrofit Development Activities," NH DES May 29, 2007.
VII. University of New Hampshire, Stormwater Center's website.
VIII. Vermont Stormwater Management Manual, Volume I – Stormwater Treatment Standards, Vermont Agency of Natural Resources, April 2002, 5th Printing.
IX. US Department of Defense, Unified Facilities Criteria (UFC), Design: Low Impact Development Manual, 25 October 2004.

There are a seemingly unlimited number of readily available documents on the subject of stormwater management. In addition to the traditional stormwater management practices, Low Impact Development (LID) practices are well represented in the literature. "Low Impact Development (LID) is a stormwater management strategy … LID employs a variety of natural and built features that reduce the rate of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground." LID is the preferred method of the proposed AOT rules of the NH DES, as well as the stormwater programs in a number of other states.

As a result of the review by TEC, the following recommendations for developing appropriate stormwater technologies for Northwood have been developed:

1. Northwood stormwater technologies should parallel or complement those contained in the AOT rules.
2. Small stormwater events should be evaluated for stormwater treatment and stream channel protection.
3. Larger storm events should be evaluated for flooding impacts both on site and below the project site.
4. LID practices should be emphasized, particularly for smaller developments which will only be regulated at the local level.
5. Appropriateness of stormwater practices for a particular project will depend on such features as:
    a. Proposed land use.
    b. Proposed development density.
    c. Position of proposed development on the overall landscape.
    d. Soils.
    e. Sensitivity of adjacent natural resources.
6. Maintenance of stormwater practices should be addressed.

Following review by the Water Resources Subcommittee, TEC will be able to focus on the types of stormwater technologies appropriate for Northwood.

Summary of Documents Reviewed

I. Northwood Subdivision Regulations Revised July 2004

3.04 DRAINAGE

- Provisions for retention and gradual release of storm water. … shall not drain onto adjacent … in an amount which exceeds pre-development.
- Design by PE required.
- Design for 25-year storm. No standing water shall be permitted in ditches, culverts or catch basins.
- Details for drainage facilities at 1"=20".

II. Northwood Development Ordinance Amended March 11, 2008

This is the zoning ordinance for the Town of Northwood, and although it does not contain specific items which can be considered BMPs, it in fact incorporates features that positively impact storm water runoff, as listed below:

Section 5.01 Wetlands Conservation Overlay District

(E) Setbacks

(1) "Where the Wetland Conservation Overlay District and the Conservation Area Overlay District overlap, or where there exists a prime wetland, a 100-foot setback area shall be maintained. …"

Section 5.05 Steep Slope Protection Overlay District

Regulates development on slopes between 20 and 25% for construction related erosion and sediment control and post-construction storm drainage.

Section 6.00 Open Space Design

Provides for smaller lots allowing for a more compact design and reduction in impervious area.

III. Northwood Site Plan Review Regulations (2008 edition)

Section IX Design Standards and Required Improvements

D. Storm Water Drainage

(1) General Requirements

(a) All developments shall make adequate provisions for storm water disposal facilities

P.E. stamp required.
Limits increase in flow off-site.

(b) Prohibit increase, modification or alteration of off-site drainage, erosion or sedimentation.

Provide and maintain means that eliminate detrimental downstream effects.

Shall not increase amount of erosion and sediment in surface waters.

(c) Drainage analysis and Storm Water Management Plan for any site development disturbing 20,000 sf or more, constructing of a road and/or disturbing environmentally critical areas.

(2) Design Standards

(a) Design for 25-year storm event.

Design prepared in conformance with the Green Book.

Drainage facilities in road ROW or 25 ft wide easement.

(b) Pre- and Post-Development Flow

[1] Provide pre- and post-development peak flow rates.

Any site wooded in past five years must be considered undisturbed woods for calculating pre-development flow rates.

[2] 2-year post –development peak flow rate shall be (a) less than or equal to 50% of 2-year, 24-hour pre-development peak flow rate and (b) less than or equal to the one-year, 24 hour pre-development peak flow rate.

[3] 10-year, 24-hour post-development peak flow rate shall not exceed the predevelopment peak flow rate for all flows off-site.

[4] Peak flow rates shall be measured at the drainage system discharge location or down-gradient property boundary.

[5] Design point off property allowed with board approval.

Evaluation of downstream facilities such as culverts.

[6] Post-development total runoff volume shall be equal to 90 to 110 % of pre-development total runoff volume, based on a 2-year, 10-year and 25-year storms.

(c) Groundwater Recharge – Stormwater management shall provide that the annual average recharge volume for the major HSG are maintained.

[1] For all areas covered by low permeability surfaces total volume of recharge that must be maintained shall be calculated as follows:

$$\text{REQUIRED RECHARGE VOLUME } (ft^3) = \frac{\text{(Soil Recharge Factor) X (Area)}}{12}$$

Soil Recharge Factor expressed as follows:

USDA/NRCS HSG	Soil Recharge Factor (inches)
A	0.40
B	0.25
C	0.10.
D	Not required

Area = area in square footage on low permeability surfaces

[2] Pre-treatment requirements

1) Pretreatment prior to groundwater recharge device.

2) Designed to capture anticipated pollutants and easily maintained.

[3] Sizing and design of infiltration (recharge) BMPs

1) Drain within 72 hours from end of storm.

2) At least 3-feet above seasonal high groundwater and bedrock.

3) Soils under BMP to be scarified or tilled to improve infiltration.

4) Infiltration BMPs not located in areas with materials or soils containing regulated or hazardous materials or areas of contaminated groundwater.

[4] Infiltration prohibited or subject to additional pre-treatment under the following:

1) Well-head protection or water supply intake protection area.

2) Area in an area where groundwater reclassified to GAA, GA1 or GA2.

3) Stormwater from "high-load area," as described in Section (e).

(d) Water Quality: If more than 35% site disturbance or 25% low permeability cover:

[1] Remove 80% of the average annual load of TSS, floatables, greases, and oils and/or;

[2] Remove 40% of phosphorus.

(e) Land uses with Higher Potential Pollutant Loads

[1] The following are considered high load and must comply with subsections 1, 2, and 3 below:

1) Areas where regulated substances are exposed to rainfall or runoff; or

2) Areas that generate higher concentrations or hydrocarbons, metals or suspended solids (Followed by a list of 13 facilities).

[2] In addition to BMPs provide a SWPPP describing methods for source reduction and methods of pretreatment.

[3] Infiltration of stormwater from high-load areas is prohibited. Except on parking areas and other areas of the site not involved in high-load uses with pretreatment.

[4] For high-load areas filtering and infiltration practices shall be sealed or lined.

(f) Natural Watercourses – Development transverse by natural watercourse, drainage way, channel, or stream an easement shall be provided.

(g) Accommodation of Upstream Drainage Area.

(h) Flood Plain Areas – Comply with Special Flood Hazard Areas of the regulations.

(i) Areas of poor Drainage – PB may restrict.

(3) Maintenance

(a) O & M

(b) Recording site plan at registry of deeds

(c) Ownership

(4) Reclamation, Redevelopment and Reuse – Previously developed land shall meet the stormwater management standards to the maximum extent technically feasible.

IV. Draft "Review of Northwood's Stormwater Management Regulations" By Stone Environmental, July 12, 2007

Section 4 Comparison of Northwood's Existing Development Rules with Center for Watershed Protection's (CWP)

CWP Principal	CWP Brief Description	Northwood
1 - Street Width	Design residential streets for the minimum required pavement width	Minimum 22-feet w/4 ft gravel shoulders
2 - Street Length	Reduce total length of residential streets.	150-ft or 125-ft minimum frontage per lot
3 - Right-of-Ways	Minimize width of ROW	50-ft required
4 - Cul-de-Sacs	Minimize number of residential cul-de-sacs and incorporate landscape areas to reduce their impervious cover	Not addressed
5 - Vegetated Open Channels	Where applicable vegetated open channels should be use to convey stormwater	Not addressed
6 - Parking Ratios	Curb excess parking space construction	Minimum per use, maximum not specified
7 – Parking Codes	Revise parking codes where mass transit is available or shared parking arrangements are made	Not addressed
8. Parking Lots	Reduce overall imperviousness-compact spaces, reduce stall dimensions, efficient parking lanes, and pervious spillover parking areas	9-ft by 18-ft spaces required, common for NH. Compact spaces not addressed, pervious surfaces not addressed
9 - Structured Parking	Encourage structured and shared parking	No considered important in Northwood
10 – Parking Lot Runoff	Provide stormwater treatment to parking areas using bioretention, filter strips and other practices integrated into the landscaping.	Not specified
11 – Open Space Design	Environmentally-sensitive practices to minimize total impervious area	Allowed under the Development Ordinance
12 – Setbacks and Frontages	Reduce setbacks to reduce total road and driveway lengths	Setback requirements for conventional and open space are identical
13 – Sidewalks	Locate sidewalks on only one side of street, grade to pervious areas	Required on both sides of the street
14 – Driveways	Promote alternate driveway surfaces and shared driveways	Shared driveways between a two lots allowed. Alternate surfaces not addressed
15 – Open Space Management	Clearly specify how open space is to be managed	Not addressed
16 – Rooftop Runoff	Direct roof runoff to pervious areas	Not addressed

17 – Buffer Systems	Create natural vegetated buffers along streams, critical environmental areas, floodplains, steep slopes, wetlands	Buffers required along wetlands
18 – Clearing and Grading	Limit clearing and grading to that required for buildings, access and fire protection	25% of area to remain natural or be landscaped
19- Land Conservation Incentives	Provide incentives in the form of density compensation, buffer averaging, tax reduction, stormwater credits, and by right open space development to promote conservation of stream buffers, forests, meadows etc	Not specified
20 – Stormwater Management	New stormwater outfalls should not discharge untreated or unmanaged stormwater into jurisdictional wetlands, sole-source aquifers and other water bodies	Not specified.

V. NH Department of Environmental Services
April 9, 2008, Initial Proposal
Alteration of Terrain (AoT) Rules

Water Quality Volume (WQV) based upon 1-inch of rainfall – Varies with the percent impervious of the site.

Water Quality Flow (WQF) equals the WQV times the unit peak hydrograph (WQV X q_u).

Ground Water Recharge Volume (GRV) equals volume of runoff that must be captured and infiltrated.

Required (GRV) is based upon hydrologic soil group

Hydrologic Soil Group (HSG)	"R_d" Groundwater Recharge Depth Inches
A	0.4
B	0.25
C	0.10
D	Not Required

GRV = Impervious Area X R_d

QUALITY PRACTICE

Stormwater Ponds

Env-Wq 1508.03 Stormwater Ponds include micropool extended detention ponds, wet ponds, multiple pond systems and pocket ponds.

Stormwater Wetland

Env-Wq 1508.04 Stormwater Wetlands include shallow wetlands, extended detention wetlands, pond/wetland systems, and gravel wetlands.

Infiltration

Env-Wq 1508.05 Infiltration Practices include infiltration trenches, infiltration basins, dry wells, and drip edges.

Filtering Practices

- Pretreatment
- Underground Sand Filter
- Bio Retention
- Pervious Asphalt Pavement
- Pervious Concrete Pavement

Env-Wq 1508.06 Filtering Practices include surface sand filters, underground sand filters, tree box filters, bioretention systems, pervious asphalt, and pervious concrete.

Flow Through Treatment Swale

Env-Wq 1508.07 Flow Through Treatment Swales

Vegetated Buffers

Env-Wq 1508.08 Vegetated Buffers include residential or small pervious area buffers, developed area buffers, roadway buffers, and ditch turn-out buffers.

Env-Wq 1508.10 Pretreatment Practice – Sediment Forebay Used ahead of other practice.

Env-Wq 1508-11 Pretreatment Practice – Vegetated Filter Strips.

Env-Wq 1508.12 Pretreatment Practice – Vegetated Swale.

Env-Wq 1508.13 Pretreatment Practice – Flow-Through Device.

Env-Wq 1508.14 Pretreatment Practice – Deep Sump Catch Basin.

QUANTITY

Channel Protection Requirements (Page 53)

A minimum of one of the following must be met

2-year, 24-hour Post-development volume =/< Predevelopment Volume	2-year, 24-hour post-development rate =/< 2-year, 24-hour predevelopment volume
	2-year, 24-hour post-development peak flow shall be </= 50% of the 2-year, 24-hour predevelopment peak flow rate.
	2-year, 24-hour post-development peak flow rate shall be </= 1-year, 24-hour pre-development peak flow.

Peak Runoff Control Requirements (Page 53)

1. 10-year, 24-hour post-development peak flow rate shall not exceed the 10-year 24-hour pre-development flow rate for all flows leaving the site

2. The 50-year, 24-hour post-development peak flow rate shall not exceed the 50-year, 24-hour pre-development peak flow rate for all flows leaving the site.

   Note: Exemption if no increase downstream peak

VI. Draft – NH Stormwater Management Manual – Stormwater Management Techniques to Achieve Pollutant Load Reductions for New or Retrofit Development Activities, NH DES May 29, 2007

Potential Water Quality Impacts

Changes to Stream flow

- Increase runoff volumes.
- Increase peak runoff discharges.
- Increase runoff velocities.
- Shorter times of concentration.
- Increase frequency of bank-full and near bank-full events.
- Increase flooding.
- Lower baseflows (dry weather flows).

Changes to Stream Geomorphology

- Stream widening and bank erosion.
- High flow velocities.
- Loss of riparian vegetation and canopy.
- Changes in stream bed due to sedimentation.
- Increase floodplain elevation.

Changes to Aquatic Habitat

- Degradation of habitat structure – channel scour, streambank erosion, riparian vegetation loss, sediment deposition.
- Loss of pool-riffle structure.
- Reduced baseflows.
- Increase stream temperatures.
- Decline in abundance and biodiversity of fish and benthic organisms.

Table 6-4a. BMP Removal Efficiencies

BMP	Ref 1,2	BOD	COD	TSS	Pb	Cu	Zn	TN	TP	Cd
Bioretention	2			0.72-0.99	0.7-0.95		0.64-0.95	0.49	0.51-0.91	
Vegetated filter strip	A&B	0.505	0.4	0.73	0.45		0.6	0.4	0.4525	
Grass Swale	A,B&C	0.3	0.25	0.65	0.7	0.5	0.6	0.1	0.25	0.5
Infiltration device	A	0.83		0.94					0.83	
Extended wet detention	A&B	0.72		0.86	0.4		0.2	0.55	0.685	
Stormwater wetland	A&B	0.63	0.5	0.78	0.65		0.35	0.2	0.44	
Dry detention	A&B	0.27	0.2	0.58	0.5		0.2	0.3	0.26	
Settling basin	A	0.56		0.82					0.515	
Sand filter	A	0.4		0.83					0.375	
WQ Inlets	A&B	0.13	0.05	0.37	0.15		0.05	0.02	0.09	
Weekly street sweeping	A	0.06		0.16					0.06	
Infiltration basin	B&D		0.65	0.75	0.65		0.65	0.6	0.65	
Infiltration trench	B&D		0.65	0.75	0.65		0.65	0.55	0.6	
Porous pavement	B		0.8	0.9	1		1	0.85	0.65	
Concrete grid pavement	B		0.9	0.9	0.9		0.9	0.9	0.9	
Sand filter	B		0.55	0.8	0.6		0.65	0.35	0.5	
WQ inlet w/sand filter	B		0.55	0.8	0.8		0.65	0.35		
Hydrodynamic separator	B		0.05	0.15	0.15		0.05	0.05	0.05	
Wet pond	B		0.4	0.6	0.75		0.6	0.35	0.45	
Agriculture filter strip	C								0.5325	0.6125

Sources as referenced in NH DES draft manual.

