AECOM Environment

Prepared for:
Town of Sanbornton

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AECOM
Manchester, NH
60163921
September 2012

Black Brook
Watershed Management Plan

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Executive Summary

A watershed management plan was prepared for Black Brook Watershed, New Hampshire. Black Brook is a tributary to Lake Winnisquam. Lake Winnisquam is a high quality lake but has experienced threats to water quality in recent years. This effort included the construction of a nutrient budget and setting a target value for phosphorus loading for the Black Brook watershed that would not cause algal blooms and preserve the lake as the high quality water it has been in recent history. Limiting phosphorus concentrations and associated algal growth should be sufficient to maintain water quality throughout the lake. While the Black Brook watershed is only a small part of the greater Lake Winnisquam watershed, the development of a plan for this watershed is expected to serve as a model for additional watersheds around the lake. The phosphorus loads are allocated among all sources of phosphorus to the lake such that resultant in-lake phosphorus concentrations meet the target and Lake Winnisquam supports its designated uses. The portion of the load that comes from Black Brook is then evaluated in more detail.

The analysis suggests that the current loads of phosphorus to Lake Winnisquam should be maintained at the current in-lake phosphorus concentration. However, the target value 6.4 μg/L should be coupled with a short-term goal of 6.1 μg/L to allow for some inevitable future increases in phosphorus without compromising water quality. The plan puts primary emphasis on reducing watershed phosphorus sources over other sources due to the relative load contribution from the watershed and practical implementation considerations. It is expected that these reductions would be phased in over a period of several years. Successful implementation of this watershed management plan will be based on maintenance of in lake total phosphorus concentrations at or below the phosphorus target. Specific targeted measures to control phosphorus inputs to the lake are presented and discussed. Guidance for obtaining additional Clean Water Act (Section 319) funding for nonpoint source control is presented in Section 11.0. Suggestions for enhancement of the current monitoring program to monitor progress and effectiveness of control measures are provided.

1.0 Introduction and Water Quality Summary

Lake Winnisquam is a 4264 acre lake with a watershed that encompassed much of the Lakes Region of New Hampshire. The majority of the flow to Lake Winnisquam comes from the Winnipesaukee River which drains Lake Winnipesaukee, the largest lake in the state.(NHDES 2009). The Black Brook watershed comprises less than 10% of the direct watershed of Lake Winnisquam and just over 1% of the entire watershed with the Winnipesaukee River watershed included. Black Brook drains to the Pot Island Basin of Lake Winnisquam, one of three basins in the lake. Characteristics of Lake Winnisquam are presented in Table 1-1. The watershed and the Black Brook subwatershed are shown in Figure 1-1. The amount of impervious cover (i.e., development) within a watershed is correlated with water quality. Poor water quality and significant changes in hydrology are typically experienced in watersheds where impervious cover is at or greater than 10% of the total area (CWP 2003). In areas where impervious cover is greater than 25% (CWP 2003) waters are typically of poor quality and may not support such uses as swimming, and drinking. Although the Black Brook watershed is below the 10% threshold, localized, short-term or periodic water quality problems have been observed.

Table 1-1: Characteristics of Lake Winnisquam, NH

Parameter	Value
Pot Island Basin Area (acres)	3,039
Whole Lake Area (acres)	4,264
Pot Island Basin Volume (m^3)	243,214,210
Whole Lake Volume (m^3)	275,026,320
Black Brook Watershed Area (square miles)	4.6
Pot Island Watershed Area (square miles)	19.9
Lake Winnisquam Direct Watershed without Winnipesaukee River (square miles)	57
Lake Winnisquam Watershed Area with Winnipesukee River (square miles)	430
Mean Depth (ft)	32.2
Max Depth (ft)	173.9
Flushing Rate (yr^{-1})	2.24

Recent water quality data from the New Hampshire Volunteer Lake Assessment Program website were reviewed in the 2009 VLAP report (NHDES 2010). Epilimnetic (upper layer) total phosphorus (TP), Secchi transparency and chlorophyll a (a measure of the amount of algae) concentrations have shown considerable variability over years but a review of the data suggests that mean concentrations are relatively low and have not changed significantly over time. A cyanobacteria warning was issued by NHDES in 2008. Cyanobacteria can release toxins that can be potentially harmful to animals and humans. Deep lakes in the northern temperate region typically undergo thermal stratification. During stratification, oxygen in bottom waters can get depleted by organic matter decomposition processes. In the absence of oxygen, phosphorus can be released from iron in the bottom sediments and be circulated into the water column becoming available for algal uptake. In Lake Winnisquam, concentrations of phosphorus from the hypolimnion (deep layer) have decreased over time suggesting that the lake is continuing to recover since the elimination of wastewater discharges to the lake in the 1970's.

Lake Winnisquam supports a cold water fishery as well as a number of warm water fish species. According to New Hampshire Fish and Game (2011) the lake supports rainbow trout (stocked), lake trout, salmon, largemouth bass, smallmouth bass, white perch, bluegill, chain pickerel and hornpout.

Cyanobacteria were reported in Lake Winnisquam in 2008 (NHDES 2008a). Cyanobacteria and other algal species typically increase in numbers in response to nutrient enrichment. Phosphorus is the primary limiting nutrient in northern temperate lakes, hence algal growth is likely directly related to phosphorus concentrations. Nitrogen can also play a role in determining the type of algae present and the amount of algal growth in a waterbody since some cyanobacteria can fix nitrogen from the atmosphere. A watershed management plan for total phosphorus (TP) as a surrogate for chlorophyll *a* (chl *a*) and cyanobacteria has been prepared for Lake Winnisquam and the results are presented in this report.

The New Hampshire Department of Environmental Services (NH DES) conducted water quality monitoring in the Pot Island Basin of Lake Winnisquam in 1979, 1984, 1990, and 2001 for Lake Trophic Studies (NHDES 2009). Lake Winnisquam has participated in the Volunteer Lake Assessment Program (VLAP) since 1987 (NH DES 2009). Lake Winnisquam also participates in the Lake Host program (NHDES 2009) to educate boaters and examine boats and trailers for exotic plants entering or leaving lakes.

The mean, median and range of selected water quality parameters from each sampling location from the most recent data available (2001-2010) are summarized in Table 1-2. Secchi disk transparencies (SDT), a measure of water clarity, are high, ranging from 6.0 to 10.3 m with a mean of 8.3 m. Chlorophyll a (chl *a*) concentrations, a measure of algal productivity, are low over this time period range from 0.5 to 3.6 μg/L. Total phosphorus (TP) concentrations (the primary nutrient for algal growth) in the epilimnion (surface layer) range from 2.5 to 12 μg/L with a mean of 4.9 μg/L. Hypolimnetic (deep layer) TP concentrations are similar to epilimnetic concentrations ranging from <5.0 to 9.1 μg/L with a mean of 6.6 μg/L. Similar surface and bottom concentrations during the summer stratification period suggest that there is currently little to no sediment release of TP. NHDES (2009) concluded through a statistical evaluation of water quality data collected since 1987 that summer composite chl *a* concentrations, Secchi transparencies and TP concentrations have not changed over that period. Hypolimnetic (deep) concentrations of total phosphorus have significantly decreased throughout the period suggesting that the lake is still improving since the diversion of wastewater from the lake in the 1970's. All of these measures showed that Lake Winnisquam water quality was much better than the typical NH lake and better than most similar high quality lakes.

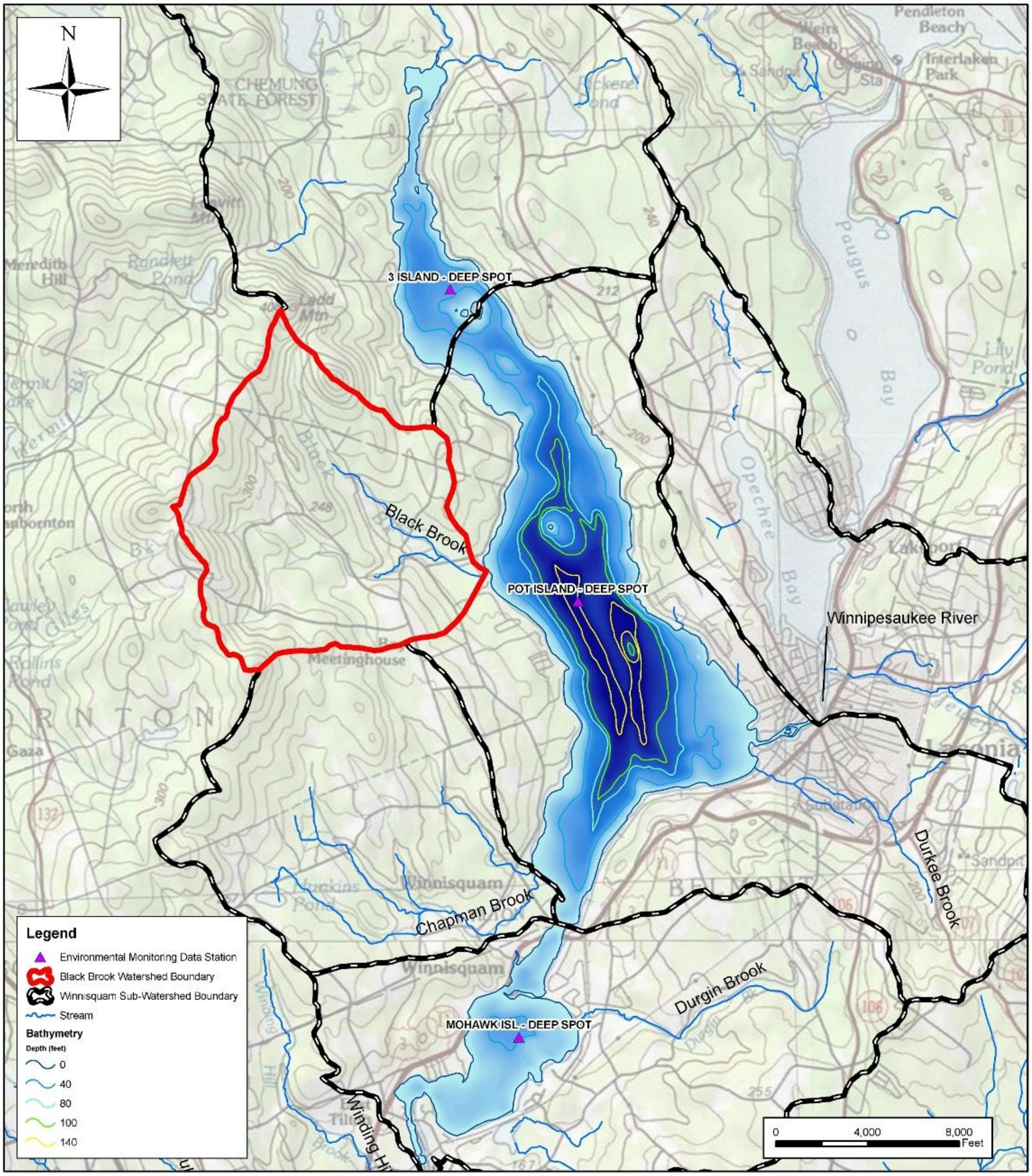


Figure 1-1: Lake Winnisquam Location and Bathymetry

Table 1-2: Lake Winnisquam - Pot Island Basin
Summer Water Quality Summary Water Quality Data 2001-2010

	Pot Island Station					**Black Brook**	**Winnipesaukee River**
Statistic	**TP Epi**	**TP Meta**	**TP Hypo**	**SDT**	**Chl *a***	**TP**	**TP**
Units	μg/L	μg/L	μg/L	m	μg/L	μg/L	μg/L
Min	<5.0	<5.0	<5.0	6.0	0.5	<5.0	<5.0
Max	9.1	11.3	10.3	10.3	3.6	21.0	14.0
Mean	6.6	7.8	7.7	8.3	2.0	10.6	7.3
Median	6.4	7.9	7.6	8.1	1.9	10.0	7.0

Mean and median statistics derived from annual mean values of typically two or three samples collected in July, August, and/or September.
TP= Total Phosphorus; Epi = epilimnion; Meta = metalimnion; Hypo = hypolimnion; SDT= Secchi Disk Transparency, Chl *a*= Chlorophyll a

Lake Winnisquam has numerous tributaries and direct stormwater inputs (Figure 1-2). A summary of the water quality data from Black Brook and the Winnipesaukee River is presented in Table 1-2. Water quality entering the lake from the Winnipesukee River provides most of the flow to Lake Winnisquam and fortunately has very good quality most of the time. There are times when the water quality of the Winnipesaukee River could be improved. It is likely that stormwater inputs to the river from Laconia and other developed areas along the river contribute to the elevated TP concentrations in the river. TP is elevated in Black Brook at times. We suggest a number of best management practices (both structural and non-structural to lower loads of phosphorus from the Black Brook watershed to Lake Winnisquam.

These data, together with suggested management recommendations, provide a basis for the development of a Watershed Management Plan for the Black Brook watershed. Outreach and education will be an important aspect of this project. A Site Specific Project Plan (SSPP) detailing the steps to be undertaken in development of the plan was presented to NHDES in the fall of 2010 and approved.

The purpose of the Black Brook watershed plan is to establish TP loading targets, a plan to meet those targets and a means for measuring progress. This watershed plan is the first step in a multi phased project to protect the high quality of Lake Winnisquam. Water quality that is consistent with state standards is, a priori, expected to protect designated uses. This plan recognizes the unique nature of Lake Winnisquam as a high quality water and sets targets and goals considered to be more protective of water quality than the minimum requirements to protect the lake's designated uses. AECOM prepared this watershed plan according to the United States Environmental Protection Agency's (US EPA) guidance (US EPA, 2008). The main objectives of this watershed plan include the following 9 elements from the EPA guidance:

1. Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant

subcategory level along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

2. An estimate of the load reductions expected from management measures.
3. A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.
4. Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
5. An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
7. A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
8. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
9. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above.

This watershed management plan is expected to fulfill the nine requirements for a watershed management plan required to qualify a project for Section 319 restoration funding.

2.0 Phosphorus Target

2.1 Numeric Water Quality Target

To develop a watershed management plan, it is necessary to derive a numeric TP target values (e.g., in-lake concentration) for determining acceptable nutrient loads. The suggested TP values are described in the following paragraphs.

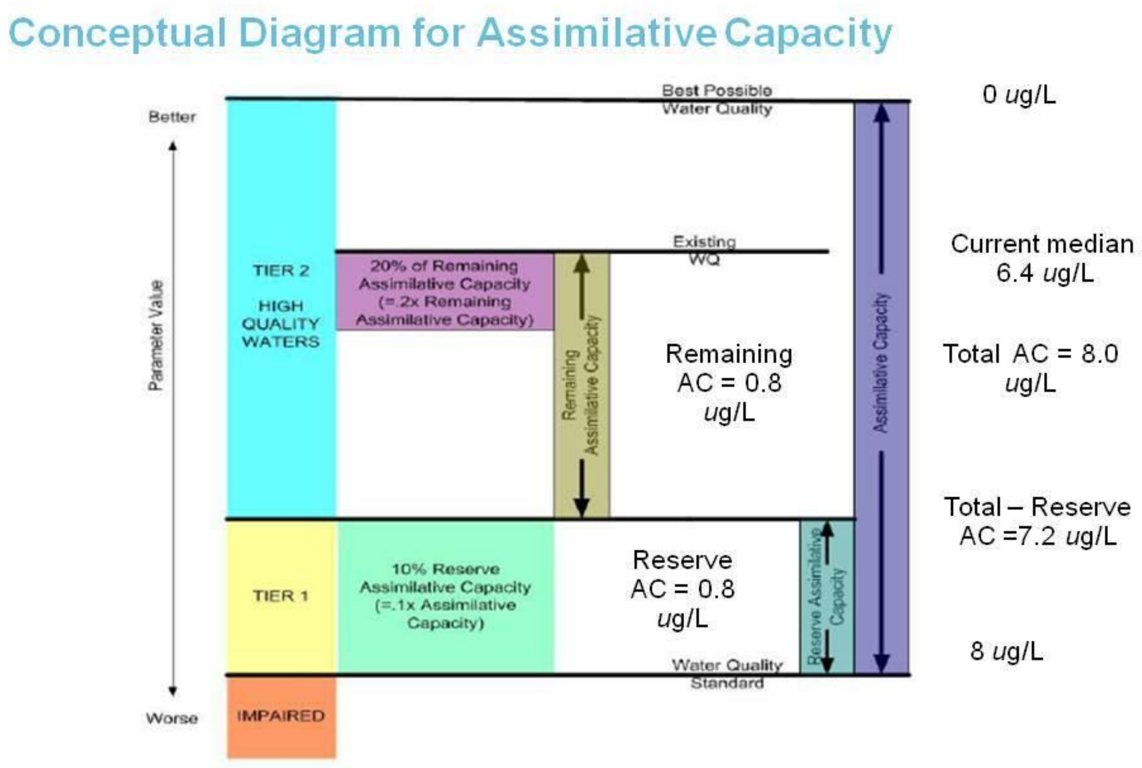


Figure 2-1: Lake Winnisquam Water Quality Target

Determining the nutrient load that a lake can assimilate without degrading or exceeding water quality standards is challenging and complex. First, many lakes receive a high proportion of their nutrient loading from non-point sources, which are highly variable and are difficult to quantify. Secondly, lakes demonstrate nutrient loading on a seasonal scale, not a daily basis. Loading during the winter months may have little effect on summer algal densities. Finally, variability in loading may be very high in response to weather patterns, and the forms in which nutrients enter lakes may cause increased variability in response. Therefore, it is usually considered most appropriate to quantify a lake nutrient budget as an annual load and evaluate the results of that annual load on mid-summer conditions that are most critical to supporting recreational and aquatic life uses. Accordingly, the nutrient loading capacity of lakes is typically determined through water quality modeling, which is usually expressed on an annual basis. Thus, while a single value may be chosen as the target load for each nutrient, it represents a range of loads with a probability distribution for associated water quality problems (such as algal blooms). Uncertainty is likely to be very high, and the resulting target load should be viewed as a nutrient-loading goal that helps set the direction and magnitude of management, not as a rigid standard that must be achieved to protect against eutrophication. While data from individual sampling dates and seasons are important to understanding the nutrient loading dynamics of Lake Winnisquam, the annual mean load should be given primacy when developing and evaluating the effectiveness of nutrient loading reduction strategies.

Numerical water quality criteria for TP in oligotrophic lakes were recently developed by the State of New Hampshire. For Lake Winnisquam, an oligotrophic lake, the criteria is set at < 8 µg/L. This criterion is over 20% higher than the current median concentration of TP (6.4 µg/L). Best professional judgment of AECOM, NH DES, and the Town of Sanbornton was employed to select a quantitative target in-lake TP concentration that will protect water quality. Review of existing data and modeling of current conditions suggested that the current phosphorus concentrations in the lake would result in acceptable water quality going forward. This point is bolstered by the fact that water quality as measured by chl *a* and TP has not changed appreciably in recent years. However, it was acknowledged that short-term phenomenon had the potential to cause periodic water quality problems like the bloom experienced in 2008 and the anecdotal evidence that nearshore water quality may be declining. It was further recognized that there would be future development in the greater Lake Winnisquam watershed as well as the Black Brook watershed.