1. USEPA Region 5
    A. Appendix D. Model Best Management Practice Selection Methodology & Lake County Decision Making Framework, NIPC. July 1994
    B. www.epa.gov/owowwtrl/NPS/MMGI/Chapter4/table407.gif
    C. http://ohiolineag.ohio-state.edu/aex-fact/0467.html; took middle value of ranges of confliction results
    D. Athaqde 1983
2. Sources: US EPA. 2000; Prince George's County Maryland, 2000; US EPA 2006 (compiled)

Table 6-4b. Pollutant Removal Efficiencies by BMP Type

BMP	TSS	TP	TN	Metals[1]	Bacteria
Wet pond	0.80	0.50 (0.51)	0.35(0.33)	0.60(0.62)	0.70
Stormwater wetlands	0.80[2](0.76)	0.50(0.49)	0.30	0.40(0.42)	0.80(0.78)
Filtering practices	0.85(0.86)	0.60(0.59)	0.40(0.38)	0.70(0.69)	0.35(0.37)
Infiltration practices	0.90[3](0.95)	70	0.50(0.51)	0.90[3](0.99)	0.90[4]
Water quality swales	0.85(0.84)	0.40(0.39)	0.50[5](0.84)	0.70	0.0(-0.25)

1. Average zinc and copper. Only zinc for filtration.
2. Many wetland practices in the database were poorly designed; consequently, the sediment removal was adjusted upward.
3. It is assumed that no practice in greater than 90% efficient.
4. Data inferred from sediment removal.
5. Actual data is based on only tow highly performing practices.
6. Assume 0 rather than a negative removal.

Pollutant Removal Database – Revised Edition (winter, 2000).

Source: Adapted from Horsely Witten Group Appendix A: Model Stormwater Regulations Duxbury, Marshfield, and Plymouth, MA, December 31, 2004.

Chapter 7 – Non-Structural Site Design Techniques

7-1 Site Design Techniques

- Minimize Disturbed Area
- Minimize Impervious Cover
- Disconnect Impervious Cover
- Minimize Soil Compaction
- Use Alternative Pavement

7-2 Impervious Surface Disconnection Methods. These are non-structural stormwater management practices that are focused on infiltrating runoff.

- Disconnection of Rooftop Runoff
- Disconnection of Non-Rooftop Runoff
- Stream Buffers
- Grass Channels
- Conservation of Natural Areas
- Environmentally Sensitive Development

Chapter 8 – Selection Criteria for Best Management Practices

8-1 Land Use Criteria

1. Rural: The primary pollutants of concern in rural areas are most often sediment and nutrients. Because of this most stormwater BMPs are appropriate in rural areas, even those that require a large amount of land area. Rural areas also provide an increased opportunity to use non-structural site design techniques, such as maintaining stream buffers and disconnecting impervious surfaces.
2. Roads and Highways: Typical pollutants associated with road and highway runoff include sediments, chlorides, hydrocarbons, metals, and even nitrogen and bacteria. Because of this multiple treatment practices may be needed to address the variety of pollutants. Roads can have a narrow right-of-way that limits space and configuration of BMPs.
3. Commercial Development: Commonly, the majority of the land is consumed by the structure and parking area. Alternative pavements and bioretention areas, for example may be used to promote infiltration and reduce the amount of impervious cover.
4. High Load Areas: Activities include the need for storage of regulated substances that may be exposed to rainfall or runoff. Like commercial development the majority of the available land may be consumed by the building structure of parking lot, the added challenge is that infiltration should be discouraged in order to protect groundwater supplies.

Table 8-1 Land Use Selection Criteria

Category	Practice	Rural	Residential	Roads and Highways	Commercial	High-load Areas[3]
Stormwater Pond	Wet Pond	A	C	A	A[2]	C
	Micropool Extended Detention Pond	A	B	A	A[2]	C
	Wet extended detention pond	A	B	A	A[2]	C
	Multiple pond system	A	C	B	A[2]	C
Stormwater Wetland	Shallow wetland	A	C	A	A[2]	C
	Extended detention wetland	A	C	A	A[2]	C
	Pond/wetland system	A	B	B	B[2]	C
Infiltration Practices	Infiltration trench	B	B	B	B	C
	Infiltration basin	A	B	A	A	C
Filtering Practice	Surface sand filter	B	A	A	A[1]	C
	Underground sand filter	C	B	A	A	A
	Perimeter sand filter	C	C	C	B	B
	Bioretention	B	B	A	A[1]	B
Water Quality Swales	Dry swale	A	A	A	B[1]	C
	Wet swale	A	B	A	B	C

NOTES: A appropriate
B somewhat appropriate
C least appropriate

[1] If not designed to infiltrate.
[2] May require pond liner.
[3] Secondary treatment practices and stormwater treatment trains are typically more appropriate for High-Load areas.
Source: Adapted from CT DEP 2004

8-2 Physical Feasibility Factors

1. Infiltration Capacity – Effectiveness of infiltration practices; easier to mimic natural hydrology of a site if impervious surfaces are located over areas that naturally have low infiltration capacity.
2. Water Table
3. Drainage Area
4. Slope
5. Required Head

Table 8-2 Physical Feasibility Criteria

Category	Practice	Soil Infiltration Capacity	SHWT	Drainage Area (Acres)	Slope	Required Head
Stormwater Pond	Micropool Extended Detention Pond	USDA HSG A and B soils may require pond liner unless groundwater intercepted	Construct below water table Use liner for sites with higher potential pollutant loads or water supply aquifers	10 Min[1]	15% Max	4 to 8 ft
	Wet Pond			25 Min[1]		
	Wet extended detention pond					
	Multiple pond system			1-5 Max[2] (Pocket Pond)		
Stormwater Wetland	Shallow wetland	USDA HSG A and B soils may require pond liner unless groundwater intercepted	Construct below water table Use liner for sites with higher potential pollutant loads or water supply aquifers	10 Min	8% max	2 to 5 ft
	Extended detention wetland			5 max[2] (pocket pond)		
	Pond/wetland system					
Infiltration Practices	Infiltration trench	Min field measured infiltration rate 0.3 in/hr Max infiltration rate 5.0 in/hr Pre-treatment required over 3.0 in/hr	Bottom of facility 3 feet above SHWT	2 max[2]	15% max	1 ft
	Infiltration basin			10 max[2]		3 ft
Filtering Practice	Surface sand filter	Unrestricted	Underdrain for unlined system 2 ft above SHWT	25 max[2]	6% max	5 ft
	Underground sand filter			10 max[2]		5 to 7 ft
	Perimeter sand filter			2 max[2]		2 to 3 ft
	Bioretention			5 max[2]		3 to 5 ft
Water Quality Swales	Dry swale	Unrestricted	Swale bottom 2 -4 ft above SHWT	5 max[2]	5% max	3 to 5 ft
	Wet swale		At or below SHWT			< 1 ft

Notes: [1] Unless adequate water balance
[2] Drainage area can be larger if appropriately sized and designed

Table 8-5 BMP Capability Criteria

Category	Practice	Pollutant Reduction						Groundwater recharge vol reduction	Stream channel Protection	Peak Flow Control
		Sediment	Total P	Total N	Metals	Hydro Carbons	Bacteria			
Stormwater Pond	Micropool Extended Detention Pond	A	A	A	A	A	B	C	A	A
	Wet Pond							B	A	A
	Wet extended detention pond							B	A	A
	Multiple pond system							C	A	A
Stormwater Wetland	Shallow wetland	A	A	A	B	A	A	C	A	B
	Extended detention wetland							C	A	A
	Pond/wetland system							C	A	A
Infiltration Practices	Infiltration trench	A	A	A	A	B	A	A	B	C
	Infiltration basin							A	A	B
Filtering Practice	Surface sand filter	A	A	A	A	A	B	B[1]	B	C
	Underground sand filter							C	C	C
	Perimeter sand filter							C	C	C
	Bioretention							B[1]	B	C
Water Quality Swales	Dry swale	A	B	B	A	B	C	B[1]	C	C
	Wet swale							C	C	C

NOTES: A Effective; B Somewhat effective; C Least effective

[1] If designed as exfilter

Source NH DES adopted from CT DEP 2004

Table 8-6 Maintenance Criteria

Category	Practice	Maintenance Sensitivity	Inspections	Sediment Removal	Other
Stormwater Pond	Micropool Extended Detention Pond	C	C	B	Aging ponds become ineffective and may become pollutant source in some cases; more frequent dredging may be required in watersheds with significant sediment loads
	Wet Pond	C	C	B	
	Wet extended detention pond	C	C	B	
	Multiple pond system	C	C	B	
Stormwater Wetland	Shallow wetland	B	B	A	Requires periodic harvesting to maximize nutrient and metals removal
	Extended detention wetland	C	C	A	
	Pond/wetland system	C	C	A	
Infiltration Practices	Infiltration trench	A	A	A	Frequent sediment/debris removal required to maintain performance
	Infiltration basin	A	A	A	
Filtering Practice	Surface sand filter	A	A	A	Periodic removal and replacement of media is required
	Underground sand filter	A	A	A	
	Perimeter sand filter	A	A	A	
	Bioretention	A	A	A	
Water Quality Swales	Dry swale	C	C	C	Sediment removal may damage swale
	Wet swale	C	C	C	

NOTES: A Significant; B Moderate; C Least
Source: NH DES adapted from CT DEP

Table 8-7 Community and Environmental Criteria

Category	Practice	Maintenance Requirements	Community Acceptance	Affordability	Safety	Habitat
Stormwater Pond	Micropool Extended Detention Pond	B	B	A	A	B
	Wet Pond	A	A	A	C	A
	Wet extended detention pond	A	A	A	C	A
	Multiple pond system	A	A	B	C	A
Stormwater Wetland	Shallow wetland	B	A	B	A	A
	Extended detention wetland	B	B	B	B	A
	Pond/wetland system	A	A	B	C	A
Infiltration Practices	Infiltration trench	C	A	B	A	C
	Infiltration basin	C	C	B	A	C
Filtering Practice	Surface sand filter	B	B	C	B	C
	Underground sand filter	C	A	C	A	C
	Perimeter sand filter	C	A	C	A	C
	Bioretention	B	B	B	A	B
Water Quality Swales	Dry swale	A	A	B	A	C
	Wet swale	A	B	A	A	B

NOTES: A High; B Moderate; C Low
Source: NH DES adapted from NY DEC 2003

VII. University of New Hampshire, Stormwater Center's Web Site

The Center is evaluating both conventional and LID measures.

Conventional Measures

Vegetated and Rock Line Swales

Vegetated dry, wet, or stone-lined stormwater swales are open, channel-like structures that are used to convey stormwater runoff. Trapezoidal channel with minimum slope. Its ability to remove pollutants is modest at best, venerable to large high-velocity storm flows its effectiveness will likely decline with age. Vegetated swales are the most commonly employed stormwater management system.

UNH reports large seasonal variations in performance for TSS, total petroleum hydrocarbons and Zn.

Retention Pond

Retention ponds or "wet ponds" are among the most common stormwater treatment systems. Retention ponds retain a resident pool of standing water, which improves water quality treatment between storms. Retention ponds demonstrate a reasonable strong water quality treatment, particularly in comparison to dry pond systems.

The UNH Stormwater Center reported reasonably effective removals during the first year of operation; however the Center reports a reduction in performance during the second year of operation.

Approximate removal efficiencies:

TSS	70%
Total petroleum hydrocarbons	80%
Dissolved inorganic nitrogen	40%
Zn	90%
Total phosphorus	20%

Hydrodynamic Separators (HDS)

These are manufactured, flow through devices that remove sediment, trap debris, and separate floating oils from runoff. The Center evaluated four (4) different designs. The results indicated that they are most effective when used as

pretreatment devices to remove sediment particles greater than 100 microns in diameter.

A typical HDS consists of a chamber configured to create tangential flow, meaning that the stormwater enters the device through an angled inlet that creates a swirl action to enhance particle settling. Many also contain a flow partition to minimize sediment re-suspension. Typically, they are equipped with a baffle to remove floating debris.

Water quality performance was moderate to poor. The ability of HDS devices to remove sediments was significantly impacted during cold weather months. This is due to the increased viscosity of stormwater runoff and high concentrations of chloride, both of which combine to reduce particle-settling velocity.

Approximate removal efficiencies:

TSS	30%
Total petroleum hydrocarbons	40%
Dissolved inorganic nitrogen	0%
Zn	20%
Total phosphorus	>5%

Low Impact Development (LID) Measures

Bio Retention System

Bio retention systems are landscaped depressions where runoff flows to and collects. The systems are constructed with an engineered soils media and under drain system which filters the runoff allow a portion to infiltrate and collecting the remainder. Bioretention systems area among the most common low impact development stormwater measures.

The Center reports that its bioretention system has proven effective in removing nearly all of the pollutants commonly associated with stormwater treatment performance assessments.

Approximate removal efficiencies:

TSS	95%+
Total petroleum hydrocarbons	55%
Dissolved inorganic nitrogen	30%
Zn	100%
Total phosphorus	5%

Tree Box Filet

Tree box filters are mini bioretention systems that combine the versatility of manufactured devices with the water quality treatment of vegetated systems. The tree box filter's basic design is a concrete vault filled with a bioretention soil mix, planted with vegetation, and underlain with a sub drain. They typically are constructed at the edge of a paved area or in a sidewalk, and in addition to the water quality function, they are integrated into the overall site landscape design.

Approximate removal efficiencies:

TSS	95%+
Total petroleum hydrocarbons	90%
Dissolved inorganic nitrogen	40%
Zn	95%+
Total phosphorus	0%

Subsurface Gravel Wetland

A created wetland with subsurface flow media, it approximates the look and function of a natural wetland, effectively removing sediments and other pollutants commonly found in runoff. It demonstrates a tremendous capacity to reduce peak flow and improve water quality.

The gravel wetland does an exceptional job of removing nearly all of the pollutants commonly associated with stormwater treatment performance assessment. It consistently exceeds EPA's recommended level of removal for TSS and meets regional ambient water quality criteria for nutrients, heavy metals, and petroleum hydrocarbons.

Approximate removal efficiencies:

TSS	95%+
Total petroleum hydrocarbons	95%+
Dissolved inorganic nitrogen	95%+
Zn	95%+
Total phosphorus	55%

Surface Sand Filter

The surface sand filter tested at the Stormwater Center consists of a sediment forebay and a surface sand filtration basin. The filtration basin is composed of a 30-inch deep course to medium grained sand. To achieve maximum reduction of peak flow and stormwater runoff it is important to locate them in soils that

accommodate infiltration and to minimize ponding depth. In the right soils they, they provide infiltration similar to undeveloped areas.

The surface sand filter at the Stormwater Center performed only moderately well at removing most pollutants commonly associated with stormwater treatment performance assessment.

Approximate removal efficiencies:

TSS	50%
Total petroleum hydrocarbons	95%+
Dissolved inorganic nitrogen	0%+
Zn	80%
Total phosphorus	30%

Porous Pavement

The porous asphalt pavement system utilized at the Stormwater Center consists of four (4) basic layers:

- The top is a four-inch layer of porous asphalt pavement with 18 to 20 percent void space.
- The second layer is a four-inch choker course consisting of ¾-inch crushed stone.
- The third layer consists of 24-inches of poorly graded sand or bank run gravel.
- The fourth layer is 21-inches of crushed stone with a six-inch elevated sub drain.