Target options were discussed at a meeting held on April 21, 2011 with NHDES, AECOM and the Town of Sanbornton. A memorandum was then prepared by AECOM to present target options and recommend an acceptable target for Lake Winnisquam (Appendix A). Using the conceptual assimilative capacity approach and a criteria of 8 ug/L as the cutoff point between oligotropic and mesotrophic lakes, the target for Lake Winnisquam could be set at 0.2 ug/L higher than existing conditions allowing for a 10% reserve and using 20% of the remaining assimilative capacity. It was agreed that this target was too high for Lake Winnisquam given that periodic water quality problems had been experienced at current levels of phosphorus despite the fact that the annual average TP and chlor a concentration has been steady in recent years. Meeting attendees generally agreed that the water quality target should be set at current conditions (mean summer in-lake total phosphorus concentration= 6.6 *u*g/L and median = 6.4 *u*g/L based on the last 10 years of water quality data). A short term median summer in-lake total phosphorus goal of 6.1 *u*g/l (5% reduction from current) is proposed recognizing that current land development practices with minimal stormwater treatment may continue for some time into the future. Meeting this short term goal through watershed phosphorus load reductions with Best Management Practices (BMPs) will provide a buffer to this future development. This load reduction that results in a 5% in-lake reduction will be allocated across the watershed of the Pot Island basin of Winnisquam (including a value for the Black Brook watershed) as well as the direct sources of phosphorus to the Pot Island Basin provided by the Winnipesaukee River and the 3 Island Basin. Load reduction through BMP's is discussed further in Section 9 of the report.

The numeric (in-lake) water quality target for TP for Lake Winnisquam is 6.4 µg/L for a summer epilimnetic median concentration which is equivalent to the spring overturn TP concentration. Mean annual TP concentrations are usually higher than summer epilimnetic concentrations (Nurnberg 1996, 1998) however recent data from Lake Winnisquam in the spring suggests that spring overturn concentrations are very similar to summer epilimnetic concentrations probably due to the influence of the large volume of inflow water from the Winnipesaukee River. The target number is supported by evaluation of the Trophic State Indices (TSI) developed by Carlson (1977) and a probabilistic assessment of the likelihood of blooms (Walker 1984, 2000) discussed below in the modeling sections. The "weight of evidence" suggests that 6.4 μg/L is an appropriate target that will allow Lake Winnisquam to remain in its current high quality state. Possible reductions to move Lake Winnisquam below this target to a short term goal in lake summer median concentration of 6.1 μg/L to allow for future increases in TP are discussed in Section 7 below. The target concentration corresponds to non-bloom conditions, as reflected in suitable measures of both SDT and chl *a*.

3.0 LLRM Model of Current Conditions

Current TP loading was assessed using the Lake Loading Response Model (LLRM) methodology, which is a land use export coefficient model developed by AECOM for use in New England and modified for New Hampshire lakes by incorporating New Hampshire land use TP export coefficients when available and adding septic system loading into the model (CT DEP and ENSR, 2004). AECOM has recently incorporated the BMP effectiveness tables into LLRM to better evaluate proposed phosphorus reduction scenarios.

The major direct and indirect nonpoint sources of TP to Lake Winnisquam include:

- Atmospheric deposition (direct precipitation to the lake)
- Loading from Lake Winnipesaukee and Lake Opechee via the Winnipesaukee River
- Surface water base flow (dry weather tributary flows, including any groundwater seepage into streams from groundwater)
- Stormwater runoff (runoff draining to tributaries or directly to the lake)
- Waterfowl (direct input from resident and migrating birds)
- Direct groundwater seepage including septic system inputs from shorefront residences

Although the lake stratifies in the summer, the mean summer epilimnion and hypolimnion TP are similar so, internal loading is not expected be a major TP source to Lake Winnisquam. Internal loading therefore was not calculated in the current conditions model.

There are no permitted point source discharges of nutrients in the Black Brook watershed. However, construction activities in the watershed that disturb greater than one acre of land and convey stormwater through pipes, ditches, swales, roads or channels to surface water require a federal General Permit for Stormwater Discharge from Construction Activities. However, construction discharges are not incorporated in the model due to their variability and short-term impacts.

The Black Brook watershed contains one major tributary and two major branches draining most of the watershed as well as a number of smaller tributary streams (Figure 1-1). TP loads were estimated based on runoff and groundwater land use export coefficients. The TP loads were then attenuated as necessary to match tributary monitoring data, if available. Where no tributary data were available or current, then the attenuation factor was based on the slope, soils, and wetland attenuation.

Lake Winnisquam functions as three separate but linked lakes in series. The Black Brook watershed drains into the middle basin called the Pot Island Basin. Upstream (north) of the Pot Island Basin is the Three Island Basin. Downstream (southwest) of the Pot Island Basin is the Mohawk Basin. The Winnipesaukee River empties into the Pot Island Basin and is by far the largest tributary to Lake Winnisquam. Because the focus of this project was on the Black Brook watershed, the Three Island Basin and the Winnipesaukee River were considered as point sources to the basin and assigned loads based on monitoring data and either standard water yields in the case of Three Island Basin or measured flow at the Lakeport Dam at the outlet of Lake Winnipesaukee coupled with a standard water yield for contributing land below the Lakeport Dam in the case of the Winnipesaukee River. Chapman Brook was included as a separate subwatershed in the analysis at the request of the project steering committee. Pot Island Basin was modeled assuming that much of the input from Chapman Brook (90%) may be short circuited out of the Pot Island Basin to the Mohawk Basin due to its proximity of the outlet of the Pot Island Basin at the Route 3 Bridge. The Mohawk Basin was not considered in the analysis as it is downgradient of the Pot Island Basin. A conceptual diagram of the lake model is presented in Figure 3-1.

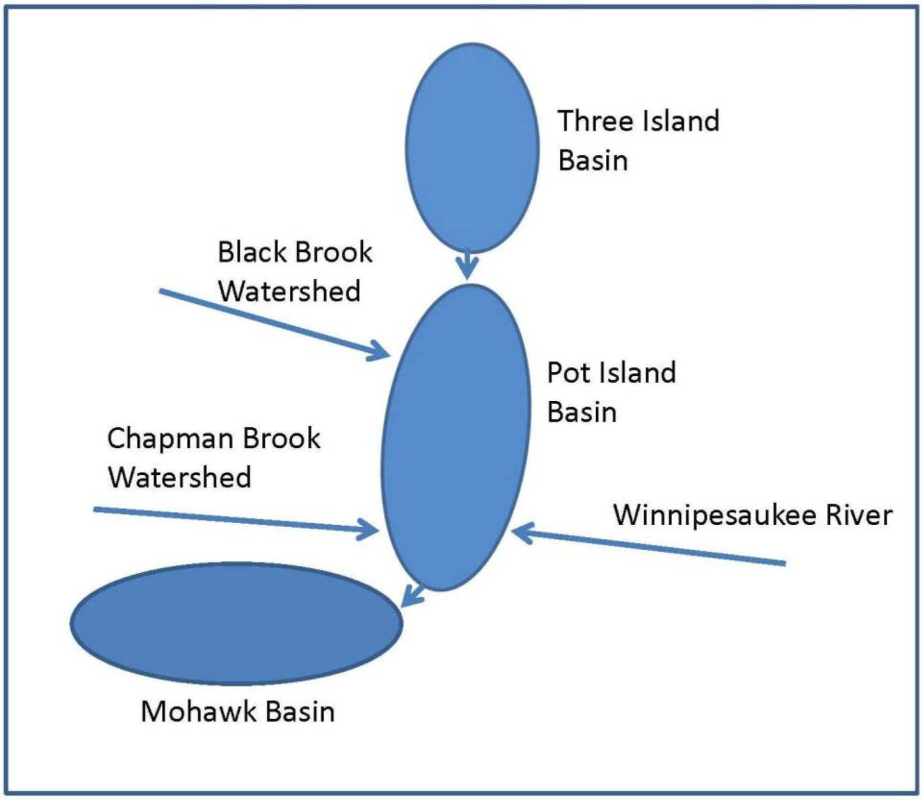


Figure 3-1: Conceptual model of Lake Winnisquam for LLRM model assessment of Black Brook

Loads from the watershed (Figure 3-2) as well as direct sources were then used to predict in-lake concentrations of TP, chl *a*, SDT, and algal bloom probability. The estimated load and in-lake predictions were then compared to in-lake concentrations. Because the inflow to the Pot Island Basin is so heavily influenced by the flow from the Winnipesaukee River, it is believed that the average summer concentrations are likely representative of annual average or average at spring overturn values. Spring data from 2011 support this assumption. The year round influence of inflow from the Winnipesaukee River dampens the "typical" summer epilimnetic phosphorus dynamics. In many lakes, the summer epilimnetic phosphorus concentrations are lower than annual average concentrations (spring overturn) due to reduced loading and settling of algal cells and other particles. Because there is a continuous load of phosphorus and water from the Winnipesaukee River to the epilimnion throughout the summer, we don't observe that phenomenon in Lake Winnisquam. As a result concentrations of phosphorus are relatively stable throughout the year.

The attenuation factors were used as calibration tools to achieve a close agreement between predicted in-lake TP and observed mean/median TP. However, perfect agreement between modeled concentrations and monitoring data were not expected as monitoring data are limited for some locations and are biased towards summer conditions when TP concentrations are expected to be lower than the annual mean predicted by the loading model.

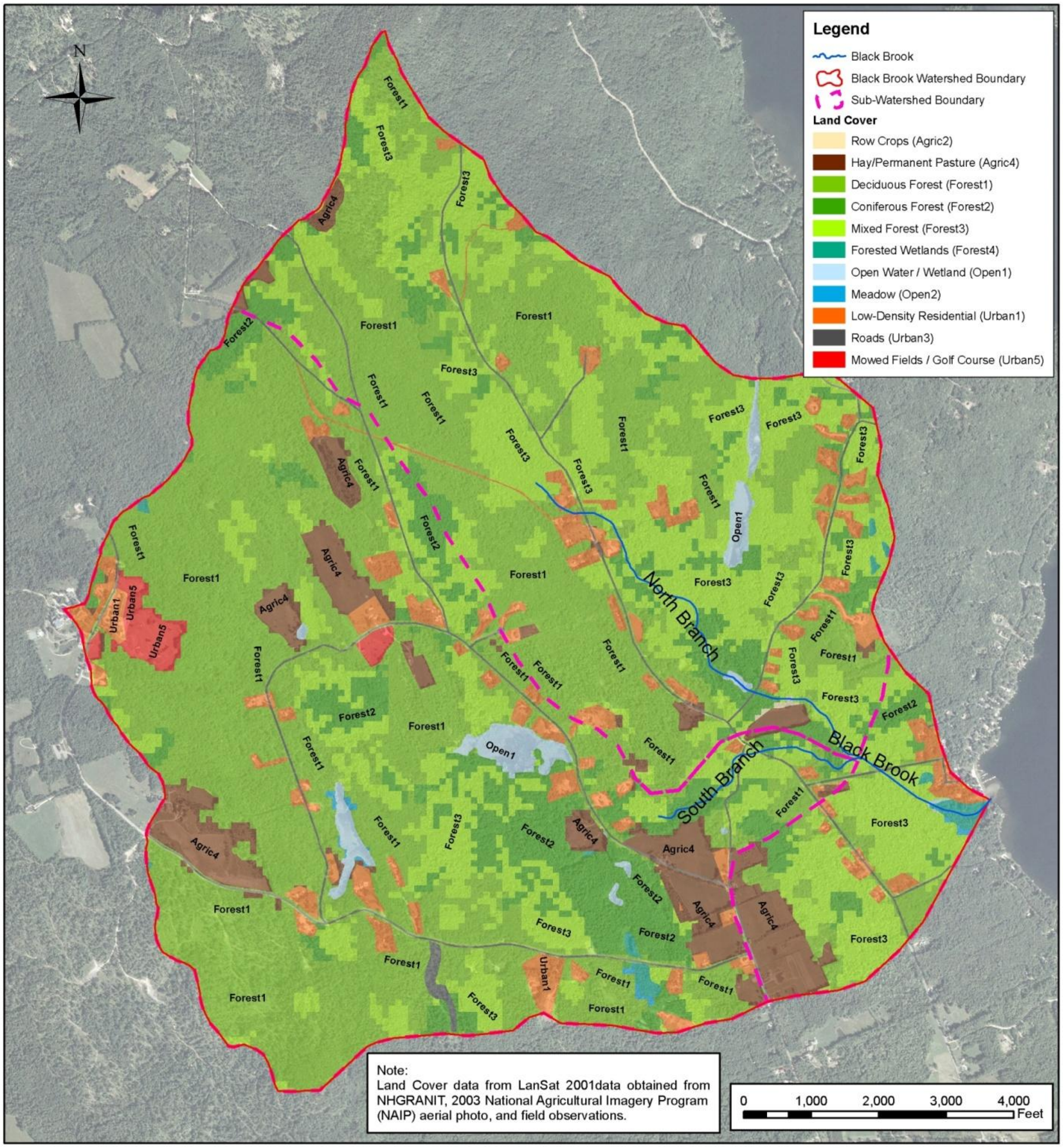


Figure 3-2: Black Brook Watershed Land Use

3.1 Hydrologic Inputs and Water Loading

Calculating TP loads to the Pot Island Basin of Lake Winnisquam requires estimation of the sources of water to this basin. The four primary sources of water are: 1) atmospheric direct precipitation; 2) runoff, which includes all overland flow to the tributaries and direct drainage to the lake; 3) baseflow, which includes all precipitation that infiltrates and is then subsequently released to surface water in the tributaries or directly to the lake (i.e., groundwater) and; 4) point sources including upstream basins and the Winnipesaukee River. Baseflow is roughly analogous to dry weather flows in streams and direct groundwater discharge to the lake. The water budget is broken down into its components in Table 3-1.

- Precipitation - Mean annual precipitation was assumed to be representative of a typical hydrologic period for the watershed. The annual precipitation value was derived from the USGS publication: Open File Report 96-395, "Mean Annual Precipitation and Evaporation - Plate 2", (USGS 1996) and confirmed with precipitation data from weather station in Concord. For the Black Brook watershed, 1.20 m (47.14 in) of annual precipitation was used.
- Runoff - For each land use category, annual runoff was calculated by multiplying mean annual precipitation by basin area and a land use specific runoff fraction. The runoff fraction represents the portion of rainfall converted to overland flow. This was compared to the standard water yield for this area.
- Baseflow - The baseflow calculation was calculated in a manner similar to runoff. However, a baseflow fraction was used in place of a runoff fraction for each land use. The baseflow fraction represents the portion of rainfall converted to baseflow.
- Point Source – This includes loads from the Three Island Basin and the Winnipesaukee River.

Runoff and baseflow fractions from Dunn and Leopold (1978) were altered slightly to be representative for the generally steeper slopes in the Black Brook watershed (i.e. less infiltration to baseflow and more runoff). The fractions are listed in Appendix B. The hydrologic budget was calibrated to a representative standard water yield for New England (Sopper and Lull, 1970; Higgins and Colonell 1971, verified by assessment of yield from various New England USGS flow gauging stations).

Table 3-1: Pot Island Basin and Black Brook Water Budget

WATER BUDGET	M^3/YR
Atmospheric	14,727,658
Septic System	45,625
BB-South Branch[1]	4,116,813
BB-North Branch[1]	3,173,386
BB-Main Stem	7,511,531
Pot Island Basin	14,816,419
Chapman Brook	1,048,555
3 Island Basin[2]	28,650,767
Winnipesaukee River[2]	484,010,528
Total	**550,811,083**

[1]Note the Black Brook North and South Branch totals are not used directly to calculate Pot Island Basin total since they are included in the total for the Black Brook Main Stem.
[2]Input from these two basins are modeled as point sources of water to the Pot Island Basin

3.2 Nutrient Inputs

Land Use Export

The Black Brook watershed boundary was delineated using NRCS and NH DES HUC8 delineations and the Winnisquam Lake USGS topographic quadrangle map, 1987. Land uses within the watershed were determined using several sources of information including: (1) Geographic Information System (GIS) data, (2) analysis of aerial photographs and (3) drive-by observations.

The TP load for the watershed was calculated using export coefficients for each land use type. The watershed loading was adjusted based upon proximity to the lake, soil type, presence of wetlands, and attenuation provided by Best Management Practices (BMPs) for water or nutrient export mitigation. The watershed load (baseflow and runoff) was combined with direct loads (atmospheric, septic system, and waterfowl) to calculate TP loading. The generated load to the lake was then input into a series of empirical models that provided predictions of in-lake TP concentrations, chl *a* concentrations, algal bloom frequency and water clarity. Details on model input parameters and major assumptions used to estimate the baseline loading (i.e., existing conditions) for Lake Winnisquam are described below.

- Areal land use estimates were generated from land cover GIS data layers from NH GRANIT. For Lake Winnisquam, data sources are: 2001 NH Land Cover Assessment data (Complex Systems Research Center (CSRC), Durham, New Hampshire), New Hampshire Roads (NH Department of Transportation), National Wetlands Inventory (NRCS)and New Hampshire Hydrography Dataset (CSRC, USGS, US EPA, NH DES)). Land use categories were matched with the LLRM land use categories and their respective TP export coefficients. Table 3-2 lists LLRM land use categories in which the GRANIT categories were matched. Land cover data and aerial photographs were used to determine certain land use classifications, such as agriculture and forest types. Selected land uses were confirmed on the ground during a watershed survey and through consultation with the town planner. Watershed land use is presented spatially in Figure 3-2 and summarized in Table 3-2.

- TP export coefficient ranges were derived from values summarized by Reckhow et al. (1980), Dudley et al. (1997) as cited in ME DEP (2003) and Schloss and Connor (2000). Appendix Table B-1 provides ranges for export coefficients and Appendix Table B-2 provides the runoff and baseflow export coefficient for each land use category in the Black Brook watershed and the sources for each export coefficient. Residential areas were designated as Urban 1 (Low Density Residential). The export coefficient for Urban 1 was set at 0.9 kg/ha/yr. A University of New Hampshire study also found a TP runoff export coefficient of 0.35 kg/ha/yr to be at the lower end of the range and 0.9 kg/ha/yr to be a moderate export coefficient for urban land use in the Flints Pond watershed (Schloss and Connor, 2000). The land use distribution in the Flints Pond watershed of denser residential along the shoreline and low density non-shoreline residential found is also found in the Pot Island Basin watershed (AECOM, 2009).
- Areal loading estimates were attenuated within the model based on natural features such as porous soils and wetlands that would decrease loading. The Black Brook watershed has relatively steep, shallow, moderate- to poorly-drained soils. The watershed also has some wetland complexes in the watershed which are expected to reduce the rate of runoff flow and encourage water infiltration, settling and adsorption of TP. A TP attenuation factor of 10% was applied to the Pot Island Basin and North and South Branches of Black Brook, meaning that 90% of the generated TP load from these areas is actually delivered to the lake. An additional 5% of attenuation was assumed in the confluence reach of Black Brook. Chapman Brook was assigned an attenuation factor of 90% due to its proximity to the outlet of the Pot Island Basin. It was assumed that the majority of the water and phosphorus associated with Chapman Brook exits the Pot Island Basin without entering the main basin.
- Annual areal loading of TP from the Black Brook watershed is estimated to be 224 kg/yr, which represents 4.3% of the total load to the Pot Island Basin. The total phosphorus load to the Pot Island Basin is 5182 kg/yr. The distribution of the load among sources is presented in Table 3-3.