Porous asphalt pavements are an extremely effective approach to stormwater management; rainfall drains through the pavement and directly infiltrates the sub drainage. This significantly reduces runoff volume, decreases runoff temperature, improves water quality, and essentially eliminates impervious surface. The water quality treatment performance generally has been excellent. It consistently exceeds EPA's recommended level of removal of TSS and meets regional ambient water quality criteria for petroleum hydrocarbons and zinc.

The porous asphalt system's ability to manage runoff was exceptional. It has outperformed all systems tested at the Stormwater Center.

Approximate removal efficiencies:

TSS	95%+
Total petroleum hydrocarbons	95%+
Dissolved inorganic nitrogen	0%
Zn	95%+
Total phosphorus	40%

VIII. Vermont Stormwater Management Manual, Volume I – Stormwater Treatment Standards, Vermont Agency of Natural Resources, April 2002, 5th Printing

1.1 Treatment Standards

1.1.1 Water Quality Treatment Standards (WQTS)
Objective to capture 90% of the annual storm events, and remove 80% of the average annual post development TSS and 40% of the TP.

1.1.4 Overbank Flood Protection Treatment Standard
The post-development peak discharge rate shall not exceed the pre-development peak discharge rate for the 10-year, 24-hour storm event

1.1.5 Extreme Flood Protection Treatment Standard
The post-development peak discharge rate shall not exceed the pre-development peak discharge rate for the 100-year, 24-hour storm event.

1.3.2. Water Quality Peak Flow Calculation

$Q_{wq} = q_u * A * WQ_v$

Q_{wq} = peak discharge in cfs
q_u = peak discharge rate in cfs/mi^2/inch
A = drainage area in square miles
WQ_v = Water Quality Volume in watershed inches

2.1 Acceptable Stormwater Treatment Practices (STPs)

STPs to meet the following objectives:
- Water quality
- Water quantity
- Groundwater recharge

2.2 Water Quality STPs
Criteria:
1. Capture and treat the WQ_v
2. Remove 80% TSS and 40% TP
3. Acceptable performance and longevity in the field

From Table 2.1 Lists of Practices Acceptable for Water Quality Treatment

GROUP	PRACTICE	DESCRIPTION
Stormwater Ponds Combination of permanent pool and extended detention capable of treating the WQ_v	Micropool Extended Detention Pond	Pond treats the majority of the WQ_V through extended detention and incorporates a micropool at the outlet of the pond to prevent sediment resuspension
	Wet Pond	Pond that provides storage for the entire water quality volume in the permanent pool
	Wet Extended Detention Pond	Pond that treats a portion of the WQ_V by detaining storm flows above the permanent pool for a specified minimum detention time.
	Multiple Pond System	A group of ponds that collectively treat the WQ_V
	Pocket Pond	A pond design adapted for the treatment of runoff from small drainage area and which has little or no baseflow and relies on groundwater to maintain a permanent pool
Stormwater Wetlands Practices that include significant shallow marsh areas and may also incorporate small permanent pools	Shallow Marsh	A wetland that provides water quality treatment primarily in a wet shallow marsh
	Extended Detention Wetland	A wetland system that provides a portion of the water quality volume by detaining storm flows above the marsh surface
	Pond/Wetland System	A wetland system that provides a portion of the water quality volume in the permanent pool of a wet pond that precedes the shallow marsh wetland.
	Gravel Wetland	A wetland system composed of a wetland plant mat grown in a gravel or rock matrix
Infiltration Practices Capture and store WQ_V before infiltrating into ground	Infiltration Trench	An infiltration practice that stores the water quality volume in the void spaces of a gravel trench before it is infiltrated into the ground.
	Infiltration Basin	An infiltration practice that stores the water quality volume in a shallow surface depression, before it is infiltrated into the ground.
Filtering Practices Capture WQ_V and pass through sand bed, organic matter, soil or other media	Surface Sand filter	A filtering practice that treats stormwater by settling out larger particles in a sediment chamber, and then filtering stormwater through a sand matrix.
	Underground Sand Filter	A filtering practice that treats stormwater as it flows through underground settling and filtering chambers
	Perimeter Sand Filter	A filter that incorporates a shallow sediment chamber and filter bed as parallel vaults adjacent to a parking lot.
	Organic Filter	A filtering practice that uses an organic medium such compost in the filter or incorporates organic material in addition to sand (e.g., peat/sand mix)
	Bioretention	A shallow depression that treats stormwater as it flows through a soil matrix, and is returned to the storm drain system.
Open Channels Practices that capture and treat WQ_V within dry or wet cells formed by check dams or other means	Dry Swale	An open vegetated channel or depression explicitly designed to detain and promote the filtration of stormwater runoff into an underlying soil media.
	Wet Swale	An open vegetated channel or depression designed to retain water or intercept groundwater for water quality treatment.
	Grass Swale	An open channel or depression designed to convey and detain the WQ_V at a maximum velocity of 1fps with a minimum residence time of 10 minutes

2.3 Groundwater Recharge Stormwater Treatment Practices (STPs)

Type	Practice	Notes
Structural	Infiltration Trench	Practice explicitly designed for groundwater recharge
	Infiltration Basin	Practice explicitly designed for groundwater recharge
	Surface Sand Filter	Provides recharge only if designed as an exfilter system
	Organic Filter	Provides recharge only if designed as an exfilter system
	Bioretention	Provides recharge only if designed as an exfilter system
	Dry Swale	Provides recharge only if designed as an exfilter system
	Grass Channel	Refer to document
Nonstructural (Design Credits)	Disconnection of Rooftop Runoff	Vermont Rules allow credits for use of these devices
	Disconnection of non-rooftop runoff	
	Sheet flow runoff to stream buffer	
	Use of Open Vegetated Swales	
	Environmentally sensitive rural development	

2.6 Stormwater Hotspots

A stormwater hotspot is defined as a land use or activity that generates higher concentrations of hydrocarbons, trace metals or toxicants than are found in typical stormwater runoff. If a site or specific discharge point at a site is designated as a hotspot, … First and foremost, stormwater runoff from hotspot discharges cannot be allowed to infiltrate into groundwater unless an individual stormwater permit is obtained.

Table 2.3 Classification of Stormwater Hotspots

The following land uses and activities are deemed stormwater hotspots:

- Vehicle salvage yards and recycling facilities.
- Vehicle fueling stations.
- Vehicle service and maintenance facilities.
- Vehicle and equipment cleaning facilities.
- Fleet storage areas.
- Industrial sites.
- Marinas (service and maintenance).
- Outdoor liquid container storage.
- Outdoor loading/unloading facilities.
- Public works storage areas.
- Facilities that generate or store hazardous materials.
- Commercial container nursery.

IX. U.S. Department of Defense, Unified Facilities Criteria (UFC), Design: Low Impact Development Manual, 25 October 2004

Chapter 1 – Introduction to LID and Manual Overview

1-1 Definition of LID. Low Impact Development (LID) is a stormwater management strategy …LID employs a variety of natural and built features that reduce the rate of runoff, filter out its pollutants, and facilitate the infiltration of water into the ground.

From Figure 1-1

Key LID Elements:

- Directing Runoff to Natural Areas.
- Conservation – Preserves native trees, vegetation and soils. – Maintains natural drainage patterns.
- Small-Scale Controls – Mimics natural hydrology and processes.
- Customized Site Design – Ensures each site helps protect the entire watershed.
- Maintenance, Pollution Prevention and Education – Reduces pollutant loads and increases efficiency and longevity – Educates and involves the public.

1-4 LID Site Design Strategies

Some examples of LID site design strategies include:

- Grade to encourage sheet flow and lengthen flow paths.
- Maintain natural drainage divides to keep flow paths dispersed.
- Disconnect impervious areas such as pavement and roofs from the storm drain network, allowing runoff to be conveyed over pervious areas.
- Preserve the naturally vegetated areas and soil types that slow runoff, filter out pollutants, and facilitate infiltration.
- Direct runoff into or across vegetated areas to help filter runoff and encourage recharge.
- Provide small-scale distributed features and devices that help meet regulatory and resource objectives.
- Treat pollutant loads where they are generated, or prevent their generation.

1-5 Basic List of Integrated Management Practices (IMPs)

Bioretention: Vegetated depressions that collect runoff and facilitate its infiltration into the ground.

Dry Wells: Gravel- or stone-filled pits that are located to catch water from roof downspouts of paved areas.

Filter Strips: Bands of dense vegetation planted immediately downstream of a runoff source designed to filter runoff before entering a receiving structure or water body.

Grassed Swales: Shallow channels lined with grass and used to convey and store runoff.

Infiltration Trenches: Trenches filled with porous media such as bioretention material, sand, or aggregated that collect runoff and exfiltrate it into the ground.

Inlet Pollution Removal Devices: Small stormwater treatment systems that are installed below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain.

Permeable Pavement: Asphalt or concrete rendered porous by the aggregate structure.

Permeable Pavers: Manufactured paving stones containing spaces where water can penetrate into the porous media placed underneath.

Rain Barrels and Cisterns: Containers of various sizes that store the runoff delivered through building downspouts. Rain barrels are generally smaller structures located above ground. Cisterns are larger, often buried underground, and may connect to the building's plumbing or irrigation system.

Soil Amendments: Minerals or organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation.

Tree Box Filters: Curbside containers placed below-grade, covered with a grate, filled with filter media and planted with a tree in the center.

Vegetated buffers: Natural or man-made vegetated areas adjacent to a water body, providing erosion control, filtering capability, and habitat.

Vegetated Roofs: Impermeable roof membranes overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundation.

Chapter 5 LID Design Goals and Objectives

5-3 Fundamental Site Planning Concepts – The goal of LID site planning is to allow for full development and function of the intended site activity while maintaining the site's essential natural or existing hydrologic function. The LID site design process is sequential and iterative, and embraces the following five concepts:

- Hydrology is the Integrating Framework for the Design
  - LID designs have the goal of mimicking the natural site drainage processes and functions.
- Distribute Controls Through Micromanagement
  - View the site as a series of interconnected small-scale design controls
- Stormwater is controlled at the Source
- Incorporate Non-Structural Systems Where Possible
  - LID designs recognize the potential of natural systems to intercept and filter pollutants.
- Utilize Multifunctional Landscape, Buildings and Infrastructures
  - The primary criterion in selecting LID practices is that the design component contributes to satisfying the design and regulatory objectives. Design features are often multifunctional and satisfy multiple objectives.

Table 6-1 Functions of LID Features

Feature	Effect or Function				
	Slower Runoff	Infiltration	Retention	Detention	Water Quality Control
Soil Amendments		**X**			
Bioretention		**X**	**X**	**X**	**X**
Dry Wells		**X**	**X**		**X**
Filter Strips	**X**				**X**
Vegetated Buffers	**X**				**X**
Grassed Swales	**X**				**X**
Infiltration Trenches		**X**			**X**
Inlet Devices					**X**
Rain Barrels			**X**		
Cisterns			**X**		
Tree Box Filters					**X**
Vegetated Roofs	**X**			**X**	**X**
Permeable Pavers		**X**			**X**

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Town of Northwood
Buffer Ordinance

A Final Report to

The New Hampshire Estuaries Project

Submitted by

Strafford Regional Planning Commission
for
Northwood Planning Board – Water Resources Subcommittee
Northwood, NH

October 29, 2008

This project was funded in part by a grant from the New Hampshire Estuaries Project as authorized by the U.S. Environmental Protection Agency's National Estuary Program.

Table of Contents

Abstract

The Town of Northwood Planning Board and the Water Resources Subcommitee, with grant assistance from the New Hampshire Estuaries Project, is working to complete a development ordinance for protection of riparian and shoreland areas adjacent to streams, rivers, lakes and ponds in the town.

The primary goal of implementing a shoreland ordinance in Northwood is to provide water quality protection for and maintain the functions and values of streams, rivers and surfaces waters by limiting development adjacent to them.

Northwood has unique geographic and hydrologic features that are recognized as valuable local and regional resources. The following resources would be protected by implementing a shoreland protection ordinance:

- the headwater areas of five regional watersheds
- headwaters of two designated rivers under the NH Rivers Management and Protection Program and one federally designated Wild and Scenic River
- source waters for two public drinking water supplies within the region
- water quality of the Great Bay and communities downstream in the Coastal Watershed
- economic benefits of providing for flood protection, infrastructure stability, and recreational, aesthetic and property values

Executive Summary

The Town of Northwood Planning Board and its Water Resources subcommitee, with grant assistance from the New Hampshire Estuaries Project, is working to complete a development ordinance for protection of riparian and shoreland areas adjacent to streams, rivers, lakes and ponds in the town. The draft ordinance was developed by the Strafford Regional Planning Commission with assistance from members of the Water Resources Subcommittee.

The primary goal of implementing a shoreland ordinance is to provide protection for and maintain the functions and values of streams, rivers and surfaces waters by limiting development adjacent to them. The proposed Protected Shoreland Ordinance would apply to all perennial streams, rivers and surface waters in Northwood, including those public waters (lakes and great ponds) under the jurisdiction of the New Hampshire Comprehensive Shoreland Protection Act.

The draft ordinance proposes requirements to maintain building setbacks, restrict high risk land uses, and manage stormwater effectively to protect surface water quality, alleviate downstream flooding, and generally protect the functions and values of riparian and shoreland areas for the benefit of the town.

Following is a detailed summary of the unique qualities of streams, rivers, surface waters and watersheds in Northwood, and the rationale for protecting these resources.

- *State Protection - NH Comprehensive Shoreland Protection Act*

Northwood has no 4th order and higher streams and rivers; therefore none of Northwood's streams and rivers are regulated under the jurisdiction of the Comprehensive Shoreland Protection Act (CSPA). The *Official List of Public Waters* by the NH Department of Environmental Services reports that thirteen lakes and ponds are regulated under the CSPA in Northwood.

- *Headwater Streams and Watersheds*

From a regional watershed perspective, Northwood is unique in that it contains the headwater drainage areas of five regional watersheds: the Suncook River, the Bean River, the Lamprey River, the Isinglass River/Nippo Brook, and Bow Lake. The headwater streams of these major watersheds (mainly first order streams) comprise 61 percent of the total stream miles in Northwood (as reported in National Hydrography Dataset (NH DES), November 2007). Headwater streams are particularly important for maintaining water quality due to the shear number of miles they represent in most watershed drainage systems and their contribution to high water quality.

- *Public Drinking Water Supplies*

Both Pleasant Lake and the Lamprey River are surface water sources for public drinking water supplies for the towns of Deerfield and Durham, respectively. Deerfield recently adopted a land use ordinance to protect Pleasant Lake from water quality degradation.

Significant areas of the Lamprey River watershed in Northwood are protected lands. However, some headwater streams (first and second order streams) are located in unprotected areas of the watershed. These first and second order streams are not regulated under the CSPA.

- *State Designated and Protected Rivers*

The Isinglass River in Strafford, Barrington and Rochester, and portions of the Lamprey River in Lee, Epping and Durham are designated as NH Protected Rivers under the Rivers Management and Protection Program. Under the provisions of RSA 483, the special qualities of the Isinglass and Lamprey Rivers are recognized, and as designated rivers, increased protections are provided against the construction of new dams, channel alterations, water quality impairment, and the siting of solid and hazardous waste facilities in the river corridor. While designation of these rivers improves the protection and management of the rivers themselves, ongoing efforts at the local level are needed to address the use and conservation of these river corridors and watersheds, and to protect water quality for the purpose of maintaining the state designated use as Class B water bodies. It is important to note that the lower portion of the Lamprey River is also federally designated as a Wild and Scenic River, one of only two such designated rivers in New Hampshire.

- *Surface Water Quality*

Not only is surface water quality important to the Town of Northwood, but the quality of water leaving the town effects other communities and natural resources within the local watersheds. Some communities downstream in these watersheds are responsible for meeting the EPA Phase II stormwater requirements that require attainment of stringent standards for surface water quality. Therefore, it is of regional importance to maintain the quality of surface water entering these communities from upstream. In addition, maintaining the quality of surface waters throughout the subwatersheds of the greater Coastal watershed and the Great Bay is critical to achieving the local, state and federal goals for protection of the functions and benefits of the natural resources contained within them.

- *Functions and Values of Riparian and Shoreland Areas*

Riparian and shoreland areas that are naturally vegetated - whether grass meadows, forests or shrub and ground cover - are most effective in providing wildlife and fisheries habitat, removing pollutants, maintaining stable streambanks and shorelands, and preventing negative impacts resulting from human activity such as flooding, degradation of water quality, and loss of aesthetic, recreational and land values.

- *Local Conservation Areas*

Northwood has recognized specific areas – Conservation Areas - which possess unique, valuable and irreplaceable natural resources. These Northwood Development Ordinance Section 5.02 Conservation Area Overlay District places specific restrictions on building setbacks from wetlands and surface waters, specific land uses, development density and development pattern within these areas for the purpose of conserving their natural resources. The protected Conservation Areas in Northwood

include Acorn Pond Region, Big Woods Region, Gulch Groundwater Aquifer, Kelsey Mills Region, Narrows Scenic Vista, Northwood Lake Bog Region, and Saddleback Mountain Region.

The Planning Board and the Water Resources subcommittee will continue to review the proposed ordinance and consider endorsing such an ordinance on the ballot for either the March 2009 or March 2010 ballot for vote by citizens of the town.

I. Introduction

In the past several decades, southern New Hampshire has experienced tremendous growth in population and intensification of land use, particularly suburban development and along major transportation corridors such as Route 4 in Northwood. The result of such development is the alteration of natural hydrologic functions and water quality of local watersheds including the loss of riparian vegetation, erosion of uplands and shorelands, sedimentation in surface waters, and loss and fragmentation of habitat.

Municipalities across the state recognize the values that healthy functioning streams, rivers, lakes and ponds provide to the local community and the importance of protecting the designated uses of these surface waters for the benefit of the public.

On the state level, RSA 483-B:8:I-II permits municipalities to adopt shoreland protections more stringent than the minimum standards of the Comprehensive Shoreland Protection Act (CSPA) and encourages adoption of land use ordinances for shorelands of water bodies and water courses other than public waters regulated under the CSPA.

In order to protect its valuable resources, the Town of Northwood Planning Board through their Water Resources subcommittee has developed a draft Protected Shoreland Ordinance. The draft ordinance proposes requirements to maintain building setbacks, restrict high risk land uses, and manage stormwater effectively to protect surface water quality, alleviate downstream flooding, and generally protect the functions and values of riparian and shoreland areas for the benefit of the town.

II. Project Goals and Objectives

The primary goal of implementing a shoreland ordinance in Northwood is to provide water quality protection for and maintain the functions and values of streams, rivers and surfaces waters by limiting development adjacent to them. The Planning Board recognizes the significance of the headwater areas of five regional watersheds and the importance of protecting the quality of surface waters and the stability of drainage systems to alleviate flooding and infrastructure damage during storms for the benefit of its residents and businesses. In addition, Northwood's streams, rivers and surfaces waters provide valuable benefits to the local economy through water recreation, fishing and the aesthetic and property value of healthy shorelands.

The purpose of the proposed ordinance would be to provide similar protections as the Comprehensive Shoreland Protection Ordinance (CSPA) to third order and lower streams and lakes and ponds of less than 10 acres in Northwood, and in some instances, provide more stringent protections than the CSPA. Therefore, the proposed Protected Shoreland Ordinance would apply to all perennial streams, rivers and surface waters in Northwood, including those public waters (lakes and great ponds) under the jurisdiction of the New Hampshire Comprehensive Shoreland Protection Act.

III. Methods

The Water Resources subcommittee had a series of five working sessions with Julie LaBranche, Strafford Regional Planning Commission, from June through October 2008 to develop the draft ordinance and supporting materials. The initial working sessions focused on identifying water quality issues and concerns, identifying resources in need of protection, and prioritizing protection measures and requirements. The remaining working sessions consisted largely of reviewing technical supporting documentation, making revisions to the water resources map, and discussing and developing content of the draft Protected Shoreland Ordinance. To facilitate progress between meetings, Ms. LaBranche provided via email to the Water Resources subcommittee weekly document revisions and other information for review and comment.

On October 9, 2008, the Water Resources subcommittee Chair Karen Smith and Julie LaBranche gave a presentation to the Planning Board of the Rationale document (refer to Appendix C), the draft Protected Shoreland Ordinance, and the Water Resources Map. The presentation lasted for roughly 2 hours during which the Rationale was discussed in detail and the highlights of the ordinance requirements were reviewed. The Planning Board also spent time at the end of the presentation to take a closer look at the Water Resources Map, which depicts: the major regional watersheds; streams, rivers lakes and ponds; buffers and setbacks of varying widths (50, 100, 150, 200 feet); the Conservation Areas (as defined in the Development Ordinance), and conservation lands.

IV. Results and Discussion

Moving Forward with Finalizing the Ordinance

At the conclusion of their meeting October 9, 2008, the Planning Board made no motion or decision to take action on submitting the draft ordinance for official review and a public hearing, but indicated they would like additional time to review the materials and work with the Water Resources subcommittee to review and develop the ordinance further.

Supportive Materials

The Water Resources subcommittee would like to pursue outreach to the public regarding the rationale for the ordinance, the requirements of the ordinance, and how the ordinance may affect property owners. Included as part of this project are the following materials which will be provided to the subcommittee to assist the in these efforts:

- Powerpoint Presentation
- Series of Fact Sheets about the importance of buffers and buffer management, stewardship of shorelands and riparian areas
- Comparison Matrix of CSPA and Draft Ordinance Requirements
- Resources map showing proposed buffers and protected shoreland areas, Conservation Areas and regional watersheds

Note: The PowerPoint Presentation and Fact Sheets are contained on the CD included with this report.

V. Conclusions

The Town of Northwood Water Resources subcommittee has thoughtfully developed a Draft Protected Shoreland Ordinance based upon the unique characteristics of the water resources within their boundaries, consideration of the level of protection currently in place for these resources both on the state and local level, and the benefits that protecting these resources would provide the town. As part of this grant, the subcommittee participated in developing a detailed and informed rationale to support the basis for adoption of such an ordinance.

The next very important step for the subcommittee and the Planning Board will be to seek public input during consideration of the ordinance and provide a forum for the public to learn about the requirements and benefits of adopting local protections for streams, river, lakes and ponds in Northwood.

If adopted, the proposed Protected Shoreland Ordinance will extend similar and in some instances more stringent protection standards than the minimum requirements of the Comprehensive Shoreland Protection Act. This extension of protection standards on the local level is specifically supported by the language of RSA 483-B:8:I-II, which permits municipalities to adopt shoreland protections more stringent than the minimum standards of the CSPA and encourages adoption of land use ordinances for shorelands of water bodies and water courses other than public waters regulated under the CSPA.

VI. Recommendations

1. Northwood Development Ordinance, Section 5.01 Wetlands Conservation Overlay District. Add clarification that the Overlay District (Section 5.01(B) and the required 100 foot setback within the Conservation Area Overlay district apply to wetlands *as well as to all surface waters, specifically all perennial streams, rivers, lakes and ponds* [Section 5.01(E)].

2. The stormwater management regulations recently adopted as part of the Site Plan Review Regulations should be incorporated into the Subdivision Regulations of Northwood.

3. The draft proposed Protected Shoreland Ordinance contains provisions to permit specific structures, uses and activities within the Waterfront Buffer by grant of a Conditional Use Permit from the Planning Board. At this time, Northwood has not adopted in its Development Ordinance the necessary administrative procedures and requirements for grant of Conditional Use Permits. A municipality's authority to require a conditional use permit comes from RSA 674:16 (the general grant of zoning power) and RSA 674:21 (allowing the use of innovative land use controls and conditional use permits). Both of those statutes require ordinances to be enacted under the zoning ordinance enactment procedures of RSA 675:2-5.[1]

   Conditional use permits can be administered by any person or board the town selects (RSA 674:21, II). The Planning Board is often granted administration authority for these permits, whereby the conditional use permitting process can be combined or submitted concurrently with a site plan review or subdivision application for a more streamlined approval process. Refer to Appendix B for a draft Conditional Use Permit Ordinance.

   As part of their review of the proposed Protected Shoreland Ordinance, the Planning Board must decide whether to accept the Conditional Use Permit requirements, and if so, to whom the administration authority will be granted. Another option the Planning Board may consider is to allow those specific uses under the "Conditional Use Permit" section of the proposed ordinance by Special Exception, which would be granted by the Zoning Board.

4. Existing Requirements in the Northwood Development Ordinance for Special Exceptions in the proposed Protected Shoreland District

   It is important to note that the Northwood Development Ordinance contains specific requirements to permit alteration of nonconforming lots, uses and structures. These

[1] NH Local Government Center, January 2006, *Town and City available at http://www.nhmunicipal.org/LGCWebsite/InfoForOfficials/legalqamasterpage.asp?offset=20&LegalQAID=41*

requirements allow for alterations of noncomforming conditions through grant of a Special Exception from the Zoning Board. Refer to excerpts from the Northwood Development Ordinance below.

1.04 NON-CONFORMITY. This section specifies those rights to which nonconforming uses, structures and lots are entitled.
(B) Non-conforming Structure. The following control non-conforming structures:
(3) Portions of structures within a setback may be enclosed or expanded upwards if granted a Special Exception by the ZBA. The ZBA shall grant the Special Exception only if the following conditions are met:
(a) If an upward expansion, it shall not have any adverse impact on any neighboring property, including but not limited to blocking of views and/or sunlight.
(b) If an upward expansion, it shall not exceed the maximum height limitations specified in this Ordinance.
(c) the expansion shall not increase any other nonconforming aspect of the structure or lot. (Rev. 3/00)
(C) Non-conforming Lot. The following control non-conforming lots:
(3) Dimensionally nonconforming lots which were created or Northwood Development Ordinance Adopted March 9, 1999 Page 5 existed prior to December 31, 2005 and which contain less than 80,000 square feet may be developed without compliance with the requirements established by section 3.02 of this ordinance for lot size if granted a Special Exception by the ZBA. The ZBA shall grant the Special Exception only if the following conditions are met (Rev:3/08):
(a) septic systems shall be located 75 feet or greater from open drainage or surface water, 50 feet or greater from hydric B soils, 75 feet or greater from existing wells; and septic systems must meet all other setback requirements set by the New Hampshire Department of Environmental Services, unless a waiver has been granted by the appropriate state regulatory agency; and,
(b) the well protection radius shall be 75' or greater and may not extend beyond the building setback on an adjoining lot; (Rev. 3/06) and,
(c) all other dimensional requirements shall be met.(Rev. 3/08)
(5) If water body or wetland setbacks can not be achieved on an undeveloped pre-existing lot because the lot does not have sufficient depth from the water body or wetland, a new structure shall be permitted if granted a Special Exception by the ZBA. The ZBA shall grant the Special Exception only if the following conditions are met:
(a) Sanitary water supply and sewage disposal are provided, and if on-site, the sewage disposal is located as far from the water body or wetland as is feasible or necessary;
(b) Non-water body or non-wetland setbacks shall be reduced by up to 50% before the water body or wetland setback is reduced, ensuring maximum protection of the water body, shoreline, or wetland.
(c) The structure shall not be located within the 100 year floodplain.
(d) Non-waterbody and non-wetland setbacks shall not be reduced to less than 10 feet.

SECTION 5.00 OVERLAY DISTRICTS.
5.01 WETLANDS CONSERVATION OVERLAY DISTRICT.
(D) Uses allowed by Special Exceptions. Special exceptions may be granted by the Board of Adjustment, upon notice and hearing as prescribed in RSA Chapter 676, for the following uses within the Wetlands Conservation Overlay District and its setbacks:
(1) Those uses essential to the productive use of land not within the Wetlands Conservation Overlay District shall be allowed by Special Exception. Those uses include, but are not limited to: the construction of roads, other access ways, utility rights-of-way and easements, including power lines and pipelines, with adequate provisions where called for, for the continued, uninterrupted flow of surface run-off water. The ZBA shall grant a Special Exception, provided the following are met:

(a) after the applicant meets with the Conservation Commission, findings by the Northwood Conservation Commission regarding the proposal are submitted with the Special Exception application, are reviewed by the ZBA, and are made part of the record of the case; and
(b) dredging, filling or other alteration shall be designed to minimize adverse impact on the wetland and its setbacks, even if this requires adjustments in design outside of this overlay district; and
(c) there shall be provisions made to restore the site as nearly as possible to its original grade and condition; and (Rev. 3/01)
(d) a state wetlands permit shall be obtained when required.
(e) a Special Exception is not required when the use meets the criteria for a permit by notification as defined by the NH Wetlands Bureau Code of Administrative Rules. (Rev. 3/00) (Rev. 3/05)
(E) Setbacks.
(1) Where the Wetland Conservation Overlay District and the Conservation Area Overlay District overlap, or where there exists a prime wetland, a 100 foot setback area shall be maintained. No structures shall be constructed within this setback. Vegetation within this buffer area shall remain in its natural state. (Rev. 3/00)
(3) Structures shall not be placed within 20 feet of the edge of a wetland unless a Special Exception for the structure and use have been obtained in accordance with §5.01(D)(2). The 20 foot setback may be reduced on pre-existing non-conforming lots in accordance with §1.04(C)(2). If the setback is reduced in accordance with §1.04(C)(2), structures shall not be closer to the wetland than the reduced setback allows unless a Special Exception for the structure and use have been obtained in accordance with §5.01(D)(2).

In considering options to permit specific uses by Conditional Use Permit as proposed in the Draft Protected Shoreland Ordinance, the Planning Board must determine which would be the stricter standard and may also consider amending the existing language noted above to make this clear.

VIII. Appendices

Appendix A - Draft Protected Shoreland Ordinance
Appendix B – Comparison Matrix of CSPA and Draft Ordinance
Appendix C – Draft Conditional Use Permit Ordinance
Appendix D - Rationale for Implementation of a Protected Shoreland Ordinance
Appendix E - Draft Press Release and Distribution List
Appendix F - Map of WatersResources for the Draft Protected Shoreland Ordinance

Appendix A - Draft Protected Shoreland Ordinance

DRAFT
PROTECTED SHORELAND ORDINANCE
TOWN OF NORTHWOOD, NEW HAMPSHIRE

I. Title and Authority

A. Title: This Ordinance shall be known as the "Protected Shoreland Ordinance" of the Town of Northwood, New Hampshire.

B. Authority: Pursuant to the authority granted by RSA 483-B:8, Municipal Authority; RSA 674:17 I., Purposes of Zoning Ordinances; this ordinance is hereby adopted by the Town of Northwood, New Hampshire to protect the public health, safety, and general welfare.

II. Purpose and Intent

The purpose of this ordinance is to protect the quality of all streams, rivers and surface waters in the Town of Northwood; to protect riparian and aquatic ecosystems; and to provide for the environmentally sound use of land resources.