Table 3-2: Land Use Categories by Subwatershed (Existing Conditions)

	Subwatershed Area (Hectares (Acres))				
Land Use	**Black Brook South Branch**	**Black Brook North Branch**	**Black Brook Main Stem**	**Pot Island Basin**	**Chapman Brook**
Urban 1 (Low Density Residential)	37.5 (93)	26.4 (65)	7.0 (17)	200.0 (494)	5.7 (14)
Urban 2 (Mid Density Residential/Commercial)	--	--	--	41.5 (103)	--
Urban 3 (Roads)	11.2 (28)	5.6 (14)	1.9 (5)	241.6 (597)	37.8 (93)
Urban 4 (Industrial)	--	--	--	--	--
Urban 5 (Mowed Fields)	10.2 (25)	--	--	--	--
Agric 1 (Cvr Crop)	--	--	--	--	--
Agric 2 (Row Crop)	--	0.4 (1)	--	0.9 (2)	7.6 (19)
Agric 3 (Grazing)	--	--	--	--	--
Agric 4 (Hayfield)	53.9 (133)	8.2 (20)	15.3 (38)	204.7 (506)	174.0 (430)
Forest 1 (Deciduous)	323.1 (798)	206.1 (509)	12.3 (30)	563.3 (1392)	477.8 (1181)
Forest 2 (NonDeciduous)	83.6 (207)	44.2 (109)	7.9 (19)	323.0 (798)	293.2 (725)
Forest 3 (Mixed)	88.2 (218)	173.3 (428)	43.6 (108)	570.4 (1409)	447.6 (1106)
Forest 4 (Wetland)	2.2 (5)	0.6 (2)	2.3 (6)	--	1.1 (3)
Open 1 (Wetland/Lake)	11.3 (28)	5.5 (14)	0.2 (0.4)	63.8 (158)	15.5 (38)
Open 2 (Meadow)	1.1 (3)	--	0.3 (1)	7.5 (19)	13.6 (34)
Open 3 (Excavation)	--	--	--	9.6 (24)	20.4 (50)
TOTAL	622.2 (1538)	470.3 (1162)	90.7 (224)	2226.3 (5501)	1494.3 (3692)

Atmospheric Deposition

Nutrient inputs from atmospheric deposition were estimated based on a TP coefficient for direct precipitation. The atmospheric load of 0.25 kg/ha/yr includes both the mass of TP in rainfall and the mass in dryfall (Wetzel, 2001). The sum of these masses is carried by rainfall. The concentration calculated for use in the loading estimate 24 μg/L is roughly equivalent to the mean concentration (25 μg/L) observed in rainfall in Concord, NH (NH DES, 2008 Unpublished Data). The coefficient was then multiplied by the lake area (ha) in order to obtain an annual atmospheric deposition TP load. The contribution of atmospheric deposition to the annual TP load to the Pot Island Basin was estimated to be 308 kg/yr or 5.9% of the total load.

Septic systems

TP export loading from residential septic systems was estimated within the 125 ft shoreline zone. The 125 ft zone is the minimum distance from lakes that new septic systems are allowed in New Hampshire with rapid groundwater movement through gravel soils. The TP load was calculated by multiplying a TP export coefficient (based on literature values for wastewater TP concentrations and expected water use), the number of dwellings, the mean number of people per dwelling, the number of days occupied per year, and an attenuation coefficient of 90% for systems meaning that 10% of the phosphorus load from these systems reaches the lake. In the Pot Island watershed, the TP loading from shoreline septic systems was estimated to be 36.5 kg/yr, which is 0.7% of the TP load to the Pot Island Basin. A more detailed septic survey as more subwatersheds around Lake Winnisquam are investigated may yield more precise estimates of septic loading. The following assumptions were used in estimating the TP load from septic systems.

- It was estimated that 200 year round residences are within 125 feet of the Pot Island Basin.
- Two and a half people were estimated to reside in each dwelling. It was estimated that each resident uses 65 gallons per day for 365 days per year
- The TP coefficients were calculated based on mean TP concentration in domestic wastewater of 8 mg/L and mean household water uses (Metcalf & Eddy, 1991).
- All septic loads to Lake Winnisquam from septic systems were attenuated 90% (Dudley and Stephenson, 1973; Brown and Associates, 1980) to account for TP uptake in the soil between the septic systems and the lake (10% of TP gets to the lake).

Direct Inputs from the Three Island Basin and the Winnipesaukee River.

The LLRM model was configured to consider the Three Island Basin and the Winnipesaukee River as point sources. Average annual water yield/flow was multiplied by average annual phosphorus concentrations from these sources to derive an estimated annual load to the Pot Island Basin of Lake Winnisquam. The total annual phosphorus load from the Three Island Basin was estimated to be 183.4 kg/yr while the load from the Winnipesaukee River was estimated to be 3533.3 kg/yr. It was assumed that 95% of the phosphorus load that enters the lake through the Winnipesaukee River mixes in the Pot Island Basin and the remaining 5% leaves through the basin outlet to the Mohawk Basin without mixing (Conner personal communication 2011).

3.3 Phosphorus Loading Assessment Summary

The current TP load to the Pot Island Basin of Lake Winnisquam was estimated to be 5182.2 kg/yr from all sources. The TP load according to source is presented in Table 3-3.

Loading from the watershed was overwhelmingly the largest source at 4838.2 kg/yr (93%) of the TP load to the Pot island Basin. Direct precipitation provides approximately 6% of the annual TP load or 307.5 kg/yr. The Winnipesaukee River is responsible for 68% of the phosphorus load to the Pot Island Basin. Septic systems contribute 36.5 kg/yr or 1% of the annual TP budget for the Pot island Basin.

Table 3-3: Pot Island Basin of Lake Winnisquam Phosphorus Loading Summary

TP INPUTS	Modeled Current TP Loading (kg/yr)	% of Total Load
Atmospheric	307.5	6
Internal	0.0	0
Waterfowl	0.0	0
Septic Systems	36.5	1
BB-South Branch[1]	134.1	3
BB-North Branch[1]	75.0	1
BB-Main Stem	223.7	4
Pot Island Basin	863.4	17
Chapman Brk	34.5	1
Winnipesaukee River[2]	3533.3	68
Three Island Basin[2]	183.4	4
Watershed Total	4838.2	93
Total	**5182.2**	**100**

[1]Note the Black Brook North and South Branch totals are not used directly to calculate Pot Island Basin total since they are included in the total for the Black Brook Main Stem.

[2]Input from these two basins are modeled as point sources of phosphorus to the Pot Island Basin

3.4 Phosphorus Loading Assessment Limitations

While the analysis presented above provides a reasonable accounting of sources of TP loading to the Pot Island Basin of Lake Winnisquam, there are several limitations to the analysis:

- Precipitation varies among years and hence hydrologic loading will vary. This may greatly influence TP loads in any given year, given the importance of runoff to loading.
- Spatial analysis has innate limitations related to the resolution and timeliness of the underlying data. In places, local knowledge was used to ensure the land use distribution in the LLRM model was reasonably accurate, but data layers were not 100% verified on the ground. In addition, land uses were aggregated into classes which were then assigned export coefficients; variability in export within classes was not evaluated or expressed.

- TP export coefficients as well as runoff/baseflow exports were representative but also had limitations as they were not calculated for the study water body, but rather are regional estimates.
- The TP loading estimate from septic systems was limited by the assumptions associated with this calculation described above in the “Septic Systems” subsection.
- Water quality data for Black Brook and other sources to Lake Winnisquam are limited, restricting calibration of the model.

3.5 Lake Response to Current Phosphorus Loads

TP load outputs from the LLRM Methodology were used to predict in-lake TP concentrations using five empirical models. The models include: Kirchner-Dillon (1975), Vollenweider (1975), Reckhow (1977), Larsen-Mercier (1976), Jones-Bachmann (1976), and Nurnberg (1998). These empirical models estimate TP from system features, such as depth and detention time of the waterbody. The load generated from the export portion of LLRM was used in these equations to predict in-lake TP. The mean predicted TP concentration from these models was compared to measured (observed) values. Input factors in the export portion of the model, such as export coefficients and attenuation, were adjusted to yield an acceptable agreement between measured and average predicted TP. Because these empirical models account for a degree of TP loss to the lake sediments, the in-lake concentrations predicted by the empirical models are lower than those predicted by a straight mass-balance for the Pot Island Basin (9 μg/L) where the mass of TP entering the lake is equal to the mass exiting the lake without any retention. Also, the empirical models are based on relationships derived from many other lakes. As such, they may not apply accurately to any one lake, but provide an approximation of predicted in-lake TP concentrations and a reasonable estimate of the direction and magnitude of change that might be expected if loading is altered. These empirical modeling results are presented in Table 3-4.

The TP load estimated using LLRM methodology translates to predicted mean in-lake concentrations ranging from 5.7 to 7.3 μg/L. The mean in-lake TP concentration of the five empirical models was 6.6 μg/L. The mean and median epilimnetic TP concentration from observed in-lake data from 2001 to 2010 were 6.6 and 6.4 μg/L, respectively.

Table 3-4: Predicted In-Lake Total Phosphorous Concentration for Pot Island Basin under Current Conditions using Empirical Models

Empirical Equation	Equation	Predicted TP (*ug*/L)
Mass Balance	TP=L/(Z(F))*1000	9.4
Kirchner-Dillon 1975	TP=L(1-Rp)/(Z(F))*1000	7.3
Vollenweider 1975	TP=L/(Z(S+F))*1000	7.2
Larsen-Mercier 1976	TP=L(1-Rlm)/(Z(F))*1000	5.7
Jones-Bachmann 1976	TP=0.84(L)/(Z(0.65+F))*1000	6.1
Reckhow General 1977	TP=L/(11.6+1.2(Z(F)))*1000	6.4
Nurnberg (1998)	TP=(L/Z(F))(1-(15/(18+Z(F)))) * 1000	7.2
Average of Above 6 Model Values		***6.6***
Observed Summer Epilimnion Mean		***6.6***
Observed Summer Epilimnion Median		***6.4***

Variable	Description	Units	Equation
L	Phosphorus Load to Lake	g P/m2/yr	
Z	Mean Depth	m	Volume/area
F	Flushing Rate	flushings/yr	Inflow/volume
S	Suspended Fraction	no units	Effluent TP/Influent TP
Qs	Areal Water Load	m/yr	Z(F)
Vs	Settling Velocity	m	Z(S)
Rp	Retention Coefficient (settling rate)	no units	((Vs+13.2)/2)/(((Vs+13.2)/2)+Qs)
Rlm	Retention Coefficient (flushing rate)	no units	1/(1+F^0.5)

Once TP estimates were derived, annual mean chl *a* and SDT can be predicted based on another set of empirical equations: Carlson (1977), Dillon and Rigler (1974), Jones and Bachman (1976), Oglesby and Schaffner (1978), Vollenweider (1982), and Jones, Rast and Lee (1979). Bloom frequency was also calculated based on equations developed by Walker (1984, 2000) using a natural log mean chl *a* standard deviation of 0.5. These predictions are presented in Table 3-5. Predicted mean chl *a* concentrations (Table 3-5) are similar to those observed in the monitoring data. Predicted Secchi transparencies are substantially lower than observed which may be a reflection of the minimal amount of dissolved color in Lake Winnisquam and a general lack of non-algal turbidity.

Table 3-5: Predicted In-Lake Chlorophyll a and Secchi Disk Transparency Predictions based on an Annual Average In-Lake Phosphorous Concentration of 6.6 μg/L

Empirical Equation	**Equation**	**Predicted Value**
Mean Chlorophyll		***ug*/L**
Carlson 1977	Chl=0.087*(Pred TP)^1.45	1.4
Dillon and Rigler 1974	Chl=10^(1.449*LOG(Pred TP)-1.136)	1.1
Jones and Bachmann 1976	Chl=10^(1.46*LOG(Pred TP)-1.09)	1.3
Oglesby and Schaffner 1978	Chl=0.574*(Pred TP)-2.9	0.9
Modified Vollenweider 1982	Chl=2*0.28*(Pred TP)^0.96	3.5
Average of Model Values		**1.6**
Observed Summer Mean		***2.0***
Peak Chlorophyll		***ug*/L**
Modified Vollenweider (TP) 1982	Chl=2*0.64*(Pred TP)^1.05	9.4
Vollenweider (CHL) 1982	Chl=2.6*(AVERAGE(Pred Chl))^1.06	4.4
Modified Jones, Rast and Lee 1979	Chl=2*1.7*(AVERAGE(Pred Chl))+0.2	5.7
Average of Model Values		**6.5**
Observed Summer Maximum		***3.6***
Bloom Probability		***% of Summer***
Probability of Chl >15 *u*g/L	See Walker 1984 & 2000	0.00%
Secchi Transparency		***m***
Mean: Oglesby and Schaffner 1978	SDT=10^(1.36-0.764*LOG(Pred TP))	5.4
Max: Modified Vollenweider 1982	SDT=9.77*Pred TP^-0.28	5.7
Observed Summer Mean		***8.3***
Observed Summer Maximum		***10.3***

Variable	**Description**	**Units**
"Pred TP"	The average TP calculated from the 5 predictive equation models in Table 3-5	*u*g/L
"Pred Chl"	The average of the 3 predictive equations calculating mean chlorophyll	*u*g/L

*The observed summer maximum is based on n=26 and is not necessarily the peak chlorophyll

3.6 Critical Conditions

Critical conditions in Lake Winnisquam typically occur during the summertime, when the potential (both occurrence and frequency) for nuisance algal blooms are greatest. The loading capacity for TP was set to achieve desired water quality targets during this critical time period and also provide adequate protection for designated uses throughout the year. This was accomplished by using a target concentration based generally on summer epilimnetic data and applying it as a mean annual concentration in the predictive models used to establish the mean annual maximum load. Summer epilimnetic concentrations of phosphorus are typically lower than annual average concentrations (Nurnberg 1998).

3.7 Seasonal Variation

As explained in Section 3.5, the Lake Winnisquam model takes into account seasonal variations because the target annual load is developed to be protective of the most sensitive (i.e., biologically responsive) time of year (summer), when conditions most favor the growth of algae.

3.8 Loading Model Development Summary

The relationship between TP and algal biomass is well documented in scientific literature. This assessment was developed for TP and is designed to protect Lake Winnisquam and its designated uses impacted by excessive chl *a* concentrations.

In conclusion, water quality was linked to TP loading by:

- Choosing a preliminary target in-lake TP level, based on historic state-wide and in-lake water quality data, best professional judgment, and through consultation with NH DES and Sanbornton, sufficient to attain water quality standards and support designated uses. The preliminary in-lake TP concentration target is a mean of 6.6 μg/L (median 6.4 μg/L).
- Recognizing that future development may increase future loading a short term goal of an in-lake mean concentration of 6.3 μg/L (median 6.1 μg/L) was set.
- Using the mean of five empirical models that link in-lake TP concentration and load, calibrated to lake-specific conditions, to estimate the load responsible for observed in-lake TP concentrations.
- Determining the overall mean annual in-lake TP concentration from those models, given that the observed in-lake concentrations may represent only a portion of the year or a specific location within the lake.
- Using the predicted mean annual in-lake TP concentration to predict Secchi disk transparency, chl *a* concentration and algal bloom frequency.
- Using the aforementioned empirical models to determine the TP load reduction needed to meet the numeric concentration target.
- Using a GIS-based spreadsheet model to provide a relative estimate of loads from watershed land areas and uses under current and various projected scenarios to assist stakeholders in developing TP reduction strategies.

4.0 Evaluation of Alternative Loading Scenarios

The LLRM model was used to evaluate a number of alternative loading scenarios and the probable lake response to these loadings. These scenarios included:

- Current Loading
- Natural Environmental Background Loading
- Build-out of Watershed
- Reduction of Watershed Loads to Meet Mean 6.3 μg/L Short Term Goal

The current loading scenario is discussed above in Section 3.0. Each scenario described below represents a change from the current loading scenario. The discussion of each scenario includes only the portions of the current loading scenario that were altered for the specific simulation. A comparison of the results of each of the alternative scenarios is presented in Tables 4-1 and 4 -2.

Table 4-1: Comparison of Phosphorous Loading Scenarios for the Pot Island Basin, Lake Winnisquam

Inputs	**Current Load (kg/yr)**	**Natural Environmental Background (kg/yr)[1]**	**Build Out Analysis (kg/yr)[1]**	**Short-Term Goal to Obtain 6.3 *u*g/L Mean In-lake Concentration (kg/yr)**
Atmospheric	307.5	307.5	307.5	307.5
Waterfowl	0	0	0	0
Septic System	36.5	0.0	73.0	34.7
Watershed Load	4,838	1,352	11,597	4,597
Total Load	**5,182**	**1,660**	**11,977**	**4,939**
Change from Current Total Load (kg/yr)	-	-3,522	6,795	-243
Percent Change from Current Total Load (%)	-	-68%	131%	-5%
Black Brook Load (kg/yr)	224	102	791	213
Percent Change from Current Black Brook Load (%)	-	-45%	253%	-5%

[1]Note that natural environmental background and buildout analyses were only conducted for the Pot Island Basin. Other areas of the watershed such as Lake Winnipesaukee and the Three Island Basin were estimated (see section 4.2)

Table 4-2: Lake Water Quality Response to Different Loading Scenarios for the Pot Island Basin, Lake Winnisquam

Parameters	Current Load	Natural Environmental Background[1]	Build Out Analysis[1]	Short-Term Goal to Obtain 6.3 *u*g/L Mean In-lake Concentration
TP Load (kg/yr)	5,182	1,660	11,977	4,939
Mean Annual TP (*u*g/L)	6.6	1.9	16.0	6.3
Mean Secchi Disk Transparency (m)	5.4	13.9	2.8	5.6
Mean Chlorophyll *a* (*u*g/L)	1.6	0.4	5.6	1.5
Peak Chlorophyll *a* (*u*g/L)	6.5	1.2	19.6	6.1
Probability of Summer Bloom (Chl *a* > 15 *u*g/L)	0.0%	0.0%	1.3%	0.0%

[1]Note that natural environmental background and buildout analyses were only conducted for the Pot Island Basin. Other areas of the watershed such as Lake Winnipesaukee and the 3 Island Basin were estimated (see section 4.2)

4.1 Natural Environmental Background Phosphorus Loading

Natural environmental background levels of TP in the lake were evaluated using the LLRM model. Natural background was defined as background TP loading from non-anthropogenic sources. Hence, land uses in the Pot Island watershed were set to its assumed “natural” state of forests and wetlands. Loading was then calculated using the LLRM model as described above. This estimate is useful as it sets a realistic lower bound of TP loading and in-lake concentrations possible for Lake Winnisquam. Loadings and target concentrations below these levels are very unlikely to be achieved.

The septic loads were removed and all developed land was converted to forests. The developed land was split into mixed, deciduous, and coniferous forest categories in the same percentages as the current watershed forest composition. Wetland areas were not changed because it was assumed no wetland had been lost due to development. The estimated percent difference in loading from the Pot Island Basin between current conditions and natural environmental conditions was then applied to the loads from the Three Island Basin and the Winnipesaukee River. A detailed land use analysis was not conducted for this portion of the watershed so absolute numbers from this analysis should be interpreted with caution.

Background TP loads under this scenario were 1,660 kg/yr total with a watershed load of 1,352 kg/yr. Table 4-1 compares loads for possible scenarios. The calculated background loading of TP to Lake Winnisquam would result in mean in-lake TP concentration of 1.9 µg/L, a mean Secchi Disk transparency of 13.9 m, and a bloom probability of chl *a* > 15 µg/L of 0.0%. Estimated TP loading to the lake under this scenario is 68% lower than current loads to the lake for the entire watershed and 45% lower than current loads for the Black Brook watershed (Table 4-1). The lake would support designated uses and be viewed as pristine under this scenario as in-lake predicted mean TP concentration (1.9 μg/L) is well below the target value (6.6 μg/L) and the short-term goal (6.3 μg/L). This scenario provides the lower limit of phosphorus concentrations for Lake Winnisquam.

4.2 Build Out Analysis

Since the human population within a watershed may continue to grow and contribute additional TP to the impaired lakes, watershed plans should allow for growth and associated future TP loading. For example, in Maine, target TP loading from anticipated future development is set to allow a 1.0 µg/L change in in-lake TP concentration (Dennis et al., 1992). It should be recognized that the NH DES has no mechanism for regulation/enforcement of TP export from future developments of single house lots that do not require a Section 401 Water Quality Certification or fall under the thresholds for alteration of terrain permits (100,000 square feet of disturbance or 50,000 square feet within 250 feet of a lake). Municipalities can, however, regulate such development by revising their land use ordinances/regulations to require no additional loading of TP from new development. Increases in future loads were anticipated in this plan by incorporating a short term goal of reduction of loading and in-lake concentrations below the target. A build out scenario was developed to form the upper bound for development potential and is presented below.

The build out scenario was developed to assess the impact of complete development of the watershed. This scenario involved converting all existing forested and agricultural land not currently in conservation to low density residential land within the Pot Island watershed. This did not include wetland areas or conservation areas but did include areas with insufficient road frontage under the current conditions assuming that more roads could be built to serve these areas. It was assumed that all future building would retain similar characteristics as current building in the watershed and similar levels of best management practices. This was designed as a worst case scenario. In reality, some level of best management practices could be expected for future development so the actual increases in loading might be lower than those projected. It should also be noted that development could include more intensive uses which would tend to increase the loading estimates. The estimated percent difference in loading from the Pot Island Basin between current conditions and build out condition was then applied to the loads from the Three Island Basin and the Winnipesaukee River. A detailed land use analysis was not conducted for this portion of the watershed so absolute numbers from this analysis should be interpreted with caution.

Under this scenario, loading to the Pot Island Basin from all sources would be expected to increase 131% over current levels to a total of 11,977 kg/yr (Table 4-1). This would result in an in-lake average TP concentration of 16.0 µg/L, a mean transparency of 2.8 m which is roughly half of the current transparency and a probability of a bloom greater than 15 µg/L of 1.3% translating to 5 days per year (Table 4-2). Under this scenario, loads from the Black Brook watershed to the Pot Island Basin would roughly triple. Clearly, this is a scenario that would produce unacceptable water quality in Lake Winnisquam. Tables 4-4 and 4-5 summarize estimated changes in phosphorus loading and land use under the future buildout scenario.

4.3 Reduction of Loads to Meet In-lake Short-Term TP Goal of 6.3 μg/L Mean In-Lake Concentration

This scenario involves the focus of resources on the largest source of TP to Lake Winnisquam, the watershed load as well as one of the smaller loads (septic systems). Under this scenario, watershed TP loads were iteratively reduced until predicted in-lake concentrations met the 6.3 μg/L short-term goal for an annual mean concentration (equivalent to a median value of 6.1 μg/L). In order to achieve an average in-lake concentration of 6.3 µg/L (median of 6.1, the short term goal), phosphorus loading from the watershed (including septic systems) must be reduced from the current level of 4,838 kg/yr to 4,597 kg/yr for a reduction of 243 kg/yr or 5% of all sources (Table 4-1). This includes sources in the Three Island Basin and the Winnipesaukee River Watershed as well as all sources to the Pot Island basin with the exception of atmospheric contributions. The watershed reduction required from the Black Brook watershed to meet this goal is 10.7 kg from a current total load of 223.7 kg/yr to yield a short term goal of 213.0 kg/yr.

As some sources are less controllable than others, the actual reduction to be applied to achieve this goal will vary by source (see Sections 6 and 7). A 5% reduction from manageable watershed sources (Table 3-5) would be required to achieve the 6.3 ug/l annual average short-term goal TP concentration. Loading reduction strategies are discussed further in Section 7 below.

There are other combinations of alternatives that could also meet the short-term goal. Water quality under this scenario would be improved over current conditions but it should be recognized that current conditions are the target and this scenario allows some level of future development to be accommodated. Options for meeting this short-term goal are presented in the management section of this document (Section 7).

4.4 Distribution of Load in Black Brook Watershed

Tables 4-3 and 4-4 present the distribution of the phosphorus load to Lake Winnisquam from the Black Brook watershed under the current condition and under the future build-out scenario as predicted by the LLRM model. Reductions associated with the short-term goal scenario are not presented as there are numerous combinations of BMP's that could meet this target. The potential BMP's and associated reductions are discussed further below in Sections 5 and 6.

Phosphorus loading by land use category and subwatershed to Lake Winnisquam from the Black Brook watershed under current conditions are presented in Table 4-3. Note the Main Stem subwatershed includes only direct drainage to Black Brook from the confluence of the North and South Branches to the mouth of Black Brook.

Table 4-3: Phosphorus Loading to Black Brook by Land Use (Current Conditions)

LAND USE	BB-South Branch (kg/yr)	BB-North Branch (kg/yr)	BB Main Stem (kg/yr)	Black Brook Total (kg/yr)
Urban 1 (Low Density Residential)	30.7	21.6	6.4	55.8
Urban 2 (Mid Density Residential/Commercial)	0.0	0.0	0.0	0.0
Urban 3 (Roads)	18.2	9.1	3.5	29.2
Urban 4 (Industrial)	0.0	0.0	0.0	0.0
Urban 5 (Mowed Fields)	7.4	0.0	0.0	7.0
Agric 1 (Cvr Crop)	0.0	0.0	0.0	0.0
Agric 2 (Row Crop)	0.0	0.8	0.0	0.8
Agric 3 (Grazing)	0.0	0.0	0.0	0.0
Agric 4 (Hayfield)	31.5	4.8	9.9	44.0
Forest 1 (Deciduous)	30.2	19.3	1.3	48.3
Forest 2 (NonDeciduous)	7.3	3.9	0.8	11.3
Forest 3 (Mixed)	7.7	15.1	4.2	25.7
Forest 4 (Wetland)	0.2	0.0	0.2	0.4
Open 1 (Wetland/Lake)	0.7	0.3	0.0	1.0
Open 2 (Meadow)	0.2	0.0	0.1	0.2
Open 3 (Excavation)	0.0	0.0	0.0	0.0
Total Black Brook Load	**134.1**	**75.0**	**26.3**	**223.7**

Phosphorus loading by land use category and subwatershed to Lake Winnisquam from the Black Brook watershed under future buildout conditions are presented in Table 4-4. Note the Main Stem subwatershed includes only direct drainage to Black Brook from the confluence of the North and South Branches to the mouth of Black Brook.

Table 4-4: Phosphorus Loading to Black Brook by Land Use (Buildout Conditions)

LAND USE	BB-South Branch (kg/yr)	BB-North Branch (kg/yr)	BB Main Stem (kg/yr)	Black Brook Total (kg/yr)
Urban 1 (Low Density Residential)	297.4	232.1	41.6	542.5
Urban 2 (Mid Density Residential/Commercial)	0.0	0.0	0.0	0.0
Urban 3 (Roads)	111.8	82.9	15.8	200.0
Urban 4 (Industrial)	0.0	0.0	0.0	0.0
Urban 5 (Mowed Fields)	7.4	0.0	0.0	7.1
Agric 1 (Cvr Crop)	0.0	0.0	0.0	0.0
Agric 2 (Row Crop)	0.0	0.2	0.0	0.2
Agric 3 (Grazing)	0.0	0.0	0.0	0.0
Agric 4 (Hayfield)	9.5	1.4	3.0	13.2
Forest 1 (Deciduous)	9.1	5.8	0.5	14.6
Forest 2 (NonDeciduous)	2.2	1.2	0.3	3.5
Forest 3 (Mixed)	2.3	4.6	2.1	8.6
Forest 4 (Wetland)	0.2	0.0	0.2	0.4
Open 1 (Wetland/Lake)	0.7	0.3	0.0	1.0
Open 2 (Meadow)	0.2	0.0	0.1	0.2
Open 3 (Excavation)	0.0	0.0	0.0	0.0
Total Black Brook Load	**440.8**	**328.6**	**63.5**	**791.2**

Table 4-5: Land Use Categories by Subwatershed (Buildout Conditions)

Land Use	Subwatershed Area (Hectares (acres))				
	BB-South Branch	BB-North Branch	BB-Main Stem	Pot Island Basin	Chapman Brk
Urban 1 (Low Density Residential)	363.1 (897.3)	283.4 (700.3)	45.7 (112.9)	1271.7 (3142.4)	885.1 (2187.1)
Urban 2 (Mid Density Residential/Commercial)	-	-	-	41.5 (102.5)	-
Urban 3 (Roads)	68.6 (169.6)	50.9 (125.8)	8.7 (21.6)	394.6 (975.1)	193 (476.9)
Urban 4 (Industrial)	-	-	-	-	-
Urban 5 (Mowed Fields)	10.2 (25.2)	-	-	-	-
Agric 1 (Cvr Crop)	-	-	-	-	-
Agric 2 (Row Crop)	-	0.1 (0.3)	-	0.6 (1.5)	-
Agric 3 (Grazing)	-	-	-	-	-
Agric 4 (Hayfield)	16.2 (40.0)	2.5 (6.1)	4.6 (11.3)	-	-
Forest 1 (Deciduous)	97.1 (240.0)	61.8 (152.8)	4.4 (10.9)	169.0 (417.6)	143.3 (354.1)
Forest 2 (NonDeciduous)	25.6 (63.3)	13.3 (32.9)	2.7 (6.6)	96.9 (439.4)	88.0 (217.5)
Forest 3 (Mixed)	26.9 (66.4)	52.1 (128.8)	21.9 (54.1)	171.1 (422.8)	134.3 (331.9)
Forest 4 (Wetland)	2.2 (5.3)	0.6 (1.6)	2.3 (5.7)		1.1 (2.7)
Open 1 (Wetland/Lake)	11.3 (27.9)	5.5 (13.5)	0.2 (0.4)	63.8 (157.7)	15.5 (38.3)
Open 2 (Meadow)	1.1 (2.8)	-	0.3 (0.7)	7.5 (18.5)	13.6 (33.6)
Open 3 (Excavation)	-	-	-	9.6 (23.5)	20.4 (50.4)
TOTAL	622.3 (1537.7)	470.3 (1162.1)	90.7 (224.1)	2226.3 (5501.3)	1494.3 (3692.5)

5.0 Options for Managing Phosphorus Loading to Lake Winnisquam from the Black Brook Watershed.

This section describes non-point sources of phosphorus within the Black Brook watershed and outlines methods that could be employed to control their transport into Lake Winnisquam. These management practices could provide reductions in current loading rates and should be considered along with other management options as the Black Brook watershed becomes more developed and the need to manage loads becomes more critical to the preservation of Lake Winnisquam water quality.

Of the various sources of TP identified by land use in Section 4.4, the largest contributors of TP per land area are most appropriate sources to target for reductions. In the Black Brook watershed these consist of developed land (Urban 1), roads (Urban 3), hayfields (Agric4) and mowed fields (Urban5). These sources can be managed by employing BMPs and establishing regulations that support measures that protect the water quality of Black Brook and Lake Winnisquam.

Experience suggests that aggressive implementation of watershed BMPs may result in a maximum practical TP loading reduction of 60-70% in some watersheds. Greater reductions are possible, but consideration of costs, space requirements, and legal ramifications (e.g., land acquisitions, jurisdictional issues), limit attainment of such reductions. Most techniques applied in a practical manner do not yield >60% reductions in TP loads (Center of Watershed Protection, 2000). Better results may be possible with widespread application of low impact development techniques, as these reduce post-development volume of runoff as well as improve its quality, but there is not enough of a track record yet to generalize attainable results on a watershed basis.

The actual reduction in watershed loading from the Black Brook watershed necessary to meet the 6.3 µg/L short-term goal is 5%, and it is assumed that this reduction would be obtained mainly from the runoff portion of the load. This level of reduction is well within the practical maximum suggested by Center of Watershed Protection (2000), and should be achievable. Implementation will be phased in over a period of several years, with monitoring and adjustment as necessary.

There are a number of BMPs that could potentially be implemented in the Black Brook watershed (Table 5-1). BMPs fall into three main functional groups: 1) Recharge / Infiltration Practices, 2) Low Impact Development Practices, and 3) Extended Detention Practices. The table lists the practices, the pollutants typically removed and the degree of effectiveness for each type of BMP. Specific information on the BMPs is well summarized by the Center for Watershed Protection (2000).

Some of these practices may be directly applicable to the Black Brook watershed. Natural wetlands function to slow runoff water thereby encouraging infiltration of water and removal of TP through settling, soil adsorption and plant uptake. These functions should be preserved throughout the watershed. Maintaining buffers between lawn and other disturbed areas and Black Brook as well as encouraging minimal or no use of fertilizers is recommended. If fertilizer must be used, low or no TP fertilizer is recommended for lake protection.

Detention and infiltration practices can improve the quality of storm water originating from the roads and developments in the Black Brook watershed. Designing and installing BMPs that encourage infiltration or stormwater detention would reduce channel erosion and reduce TP concentrations by settling and contact with the soil prior to entry to the lake.

Key
Adverse Impact
Moderate Mitigation
Good Mitigation
Minimal Mitigation
Moderately Suited
Well Suited
Not Applicable

Table 5-1: Best Management Practices Selection Matrix

Management Practice	Ability to Mitigate: Runoff Volume (↑)	Peak Flow Rates (↑)	Bankfull Flow (↑)	Baseflow (↓)	Mod. Sed. Transport	Channel Morph. Changes[1]	In-Stream Temp. (↑)	Sediment conc. (↑)	Nutrient conc. (↑)	Metal Conc. (↑)	Hydrocarbon Conc. (↑)	Bacteria/Pathogens (↑)	Organic carbon Conc. (↑)	MTBE Conc. (↑)	Pesticide conc. (↑)	Deicer conc. (↑)	Applicability: New Development	Retrofit	Urban	Sub-Urban	Residential Sub-Division	Commercial	Industrial	Notes
Recharge / Infiltration Practices[2]																								
Infiltration Swale	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Permeable site soils required. Pre-treatment recommended.
Infiltration Trench/Galley	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Permeable site soils required. Pre-treatment recommended.
Retention/Infiltration Basin	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Permeable site soils required. Pre-treatment recommended.
Low Impact Development Practices																								
Bioretention	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Disconnecting Impervious Area	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Flow Path Practices	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Includes increasing roughness, sheet flow, flow path length, and flattening slopes.
Green Roof	Good	Good	Good	Minimal	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well Suited	Moderately Suited	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	
Minimize Disturbance Area	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Used as a component of LID site design.
Minimize Site Imperviousness	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Includes imiting use of sidewalks, and reducing road/driveway length/width.
Porous Pavement	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Preserve Infiltratable Soils	Good	Moderate	Moderate	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Used as a component of LID site design.
Preserve Natural Depression Areas	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Used as a component of LID site design.
Rain Barrels/Cisterns	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Rain Garden	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Good	Good	Good	Good	Good	Good	Moderate	Good	Moderate	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Soil Amendment	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Moderately Suited	Moderately Suited	Used as a component of LID site design.
Vegetated Filter Strip	Good	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Minimal	Minimal	Well Suited	Well Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Vegetation Preservation	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Well Suited	Not Applicable	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Used as a component of LID site design.
Extended Detention Practices																								
Created Wetland/Biofilter Detention	Moderate	Good	Moderate	Minimal	Moderate	Moderate	Adverse Impact	Moderate	Moderate	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Moderate	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Extended Detention Pond	Minimal	Good	Moderate	Minimal	Moderate	Moderate	Adverse Impact	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Minimal	Moderate	Minimal	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Wet Detention	Minimal	Good	Moderate	Minimal	Moderate	Moderate	Adverse Impact	Moderate	Moderate	Moderate	Good	Adverse Impact	Moderate	Minimal	Moderate	Minimal	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Other Best Management Practices																								
Deep Sump Catch Basins	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Pre-treatment prior to infiltration BMPs
Sand/Organic Filter	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Minimal	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	
Swale	Moderate	Good	Moderate	Minimal	Moderate	Moderate	Minimal	Moderate	Moderate	Moderate	Good	Moderate	Moderate	Minimal	Moderate	Minimal	Well Suited	Moderately Suited	Moderately Suited	Well Suited	Well Suited	Well Suited	Well Suited	Dry swale with some infiltration.
Water Quality Inlet	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal	Moderate	Minimal	Minimal	Moderate	Minimal	Minimal	Minimal	Minimal	Minimal	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Well Suited	Includes proprietary hydrodynamic devices. Pre-treatment prior to exfiltration BMPs.

[1] Impacts include channel enlargement/incision/embeddedness, changes in pool/riffle structure, and reduced channel sinousity.

[2] Recharge and infiltration measures require permeable soils and pre-treatment is recommended. See specific BMP descriptions for more information.

5.1 Land Development

As natural undisturbed land is developed, impervious areas and the potential for phosphorus export are typically increased. Increased volume and rates of runoff from impervious roofs, driveways, and compacted soils causes greater potential for the transport of phosphorus to surface water. If not properly managed, these increased flows can cause substantial erosion of land that previously had not conveyed water as well as along existing drainage channels. The sediment load from such erosion can be a major source of phosphorus as the available phosphorus is transported by stormwater to surface waters.

Specific sources of phosphorus introduced with development include lawn and garden fertilizers, septic systems, and pet and livestock/fowl waste. Without proper erosion controls, a considerable amount of phosphorus and sediment can also be transported during construction activities.

Based on the land use data used in this study, there are currently 89.6 hectares (222 acres) of developed residential land and roads in the Black Brook watershed. This is 7.6 percent of the total Black Brook watershed area. Existing development within the Black Brook watershed is dispersed throughout the watershed and no densely populated areas currently exist. Future increases in TP loading from stormwater runoff associated with new development are a particular concern in the Black Brook watershed due to the presence of steep slopes and the potential for new driveway and road cuts to cause runoff from the development to contribute to the existing roadway swales which in many cases are not suitable for high-flow conveyance or stormwater treatment.

5.1.1 Existing Land Development Protection

Development regulations pertaining to the Black Brook watershed are under the jurisdiction of the federal government, the State of New Hampshire and the Towns of Sanbornton and Meredith. While this is not intended to be an exhaustive review of those regulations, it highlights important provisions of each of the jurisdictions regulations that have relevance to water quality in the Black Brook watershed. Any specific development project should do a complete review of requirements prior to any action.

Federal Requirements

- Dredge and fill permit. – Under section 404 of the Clean Water Act dredging and filling of waters of the United States is regulated. A permit is required for dredging or filling water. This included many activities on the waterfront, along streams or in wetlands including construction of beaches, break walls and boat houses.
- Stormwater Permit – A federal stormwater permit (NPDES – Phase II Construction Permit) is required for any land disturbance of greater than 1 acre.

State Requirements

- Site Specific Permit – A Site Specific Permit is required when disturbing more than 100,000 square feet of land or more than 50,000 square feet of land in the Shoreland zone (within 250 feet of a lake or tributary).
- State Septic Permit – A permit for on-site wastewater disposal is required for new construction or expansion of current use of a structure to include additional bedrooms.