The Town of Northwood finds that the protection of the streams, rivers and surface waters of Northwood is vital to the health, safety and economic welfare of its citizens. It is the desire of Northwood to protect and maintain surface water resources by implementing these regulations. It is the desire of Northwood to protect and maintain the native vegetation in riparian and shoreland areas by implementing specifications for the establishment, protection, and maintenance of vegetated buffers along all stream and river systems and surface waters to achieve the stated purpose of this ordinance.

Whereas, buffers adjacent to streams, rivers and surface waters provide environmental protections, resource management benefits, and services important to the health and welfare of the community. It is therefore the intent of this ordinance to establish riparian and shoreland buffers adjacent to all streams, river and surface water bodies in Northwood in which regulated development and limited land uses and activities will be permitted. The economic values, public benefits and environmental resources provided by riparian and shoreland buffers include:

- minimizing the impact of floods by promoting bank stabilization and reducing erosion,
- generally maintaining water quality, and protecting public and private water supplies,
- reducing sedimentation and removing pollutants in stormwater runoff,
- providing groundwater recharge through infiltration of runoff,
- protecting aquatic habitat by protecting riparian areas and wetlands and maintaining stream base flow,
- providing scenic, aesthetic and property values, and
- sustaining the economic benefit of recreational water bodies.

IV. Applicability

A. Protected Shoreland District**.** The Protected Shoreland District of Northwood, New Hampshire is an overlay district superimposed over the town's existing zoning districts. The District includes within its boundary a protected riparian area adjacent to all perennial

streams and rivers, and the shoreland adjacent to surface waters located within the municipality, including all public waters under the jurisdiction of the NH Comprehensive Shoreland Protection Act. The Protected Shoreland District does not apply to fire ponds and farm ponds, as defined by this ordinance.

B. District Boundaries. The boundaries of the Protected Shoreland District ("the District") shall encompass all land within a horizontal distance of 250 feet perpendicular from the reference line of all perennial streams, rivers and surface waters as defined by this ordinance. It is the responsibility of an applicant to fully identify and delineate as part of an application all perennial streams, rivers and surface water bodies on the site.

C. Interpretation of District Boundaries. Where uncertainty exists as to the exact location of district boundary lines, the Code Enforcement Officer or designee shall be the final authority as to boundary locations.

D. This ordinance shall apply to all forestry and timber harvesting activities not permitted under RSA 227:J.

E. This ordinance shall apply to surface mining operations except those operations that are operating in compliance with an approved permit under the Town of Northwood Ordinances, Section XI Excavation of Earth Products.

F. This ordinance shall not apply to agricultural operations that are covered by an approved Natural Resources Conservation Service (NRCS) conservation plan that includes the application of best management practices (BMPs) as required by RSA 483-B:3, III.

V. Definitions

Best Management Practices (BMPs) - a proven or accepted structural, non-structural, or vegetative measure the application of which reduces erosion or sedimentation, stabilizes stream channels, or reduces peak storm discharge, or improves the quality of stormwater runoff, or diminishes the quantity of stormwater runoff flowing to a single location by using multiple BMPs at separate and dispersed locations. BMPs also include construction site maintenance measures such as removing construction debris and construction waste from construction sites and disposing of debris and waste appropriately in order to reduce contamination of stormwater runoff.

Development is defined as:

1. The improvement of property for any purpose involving building;
2. Subdivision or the division of a tract or parcel of land into two or more parcels;
3. The combination of any two or more lots, tracts, or parcels of property for any purpose; and
4. The preparation of land or disturbance of the land surface for any of the above purposes.

Disturbance – an activity in which natural vegetation is removed, soil is exposed or removed, or where the land surface is altered.

Farm Pond – a depression made in the land surface or constructed with berms, usually made of earth, to detain water for irrigation, waterfowl, other farm uses or activities, or for recreation.

Fire Pond - a depression made in the land surface or constructed with berms, usually made of earth, used to store water for the purpose of fire suppression or prevention.
Ground Cover – any herbaceous or woody plant which normally grows to a mature height of 2 feet or less, especially mat forming vegetation which stabilizes the soil.
Impervious Surface – any areas covered by material that cannot absorb water or effectively infiltrate water into the soil. Examples of impervious surfaces include buildings, roofs, decks, patios, and paved, and gravel or crushed stone driveways, paths, parking areas, and walkways.
Lot of Record – a legally created parcel, the plat and description of which has been recorded at the registry of deeds for the county in which it is located.
Natural Revegetation – upon cessation of mowing or other landscaping maintenance, the process by which ground cover, grasses, shrubs and trees are established by natural succession.
Non-Conforming Lot – a single lot of record, which, at the effective date of adoption or amendment of this Ordinance, does not meet the dimensional requirements of the district in which it is located or a lot that does not meet the requirements of this ordinance.
Non-Conforming Structure – a structure which does not meet any one or more of the following dimensional requirements; setback, height, or lot coverage, but which is allowed solely because it was in lawful existence at the time this Ordinance or subsequent amendments take effect, or a structure that does not meet the requirements of this ordinance
Non-Conforming Use – use of buildings, structures, premises, land or parts therefore which is not permitted in the district in which it is situated, but which is allowed to remain solely because it was in lawful existence at the time this Ordinance or subsequent amendments take effect, or a use that does not meet the requirements of this ordinance
Ordinary High Water Mark - the line on the shore, running parallel to the main stem of the river, established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the immediate bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.
Primary Building Line – the closest distance of an existing non-conforming structure measured from the reference line of a stream, river or surface water body.
Reference Line – is defined by this Ordinance as follows:

(a) for natural fresh water bodies without artificial impoundments, the natural mean high water level (including the natural mean high water level for water bodies as determined by the NH Department of Environmental Services in the List of Public Waters published by the Department pursuant to RSA 271:20.II.);
(b) for artificially impounded fresh water bodies with established flowage rights, the limit of the flowage rights, and for water bodies without established flowage rights, the waterline at full pond as determined by the elevation of the spillway crest;
(c) for third and fourth order and higher rivers and streams, the ordinary high water mark; and
(d) for first and second order streams, the extent of the defined channel.

Protected Shoreland - a vegetated area, including trees, shrubs, and herbaceous vegetation that exists or is established within 250 feet of the reference line a stream or river, or from the mean high water level of a lake, pond or reservoir.
Setback – the horizontal distance from the reference line of a stream, river or surface waters to the nearest part of a structure.

Stream, Perennial - a stream that normally flows year round because it is sustained by groundwater discharge as well as by surface water. A perennial stream exhibits the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water. Perennial streams (or portions thereof) are portrayed as solid blue lines on a USGS topographic map, where mapped.
Stormwater or Surface Water Runoff – water that flows over the surface of land resulting from rainfall or snowmelt. Surface water enters streams and rivers to become channelized stream flow.
Surface Waters – standing water or flowing water at or on the surface of the ground, including streams, rivers, lakes, ponds and reservoirs.
Water Dependent Use or Structure – a use or structure that services and supports activities that require direct access to, or contact with the water, or both, as an operational necessity and that requires a permit under RSA 482-A, including but not limited to a dock, pier, breakwater, beach, boathouse, retaining wall, or launching ramp. Hydroelectric facilities, including, but not limited to, dams, dikes, penstocks, and powerhouses, shall be recognized as water dependent structures; however, these uses are exempt from the requirements of this Ordinance.

VI. Protected Shoreland and Buffer Requirements

A. Within the Protected Shoreland District:
   1. Structures shall be located a minimum distance of 50 feet from the reference line of a stream, river and surface waters; and
   2. Septic systems shall be located a minimum distance of 75 feet from the reference line of a stream, river and surface waters.

B. Within the Protected Shoreland District:
   1. The total area of impervious surface on any lot or portion of a lot within the Protected Shoreland District shall not exceed twenty percent (20%). The percent impervious surface area shall be calculated based only on the area of the parcel or lot located within the Protected Shoreland District.
   2. The total area of impervious surface on any lot or portion of a lot within the Woodland Buffer of the Protected Shoreland District may be increased up to 30 percent through the grant of a Conditional Use Permit provided that:
      a. if the Woodland Buffer is fully vegetated, clearing is limited to 35 percent of the area of the lot within the Woodland Buffer, or
      b. if the Woodland buffer is not fully vegetated, 65 percent of the area of the lot within the Woodland Buffer must be planted or allowed to naturally regenerate with vegetation. It is encouraged that plantings consist of a combination of native trees, shrubs and groundcover.

C. Within the boundaries of the Lamprey River and Isinglass River watersheds and the drainage area of Pleasant Lake in Northwood, all new structures, modifications to existing structures, and land disturbance within the Protected Shoreland District shall be designed and constructed in accordance with the stormwater management requirements and design standards as adopted in the Northwood Site Plan Review Regulations, as amended.

FOLLOWING ARE OPTIONAL REQUIREMENTS FOR PART C ABOVE

Stormwater shall be managed as described below under the following circumstances:

1. For single-unit residential development on lots legally established or developed prior to adoption of this ordinance:
   a. stormwater runoff from all impervious surfaces shall be managed on the site, and
   b. stormwater runoff shall be infiltrated (i.e. directed to an underground facility, a rain garden or other infiltration method) or directed to heavily vegetated areas of less than 15 percent slopes as overland, nonconcentrated flow.
2. For preexisting nonconforming lots, structures and uses:
   a. stormwater treatment and management shall be provided for all new impervious surface created on the site, and
   b. stormwater runoff from existing impervious surfaces shall be treated and managed to the extent possible given site conditions.

D. For determination of compliance with the requirements of this ordinance, a site plan, in accordance with the requirements of Section VIII, shall be submitted to the Building Inspector for all development activities within the Protected Shoreland District that do not require approval by the Planning Board.

E. For all new development, redevelopment, conversion of use, and expansion of existing structures and buildings, where a fully vegetated Waterfront Buffer does not exist (when buffer applicable to the site), establishment of a fully vegetated Waterfront Buffer by natural regeneration and/or combination of natural regeneration and plantings of trees, shrubs and groundcover is required.

F. Waterfront Buffer

The Waterfront Buffer serves as a Protected Shoreland consisting of a strip of land extending along the full boundary of a stream, river and surface waters. As described below in Section VI.B, the Waterfront Buffer width shall be adjusted to include contiguous areas such as steep slopes or erodible soils, where development or disturbance may adversely affect surface waters and wetlands.

1. The Waterfront Buffer shall be those protected shorelands within 0 to 50 feet of the reference line of a stream, river, and surface waters.
2. No chemicals, including pesticides of any kind or fertilizers of any kind shall be applied except those specifically applied for the purpose of conducting Agriculture operations, as described in Section IV.F.
3. Owners of lots that were legally developed prior to adoption of this ordinance may maintain but not enlarge cleared areas, including but not limited to existing lawns and beaches, within the Waterfront Buffer. Conversion to or planting of cleared areas with native species of ground cover, shrubs, saplings, and trees is encouraged but shall not be required unless it is necessary to meet the requirements of this ordinance.
4. Dead, diseased, or unsafe, trees, saplings, or shrubs that pose an imminent hazard to structures or have the potential to cause personal injury may be removed. Rocks and stumps and their root systems shall be left intact in the ground. For approval to remove

such vegetation within the Waterfront Buffer, an application with documentation of the condition(s) must be submitted to the Code Enforcement Officer.

5. Normal trimming, pruning, and thinning of branches to the extent necessary to protect structures, maintain clearances, and provide views is permitted. Trimming, pruning, and thinning of branches for the purpose of providing views shall be limited to the bottom half of the trees or within 30 feet of the ground surface, whichever is less.
6. When necessary for the completion of water-dependent construction activities, a temporary 12-foot wide access path shall be allowed. The access path shall be completely restored and replanted with native vegetation upon completion of construction except as allowed under subparagraph 6 below and Section VII.B.5.
7. A permanent 6-foot wide path to provide access to the water body, configured in a manner that will not concentrate storm water runoff or contribute to erosion, is allowed. Areas of natural ground cover and the minimum number of trees can be removed when necessary to construct a footpath to water as provided under Section VI.C.6 and Section VII.B.5. The use of pervious materials for construction of an access path is strongly encouraged.
8. The minimum 50 foot Waterfront Buffer shall be expanded if steep slopes are present within the Protected Shoreland District that drain toward surface waters under the jurisdiction of this ordinance. In these cases, the Waterfront Buffer shall be expanded to include all slopes greater than 25 percent as measured over a 10-foot horizontal interval that are contiguous with and extend beyond the minimum 50 foot Waterfront Buffer and to the landward boundary of the Protected Shoreland District.

G. Woodland Buffer

The purpose of the Woodland Buffer shall be to protect the quality of public waters by minimizing erosion, preventing siltation and turbidity, stabilizing soils, preventing excess nutrient and chemical pollution, maintaining natural water temperatures, maintaining a healthy tree canopy and understory, preserving fish and wildlife habitat, and respecting the overall natural condition of riparian and shoreland areas.

1. A Woodland Buffer shall be maintained in natural vegetation from 50 to 150 feet of the reference line of streams, rivers and surface waters.
2. The following standards apply to maintenance of a Woodland Buffer:
    a. At least 50 percent of the land area within the Woodland Buffer shall be maintained in a naturally vegetated and undisturbed state. A healthy, well-distributed stand of trees, saplings, shrubs, ground cover and their living, undamaged root systems shall be left in place. Tree canopy shall be maintained to the extent possible.
    b. Lots legally established or developed prior to adoption of this ordinance that do not comply with Section VI.F.2 of this ordinance:
        i. are encouraged to, but shall not be required to, increase the percentage of area maintained in a naturally vegetated and undisturbed state, except as may be required by the Planning Board as part of a Site Plan or Subdivision approval;
        ii. if less than 50 percent naturally vegetated, the percentage of area maintained in a naturally vegetated state shall not be decreased; and
        iii. if less than 50 percent naturally vegetated, additional clearing may be permitted to allow for expansion of an existing structure provided that an area twice the cleared area is replanted or allowed to naturally regenerate with native

vegetation within the Woodland Buffer or up to 50 percent of the Woodland Buffer is replanted or allowed to naturally generate with native vegetation, whichever is less.

3. Dead, diseased, or unsafe, trees, saplings, or shrubs that pose an imminent hazard to structures or have the potential to cause personal injury may be removed. For approval to remove such vegetation within the Woodland Buffer, an application with documentation of the condition(s) must be submitted to the Code Enforcement Officer.
4. Normal trimming, pruning, and thinning of branches to the extent necessary to protect structures, maintain clearances, and provide views is permitted. Trimming, pruning, and thinning of branches for the purpose of providing views shall be limited to the bottom half of the trees or within 30 feet of the ground surface, whichever is less.
5. Preservation of dead and living trees that provide dens and nesting places for wildlife is encouraged.
6. Planting of native species that are beneficial to wildlife are encouraged.

VII. Prohibited Uses, Structures and Activities

A. The following uses, structures and activities are prohibited within the Protected Shoreland District:
   1. Establishment or expansion of salt storage yards, automobile junk yards and solid or hazardous waste facilities.
   2. Establishment or expansion of animal feed lot operations, dry cleaning establishments, and automobile service and repair shops.
   3. Laundry and car wash establishments not on municipal or public sewer.
   4. Disposal or land application of bio-solids, including but not limited to septage, sewage sludge and animal manure.
   5. Subsurface disposal of pollutants from sewage treatment facilities (excluding existing on-site septic systems and new on-site septic systems permitted by the state).
   1. Storage of hazardous waste and substances (as defined under RSA 147-A), including but not limited to road salt, de-icing chemicals, herbicides, pesticides, or fertilizer. Limestone may be used within 25 feet of the reference line of any property.
   2. Within the Woodland Buffer (from 50 to 150 feet beyond the reference line) only low phosphate, slow release nitrogen fertilizer or limestone may be used on lawns or areas with grass, gardens and landscaped areas.
   3. Bulk or temporary storage of chemicals above or below ground.
   4. Bulk or temporary storage of petroleum products or hazardous materials above or below ground, excluding normal residential or business use of liquid petroleum products and heating fuels for on-premise use.
   5. Sand and gravel excavations (as defined in RSA 155-E).
   6. Mining or the processing of excavated materials.
   7. Dumping or disposal of snow and ice collected from roadways or parking areas from outside of the Shoreland Protection District.