- Shoreland Protection Act – Requires a permit for many activities in the 250 foot zone from a lake or tributary

Sanbornton Requirements

- Subdivision Regulations (adopted by voters March 12, 1957)
  - Expressed purpose " To prevent pollution of air, land, watercourses and waterbodies….."
  - The planning board "shall consider the impact of the proposed subdivision on the environment including, but not limited to, water and air pollution….."
  - " The subdivision plan shall be designed, in so far as possible, to preserve such natural features as wetlands, water courses, waterbodies, floodplains, steep slopes, aquifer recharge areas",
  - Lots shall be graded to the ditchline or shall have a stormwater system, no discussion of water quality or infiltration of water..
  - Stormwater management or drainage plans may be required by planning board for construction, no standards for runoff quality after development are included.
- Zoning Ordinance (2010 edition)
  - 50 foot setback from water bodies for buildings (note wetlands sections specifies 75 feet)
  - 2 acre zoning for new construction in the General Residential District
  - 6 acre zoning in the Forest Conservation District
  - 3 acre zoning in the General Agriculture District
  - 1.5 acre zoning in the Recreational District
  - Soil and erosion control plan is required for site plans and subdivisions
  - 6 acre zoning and impervious cover limit of 10% in Aquifer Conservation District
  - Cluster development allowed with planning board approval per Article 4 section T.

Meredith Requirements

- Zoning Regulations (adopted August 27, 1971, amended March 9, 2010)
  - In the Forestry and Conservation, Forestry and Rural, the minimum setback from the shoreline shall be sixty-five (65) feet
  - Most restrictive lot size prevails on a particular parcel
  - Minimum lots size based on soils and slopes and varies from approximately 1-4 acres.
  - Minimum lot size based on the Forestry and Conservation zone in the Black Brook watershed is 10 acres which would have primacy over soil based lot size requirements.
  - Minimum lot size based on the Forestry and Rural zone in the Black Brook watershed is 3 acres which may have primacy over soil based lot size requirements
  - Contains both a Conservation Subdivision and an Erosion and Sediment Control Ordinance
- Land Subdivision Regulations (March 13, 1968, amended July 8, 2008)
  - "Regard shall be shown for all natural features such as large trees, watercourses…"

- Drainage portion of ordinance deals with water quantity and not water quality
- Site Plan Review Regulations (March 15, 1975, amended July 8, 2008)
  - Water quality is not specifically addressed but reference to zoning ordinance is made which includes the Erosion and Sediment Control Ordinance

Towns in New Hampshire have the authority to develop and enforce ordinances to protect designated resources of the town such as Lake Winnisquam. The statute authority is granted under RSA 674:35 and 674:43 to regulate subdivisions, and nonresidential and multi-family residential site development, respectively. The requirements associated with the development of a town master plan are stated in RSA 674:1-4. Authority for developing and enforcing zoning ordinances are specified in 674:17-20, and the application of innovative land use controls are described in RSA 674:21.

5.1.2 Considerations for Management of Land Development

Water quality impacts associated with development activities can be mitigated through zoning and planning ordinances and measures including:

- Removing the potential for development: If a land owner is willing, a conservation organization or the town can either remove the development rights from a property through a conservation easement, or through deeded ownership of the land. Land owners may donate conservation easements in exchange for tax deductions, or request financial compensation. Approximately 1.0% of the Black Brook watershed is currently under conservation protection. These conservation lands consist of two lots totaling 29.6 acres along Black Brook Road. Additional land conservation has the potential to considerably reduce the future increases in TP export to Lake Winnisquam from the Black Brook watershed. As presented in the discussion of buildout (Section 4.2), development of all land that could currently be developed in the Black Brook watershed would result in an increase in phosphorus loading to Lake Winnisquam of 253% from the Black Brook watershed. Additional protection of lands from development would result in a direct decrease in the maximum potential increase in TP loading related to future development. A search of October 2011 real estate listings suggest that larger parcels of land without water access and without current conservation easements in Sanbornton can be purchased for approximately $5,000 – $25,000 per acre. Purchasing conservation easements on property would be less expensive than deeded ownership. Based on the analysis conducted in Section 4, the removal of the development potential from currently undeveloped forested land to low density residential land in the Black Brook watershed will eliminate potential future increases in loads of 0.8 kg TP per hectare (0.7 lb/acre) of land protected.
- General Ordinances
  - Local or regional bans on phosphorus in lawn fertilizer
- New Development / Construction Ordinances
  - Incorporate low impact development (LID) requirements
    - Dry wells
    - Infiltration trenches
    - Bioretention Systems (“rain gardens”)
    - Rain Barrels
  - Minimize disturbed areas

- Maintain natural buffers
- Maximize setbacks from lakes and tributaries
- Minimize impervious cover
- Minimize construction footprint
- Pervious pavers / pavement
- Minimize soil compaction during construction
- Provide drainage management for impervious areas (gravel & paved driveways, and roofs)inclusion of no net increase in phosphorus export provisions for development.
- Prohibit stormwater discharges from new driveways and new roads into an existing road or existing road drainage system unless potential impacts (i.e., TP and sediment loading) can be deemed negligible by a qualified professional engineer.

• Enforcement of Ordinances

Any of the above provisions could be codified in the Sanbornton or Meredith Planning or Zoning regulations. Examples of ordinances are presented in Appendix C.

The Subdivision Regulations in the Town of Sanbornton currently addresses drainage in terms of providing “adequate facilities (culvert and ditches) to allow for the removal of stormwater runoff and to maintain natural drainage patterns”. The Subdivision Regulations should be amended to include requirements for low-impact development practices and stormwater management techniques in order to protect the water quality of Black Brook and Lake Winnisquam.

5.2 Septic Systems

Phosphorus loads from septic systems are typically included in Watershed Management Plans because they can be a significant source in some watershed, especially where old camps with poorly designed septic systems and/or direct sanitary discharges exist.

Septic systems and their potential for phosphorus loading will be an important consideration in the Watershed Management Plan for Lake Winnisquam; however, there is no evidence that nutrient loading from septic systems on Black Brook is a source that needs to be addressed by this Plan.

5.3 Roads and Stormwater Management

There are approximately 12.2 miles of road within the Black Brook watershed. Of these, 6.1 miles (50.6%) are gravel roads and 6.0 miles (49.4%) are paved. The paved roads include approximately 0.40 miles of Black Brook Road, 0.52 miles of Lower Bay Road, 2.03 miles of Steele Hill Road, and 2.40 miles of Woodman Road. The gravel roads include approximately 1.01 miles of Kaulback Road, 1.14 miles of Oak Hill Road, 0.43 miles of Huse Road, and 1.99 miles of Roxbury Rd.

Roads, especially gravel roads, are a large source of TP and solids in Black Brook, which can be managed with appropriate BMPs. Section 5.6 identifies specific road drainage areas near Black Brook where runoff from roads is directly conveyed into Black Brook and BMPs are recommended. The southern branch of Black Brook is influenced by direct drainage from portions of Woodman Road and Huse Road. The main stem and northern branch of Black Brook are influenced by direct drainage from portions of Black Brook Road, and Kaulback Road. A combination of general road maintenance BMPs and the installation of structural means that promote the infiltration of stormwater from roads are recommended as described in the following sections.

5.3.1 Road Maintenance

To minimize sediment and phosphorus transport from roadways into Lake Winnisquam and its tributaries, stormwater control and treatment practices should be employed and routine maintenance of the roads and drainage systems should be performed.

A primary mechanism for the transport of phosphorus from paved roads is sheet flow washing of sediments. Sand that is applied in winter to paved roads is a major source of sediment load to down gradient streams and lakes. Best management practices for minimizing the sediment and phosphorus load from paved roads include:

- Minimize use of sand and salt during the winter;
- Remove sand from the streets prior to spring rain and ground thaw;
- Routine monitoring of and removal of sediments in stormwater catch basins.

Gravel roads are essentially impervious so precipitation quickly pools and flows to the edge of the road where it either infiltrates into surrounding soils or becomes channelized and flows along a roadside drainage ditch to the nearest surface water or topographic low point. The slope of the road and abutting land, the infiltration capacity and ground cover of the surrounding soil, and the intensity of the storm event are factors that determine the amount of sediment that is transported from gravel roads. Unfortunately these factors are generally established by the location and layout of the road. Through proper road maintenance and the incorporation of a system for treating the drainage, sediment loads associated with runoff from gravel roads can be managed.

As is the case for most potential pollution sources, control at the source is typically the easiest and most cost effective. The following best management practices address gravel roads as the source of sediment loads through on-going maintenance:

- Evaluate and maintain the best cross-road pitch as is appropriate for the drainage conditions. It is important to pitch gravel roads to minimize runoff flow velocity and contact time, ponding, and erosion. A road center crown is appropriate when surrounding topography is flat enough to infiltrate sheet flow or roadside drainage ditches/swales exist that are adequate for the expected flow. Where possible, it is ideal to maintain a road grade and pitch that causes sheet flow to the area abutting the road where it can infiltrate in undisturbed soils. Pitching the road toward the upslope edge should be considered where downslope erosion is a concern. The ditch/swale along the upslope roadside must be adequately sized and reinforced to manage the concentrated channelized flow and the discharge at the low topographic point must be capable of handling and treating the expected flow.
- Re-surface gravel roads as is needed to maintain the cross-road pitch, remove pot-holes, and maintain the road elevation as is needed for proper drainage. Crushed bank-run gravel or similar angular-grained material should be used for re-surfacing.
- When plowing, care must be taken to ensure the gravel is not disturbed.
- The edge of gravel roads must be graded such that water can freely flow to the abutting ditch/swale or ground surface. Improper grading along road shoulders can cause stormwater to channelize, erode abutting materials, and transport sediment from the road directly to a waterbody. Gravel that falls into drainage ditches and swales must be removed.
- Schedule maintenance to minimize potential erosion. Top coating should be performed after spring thaw and at a time when no or very little rain is predicted.

As runoff is channelized along roadside ditches, its potential to cause erosion and suspend sediment greatly increases. In order to minimize the sediment loads associated with drainage conveyance, it is important to understand the size and characteristics of the area draining to channel and properly engineer the channel and treatment practice for predicted storm volumes and peak rates. Refer to *Gravel Road Maintenance Manual, A Guide for Landowners on Camp and Other Gravel Roads*, MEDEP & Kennebec County Soil and Water Conservation District, April 2010, for information on proper gravel road construction and maintenance.

Routine inspections of the drainage along gravel roads are important for the identification of potential problems. Some problems with simple solutions such as a clogged culvert can cause major damage to a gravel road.

5.3.2 Culvert Cleaning/Maintenance

There has been historic overtopping of Black Brook and Woodman Road as a result of clogged or undersized culverts. During site visits in 2010 and 2011, AECOM noted the culverts at Black Brook Road and Kaulback Road were partially blocked with woody debris. Culvert blockage can cause water to pond on the upstream side of roads and potentially overtop the road during high flow events. In 2010, Woodman Road washed out at the Black Brook crossing which resulted in large amount of roadway fill material washing into the brook. The sediment and TP load from this type of event can be considerable, as well as its long-term impact to the stream morphology and associated aquatic habitat. Culverts should be inspected and cleaned at least seasonally, with more frequent cleaning prior to spring flow and during autumn leaf fall. The two 48-inch culverts and one 36-inch culvert at Black Brook Road, and the four 36-inch culverts at Kaulback Road are particularly important to inspect and clean because of their high-flow potential and natural tendency to accumulate woody debris.

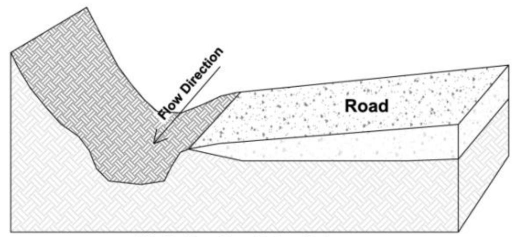
The adequacy of the sizes of culverts on Black Brook Road, Kaulback Road, and Woodman Road should be evaluated by a qualified professional engineer. Hydraulic conditions under 25-, 50- and 100-year, 24 hour, storm events should be evaluated, and culvert design modifications should be implemented if needed. The flow capacity of the culverts under Black Brook Road and Kaulback Road are dependent upon backwater conditions in the streams, thus they cannot be estimated without further study of the physical characteristics of the streams.

5.3.3 Stormwater Management Practices

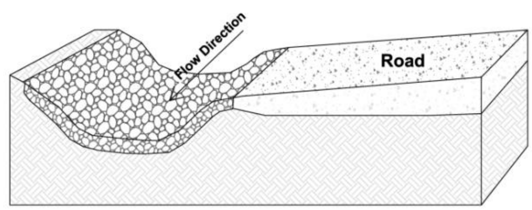
Paved and gravel roads are essentially impervious so during rain events water rapidly collects and flows to the nearest water conveyance channel or area where it can infiltrate to the ground. Road-side ditches have historically been built or were naturally created to rapidly drain stormwater to the nearest waterbody, but due to increased flooding, erosion, and contaminant transport associated with this practice, alternative techniques for managing road runoff are recommended. Minimizing the accumulation of channelized flow is the initial step toward controlling stormwater. This is accomplished by directing runoff to areas near the point of generation that are capable of natural infiltration. As greater amounts of runoff accumulates, the complexity of capturing, slowing, and treating the stormwater increases along with the costs. The New Hampshire Stormwater Manual (NHDES, 2008) is a comprehensive resource for stormwater best management practices. As residential development, and road and driveway construction takes place in the Black Brook watershed, it will be important that stormwater controls are implemented in accordance with this guidance document.

The following stormwater management practices are presented as examples of measures that could be employed in the Black Brook watershed. These measures, as well as others that are listed in Table 5-1 and described in the NH Stormwater Manual should be considered for existing sites and those that are discovered or developed in the future.

Swales



High Erosion Potential
Narrow Roadside Ditch with Steep Side-Slope



Low Erosion Potential
Riprap Reinforced Swale
Widened with Lowered Side-Slopes

Swales convey stormwater along roadsides to prevent water from ponding on, or flowing over the road. In many cases, road-side swales are ditches that have been created by channelized stormwater eroding a path of least resistance. The sediment and nutrient load associated with this type of drainage is considerable, as is the potential damage to the road integrity and abutting property. Properly designed swales provide a channel that is capable of conveying expected storm flow rates without erosion. Factors that need to be considered in the design of a road-side swale include topographic slope, drainage area, expected storm flow, swale dimensions, outlet control, base material and vegetation.

The performance of swales can be improved and their potential contribution to sediment and nutrient loading reduced by increasing their depth and width, reinforcing with appropriately sized riprap, installing check dams (riprap) and step pools, and reducing their slope (cross-section and profile). Where feasible, infiltration trenches should be considered in place of conveyance swales. Opportunities for swales to turn-out into areas with excess infiltration capacity should be assessed and utilized to convert channelized swale flow to sheet flow and infiltration.

Culvert Inlet and Outlet Scour Protection

To reduce sediment and nutrient loading associated with erosion at culvert inlets and outlets, loose sediments should be routinely removed, the inlet and outlet pools should be reinforced with appropriately sized riprap, and headwalls should be installed. Inlet and outlet culvert areas are subject to concentrated flow velocities so the potential for erosion at these locations is considerable. By installing an energy-dissipation/sediment traps at locations where scour is likely due to high flow velocities, erosion can be mitigated. These pools are intended for use at the low point of swales and intermittent streams and stormwater drainage culverts, not perennial streams. The size of this type of pool is dependent upon the expected flow rates and the site conditions.

Ditch Turnout Buffer

Ditch turn-out buffers are recommended to minimize erosion along roadside ditches where due to the grade of the road or the limitation of other stormwater control options, channelized flow is likely to cause erosion of the edge of the road or roadside ditch. Ditch turn-out buffers are designed to convert channelized flow into sheet flow by diverting ditch drainage into areas that slow the flow rates using check dams along a level channel and disperses the stormwater over a vegetated or forested area with a level spreader to allow for natural infiltration and plant update. For applications along gravel roads a sediment trap should be incorporated to ease maintenance operations. See Appendix

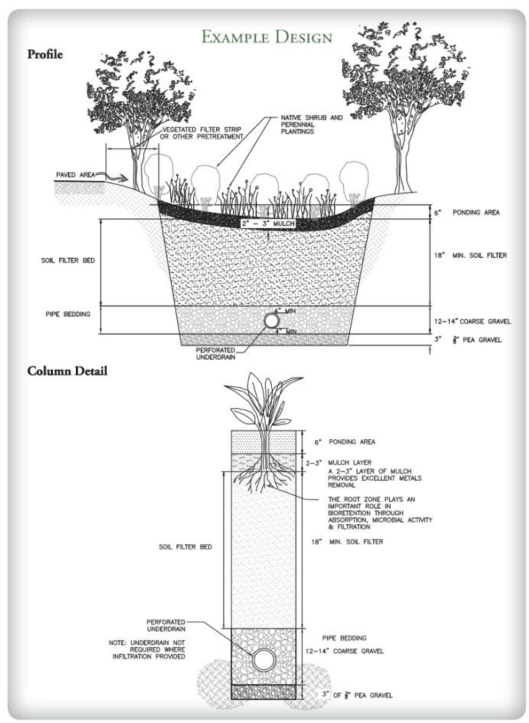
Vegetated Buffer

Vegetated buffers provide treatment for the ditch turnouts and are an effective BMP for areas where sheet flow can be maintained such as along roadway shoulders, parking lots, or at the edge of fields. Vegetated buffers are either natural undisturbed forested areas or areas where vegetation and uncompacted soil allow for plant uptake of nutrients and sheet flow infiltration. A sufficient flow path length across the buffer is necessary to ensure treatment is provided by the BMP. Design criteria are specified in the NH Stormwater Manual, Vol. 2, 4-3 (6).

Pervious Pavement / Pavers

Properly designed and constructed pervious asphalt pavement and pervious concrete pavers result in no direct runoff from these areas. The installation of pervious pavement/pavers is ideal where land area for runoff treatment is insufficient and the ability to infiltrate runoff before it channelizes is limited. Factors that control the feasibility of this stormwater control option include the depth to groundwater, depth to bedrock, native soil permeability, topographic limitations, and expected traffic load. For optimal performance it is essential that pervious pavement / pavers are constructed in accordance with current design standards (http://www.unh.edu/unhsc/sites/unh.edu.unhsc/files/pubs_specs_info/unhsc_pa_spec_10_09.pdf).

Bioretention System



Bioretention systems are shallow basins designed to infiltrate runoff thorough an engineered permeable soil material with sufficient vegetation to provide water treatment and plant uptake. Water treated with a bioretention system either infiltrates to the groundwater ("rain garden") or discharges via an underdrain system. Bioretention systems are vegetated to assist with the uptake of pollutants and to blend in with landscape aesthetics. Typically these systems are designed with a treatment capacity of the 10-year 24-hour storm. Pretreatment to remove settleable solids is required, as is a means to bypass flows greater than the design storm. Design criteria are specified in the NH Stormwater Manual, 2008, Volume 2 (http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-08-20b.pdf). Example design shown here is from the NH Stormwater Manual.

Total suspended solids and total phosphorus removal from properly designed and installed bioretention systems is reported to be approximately 90% and 65%, respectively (NH Stormwater Manual). Installed costs for bioretention systems vary widely based on their size and site complexity. Systems could cost from $3,000 for very small simple systems, to over $35,000 for large systems.

5.4 Timber Harvesting

Timber harvesting operations have considerable potential to cause soil erosion, runoff, and sediment and nutrient loading. The document, Best Management Practices for Erosion Control on Timber Harvesting Operations, 2004, published by the New Hampshire Department of Resources and Economic Development, Division of Forests and Lands is available on-line at: http://www.nhdfl.org/library/pdf/Forest%20Protection/2004%20BMPs%20for%20Erosion%20Control.pdf

Loggers should be made aware by town officials that erosion control BMPs shall be followed during timber harvesting operations. Inspections by town officials or commission members should be performed to ensure BMPs are practiced and disturbance of soils, wetlands, and waterways are properly minimized. Hiring a forester or environmental consultant with a working knowledge of forestry BMPs to conduct routine inspections during logging operations is an effective approach to control soil erosion, storm water runoff, and wetland disturbances.

5.5 Agriculture / Field Management

Based on the land use delineation used to develop the TP loading model for this plan, approximately 192 acres within the Black Brook watershed are used for agricultural purposes. Most of this area appears to be used for hay or crop production. There are some agricultural fields on Woodman Road that have direct drainage paths to Black Brook. Nutrient loading from agricultural land can be managed through many methods including runoff controls and treatment, grazing area restrictions and setbacks, and manure application timing and buffers. Considerable information is available to assist with the management of nutrient loads from agricultural lands. The US Environmental Protection Agency has published a series of Nonpoint Source Management Fact Sheets (http://www.epa.gov/owow/nps/pubs.html#ag).

Fields that are maintained for uses such as sporting fields, golf courses, cemeteries, and parks typically have higher TP export due to fertilizer, grass clippings, animal/bird feces, and higher runoff rates due to soil compaction. Maintaining natural buffers around fields and providing treatment measures for channelized drainage from fields are critical in reducing the potential loading from fields. Treatment measures that are applicable to stormwater management from fields include infiltration techniques, treatment ponds and wetlands, and natural vegetated buffers.

5.6 Black Brook - Site-Specific, Non-Point Source Management Measures

This section identifies specific areas in the Black Brook watershed that are probable sources of sediment and nutrient load to Black Brook currently and proposes Best Management Practices (BMPs) that could be employed to reduce the loading from these areas.

Locations of the proposed BMPs are presented on Figure 5-1. The predicted reductions from the management practices are estimates based upon literature values and best professional judgment. Removal efficiencies and associated construction costs are provided in Tables 5-1 and 5-2.

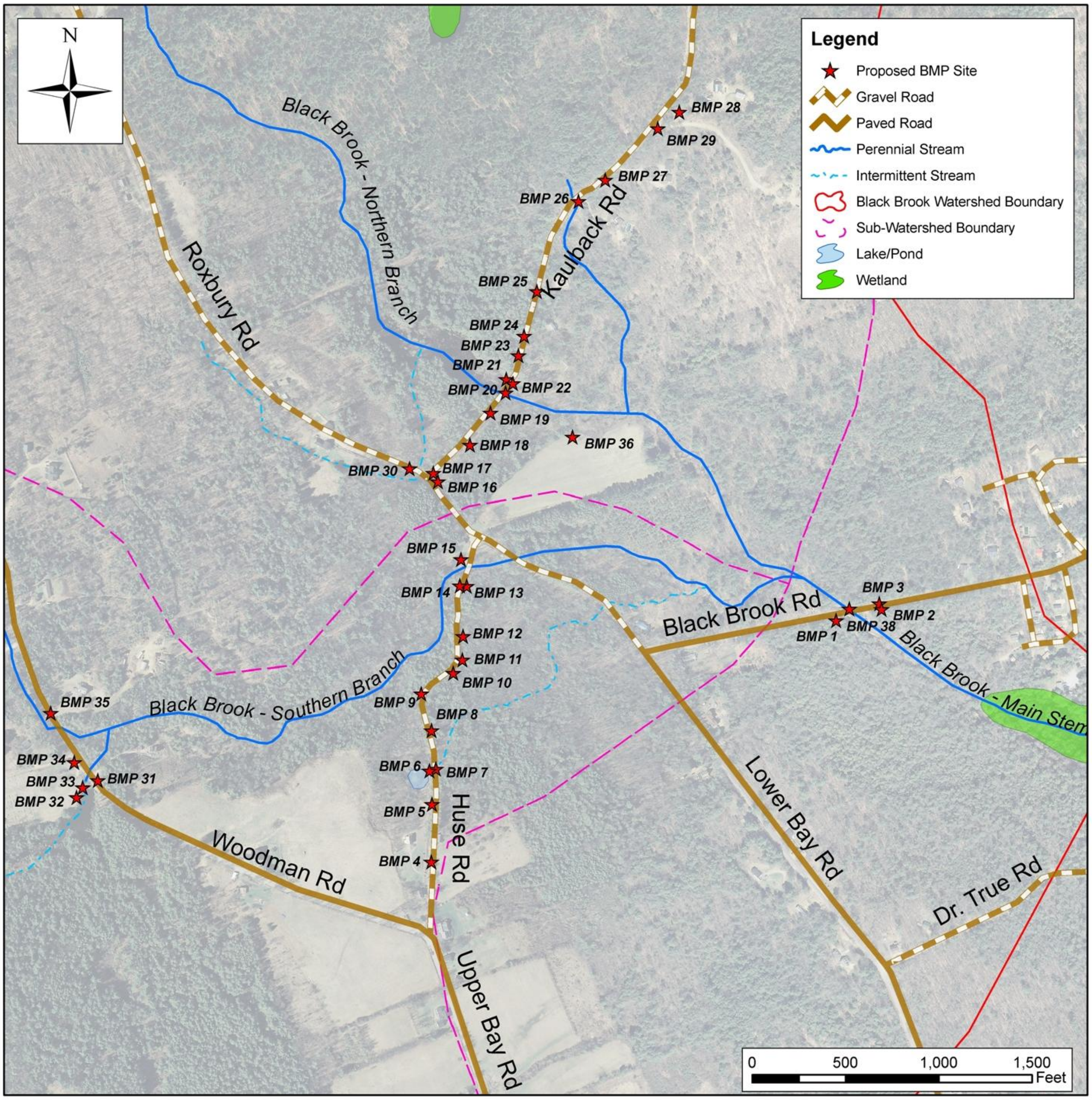


Figure 5-1: Sites for Best Management Practice Implementation

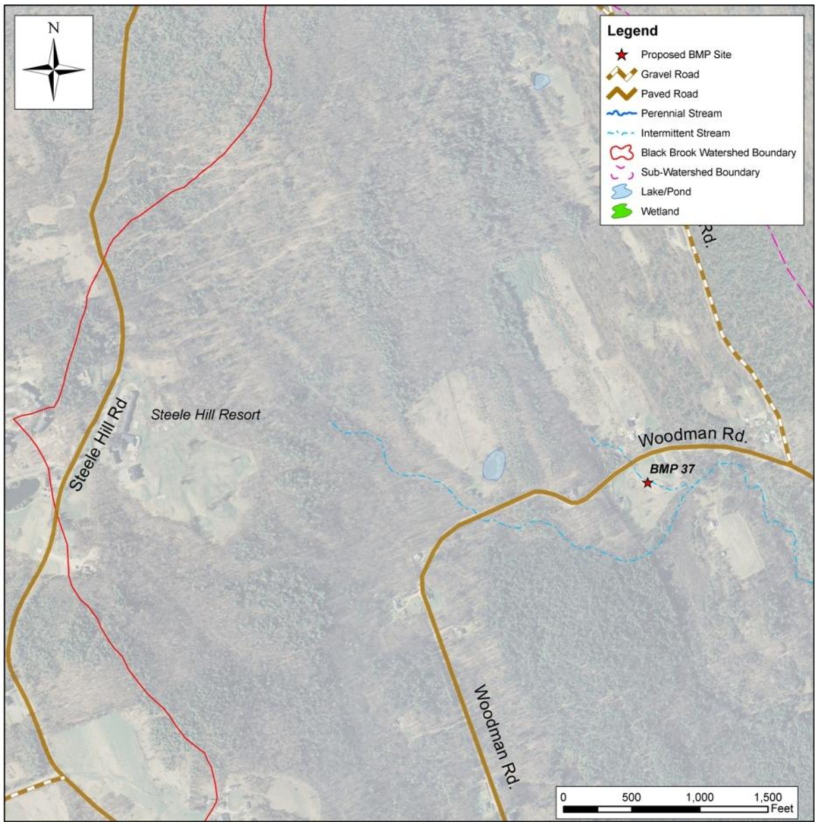


Figure 5-2: Sites for Best Management Practice Implementation - Western Headwaters

5.6.1 Road Drainage BMP's

Managing stormwater and erosion from roads in the Black Brook watershed is the most critical and accessible means of reducing TP loading to Black Brook. Recommended management practices include drainage diversion, stormwater infiltration, bioretention, source minimization, and routine maintenance. The following locations within the Black Brook watershed have the potential for specific BMP applications. Estimated TP load removal and installation costs are complied in Tables 6-1 and 6-2.

According to John Thayer, Sanbornton Public Works Director, approximately three to five inches of gravel is added to resurface gravel roads every two to three years. This equates to a total of approximately 1900 yd^3 that is lost from gravel roads each year, assuming minimal 3-inches used on all 6.1 miles of road every two-and-a-half years. Approximately 23 yd^3 is also added for traction during winter conditions based on the application rate of 250 lbs per lane mile and assuming 35 applications per year. Management practices are proposed to reduce the loss of gravel by minimizing erosion through stormwater diversions and road maintenance, and capture gravel in sediment traps.

5.6.1.1 Black Brook Road

Black Brook Road is a paved road that crosses the main stem portion of Black Brook (Figure 5-1). Black Brook Road has a slight (<2%) grade toward the Brook and is slightly higher in elevation than the abutting natural topography. As noted by AECOM during site visits in 2010 and 2011, the shoulder of the road near the crossing was not properly graded and stormwater flow and sediment transport along the edge of the road was evident. East of the crossing, evidence of direct discharge of stormwater from the edge of the road and shoulder into Black Brook existed. On the southwest side of the crossing, the shoulder is graded to divert stormwater directly into the Brook and into a low-lying floodplain area.

Photo 1: Black Brook Road, Shoulder Grading, Looking West (BMP 3)

Photo 2: Black Brook Road, Proposed Sediment Trap (BMP 1)

TP and sediment loading from the northern side of this road can be reduced by re-grading the shoulders so stormwater from the road directly runs off as sheet flow into the adjacent forested/vegetated areas (BMP 3). Efforts should be made during this re-grading work to prevent the channeling of stormwater runoff. The Black Brook Road pavement was is very poor condition at the time of the site visits. When this road is repaved, it will be important to pitch the road toward the shoulder and re-grade the shoulder with a stable material that will assist with the distribution of runoff over the adjacent undisturbed area. The runoff from the south side of Black Brook Road, east of the crossing should be directed to the adjacent forested area to prevent channelized runoff along the edge of the road from discharging directly into Black Brook (BMP 2).

On the southwestern side of the crossing the road shoulder should be graded in a manner that directs stormwater runoff to the low-lying floodplain area (BMP 1). The stormwater treatment potential in this area can be improved by installing an outlet control in the floodplain area to promote sediment capture and infiltration. Currently stormwater passes through this area and flows to Black Brook via a small tributary channel. By installing an outlet control such as rip-rap, stormwater would be retained in this area and through the settling of sediments and infiltration processes some removal of TP is possible.

Black Brook Road has historically flooded during large storm events apparently as a result of undersized culverts. These events have caused considerable erosion of the shoulder of Black Brook Road and deposition of the road-side sand and gravel into Black Brook. There are two 48-inch and one 36-inch culvert under Black Brook Road. The adequacy of the culvert sizes should be evaluated with respect to anticipated flow rates during 25-year, 50-year, and 100-year, 24-hour storm frequencies, and if needed, they should be replaced with a culvert or bridge that provides adequate passage in accordance with NH Env-Wt 904 (Design and Construction of Stream Crossings). Associated road reconstruction designs should incorporate storm water control measures that minimize TP and sediment loading to Black Brook to the maximum extent practicable. The replacement of the Black Brook Road culvert is listed on Tables 6-1 and 6-2 as BMP 38. Since this BMP is intended to prevent the wash-out events that occur during large storm discharges, the TP reduction associated with this BMP cannot be quantified on an annual basis. Under the reasonable assumption that approximately 6 yd^3 of soil are eroded from the road shoulders and stream bank during a major flooding event across Black Brook Road, approximately 1 kg of total phosphorus bound to the soil would be transferred into Black Brook, assuming 100% release of the assumed 100 mg TP/kg soil are released over time.

5.6.1.2 Huse Road

Huse Road is a gravel road located along a very steep bank adjacent to the southern branch of Black Brook (Figure 5-1). The steep portions of this road have slopes between 10%-15%. Runoff from the western side of this road channelizes and flows over the edge of a steep bank into Black Brook. The bank is eroded in many locations as a result of stormwater runoff. The eastern side of Huse Road drains along the edge of the road. Some rudimentary ditch turn-outs allow runoff from this side of the road to discharge in adjacent forested areas. These turnouts appear to routinely fill with sediments, minimizing their effectiveness. Based on gravel amounts used for resurfacing provided by the Sanbornton Public Works Director, Huse Road requires the equivalent of 135 yd^3 per year.

Minimizing sediment and TP loading from Huse Road is a challenge because of the minimal area available for stormwater controls and BMP's adjacent to the road, and the natural effect of gravel eroding from steep slopes. The following options should be considered as potential means of reducing the sediment and TP load from Huse Road.

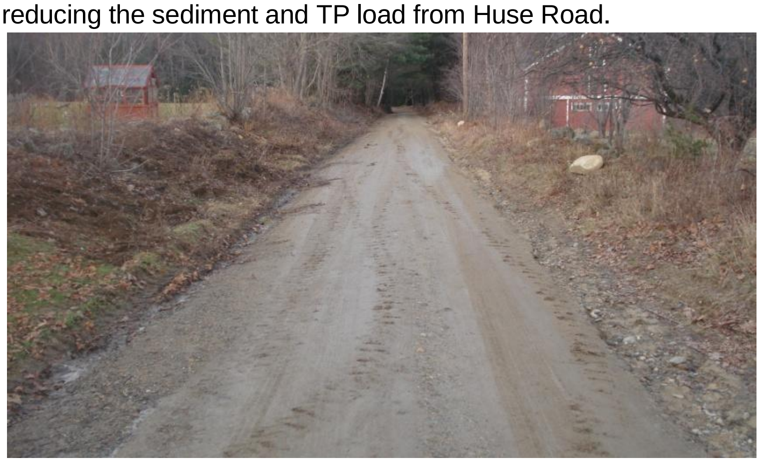


Photo 3: Huse Road, Southern Portion (BMP 4)

Much of Huse Road is lower than its adjacent native ground surface and stormwater that runs off the road surface channelizes and flows along the edge of the road. In order to reduce the erosion of the edge of the road, the proper design and construction of swales should be considered, where feasible.

In some areas this will require significant removal of adjacent soil and trees. Available right-of-way widths and granting of drainage easements may be limiting factors along with the adjacent road materials, (i.e., bedrock). BMP 4 is identified in Table 6-1 and Figure 5-1 and represents the swale construction along Huse Road. The identification of suitable swale locations is not reasonable until a comprehensive plan for addressing Huse Road is developed.

Approximately 660 feet of the western side of Huse Road is drained through a ditch turn-out into a field and a small (0.2 acre) pond that discharges into a Black Brook tributary. Improvements to this turn-out (BMP 5) include the installation of a ditch turn-out with a sediment trap and gravel trench level spreader in the adjacent field. If access to this private property is not allowed, replacement of the mounded treeline along the road with a reinforced swale with check dams should be considered as a means to capture sediment (Photo 4). At the low point of this drainage (BMP 6), the installation of a sediment trap may be a feasible BMP to provide additional removal of TP and sediment.

Photo 4: Huse Road Proposed Ditch Turn-Out with Sediment Trap (BMP 5)

The eastern side of Huse Road, approximately 850 feet from its intersection with Woodman Road, drains through a ditch turn-out into a low-lying area and is hydraulically connected to the same tributary. The existing turn-out does not appear to be functioning due to the accumulation of sediment at the inlet. This BMP (BMP 7) could be improved by installing a properly designed sediment trap and level spreader approximately 30 feet upslope from the existing locations. The discharge from the level spreader should be directed to the adjacent low-lying area. The BMP locations and details are presented in Figure 5-1 and Tables 6-1 and 6-2.

Photo 5: Huse Road, Existing Turn-Out, Proposed Sediment Trap with Forested Buffer (BMP 7)

At the locations of BMP 8 through BMP 12, ditch turn-outs exist; however there are no sediment traps or structures to diffuse runoff. At each of these locations a ditch turn-out with forested buffer may be feasible for the reduction of sediments and TP from portions of Huse Road. Much of the western side of Huse Road currently drains over the bank directly to Black Brook. Approximately 80 feet upslope from the BMP 9 location significant erosion over the bank has undermined tree roots. A stone berm should be constructed at this location to divert runoff along the western edge of the road to BMP 9. BMP 9 is a sediment trap and a level spreader. The removal of trees should be minimized in this area, while constructing a level spreader that is designed to diffuse the road runoff over a large enough area that the steep hillside will not be eroded. At other locations along the western side of Huse Road, road grading toward the inside of the slope (eastern side) is advised to minimize the erosion along the western bank. Where possible, a properly designed and constructed swale along the inside (eastern side) of the road would reduce the erosion of the road and hillside.

Photo 6: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 8)

Photo 7: Huse Road, Existing Turn-Out, Proposed Sediment Trap with Forested Buffer (BMP 9)

Photo 8: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 10)

Photo 9: Huse Road, Existing Turn-Out, Proposed Sediment Trap (BMP 11)

Photo 10: Huse Road, Existing Turn-Out, Proposed Turn-Out with Forested Buffer (BMP 12)

Runoff from the lower portion of Huse Road currently flows directly into Black Brook. There are sufficient relatively flat land areas on both sides of Huse Road immediately south of the Black Brook crossing where ditch turn-outs with sediment traps and forest buffer level spreaders could be feasible (BMP 13 and BMP 14).

Photo 11: Huse Road, Proposed Ditch Turn-Out with Forested Buffer (BMP 13)

Photo 12: Huse Road, Proposed Ditch Turn-Out with Forested Buffer (BMP 14)

Because of the steep slope of Huse Road, the loss of gravel due to erosion will be a routine occurrence and maintenance costs for re-surfacing, re-grading and sediment trap cleaning must be considered when developing a long-term plan for this road. In consideration of the long-term maintenance costs for Huse Road, the feasibility of paving Huse Road should be considered. This would require considerable capital expense since the design may require replacing a portion of the roadbed materials, hard-piping some portions of the drainage to properly design stormwater control structures, and road widening to accommodate adequately sized swales. The cost of paving Huse Road may range from approximately $200,000 to $500,000 depending upon existing conditions, and drainage and right-of-way limitations. This option was not considered with the cost estimates because the engineering involved in this type of effort exceeds the scope of this watershed management plan.

However, if properly designed, paving the steep portion of Huse Road could substantially reduce sediment and nutrient loading to Black Brook.

Another option for minimizing TP and sediment loading from Huse Road is to close the road to traffic, and stabilize the road by replacing the roadbed with loam / topsoil and seeding with native grass, bushes, and trees. This can be considered an alternative BMP in place of BMPs 4 through 14.

BMP 15 is proposed to treat runoff from the area near the intersection of Huse Road and Roxbury Road (Figure 5-1). Currently runoff from Huse Road and the private property located at this intersection flows overland directly into Black Brook. A properly designed gravel trench constructed across this area would provide some potential for infiltration and evenly distribute runoff over a buffer area prior to discharging into Black Brook. The buffer area should be an area that provides at least a 20 foot flow path from the gravel trench to the Brook, and should be created by loosening hard-packed soil and planting native grasses and shrubs that will promote infiltration. This BMP location is on private property, so land owner cooperation will be required.