VIII. Conditional Uses and Activities In the Waterfront Buffer

A. With the grant of a Conditional Use permit, the Planning Board may permit the following limited uses and activities within the Waterfront Buffer.
   1. Roads, driveways, bridges, access ways, and utilities in accordance with the following standards:
      a. The applicant shall be required to provide an analysis to ensure that no feasible alternative is available to avoid or minimize impacts to the Waterfront Buffer.
      b. The right-of-way should be the minimum width needed to allow for maintenance and installation of an access way or utility right of way.
      c. The angle of the crossing shall be perpendicular to the Protected Shorelands in order to minimize clearing requirements and shall be located to minimize overall disturbance to the buffer.
      d. The minimum number of road crossings should be used within each subdivision, to provide reasonable access and use of the property.
   2. Utilities, including but not limited to transmission lines, pipelines and associated infrastructure.
   3. The total area of impervious surface on any lot or portion of a lot within the Woodland Buffer of the Protected Shoreland District may be increased up to 30 percent providing the standards of Section VII.B and Section VIII.B are met.
   4. Water dependent uses and structures including, but not limited to, docks, wharves, and boat ramps.
   5. Recreational footpaths and trails requiring minimal removal of vegetation and without alteration of grade.
   6. Other permitted uses subject to necessary local and state approval, include the following:
      a. Public water supply facilities, including water supply intakes, pipes, water treatment facilities, pump stations and disinfectant stations;
      b. Public water and sewage treatment facilities;
      c. Hydroelectric facilities, including, but not limited to dams, dikes, penstocks and powerhouses;
      d. Public utility lines and associated structures and facilities; and
      e. Flood control structures.

B. In granting a conditional Use Permit such limited uses and activities within the Waterfront Buffer, the applicant must demonstrate to the satisfaction of the Planning Board and the Planning Board must find that all of the following standards have been met.
   1. The use is in keeping with the purpose and intent as stated in Section II of this Ordinance.
   2. The use or activity is the minimum necessary to achieve reasonable use of the property.
   2. No feasible alternative exists on the site to locate the use or activity outside the Waterfront Buffer.
   3. The least impacting route and methodology for the use or activity have been selected as the best practicable alternative.
   4. Disturbance or removal of existing vegetation has been minimized and disturbed areas are restored to the extent possible.

IX. Site Plan Requirements

A. For all development proposed within the Protected Shoreland District, a site plan shall be submitted that includes a complete and informative, descriptive and schematic representation of the proposed activity by means of narrative, maps, graphs, charts, or other written or drawn documents so as to enable the Planning Board, Building Inspector or other agent of the Town an opportunity to make a reasonably informed decision regarding compliance with the requirements of this ordinance.

B. All site plans or subdivision plans submitted and prepared for recording and all right-of-way plans shall clearly:
    1. Show the extent of forested and naturally vegetated areas, including a narrative of the species and distribution of existing vegetation and an inventory of trees within the Waterfront Buffer and Woodland buffer;
    2. Identify field delineated and surveyed streams, springs, seeps, bodies of water, wetlands, 100-year floodplain with the direction of flow shown;
    3. Hydric soils mapped in accordance with the NRCS soil survey of the site area;
    4. Slopes greater than 25 percent over a ten foot interval;
    5. Label all Protected Shorelands areas including required buffers and setbacks;
    6. Provide a note to reference any Protected Shoreland stating "Clearing, grading, construction or disturbance is permitted only in accordance with the requirements of the Protected Shoreland District Ordinance"; and
    7. Contain the signature and stamp of a certified wetland scientist and a licensed professional surveyor.

X. Non-Conforming Lots, Uses and Structures

A. Non-Conforming Lots. Non-conforming, undeveloped lots of record that are located within the Protected Shoreland District shall be developed in such a manner that demonstrates a "good faith" effort to comply to the extent possible with the requirements of this ordinance. Except as otherwise provided in this Ordinance, a non-conforming lot shall not be permitted to become more non-conforming. In the case of an existing lot becoming nonconforming as the result of establishment of a new stream or river or relocation of an existing stream or river due to natural conditions or events, the lot shall be maintained or developed in such a manner that demonstrates a "good faith" effort to comply to the extent possible with the requirements of this ordinance.

B. Non-Conforming Uses. Existing uses, which are non-conforming under this ordinance, may continue until the use ceases to exist or the use is discontinued for a period of one year. Within the Protected Shoreland District, an existing non-conforming use may not be changed to another non-conforming use and an existing nonconforming use may not be expanded to become more non-conforming. Existing non-conforming uses shall be required to meet the requirements of this ordinance to the maximum extent possible.

C. Non-Conforming Structures. Non-conforming, undeveloped lots of record that are located within the Protected Shoreland District shall comply with the following restrictions, in addition to any other requirements of the zoning ordinance:

1. Except as otherwise prohibited, non-conforming structures erected prior to the effective date of this Ordinance and located within the Protected Shoreland District may be repaired, renovated, or replaced in kind using modern technologies, provided the result is a functionally equivalent use. Such repair or replacement may alter the interior design or existing foundation, but no expansion of the existing footprint or outside dimensions shall be permitted.
2. Between the primary building line and the reference line, no alteration shall extend the structure closer to the adjacent stream, river or surface waters, except that the addition of a deck or an open porch no greater than 300 square feet is permitted up to a maximum of 12 feet closer to but no closer than 20 feet from the reference line.
3. For any expansion of a nonconforming structure landward of the primary building line within the Waterfront Buffer, an area of vegetation equivalent to the increase in footprint of the structure shall be planted preferably first within the Waterfront Buffer or alternatively within the Woodland Buffer. It is encouraged that plantings consist of a combination of native trees, shrubs and groundcover.

Appendix B – Comparison Matrix of CSPA and Draft Ordinance

Comparison of the requirements of the NH Comprehensive Shoreland Protection Act and the proposed Draft Protected Shoreland Ordinance for the Town of Northwood

Requirements	NH Comprehensive Shoreland Protection Act	Northwood Draft Protected Shoreland Ordinance
Applicability	4th order and higher streams/rivers Lakes and Great Ponds (> 10 acres)	All perennial streams and river, and lakes and ponds (of any size)
Setbacks - Structures	50 feet for Primary Structures	50 feet for any Structure (as defined by Northwood Development Ordinance)
Setbacks – Septic Systems	75 feet and where the receiving soil downgradient of the leaching portions of a septic system is a porous sand and gravel material with a percolation rate equal to or faster than 2 minutes per inch, the setback shall be at least 125 feet from the reference line	75 feet
Note: Within the Conservation Area Overlay District a 100 foot setback is required for all structures is required, and would be the stricter standard within the Protected Shoreland District.		
Buffers (as measured from reference line)	0-50 foot Waterfront Buffer 50-150 foot Woodland Buffer	Same
Activities Permitted in the Waterfront Buffer	When necessary for the completion of construction activities permitted in accordance with RSA 483-B:6, a temporary 12 foot wide access path shall be allowed. The access path shall be completely restored and replanted with native vegetation upon completion of construction except as allowed. A permanent 6-foot wide foot path to the water body, configured in a manner that will not concentrate storm water runoff or contribute to erosion, is allowed.	When necessary for the completion of water-dependent construction activities, a temporary 12-foot wide access path shall be allowed. A permanent 6-foot wide path to provide access to the water body, configured in a manner that will not concentrate storm water runoff or contribute to erosion, is allowed.
Impervious Surface	No more than 30 percent of the area of a lot located within the protected shoreland shall be composed of impervious surfaces. If the impervious surface area exceeds 20 percent, a stormwater management system shall be implemented and maintained which is designed to infiltrate increased stormwater from development, and the waterfront buffer must meet or be planted to meet the minimum 50-point score requirement.	Total area of impervious surface on any lot or portion of a lot within the Protected Shoreland District shall not exceed twenty percent (20%). Total area of impervious surface on any lot or portion of a lot within the Woodland Buffer of the Protected Shoreland District may be increased up to 30 percent through the grant of a Conditional Use Permit and compliance with requirements for natural Buffers

Requirements	NH Comprehensive Shoreland Protection Act	Northwood Draft Protected Shoreland Ordinance
Clearing – Waterfront Buffer	Clearing permitted based on the grid and point system as described in Part V (2)(D) of the RSA 483-B:9	Dead, diseased, or unsafe, trees, saplings, or shrubs that pose an imminent hazard to structures or have the potential to cause personal injury may be removed. Normal trimming, pruning, and thinning of branches to the extent necessary to protect structures, maintain clearances, and provide views is permitted.
Clearing – Woodland Buffer	For lots with one-half acre or less of land within the natural woodland buffer, the vegetation within at least 25 percent of the area outside the waterfront buffer shall be maintained in an unaltered state. For lots with greater than one-half acre of land within the natural woodland buffer, the vegetation within at least 50 percent of the area outside the waterfront buffer, exclusive of impervious surfaces, shall be maintained in an unaltered state.	At least 50 percent of the land area within the Woodland Buffer shall be maintained in a naturally vegetated and undisturbed state. Lots legally established or developed prior to adoption of this ordinance are encouraged to, but shall not be required to increase the percentage of area maintained in a naturally vegetated and undisturbed state if less than 50 percent.
Stormwater Management and Erosion Control	All new structures, modifications to existing structures, and excavation or earth moving within protected shoreland shall be designed and constructed in accordance with rules adopted by the department under RSA 541-A for terrain alteration under RSA 485-A:17, to manage stormwater and control erosion and sediment, during and after construction.	All new structures, modifications to existing structures, and land disturbance within the Protected Shoreland District shall be designed and constructed in accordance with the stormwater management requirements and design standards as adopted in the Northwood Site Plan Review Regulations, as amended, and special standards for single-unit residential development and preexisting nonconforming lots, structures and uses.
Use of Chemicals (including pesticides and fertilizers)	No fertilizer, except limestone, shall be used within 25 feet of the reference line of any property. Twenty-five feet beyond the reference line, low phosphate, slow release nitrogen fertilizer or limestone, may be used on lawns or areas with grass.	Prohibited in Waterfront Buffer

Requirements	NH Comprehensive Shoreland Protection Act	Northwood Draft Protected Shoreland Ordinance
Prohibited Uses	Uses that pose high risk of contamination to surface water	Same
Discretionary Uses/Conditional Uses	Public water supply facilities (including water supply intakes, pipes, water treatment facilities, pump stations, and disinfection stations), placement and expansion of public water and sewage treatment facilities, Hydroelectric facilities, public utility lines and associated structures and facilities, public roads, and public water access facilities shall be permitted by the commissioner as necessary, consistent with the purposes of this chapter and other state law.	Roads, driveways, bridges, access ways, and utilities; Water dependent uses and structures; Recreational footpaths and trails; Public water and sewage treatment facilities; Flood control structures; and Hydroelectric facilities
Non-Conforming Lots	Conditions may be imposed which, in the opinion of the commissioner, more nearly meet the intent of this chapter, while still accommodating the applicant's rights. Building on nonconforming lots of record shall be limited to single family residential structures and related facilities, and other water dependent structures, consistent with state law.	Non-conforming, undeveloped lots of record that are located within the Protected Shoreland District shall be developed in such a manner that demonstrates a “good faith” effort to comply to the extent possible with the requirements of this ordinance. A non-conforming lot shall not be permitted to become more non-conforming.
Non-Conforming Uses and Structures	Except as otherwise prohibited by law, nonconforming structures located within the protected shoreland may be repaired, renovated, or replaced in kind using modern technologies, provided the result is a functionally equivalent use. Such repair or replacement may alter the interior design or existing foundation, but shall result in no expansion of the existing footprint.	An existing non-conforming use may not be changed to another non-conforming use and an existing nonconforming use may not be expanded to become more non-conforming. Existing non-conforming uses shall be required to meet the requirements of this ordinance to the maximum extent possible.
Exempt Uses	Forest management as conducted in compliance with RSA 227-J:9; forestry conducted by or under the direction of a water supplier for the purpose of managing a water supply watershed; and agriculture conducted in accordance with best management practices as required by RSA 483-B:3, III	Forestry and timber harvesting activities not permitted under RSA 227:J Agricultural operations that are covered by an approved Natural Resources Conservation Service (NRCS) conservation plan that includes the application of best management practices as required by RSA 483-B:3.

Appendix C – Draft Conditional Use Permit Ordinance

EXAMPLE
CONDITIONAL USE PERMIT ORDINANCE

I. Conditional Use Permit

A. The purpose and intent of a Conditional Use permit is to allow certain uses, activities and development that are not normally permitted under conventional zoning provisions. Specifically authorized conditional uses appear in Article ___ Section _____ Table of Land Uses. A Conditional Use shall be approved if the application is found to be in compliance with the approval criteria in Article ___ Section _____. Further conditions may be placed on the Conditional Use Permit by the Planning Board to ensure that the Conditional Use will have a positive economic, fiscal, public safety, environmental, aesthetic, and social impact on the town. The Planning Board shall make findings of fact, based on the evidence presented by the applicant, Town staff, and the public, regarding whether the Conditional Use is or is not in compliance with the approval criteria of Article ____, Section ____.

B. No use, structure, building or land requiring a conditional use permit shall be used, constructed, altered or expanded unless a conditional use permit specifically required by this chapter has been authorized and issued by the Planning Board

C. Any use that was lawfully established prior to the adoption, extension or application of this chapter and is now permitted by this chapter subject to a conditional use permit may continue in the same manner and to the same extent as conducted prior to said adoption or extension of this chapter.

D. Structures or buildings devoted to any use which is permitted under the terms of this ordinance subject to the securing of a conditional use permit, may not be altered, added to, enlarged, expanded or moved from one location to another on the lot without securing a new conditional use permit.

II. Procedures

A. Application

1. Application for a conditional use permit shall be made by the owner of the affected property, or his designated agent, on a form obtainable from the Planning Office.

2. The completed application and fee as set by the Town shall be submitted to the Planning Office.

B. Procedure for Consideration

1. After receipt by the Planning Office, the completed application shall be transmitted to the Planning Board staff for their review and evaluation.

2. The Planning Office shall set a public hearing date and publish a notice, which advertises the public hearing before the Planning Board in a newspaper of general circulation. Public notice shall be made at least ten (10) calendar days prior to the meeting of the Planning Board at which the application is to be considered.

3. The Planning Board shall consider the application at its next regular meeting following the public notice process.

6. Where development approval for a conditional use includes subdivision or site plan approval by the Planning Board, the application and review procedure for a conditional use permit shall be made concurrently and in accordance with the procedures specified in the

Subdivision Regulations or Site Plan Regulations as applicable to the particular development.

C. Approval of Application and Granting of Conditional Use Permit

At least ____ (___) members must vote in favor of the issuance of a Conditional Use Permit for an application to be approved. Upon rendering a decision to grant a conditional use permit with conditions of approval that must be adhered to by the applicant, the Planning Board shall issue a conditional use permit with the conditions of approval referred to and itemized in the permit. The application shall record the Conditional Use Permit application and Findings of Fact and Conditions of Approval at the Strafford County Registry of Deeds.