Photo 13: Huse Rd/Roxbury Rd., Proposed Gravel Trench and Vegetated Buffer (BMP 15)

5.6.1.3 Kaulback Road

Kaulback Road is a gravel road that crosses the northern branch of Black Brook (Figure 5-1). Stormwater drains from the eastern side of the southern portion of Kaulback Road along the edge of the road in the roadside ditch and discharges directly to Black Brook. This ditch also receives runoff from a portion of Roxbury Road and approximately three acres of forested area south of Roxbury Road. During 2010 and 2011 site visits, this ditch was lined with sediment and leaf debris and erosion of the edge of the road was evident. This portion of Kaulback Road is bordered by steeply rising bank with a stone wall on top. Telephone poles are also installed along the road border. The primary cause of erosion along the edge of this section of Kaulback Road is the runoff and groundwater seepage from the upland forested area south of Roxbury Road. BMP 17 is the installation of a culvert under Kaulback Road that is designed to divert this runoff and groundwater seepage from the eastern side of Kaulback Road directly to the Black Brook tributary that is located immediately west of Kaulback Road. Proper culvert sizing and measures for diverting higher than design flows must be considered in the design. Also erosion controls must be incorporated in the new outlet and swale to the Black Brook tributary.

BMP 18 consists of armoring the ditch along the eastern side of Kaulback Road with riprap to minimize erosion. Where possible the ditch should be widened and deepened to improve the stability of the channel. This channel discharges directly into Black Brook. In order to treat the runoff from this section of Kaulback Road BMP 19, a sediment trap and infiltration basin is proposed for construction in the low-lying area adjacent to Black Brook (Figure 5-1).

Photo 14: Kaulback Road, Looking North Toward Black Brook – Swale Improvement (BMP 18)

Photo 15: Kaulback Road, Sediment Trap/Infiltration Basin BMP Location (BMP 19)

Photo 16: Kaulback Road, Proposed Vegetated Shoulder (BMP 20)

Kaulback Road is flat where it crosses Black Brook; however runoff from this gravel area flows directly into Black Brook. The road width in this area is approximately 30 feet. The construction of a vegetated shoulder approximately four feet wide on both side of this section of Kaulback Road would reduce the potential for the gravel road in this area to erode into the brook (BMP 20). The road shoulder would need substantial organic/top soil amendments to provide an adequate growing medium, so measures must be in place to prevent the loss of this material during construction.

Paving sections of Kaulback Road near Black Brook is an option that could be considered to reduce the road maintenance costs and the sediment and TP loading of Black Brook associated the gravel road. If it were paved, additional stormwater control measures would need to be employed to reduce the flow rate and treat the runoff appropriately.

Stormwater that drains along the lower portion of Kaulback Road currently flows directly into Black Brook. Areas for the installation of a BMP in these locations are limited, but simple sediment traps are recommended to capture some of the sediment that erodes from this portion of the road and shoulder (BMP 21 and 22). Reinforcement of the swales with riprap could also reduce erosion along these areas.

Photo 17: Kaulback Road, Proposed Sediment Trap Location (BMP 22)

Kaulback Road slopes uphill to the north from Black Brook between approximately 4% and 6%, on average. Stormwater channelizes along the edge of this road, primarily on the western side, and flows directly into Black Brook. Erosion of the road and the western roadside ditch was evident during visits in 2010 and 2011. Erosion from this ditch could be reduced by constructing a properly designed swale that is reinforced with riprap. There are two areas along the lower portion of this section of Kaulback Road where ditch turn-outs, sediment traps and level spreaders with forest buffers may be feasible BMPs for the reduction of sediment load and TP (BMP 23 and 24).

Photo 18: Kaulback Road, Looking South, Proposed Turn-Out Location (BMP 23)

Photo 19: Kaulback Road, Looking South, Proposed Turn-Out Location (BMP 24)

The installation of a culvert at the location of BMP 25 on Kaulback Road is recommended to divert storm water runoff from the up-gradient roadway and reduce the potential for the runoff from the up-gradient wetlands to overtop the road in this area. This BMP is located across a slight dip in Kaulback Road. Runoff that isn't diverted at this location can contribute to roadside erosion down-slope toward Black Brook. An eight-inch culvert will likely be adequate; however, the appropriate size should be confirmed using standard hydrological peak-flow calculations.

BMP 26 is the site of a proposed wetland restoration. A wetland area approximately 0.25 acres in size has been filled in by historic gravel road washout events. The small stream that passes through this area has caused erosion in the gravel fill, exposing between 1.5 and 2.0 feet of gravel material that will continue to be eroded if restoration does not occur. A preliminary survey to delineate the extent of the fill and identify appropriate methods of restoration would need to be conducted and a work plan for the restoration would need to be prepared for approval and permitting.

Photo 20: Gravel Road Fill, Proposed Wetland Restoration (BMP 26)

BMP 27 is the improvement of an existing relatively steep roadside swale that has been eroded. This swale should be widened and deepened, armored with riprap and, where feasible, a ditch turn-out with a sediment trap and a level spreader constructed. The installation of a sediment trap and level spreader may require a drainage easement since the right-of-way in the area will likely not provide sufficient area.

Photo 21: Proposed Swale Improvement, Ditch Turn-Out with Sediment Trap (BMP 27)

5.6.1.4 Roxbury Road

Stormwater is channeled down a steep section of Roxbury Road near its intersection with Kaulback Road (Figure 5-1). The road in the section is bordered by steep banks that rise to the natural forested topography. The edge of this section of Roxbury Road is eroded and ditch turn-outs at the low end of this road section discharge directly into a tributary to Black Brook. To reduce erosion along the edge of this road, the shoulder could be widened by cutting back the road bank where feasible and constructing a properly designed swale that is reinforced with riprap. Drainage from the southern side of the road should be directed through a culvert to the northern side of the road to avoid the direct discharge to the brook. At the low end of this section of Roxbury Road, a sediment trap and level spreader is recommended as a BMP (BMP 30) to reduce sediment and TP load from this road.

Paving the steep section of Roxbury Road may be an option that could be considered to reduce the maintenance costs and the sediment and TP loading of Black Brook associated with the gravel road. If it were paved, additional stormwater control measures would need to be employed to reduce the flow rate and treat the runoff appropriately.

Photo 22: Roxbury Road, Looking West

Photo 23: Roxbury Road, Proposed Sediment Trap and Level Spreader Location (BMP 30)

BMP 16 is proposed to treat the runoff from the section of Roxbury Road immediately east of its intersection with Kaulback Road. This BMP consists of the installation of a culvert under Roxbury Road to convey stormwater from the southern side of Roxbury Road to the northern side where an infiltration basin could potentially be constructed. The location of the proposed infiltration basin is on private property, so a drainage easement may be required.

Photo 24: Proposed Culvert to Sediment Trap/Infiltration Basin (BMP 16)

5.6.1.5 Woodman Road

Woodman Road is a paved road that crosses the southern branch of Black Brook and tributaries to Black Brook (Figure 5-1). Stormwater from approximately 7,000 square feet of the northern section of Woodman Road drains to a driveway and into a culvert that discharges to a tributary of Black Brook. The culvert appeared to be clogged during a site visit in 2011 and stormwater had caused some erosion of the gravel driveway and shoulder. The installation of a bioretention basin may be feasible in this location (BMP 31). An underdrain and a high level drain should be installed to direct the treated water or bypassed water through a new culvert to the downslope side of the driveway where the existing culvert outlet exists. The location of the proposed BMP may be on private property, so access may be a limiting factor in the feasibility of this option.

Photo 25: Woodman Road, Drainage to Proposed BMP 31

Photo 26: Woodman Road, Proposed Bioretention Basin Location (BMP 31)

BMP 34 is the deepening and widening of the swale along Woodman Road immediately down-slope of 86 Woodman Road. Runoff from the adjacent driveway currently flows into and potentially across Woodman Road. By creating a vegetated swale (50'L x 10'W x 1.5'D approximately) along the Woodman Road right-of-way in front of the Woodman Cemetery, the runoff and associated sediment from the driveway could be retained in this basin. Overflow could be directed across the existing vegetated area to the culvert under the cemetery access road.

Photo 27: Woodman Road, Proposed Swale Improvement (BMP 34)

5.6.2 Driveway Runoff

There are many locations in the Black Brook watershed where gravel driveways slope down from higher topographical areas to the adjoining road. Stormwater from these driveways is typically directed into the roadside ditch that in most areas do not meet the town standards for swales, such as those detailed in the Town of Sanbornton Subdivision Control Regulations (Section 8(c)(10)). Three locations of driveway runoff that discharges to Black Brook are noted in this plan as examples, BMP 28, 29, and 35 (Figure 5-1). At the location of BMP 35, approximately 7,100 square feet of gravel driveway drains down a steep driveway to a culvert on the west side and directly into Black Brook on the east side. There are no stormwater controls in-place, so sediment and TP are not currently reduced prior to discharge. The slope at this site is very limiting, but with considerable earth moving the construction of a sediment trap and a filtering or infiltration device such as a bioretention basin or infiltration trench may be possible. The feasibility of installing a BMP for this runoff source is dependent, in part, upon the property boundary location and property owner's cooperation.

Photo 28: Driveway Runoff, Proposed Infiltration Trench (BMP 35)

A similar driveway scenario exists on Kaulback Road, BMPs 28 and 29 (Figure 5-1). At BMP 29, approximately 8,600 square feet of gravel driveway drains down a steep driveway into a roadside swale. This swale has some cobble reinforcement so erosion along the flow path does appear to be occurring. Sediment and TP from the driveway are not attenuated along this drainage path which discharges to Black Brook after meandering through a wetland area near Kaulback Road. The placement of large logs at the edge of the driveway helps retain some sediment from the driveway, but additional measures could be put in-place, such as re-grading the area and installing berms or sediment traps in a manner that promotes on-site infiltration of stormwater. This BMP is entirely associated with the management of private property, so the Town has no authority under current regulations to restrict sediment and TP loading from either of these properties.

Photo 29: Driveway Runoff, Proposed Regrading, Berm, with Sediment Trench (BMP 29)

A revision to town ordinances associated with permitting new driveways could reduce or prevent un-treated stormwater runoff from entering town owned and maintained roads and stormwater conveyances. See Appendix C for an example of an ordinance that contains requirements for new driveways. The incorporation of low-impact development (LID) methods for stormwater control from roads and driveways in town subdivision regulations could also minimize or eliminate new sources of sediment and TP loads associated with development.

5.6.3 Field Management (Agriculture /Golf Course/Cemetery)

The TP load from agricultural and mowed fields within the Black Brook watershed contributes approximately 51 Kg/yr of the total 223.7 Kg/ yr load based on the loading model used for this plan. Loading is typically higher from fields than natural forested areas as a result of fertilizer application, manure spreading, grass cuttings, and soil compaction or disturbance. Site-specific TP load and stormwater runoff controls for all agricultural land in the Black Brook watershed could not be specified in this plan because of access limitations. However, two mowed field areas that appear to have direct runoff into Black Brook or a tributary to Black Brook were identified using aerial photographs. In the location of BMP 36, an approximately 5.7 acre field off of Roxbury Road appears to have a surface water feature within the mowed area that discharges to Black Brook via a small tributary. BMP 36 is the creation of at least a 40-foot buffer around this surface water feature where native shrubs and wetland vegetation are allowed to grow and are not cut during mowing operations. This natural plant growth will enhance infiltration of runoff and nutrient removal through plant uptake.

At the location of BMP 37 on Woodman Road (Figure 5-2), a tributary to Black Brook is apparently exposed to direct runoff from neighboring lawns. This could be a considerably high TP loading area if phosphorus fertilizer is used on these lawns. BMP 37 is the establishment of at least a 40-foot vegetated buffer along the brook. The buffer should consist of native shrubs, grasses, and wetland plants that are allowed to remain in their natural condition. The use of phosphorus fertilizers should be discussed with the abutting property owners and discouraged, and if the Town imposes a ban on phosphorus fertilizer use, these property owners should be specifically notified.

Golf courses and other fields that are typically fertilized and maintained for turf quality are sources of potentially high TP loading. Typical fertilizer application rates are 15 pounds/acre/year, of which approximately 75% is assumed to either runoff or infiltrate to groundwater (NHDES, 2010). The elimination of phosphorus fertilizer can drastically reduce the TP load to surface water. Town ordinances banning phosphorus fertilizer use have the potential to reduce this load. Steele Hill Resort, located along Steele Hill Road in the upper watershed of the southern branch of Black Brook, has approximately 16 acres of managed turf based on aerial photos (Figure 5-2). The use of phosphorus fertilizer should be discussed with the owners of this resort and discouraged, and if the Town imposes a ban on phosphorus fertilizer use, this property owner should be specifically notified.

The cemetery located on Woodman Road has approximately 2.6 acres of turf and gravel access roads (Figure 5-1) (BMP 32). The southeastern portion of the cemetery is sloped toward a beaver dam impoundment in the tributary to Black Brook. The creation of a vegetated buffer along the shore of the tributary and southeastern field would reduce the amount of runoff and TP that is discharging from this area which is currently a mowed field. The beaver dam in this pond has been breached at its southern edge. This has caused a portion of the downstream bank that is approximately 15 feet wide and 4 feet high to erode. Small trees have been uprooted by this erosion. BMP 33 is the restoration of this stream bank by re-grading and re-vegetating the bank and reinforcing the edge of the dam with riprap as needed. This restoration will reduce the continued sediment and TP load that is occurring from this unstable bank condition.

Photo 30: Woodman Cemetery, Proposed Vegetated Buffer (BMP 32)

Photo 31: Woodman Cemetery, Proposed Stream Bank Restoration (BMP 33)

6.0 Implementation Plan

The following phosphorus control implementation plan summarizes and prioritizes the recommendations for BMPs for water quality improvements including cost estimates, and provides a schedule for meeting the phosphorus load reduction required to meet the short-term goal established in this plan. The recommendations are intended to provide options of potential watershed management strategies that can improve water quality to meet target loads. Note that providing a comprehensive diagnostic/feasibility study is beyond the scope of this report, but we have attempted to narrow the range of management options in accordance with known loading issues and desired loading reductions.

The successful implementation of this watershed plan will be based on maintaining the TP target and attaining the short-term goal for reductions in TP loading to Lake Winnisquam from Black Brook. It is anticipated that TP reductions associated with this plan will be conducted in phases.

As discussed in Section 3, watershed TP loading is the predominant source (93%) of TP to Lake Winnisquam. Septic systems also contribute to the total load, but if this source were removed completely which is impractical, the annual TP load would be reduced only by 0.7% (Section 4). In the Black Brook watershed, erosion from gravel roads associated ditches as well as ditches along paved roads has been identified as a key contributor to phosphorus and sediment loading to Black Brook.

The recommended strategy to reduce TP loading into Lake Winnisquam includes the implementation of BMPs to reduce TP loading from roads and development, the establishment of stormwater treatment standards for new development, and public education and outreach. The purpose of this strategy is to attain an in-lake mean TP concentration of 6.3 µg/L, which represents the short-term goal for Lake Winnisquam as well as provide the framework necessary to prevent long-term increases in TP from exceeding the long-term goal of 6.6 µg/L (mean) (6.4 µg/L median).

Retrofitting developed land with low impact designs is a highly desirable option, especially near the brook. Educational programs can help raise the awareness of homeowners and inform them how they can alter drainage on their property to reduce nutrients entering the lake via the brook. Another option to engage the community is through technical assistance programs, such as BMP training for municipal officials and septic system inspection programs. Guidelines for evaluating TP export to lakes are found in “Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development” (Dennis et al., 1992). Guidance for low impact living on the shoreline, “Landscaping at the Water’s Edge: An Ecological Approach”, has been developed by UNH Cooperative Extension (2007).

Section 319 of the Clean Water Act was established to assist states in nonpoint source control efforts. Under Section 319, grant money can be used for technical assistance, financial assistance, education training, technology transfer, load reduction projects and monitoring to assess the success of specific nonpoint source implementation projects,

This watershed plan was written to meet the criteria of the nine elements required by EPA to be a part of watershed plans (Section 1). Application materials and instructions for 319 funding can be obtained through:

Nonpoint Coordinator
New Hampshire Department of Environmental Services
29 Hazen Drive
P.O. Box 95
Concord, NH 03302
http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Proactive planning can preserve lake water quality. However, past resistance to zoning regulations creates difficulties for proactive planning. The watershed planning process is intended to give a direction and goal for planning and watershed management. As the lake improves towards the short-term goal, the implementation strategy should be re-evaluated using current data and modeling, and the plan for further load reduction adapted accordingly.

6.1 Phosphorus Management Summary

The measures recommended for the management of phosphorus loading in the Black Brook watershed as described in Section 5.0, are prioritized with cost estimates and predicted phosphorus removal in Tables 6-1 and 6-2. The BMP Sites referenced in this table refer to locations on Figure 5-1. Recommended measures are also summarized in Table 6-3 with a proposed implementation schedule.

The cost estimates are rough approximations based on best professional judgment and available cost information. Some of the recommended measures will require technical assistance with preliminary investigations and engineering designs to develop more accurate cost estimates. The measures are prioritized with respect to their associated load and potential for overall load reduction. Table 6-3 is presented as a general guide to help direct watershed management efforts in a manner that is most cost effective with respect to the goal of reducing current and minimizing future phosphorus loading.

6.1.1 Road Maintenance and Storm Water Drainage Improvements

The BMP's for reducing phosphorus loading from storm-water runoff are prioritized in Tables 6-1 and 6-2 by their estimated removal potential. These BMP's are grouped by their general location and associated road and drainage area. Most of the BMP's result in minor reductions individually, so their potential for load reductions should be considered in terms of an overall road maintenance and storm water control program. The estimated costs and suggested implementation schedule by Project Group are summarized in Table 6-3.

Some of the BMP's may not be feasible due to property ownership issues, thus efforts to implement these BMP's may need to adjust accordingly. The effort associated with the implementation these BMP's was not considered in this ranking, so for example, performing all of the riprap and settling/energy dissipation pool installations may be more cost effective if they are done at the same time even though they are not all prioritized equally in terms of their removal potential.

Road maintenance and storm-water drainage improvements are costly given the predicted phosphorus removal from these BMPs; however, they are specific sources that can be addressed with structural measures. This is unlike the more abstract removal potentials predicted from watershed-based ordinances and education programs.