D. Revocation

In the event of a violation of any of the provisions of these regulations or amendments thereto or in the event of a failure to comply with any prescribed condition of approval or stipulations placed upon such approval, the Planning Board shall suspend any conditional use permit immediately, and shall set a date for a hearing to determine if such suspensions shall be lifted or if the conditional use permit shall be revoked. The Planning Board shall be the hearing body. In the case of a revocation of a conditional use permit, the determination of the Planning Board shall be final, unless recourse is sought in a court of competent jurisdiction.

E. Termination and Transferability

Once granted, a conditional use permit, with its terms and conditions, shall:

1. Run with the property, building, structure or use and shall not be affected by changes in ownership.
2. Terminate twelve (12) months from the date of authorization if the authorized use has not begun:
    a. Unless otherwise specified in the conditions of approval; or
    b. Unless the applicant can demonstrate sufficient reason(s) at a public hearing before the Planning Board why the permit should be extended.
    3. Terminate after twelve (12) consecutive months of nonuse of the permitted use.

F. Denial of a Conditional Use Permit Application

In the event that an application is denied by the Planning Board, no resubmittal of an application for a conditional use permit for the same or similar use may be made for one (1) year from the date of said denial, unless sufficient new evidence or conditions are offered to the Planning Board to demonstrate that the circumstances have altered and that further consideration of the application is warranted. In such an event, the resubmitted application shall follow the same procedures as the original and shall be treated as a new application.

III. Approval Criteria

A. Planning Board Decision Based on Findings

Every decision of the Planning Board pertaining to the granting, denial or amendment of a request for a conditional use permit shall be based upon findings of fact and conditions of approval. The findings of fact and conditions of approval shall be supported in the records of its proceedings. The criteria enumerated in Subsection C are required to be met in any matter upon which the Planning Board is required to decide under these regulations. A mere finding or recitation of the enumerated conditions unaccompanied by findings of specific fact shall be deemed not to be in compliance with these regulations.

B. Burden of the Applicant

The applicant shall bear the burden of persuasion, through the introduction of sufficient evidence, through testimony, or otherwise that the use or development, if completed as proposed, will comply with this Article and will satisfy the specific requirements for the use contained in the ordinance.

The criteria in Section C below may be included in this ordinacne and would likely apply to non-residential uses and major subdivisions.

C. Criteria Required for Consideration of a Conditional Use Permit

A conditional use permit shall be granted only if the Planning Board determines that the proposal conforms to all of the following conditional use permit criteria:

1. Site Suitability: The site is suitable for the proposed use, including but not limited to:
    a. Adequate vehicular and pedestrian access for the intended use;
    b. Availability of adequate public services to serve the intended use including emergency services, pedestrian facilities, schools, and other municipal services;
    c. Absence of environmental constraints; and
    d. Availability of appropriate utilities to serve the intended use including water, sewage disposal, stormwater disposal, electricity, and similar utilities.
2. External Impacts: The external impacts of the proposed use on abutting properties and the neighborhood shall not substantially impact adjacent existing uses or other uses permitted in the zone. This shall include, but not be limited to, traffic, noise, odors, vibrations, dust, fumes, hours of operation, and exterior lighting and glare. In addition, the location, nature, design, and height of the structure and its appurtenances, its scale with reference to its surroundings, and the nature and intensity of the use, shall not have an adverse effect on the surrounding environment nor discourage the appropriate and orderly development and use of land and buildings in the neighborhood.
3. Character of the Site Development: The proposed layout and design of the site shall not be incompatible with the established character of the neighborhood and shall mitigate any external impacts of the use on the neighborhood. This shall include, but not be limited to, the relationship of the building to the street, the amount, location, and screening of off-street parking, the treatment of yards and setbacks, the buffering of adjacent properties, and provisions for vehicular and pedestrian access to and within the site.
4. Character of the Buildings and Structures: The design of any new buildings or structures and the modification of existing buildings or structures on the site shall not be incompatible with the established character of the neighborhood. This shall include, but not be limited to, the scale, height, and massing of the building or structure, the roof shape or line, the architectural treatment of the front or street elevation, the location of the principal entrance, and the materials proposed to be used.
5. Preservation of Natural, Cultural, Historic, and Scenic Resources: The proposed use of the site, including all related development activities, shall preserve identified natural, cultural, historic, and scenic resources on the site and shall not degrade such identified resources on abutting properties. This shall include, but not be limited to, identified wetlands, floodplains, significant wildlife habitat, stonewalls, mature tree lines, cemeteries, graveyards, designated historic buildings or sites, scenic views, and viewsheds.
6. Impact on Property Values: The proposed use will not cause or contribute to a significant decline in property values of adjacent properties or the neighborhood.
7. Availability of Public Services and Facilities: Adequate and lawful facilities or arrangements for sewage disposal, solid waste disposal, water supply, utilities, drainage, and other necessary public or private services, are approved or assured, to ensure that the use will be

capable of proper operation. In addition, it must be determined that these services will not cause excessive demand on municipal services, including, but not limited to, water, sewer, waste disposal, police protection, fire protection, and schools.

8. Fiscal Impacts: The proposed use will not have a negative fiscal impact on the Town unless the Planning Board determines that there are other positive community impacts that off-set the negative fiscal aspects of the proposed use. The Planning Board's decision shall be based upon an analysis of the fiscal impact of the project on the town. The Planning Board may commission, at the applicant's expense, an independent analysis of the fiscal impact of the project on the town.

D. Conditions of Approval

Conditional Use Permit approvals shall be subject to appropriate conditions where such conditions are shown to be necessary to further the objectives of this ordinance and the Master Plan, or which would otherwise allow the general conditions of this ordinance to be satisfied. Conditions of approval shall be stated in writing in the issuance of a permit. The conditions shall, if applicable, may include, but are not limited to, the following:

1. Front, side, and rear setbacks in excess of the minimum requirements of the ordinance.
2. Screening of the premises from the street or adjacent property in excess of any minimum requirements of the ordinance.
3. Landscaping in excess of any minimum requirements of the ordinance.
4. Modification of the exterior features of buildings or other structures.
5. Limitations on the size of buildings, other structures or signs more stringent than the minimum or maximum requirements of the ordinance.
6. Footprint or lot coverage less than the allowed maximum of the ordinance.
7. Limitations on the number of occupants and methods and times of operation.
8. Grading of the premises for proper drainage.
9. Regulation of design of access drives, sidewalks, crosswalks, and other traffic features.
10. Off-street parking and loading spaces in excess of, or less than, the minimum requirements of this Ordinance.
11. Other performance standards as appropriate.

IV. Appeals

Any persons aggrieved by a Planning Board decision on a Conditional Use Permit may appeal that decision to the Superior Court, as provided for in RSA 677:15. A Planning Board decision on the issuance of a Conditional Use Permit cannot be appealed to the Zoning Board of Adjustment. (RSA 676:5 III)

Appendix D - Rationale for Implementation of a Protected Shoreland Ordinance

RATIONALE FOR IMPLEMENTATION OF A PROTECTED SHORELAND ORDINANCE TOWN OF NORTHWOOD, NH

Introduction to Rationale

Following is information to support the rationale for implementing a Protected Shoreland ordinance in Northwood. The primary justification is to provide protection for and maintain the functions and values of surfaces waters in the town by limiting development adjacent to streams, rivers and surface waters. The proposed Protected Shoreland Ordinance would apply to ***all perennial streams, river and surface waters in Northwood***, including those public waters (lakes and great ponds) under the jurisdiction of the NH Comprehensive Shoreland Protection Act.

The rationale includes a discussion of the following as they relate to the unique qualities of streams, rivers, surface waters and watersheds in Northwood.

- NH Comprehensive Shoreland Protection Act
- Headwater streams and watershed areas
- Public drinking water supplies
- State Designated and Protected Rivers
- Surface Water Quality
- Functions and Values of Riparian and Shoreland Areas
- Local Conservation Areas

Implementation of requirements to maintain building setbacks, restrict high risk land uses, and manage stormwater effectively will help protect surface water quality, protect against downstream flooding, and generally protect the functions and values of riparian and shoreland areas for the benefit of the town.

Table 1. Estimated Land Area Affected by Proposed Protected Shoreland District

Perennial Stream and Shoreline Buffers	Buffer Area (acres)	% Total Town Area*
Perennial Streams and Shoreline Length = 319,606.1 feet		
Perennial Streams and Shoreline Buffers		
Waterfront Buffer 0-50 feet	514.5	2.7
Woodland Buffer 50-150 feet	1,049.8	5.4
Protected Shoreland 250 feet	2,641.8	13.6

* Total Town Area = 19,356.9 acres Total Surface Waters = 1,382.7 acres

[Source: Complex Systems Research Center at the University of New Hampshire, *Stream Buffer Characterization Study* (2007)]

NH Comprehensive Shoreland Protection Act (CSPA)

RSA 483-B:8:I and II permits municipalities to adopt shoreland protections more stringent than the minimum standards of the CSPA and encourages adoption of land use ordinances for shorelands of water bodies and water courses other than public waters regulated under the CSPA.

Northwood has no 4th order and higher streams and rivers; therefore no streams and rivers in Northwood are regulated under the jurisdiction of the Comprehensive

Shoreland Protection Act (CSPA). Only the public waters listed in Table 1 below are regulated under the CSPA in Northwood.

Table 2. Official List of Public Waters by the NH Department of Environmental Services

Waterbody Name	*Waterbody Type*	*Area (acres)*	Approx. Surface Elevation (feet)
Durgin Pond	Great Pond with Artificial Impoundment	17.3	575
Harvey Lake	Great Pond with Artificial Impoundment	105.0	613
Long Pond	Great Pond with Artificial Impoundment	100.2	578
Lucas Pond	Great Pond with Artificial Impoundment	38.7	433
North River Pond (portion)	Great Pond with Artificial Impoundment	80.0	452
Northwood Lake (portion)	Great Pond with Artificial Impoundment	14.0	517
Northwood Lake (portion with Epsom)	Great Pond with Artificial Impoundment	686.9	517
Jenness Pond	Great Pond	237.5	657
Little Bow Pond	Great Pond	36.7	588
Conservation Pond	Artificial Impoundment 10 acres or more in size	10	623
Dole Marsh	Artificial Impoundment 10 acres or more in size	25	Not reported
Meadow Lake	Artificial Impoundment 10 acres or more in size	17	594
Woodman Marsh	Artificial Impoundment 10 acres or more in size	10	Not reported
Total Acres		**89.4**	

Headwater Areas

Headwater streams with a watershed area generally less than one square mile are considered primary headwater streams, and can be ephemeral, intermittent or perennial. The health of larger streams, rivers, and other surface waters in the watershed depend upon an intact primary headwater stream network. Particularly, the stream network in the upper parts of the watershed greatly affects downstream water quality.

The importance and benefits provided by primary headwater streams include: reduction of sediment delivery downstream, reduction in nutrient loading (nitrogen and phosphorous), flood storage and control, and wildlife habitat corridors and aquatic habitat. The economic reasons to protect and improve primary headwater streams include: protection of public drinking water sources, maintenance of recreational uses of lakes, ponds and rivers, minimizing damage to infrastructure (bridges, culverts, dams) and property, and maintaining channel morphology and land stability.

Northwood contains significant land area that comprises the headwater drainage areas of five regional watersheds: the Suncook River, the Bean River, the Lamprey River, the

Isinglass River/Nippo Brook, and Bow Lake. The headwater streams of these major watersheds (mainly first order streams) comprise 61 percent of the total stream miles in Northwood (as reported in National Hydrography Dataset (NH DES), November 2007). Headwater streams are particularly important for maintaining water quality due to the shear number of miles they represent in most watershed drainage systems and their contribution to high water quality.

Table 3. Miles of streams by stream order and type

Stream Order/Type	Miles	% Total Stream Miles
1st Order	31.1	61.3%
2nd Order	14.4	28.4
3rd Order	5.2	10.3
4th Order	None	--
5th Order	None	--
Total	**50.62**	**--**
Perennial	22.8	45.1
Intermittent	26.8	52.9

[Source: National Hydrography Dataset (NH DES), November 2007]

Surface Water Drinking Water Supplies

Both Pleasant Lake and the Lamprey River are surface water sources for public drinking water supplies for the towns of Deerfield and Durham, respectively. The state implements regulations pertaining to environmental, land use and public health protections for these public drinking water supplies. Deerfield recently adopted a land use ordinance to protect Pleasant Lake from water quality degradation. Significant areas of the Lamprey River watershed in Northwood are protected lands. However, some headwater streams (first and second order streams) are located in unprotected areas of the watershed. These first and second order streams are not regulated under the CSPA.

NH Protected Rivers

The Isinglass River in Strafford, Barrington and Rochester, and portions of the Lamprey River in Lee, Epping and Durham are designated as NH Protected Rivers under the Rivers Management and Protection Program. This designation recognizes the special qualities of the Isinglass and Lamprey Rivers and, under the provisions of RSA 483, and provides increased protection against the construction of new dams, damaging channel alterations, water quality impairment, and the siting of solid and hazardous waste facilities in the river corridor. While designation of these rivers improved the protection and management of the rivers themselves, ongoing efforts at the local level are needed to address the use and conservation of the river corridor and watershed, and to protect water quality for the purpose of maintaining the state designated uses of these rivers as Class B water bodies. The lower portion of the Lamprey River is also federally designated as Wild and Scenic River, one of only two such designated rivers in New Hampshire.

Surface Water Quality

Not only is surface water quality important to the Town of Northwood, but it effects other communities and natural resources down stream within the watershed. Some of these communities are responsible for meeting the EPA Phase II stormwater requirements that require attainment of stringent standards for surface water quality. Therefore, it is of regional importance to maintain the quality of surface water entering these communities from

upstream. In addition, maintaining the quality of surface waters throughout the subwatersheds of the greater Coastal watershed and the Great Bay is critical to achieving the local, state and federal goals for protection of the functions and benefits of the natural resources contained within them.

Functions and Values of Riparian and Shoreland Areas

Riparian and shoreland areas that are naturally vegetated - whether grass meadows, forests or shrub and ground cover - are most effective in providing wildlife and fisheries habitat, removing pollutants, maintaining stable streambanks and shorelands, and preventing negative impacts resulting from human activity such as flooding, degradation of water quality, and loss of aesthetic, recreational and land values. The study *Introduction to Riparian Buffers*; Connecticut River Joint Commission for NH and VT, offers guidelines for buffer widths by function provided as summarized in the table below.

Table 4. Guidelines for buffer widths in providing specific functions and services[2]

Functions/ Services	Description	Width (feet)
Bank Stabilization	Riparian buffer vegetation helps to stabilize streambanks and reduce erosion by slowing the flow of runoff. Roots hold bank soil together, and stems protect banks by deflecting the action of waves, ice, boat wakes, and runoff.	50
Fisheries Habitat	Forested riparian buffers benefit aquatic habitat by improving the quality of nearby waters through shading, filtering, and moderating stream flow. Shade in summer maintains cooler, more even temperatures, especially on small streams. Cooler water holds more oxygen and reduces stress on fish and other aquatic creatures. A few degrees difference in temperature can have a major effect on the survival of aquatic species. Woody debris feeds the aquatic food web. It also can create stepped pools, providing cover for fish and their food supply while reducing erosion by slowing flow.	75
Nutrient Removal	The riparian buffer traps pollutants that could otherwise wash into surface and groundwater. Phosphorus and nitrogen from fertilizer and animal waste can become pollutants if more is applied to the land than plants can use. Because excess phosphorus bonds to soil particles, 80–85% can be captured when sediment is filtered out of surface water runoff by passing through the buffer. Chemical and biological activity in the soil, particularly of streamside forests, can capture and transform nitrogen and other pollutants into less harmful forms. These buffers also act as a sink when nutrients and excess water are taken up by root systems and stored in the biomass of trees.	125
Sediment Control	Riparian buffers help catch and filter out sediment and debris from surface runoff. Depending upon the width and complexity of the buffer, 50–100% of the sediments and the nutrients attached to them can settle out and be absorbed as buffer plants slow sediment- laden runoff. Wider, forested buffers are even more effective than narrow, grassy buffers.	150
Flood Control	By slowing the velocity of runoff, the riparian buffer allows water to infiltrate the soil and recharge the groundwater supply. Groundwater will reach a stream or river at a much slower rate, and over a longer period of time, than if it had entered the river as surface runoff. This helps control flooding and maintain stream flow during the driest time of the year.	200
Wildlife Habitat	The distinctive habitat offered by riparian buffers is home many plant and animal species, including those rarely found outside this narrow band of	300

[2] Connecticut River Joint Commission. 2005. Introduction to Riparian Buffers. *From:* Riparian Buffers for the Connecticut River Valley, No.1. http://www.crjc.org/riparianbuffers.htm.

	land influenced by the river. Continuous stretches of riparian buffer also serve as wildlife travel corridors.	

Conservation Areas

Northwood has recognized specific areas – Conservation Areas - which possess unique, valuable and irreplaceable natural resources. These Northwood Development Ordinance Section 5.02 Conservation Area Overlay District places specific restrictions on building setbacks from wetlands and surface waters, specific land uses, development density and development pattern within these areas for the purpose of conserving their natural resources.

Conservation Areas in Northwood are:

- Acorn Pond Region
- Big Woods Region
- Gulch Groundwater Aquifer
- Kelsey Mills Region
- Narrows Scenic Vista
- Northwood Lake Bog Region
- Saddleback Mountain Region

Proposed Regulatory Approach

1. Within the Isinglass River and Lamprey River watersheds and the Pleasant Lake drainage area located within Northwood, stormwater management and water quality treatment, consistent with such requirements of the Northwood Site Plan Review Regulations, must be implemented for all new development, redevelopment, conversion of use, and expansion of existing structures and buildings.

2. Within the Protected Shoreland (0-250 feet from reference line), establishment or expansion of specific high risk land uses will be prohibited (see draft ordinance for the list of high risk uses).

3. The proposed Protected Shoreland ordinance shall not apply to all timber harvesting activities permitted under RSA 227:J, and to agricultural operations that are covered by an approved Natural Resources Conservation Service (NRCS) conservation plan that includes the application of best management practices (BMPs).

4. The following standards are recommended for protection of streams, rivers and surface waters:

- Adopt standards consistent with those of the CSPA for the proposed Protected Shoreland and the Woodland and Waterfront Buffers, including impervious surface limits, structure setbacks and limits on high risk uses
- 50 foot no disturb buffer from all perennial streams and rivers, and all surface waters (lakes and ponds of any size)
- 50 foot setback for all buildings and structures from all surface water bodies (all perennial streams, rivers, and lakes and ponds of any size)

- 75 foot setback for septic systems from all perennial streams and rivers, and all surface waters

5. For all new development, redevelopment, conversion of use, and expansion of existing structures and buildings, where a fully vegetated Waterfront Buffer does not exist (when buffer applicable to the site), establishment of a fully vegetated Waterfront Buffer by natural regeneration and/or combination of natural regeneration and plantings of trees, shrubs and groundcover is required.

6. For expansion of a non-conforming use, structure or building permitted within the Waterfront Buffer, an area equivalent to the area of buffer disturbance shall be planted preferably within the Waterfront Buffer if not fully vegetated or within the Protected Shoreland on the site It is encouraged that plantings consist of a combination of native trees, shrubs and groundcover.

Additional Recommendations

1. **Northwood Development Ordinance, Section 5.01 Wetlands Conservation Overlay District**. Add clarification that the Overlay District (Section 5.01(B) and the required 100 foot setback within the Conservation Area Overlay district apply to wetlands ***as well as to all surface waters, specifically all perennial streams, rivers, lakes and ponds*** [Section 5.01(E)].

2. The stormwater management regulations recently adopted as part of the Site Plan Review Regulations should be incorporated into the Subdivision Regulations of Northwood.

Appendix E - Draft Press Release and Distribution List

October 29, 2008

For Immediate Release:

Contact: Karen Smith
Phone: 603-942-5130
Email: karensmitheh@msn.com

New ordinance is designed to protect valuable water resources in Northwood, NH

NORTHWOOD - The Town of Northwood Planning Board and Water Resources subcommittee commissioned the development of a "Protected Shoreland Ordinance" to protect the water quality in Northwood streams, rivers, lakes and ponds by managing land use in areas adjacent to these valuable community resources. The town was awarded a grant from the New Hampshire Estuaries Project for this project and hired Strafford Regional Planning Commission to complete the ordinance development process.

The draft Protected Shoreland Ordinance proposes requirements to:

- maintain minimum building setbacks from shoreland areas
- maintain natural vegetation and tree canopy and wildlife habitat in shoreland areas
- restrict high risk land uses, and
- manage stormwater to protect water quality.

The primary goals of the ordinance is to protect surface water quality, minimize downstream flooding, and ensure that all of the functions that shoreland and riparian areas - land next to rivers and streams - provide are protected for the benefit of the community.

Northwood's Water Resource Subcommittee Chair Karen Smith is pleased with the results of the project and believes that the ordinance, if adopted, will benefit future generations "with cleaner water, greater protection from flood events, more habitat for native wildlife, scenic waterfronts, and higher property values."

The Planning Board will review the draft ordinance at their regular meeting on _____ and will consider moving forward with a public hearing and eventually to place the ordinance on the March 2009 ballot. A copy of the draft Protected Shoreland Ordinance is available at Town Hall and on the Town's website at http://town.northwood.nh.us/.

This project was funded in part by a grant from the New Hampshire Estuaries Project ***as authorized by the U.S. Environmental Protection Agency's National Estuary Program.***

Press Release Distribution List

Fosters Daily Democrat
Adam Krauss – Email: akrauss@fosters.com

Rochester Times
John Nolan – Email: jnolan@fosters.com

Portsmouth Herald
Seacoast Media Group – Email: news@seacoastonline.com

The New Hampshire (University of NH)
Nate Batchelder, Managing Editor – Email: nst7@unh.edu
Kyle Stucker, Managing Editor – Email: kstucker31@yahoo.com

New Hampshire Estuaries Project
Dave Kellum – Email: dave.kellum@unh.edu

New Hampshire Coastal Program
Cathy Colletti – Email: Catherine.Coletti@des.nh.gov

New Hampshire Department of Environmental Services
Steven Couture, Rivers Coordinator – Email: Steven.Couture@des.nh.gov

Bear Paws Regional Greenway
Daniel Kern, Executive Director – Email: info@bear-paw.org

Isinglass River Local Advisory Committee
Elizabeth Evans, Chair – Email: graycape@metrocast.net

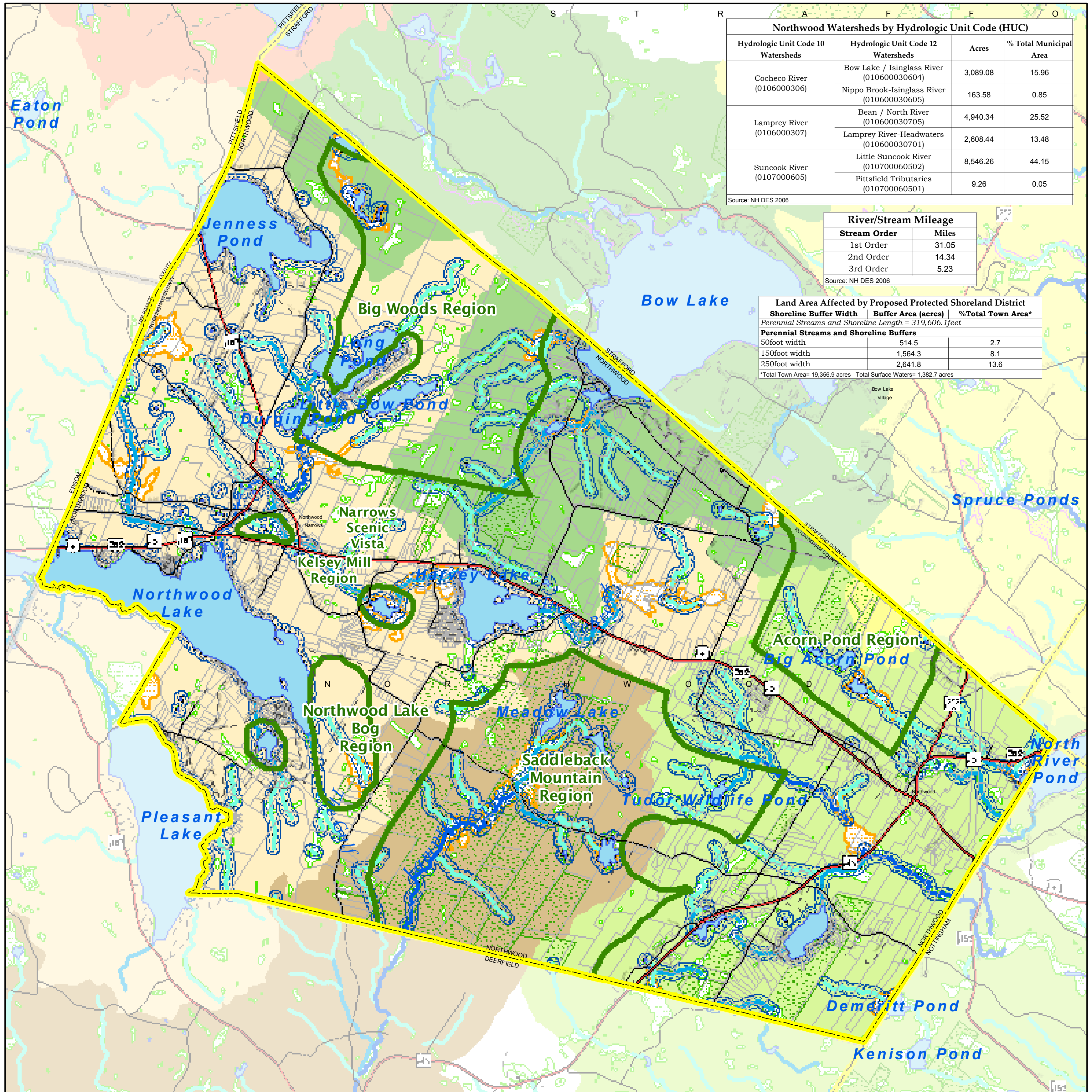
Lamprey River Advisory Committee
Sharon Meeker, Phone: 659-5441 Email: s-meeker@comcast.net
Judith Spang, Phone: 659-5936.

Lamprey River Watershed Association
Dawn Genes, - Phone: (603) 659-9363 Email: dawn.genes@lrwa-nh.org

Appendix F - Map of Water Resources - Draft Protected Shoreland Ordinance

Town of Northwood, NH

Proposed Ordinance: Protected Shoreland District



Northwood Watersheds by Hydrologic Unit Code (HUC)			
Hydrologic Unit Code 10 Watersheds	**Hydrologic Unit Code 12 Watersheds**	**Acres**	**% Total Municipal Area**
Cocheco River (0106000306)	Bow Lake / Isinglass River (010600030604)	3,089.08	15.96
	Nippo Brook-Isinglass River (010600030605)	163.58	0.85
Lamprey River (0106000307)	Bean / North River (010600030705)	4,940.34	25.52
	Lamprey River-Headwaters (010600030701)	2,608.44	13.48
Suncook River (0107000605)	Little Suncook River (010700060502)	8,546.26	44.15
	Pittsfield Tributaries (010700060501)	9.26	0.05

Source: NH DES 2006

River/Stream Mileage	
Stream Order	**Miles**
1st Order	31.05
2nd Order	14.34
3rd Order	5.23

Source: NH DES 2006

Land Area Affected by Proposed Protected Shoreland District		
Shoreline Buffer Width	**Buffer Area (acres)**	**%Total Town Area***
Perennial Streams and Shoreline Length = 319,606.1feet		
Perennial Streams and Shoreline Buffers		
50foot width	514.5	2.7
150foot width	1,564.3	8.1
250foot width	2,641.8	13.6

*Total Town Area= 19,356.9 acres Total Surface Waters= 1,382.7 acres

Legend

Locally Defined Conservation Areas
Northwood Prime Wetlands

Surface Water Features

Stream Order
- 1st Order
- 2nd Order
- 3rd Order

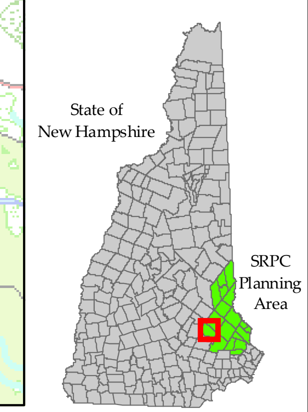
River, Lake, Pond
Wetlands
100yr Floodplain

Surface Water Buffers
- 50 Feet
- 150 Feet
- 250 Feet

Watersheds

Hydrologic Unit Code (HUC) 12
- Bean / North River
- Bow Lake / Isinglass River
- Lamprey River Headwaters
- Little Suncook River
- Nippo Brook-Isinglass River
- Pittsfield Tributaries

This map was funded in part by a grant from the New Hampshire Estuaries Project, as authorized by the U.S. Environmental Protection Agency's National Estuary Program.



Map created by the ***Strafford Regional Planning Commission***
2 Ridge St. Suite 4 Dover, NH 03820
P: 603-742-2523 F: 603-742-7986
Web: www.strafford.org Email: srpc@strafford.org
Stream Buffer Ordinance
Surface Water
Path:G:\Towns\Nor\NHEP\NorthwoodH20.mxd
Date//Author: Oct.2008//DC

Data Sources

Base features are from USGS 1:24,000 scale Digital Line Graphs, as archived in the GRANIT database. Digital data in NH GRANIT represent the efforts of the contributing agencies to record information from the cited source materials. Complex Systems Research Center (CSRC), under contract to the Office of Energy & Planning (OEP), and in consultation with cooperating agencies, maintains a continuing program to identify and correct errors in these data. Neither OEP nor CSRC make any claim as to the validity or reliability or to any implied uses of these data.

Transportation data were provided by NHDOT (5-19-08), with updates to Street names by SRPC Staff. Known errors exist within the data. SRPC welcomes feedback on any updates to street names.

Conservation lands data were taken from the archives of NH GRANIT (1/12/07).

Water Resources data were provided by NH DES November 30, 2006.

Stream order data were derived from the National Hydrology Dataset (NHD) as archived in the GRANIT Database.

Floodplain data were provided by the Federal Emergency Management Agency (FEMA).

Wetland evaluation sites were generated by Northwood Conservation Commission, 1:24,000, 1993. Sites were based on National Wetlands Inventory maps from US Fish and Wildlife Service, and wetland soils from the US Natural Resource Conservation Service (NRCS) County Soil Survey.

Base Legend

Political Features
- SRPC Boundary
- Municipal Boundary
- Tax Parcels

Road Type
- State
- Federal
- Local
- Not Maintained
- Private

0 1,000 2,000 4,000 6,000 8,000 10,000 Feet
0 0.25 0.5 1 1.5 2 Miles