Table 6-1: Recommended Measures to Manage Phosphorous Loading to Lake Winnisquam – Load Reduction Estimates for Road Drainage Improvements

BMP Site ID	Site Location	Map & Lot# (If BMP on private property or easement may be required)	Source	Basin	Estimated Contributing Drainage Area (acres)	Estimated Contributing Drainage Area (square feet)	Estimated Annual Phosphorus Load (kg/yr)[1]	BMP Description	Removal Efficiency[2]	Estimated Load Reduction (kg/yr)
BMP 1	Black Brook Road	Map 10, Lot 77	Road Runoff	Main Stem	0.05	2,100	0.1	Settling Basin	45%	0.1
BMP 2	Black Brook Road	ROW	Road Runoff	Main Stem	0.09	4,000	0.2	Forested Buffer (Shoulder Grading)	50%	0.1
BMP 3	Black Brook Road	ROW	Road Runoff	Main Stem	0.09	4,000	0.2	Forested Buffer (Shoulder Grading)	50%	0.1
BMP 1-2-3 Alternative (See BMP38)	Black Brook Road	design dependent	Road Runoff	Main Stem	0.78	34,000	1.8	Treatment/ Infiltration Swale incorporated with new road construction	45%	0.8
BMP 4	Huse Road	site dependent	Road Ditch Erosion	Southern Branch	0.14	6,000	0.9	Swale Widening and RipRap Armoring (Erosion Control Measure)	50%	0.5
BMP 5	Huse Road	Map10, Lot 62	Road Runoff	Southern Branch	0.22	9,400	1.5	Ditch Turn-Out with Sediment Trap and Gravel Trench Level Spreader	50%	0.7
BMP 6	Huse Road	Map 10, Lot 62	Road Runoff	Southern Branch	0.05	2,300	0.4	Sediment Trap	25%	0.1
BMP 7	Huse Road	Map 10, Lot 136-2	Road Runoff	Southern Branch	0.28	12,200	1.9	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.9
BMP 8	Huse Road	Map 10, Lot 136-3	Road Runoff	Southern Branch	0.04	1,900	0.3	Ditch Turn-Out with Sediment Trap	45%	0.1
BMP 9	Huse Road	Map 10, Lot 48	Road Runoff	Southern Branch	0.07	3,200	0.5	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2
BMP 10	Huse Road	Map 10, Lot 136-3	Road Runoff	Southern Branch	0.13	5,800	0.9	Ditch Turn-Out with Sediment Trap	45%	0.4
BMP 11	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.03	1,100	0.2	Ditch Turn-Out with Sediment Trap	45%	0.1
BMP 12	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.04	1,800	0.3	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.1
BMP 13	Huse Road	Map 10, Lot 49	Road Runoff	Southern Branch	0.09	3,800	0.6	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.3
BMP 14	Huse Road	Map 10, Lot 48	Road Runoff	Southern Branch	0.08	3,300	0.5	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2
BMP 15	Huse Road	Map 10, Lot 48	Road and Yard Runoff	Southern Branch	0.09	4,100	0.4	Gravel Trench - Infiltration and Vegetated Filter Strip	65%	0.3
BMP 16	Roxbury Road	Map 10, Lot 50	Road Runoff	Northern Branch	0.13	5,700	0.9	Culvert to North Side of Road, Infiltration Basin	65%	0.6
BMP 17	Kaulback Road	Map 10, Lot 33	Road Ditch Erosion	Northern Branch	2.96	129,100	0.4	Culvert under Kaulback to divert runoff from forested area to trib of Black Brook	100%	0.4
BMP 18	Kaulback Road		Road Ditch Erosion	Northern Branch	0.02	900	0.1	Swale Widening and RipRap Armoring (Erosion Control Measure)	30%	0.0
BMP 19	Kaulback Road	Map 10, Lot 50	Road Runoff	Northern Branch	0.08	3,400	0.5	Sediment Trap/Infiltration Basin	65%	0.4
BMP 20	Kaulback Road	ROW	Road Runoff	Northern Branch	0.03	1,400	0.2	Vegetated Buffer	30%	0.1
BMP 21	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.02	1,100	0.2	Sediment Trap	35%	0.1
BMP 22	Kaulback Road	Map 10, Lot 35	Road Runoff	Northern Branch	0.02	1,100	0.2	Sediment Trap	35%	0.1
BMP 23	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.03	1,500	0.2	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.1
BMP 24	Kaulback Road	Map 10, Lot 33	Road Runoff	Northern Branch	0.05	2,200	0.3	Ditch Turn-Out with Sediment Trap and Level Spreader to Forested Buffer	45%	0.2

[1] Total Phosphorus loads were calculated using the Simple Method and Event Mean Concentrations (NHDES, 2008)

[2] BMP load reductions are based on published removal efficiency values and professional judgement with respect to erosion control potential and BMP location.

Table 6-1 (Continued): Recommended Measures to Manage Phosphorous Loading to Lake Winnisquam – Load Reduction Estimates for Road Drainage Improvements

BMP Site ID	Site Location	Map & Lot# (If BMP on private property or easement may be required)	Source	Basin	Estimated Contributing Drainage Area (acres)	Estimated Contributing Drainage Area (square feet)	Estimated Annual Phosphorus Load (kg/yr)[1]	BMP Description	Removal Efficiency[2]	Estimated Load Reduction (kg/yr)
BMP 25	Kaulback Road	ROW	Road Runoff	Northern Branch	0.04	1,900	0.2	Culvert to convey road drainage and wetlands from west to eastern natural wetland area	44%	0.1
BMP 26	Kaulback Road	Map 5, Lot 17	Historic Wetland Fill from Road Washout	Northern Branch	n/a	n/a	n/a	Wetland restoration (remove gravel fill and restore wetland vegetation)		
BMP 27	Kaulback Road	Map 5, Lot 16	Road Runoff	Northern Branch	0.07	3,100	0.5	Swale Widening and RipRap Armoring / Ditch Turn-Out to Sediment Trap	30%	0.1
BMP 28	Driveway on Kaulback Road	Map 5, Lot 42	Gravel Driveway	Northern Branch	0.13	5,800	0.9	Water bar diversion to Sediment Trap and Level Spreader to Forested Buffer	45%	0.4
BMP 29	Driveway on Kaulback Road	Map 5, Lot 18	Gravel Driveway	Northern Branch	0.20	8,600	1.4	Permanent diversion berm, regrading, and gravel trench spreader to forested buffer	60%	0.8
BMP 30	Roxbury Road	Map 10, Lot 33	Road Runoff and Ditch Erosion	Northern Branch	0.19	8,300	1.3	Culvert to north side of road into Sediment Trap and Level Spreader to Forested Buffer	30%	0.4
BMP 31	Woodman Road	Map 10, Lot 46-2	Road & Ag Field Runoff	Southern Branch	1.25	54,300	0.9	Bioretention Basin at driveway	65%	0.6
BMP 32	Woodman Cemetery	Map 10, Cemetery	Field Runoff	Southern Branch	0.47	20,400	0.2	Natural vegetated buffer (30-foot vegetated buffer)	65%	0.2
BMP 33	Woodman Cemetery	Map 10, Cemetery	Stream Bank Erosion	Southern Branch	n/a	n/a	n/a	Stream bank restoration 15 ft long x 4 ft deep area washed out at corner of beaver dam.		
BMP 34	Woodman Road	ROW	Driveway Runoff	Southern Branch	0.13	5,500	0.9	Swale improvement / sediment trap	45%	0.4
BMP 35	Woodman Road	Map 10, Lot 46-3	Driveway Runoff	Southern Branch	0.16	7,100	1.1	Infiltration Trench	60%	0.7
BMP 36	Ag. Field off Roxbury Rd	Map 10, Lot 50	Agricultural Field	Northern Branch	0.74	32,100	0.6	Approx. 40 foot natural vegetated buffer between mowed field and stream	30%	0.2
BMP 37	Mowed Field off Woodman Rd	Map 4, Lot 58 & Map 10, Lot 24	Mowed Field	Southern Branch	3.43	149,400	2.8	Approx. 40 foot natural vegetated buffer between mowed field and stream	35%	1.0
BMP 38	Black Brook Road	ROW	Large Storm Event Erosion / Road Washout	Main Stem	2720	---	---	Replace existing culverts with structure designed for 100-year storm. TP removal not calculated because contribution cannot be quantified on an annual basis. Loading is event based and highly dependent upon hydrological conditions.		
								ESTIMATED TOTAL PHOSPHORUS REDUCTION (KG/YR):		**10.8**

[1] Total Phosphorus loads were calculated using the Simple Method and Event Mean Concentrations (NHDES, 2008)

[2] BMP load reductions are based on published removal efficiency values and professional judgement with respect to erosion control potential and BMP location.

Table 6-2: Recommended Measures to Manage Phosphorus Loading to Lake Winnisquam – Cost Estimates for Road Drainage Improvements

BMP Site ID	Drainage swale improvement length (feet)	Drainage swale improvement base width (feet) (assume 2:1 ss, 18" depth)	Level spreader length (ft)	Surface Area (top of basin)(sqft) w/ 1:1 side slopes (see Appendix D)	Sediment Trap / Basin Depth (ft) =Dfull (See Appendix D)	Riprap/berm stone estimate (tons)	Riprap/berm stone (cuyds)	Filter fabric area (ft^2)	Bioretention Soil / Loam (cuyds)	Inlet Headwall / Culvert ($)	Wetland/ Buffer Plants ($)	Materials Cost Estimate ($)	Labor & Equipment Cost Estimate ($)	Technical Services Cost Estimate ($) (Engineering, Permitting, etc...)	Total Cost Estimate[1]	Low Cost Estimate (-20%)[1]	High Cost Estimate (+50%)[1]	Total Estimated Cost/gram P-Reduction	Priority (Based on TP-Removal Estimates)	Project Group[2]	Assumptions
BMP 1					1	4.0	2.2					$88	$477		$600	$500	$900	$12	Low	1	Berm stone placement at low point of natural basin area
BMP 2													$733		$800	$700	$1,200	$8	Medium	1	Shoulder grading
BMP 3													$733		$800	$700	$1,200	$8	Medium	1	Shoulder grading
BMP 4	2000	2				533	296	19200				$14,901	$185,778	$30,102	$230,800	$184,700	$346,200	$487	High	4	2,000 feet of swale widening and armoring along various sections of Huse Road
BMP 5				150	2	28.0	16	560				$708	$4,064	$716	$5,500	$4,400	$8,300	$7	High	4	Ditch Turnout with sediment trap and 20 ft long x 3 ft deep gravel trench level spreader
BMP 6	20	1		80	2	18.9	11	290				$464	$3,298	$564	$4,400	$3,600	$6,600	$48	Low	4	Swale armoring and approx. 7ft dia. sediment trap
BMP 7	15	1	20	170	2	31.4	17	570				$785	$4,642	$814	$6,300	$5,100	$9,500	$7	High	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 8	20	1		80	2	13.6	8	240		$6,270		$7,236	$6,945	$2,127	$16,400	$13,200	$24,600	$124	Medium	4	Culvert and sediment trap
BMP 9	10	1	20	90	2	19.5	11	350				$486	$6,324	$1,021	$7,900	$6,400	$11,900	$35	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader / berm across up-slope turnout
BMP 10	10	1		120	2	19.1	11	340				$476	$2,796	$491	$3,800	$3,100	$5,700	$9	Medium	4	Ditch turn-out with sediment trap
BMP 11	10	1		70	2	13.1	7	240				$327	$1,916	$337	$2,600	$2,100	$3,900	$32	Low	4	Ditch turn-out with sediment trap
BMP 12	10	1	20	80	2	16.3	9	290				$406	$2,477	$432	$3,400	$2,800	$5,100	$27	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 13	10	1	20	100	2	18.7	10	340				$467	$2,829	$494	$3,800	$3,100	$5,700	$14	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 14	10	1	20	90	2	17.5	10	310				$435	$2,653	$463	$3,600	$2,900	$5,400	$15	Medium	4	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 15			20			12.0	7	170	6		$400	$915	$12,540	$2,018	$15,500	$12,400	$23,300	$58	Medium	4	Gravel interceptor trench (approx 20x3x3), 15 foot vegetated strip
BMP 16	20	1		491		12.0	7	220		$6,330		$7,263	$17,513	$3,716	$28,500	$22,800	$42,800	$49	High	2	Culvert from south side to north side of Roxbury Rd / Sediment forebay to infiltration basin
BMP 17						5.3	3	100		$6,440		$7,218	$7,969	$2,278	$17,500	$14,000	$26,300	$44	Medium	2	Culvert from east side to west side of Kaulback Road with channel protection to Black Brook tributary
BMP 18	450	1				60.0	33	2160				$1,676	$20,900	$3,386	$26,000	$20,800	$39,000	$609	Low	2	Swale armoring approximately 450' long on eastern side
BMP 19				90	2	10.8	6	190				$269	$1,584	$278	$2,200	$1,800	$3,300	$6	Medium	2	Sediment Trap (approx. 12' dia)
BMP 20									67		$800	$3,630	$11,733	$2,305	$15,400	$12,400	$23,100	$225	Low	3	Replace 4-feet of shoulder with top soil and seed with native hardy-drought tolerant grasses&shrubs / runoff diversion to sediment traps
BMP 21	40	2		70	2	21.7	12	390				$542	$3,188	$560	$4,300	$3,500	$6,500	$72	Low	3	Sediment trap at low point adjacent to brook
BMP 22	40	2		70	2	21.7	12	390				$542	$3,188	$560	$4,300	$3,500	$6,500	$72	Low	3	Sediment trap at low point adjacent to brook

Table 6-2 (Continued): Recommended Measures to Manage Phosphorus Loading to Lake Winnisquam – Cost Estimates for Road Drainage Improvements

BMP Site ID	Drainage swale improvement length (feet)	Drainage swale improvement base width (feet) (assume 2:1 ss, 18" depth)	Level Spreader length (ft)	Surface Area (top of basin)(sqft) w/ 1:1 side slopes (see Appendix D)	Sediment Trap / Basin Depth (ft) =Dfull (See Appendix D)	Riprap/berm stone estimate (tons)	Riprap/berm stone (cuyds)	Filter fabric area (ft^2)	Bioretention Soil / Loam (cuyds)	Inlet Headwall / Culvert ($)	Wetland/ Buffer Plants ($)	Materials Cost Estimate ($)	Labor & Equipment Cost Estimate ($)	Technical Services Cost Estimate ($) (Engineering, Permitting, etc...)	Total Cost Estimate[1]	Low Cost Estimate (-20%)[1]	High Cost Estimate (+50%)[1]	Total Estimated Cost/gram P-Reduction	Priority (Based on TP-Removal Estimates)	Project Group[2]	Assumptions
BMP 23	50	1	20	70	2	25.7	14	460				$642	$3,538	$627	$4,900	$4,000	$7,400	$45	Medium	3	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 24	50	1	20	80	2	26.9	15	480				$672	$3,703	$656	$5,100	$4,100	$7,700	$33	Medium	3	Ditch turn-out with sediment trap and 20 foot level spreader
BMP 25	60	2				25.3	14	460		$6,270		$8,322	$4,676	$1,950	$15,000	$12,000	$22,500	$200	Low	3	Assume 24'x 10" culvert with head walls, riprap inlet/outlet, 60' of swale improvement.
BMP 26														$20,020	$20,100	$16,100	$30,200		Medium	7	Cost for preliminary survey and development of restoration work plan. Total cost is dependent upon preliminary investigation.
BMP 27	200	2		140	3	83.5	46	1500				$2,084	$14,537	$2,493	$19,200	$15,400	$28,800	$132	Medium	3	Widen and armor swale, construct turn-out to sediment trap and forested level spreader
BMP 28	20	2		120	2	21.1	12	380				$526	$3,037	$534	$4,100	$3,300	$6,200	$10	Medium	6	Water bar across driveway to sediment trap and forested buffer
BMP 29									17		$20	$645	$4,730	$806	$6,200	$5,000	$9,300	$8	High	6	Install permanent berm, vegetate elevated 6-ft buffer strip along low-point, regrade to direct runoff into adjacent forested area
BMP 30	400	2		140	2	61.7	34	2220		$6,393		$8,757	$21,834	$4,589	$35,200	$28,200	$52,800	$90	Medium	2	Armor swale with riprap trench, add drop inlet and culvert at low point to convey south side to north, install 15 foot wide sed trap/infiltration basin, ensure diffuse outlet to forested area.
BMP 31	200	2				45.8	25	1650	14	$6,222	$500	$9,438	$27,049	$5,473	$42,000	$33,600	$63,000	$76	High	5	Bioretention basin (10x15x2) along bank, underdrain to existing culvert location (replace culvert)
BMP 32											$1,000	$1,100	$18,333	$2,915	$22,400	$18,000	$33,600	$143	Medium	6	Establish approximately 30-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 33						20.0	11	360			$300	$3,029	$11,183	$8,528	$22,800	$18,300	$34,200		High	7	Bank erosion (approx. 12x4 area) can be stabilized by re-sloping bank, reinforcing pond side with riprap, and revegetating bank.
BMP 34	25	4											$1,467	$220	$1,700	$1,400	$2,600	$4	Medium	5	Deepen swale along Woodman Road along Woodman Cemetery to capture runoff from adjacent driveway.
BMP 35	100	2				49.3	27	890		$3,120		$4,664	$12,296	$2,544	$19,600	$15,700	$29,400	$29	High	6	Armor swale with riprap, regrade and construct sediment trap and infiltration trench (4x20x3) with outlet to existing culvert.
BMP 36											1,000	$1,100	$12,222	$1,998	$15,400	$12,400	$23,100	$87	Medium	6	Establish approximately 40-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 37											1,000	$1,100	$24,444	$3,832	$29,400	$23,600	$44,100	$30	High	6	Establish approximately 40-foot natural buffer around surface water feature using native shrubs, grasses and wetland plants.
BMP 38												$80,000	$140,000	$25,000	$245,000	$196,000	$367,500		Medium	1	Cost estimate for Black Brook Road culvert replacement dependent upon findings of hydrologic/hydraulic study and site conditions.
												TOTAL COST ESTIMATES:			$912,500	$731,600	$1,369,400				

[1] Cost estimates are approximations based on estimated labor, materials, consulting costs, and best professional judgement. Costs are intended for general prioritization of measure implementation. More accurate cost estimates will require additional designs, assessments of site condition, and feasibility evaluations. Cost estimates do not consider construction oversight or as-built record drawings. Technical services estimates based on 15% of total construction cost estimate.

[2] Projects are grouped based on location and BMP type to assist with scheduling and budgetting. Estimated technical services costs are divided within groups to gain efficiency of design and survey tasks.

6.2 Implementation Schedule

Table 6-3: Implementation Schedule

Management Practice		Estimated Total Load Reduction (kg/yr)	Estimated Cost[a] ($)	Implementation Schedule
Road Drainage Improvement				
	Project Group			
	1	0.3	$247,200	Year 1
	2[b]	1.8	$109,400	Year 1
	3[b]	0.7	$68,200	Year 2
	4[b]	3.9	$304,000	Year 3
	5	0.9	$43,700	Year 2
	6	3.2	$97,100	Year 1 - Year 5[c]
	7	not quantified	$42,900	Year 1 - Year 5[c]
Road & Culvert Maintenance				
Engineering Evaluation of Culvert Adequacy		not quantified	$12,000	Year 1
Routine Culvert Cleaning		not quantified	not estimated	On-going
Maintenance of Road Drainage Structures and BMPs		not quantified	not estimated	On-going
Ordinance and Subdivision Amendments				
Driveway Permit Requirements		not quantified	N/A	Year 1
Natural Buffer Zones		not quantified	N/A	Year 1
Phosphorus-Fertilizer Ban		not quantified	N/A	Year 1

a. Cost estimates are preliminary approximations for planning purposes only.

b. Scope of work and associated costs dependent upon factors related to paving road versus simple BMP implementation with gravel road.

c. Implementation of driveway and agric/field BMPs is dependent upon land owner cooperation and feasibility factors.

7.0 Public Outreach and Education

The centerpiece of efforts to control phosphorus (and sediment) loading to Lake Winnisquam via Black Brook is public outreach and education. In addition to educating individual homeowners on the implications of their actions on phosphorus export to the lake and the impact of that phosphorus on lake water quality, the secondary purpose to education and outreach is to educate decision makers at the town level so that phosphorus management becomes part of the criteria evaluated as decisions are made on zoning, planning, public works, recreation and site development issues.

Conduct meetings to brief officials (i.e. selectmen or managers, administrators, planning boards, conservation commissioners, etc.) of cities and towns (including Sanbornton) that have Lake Winnisquam watersheds to discuss non point source pollution issues: identification, control, remedial action, short term and long term planning and zoning, etc. These discussions will be based on what has been learned in developing the current plan and will emphasize that the current plan only covers a small portion of the total watershed and that are wide area cooperation will be needed to meet Lake Winnisquam water purity goals as established in the WMP.

Send a general mailing to all Sanbornton (03269) mail boxes to provide awareness on topics like shore land protection, phosphorus fertilizers, road maintenance and septic system maintenance and citizen responsibilities in watershed, and non watershed, locations. The mailing will cite references where additional information is available.

The current public awareness and outreach program at Black Brook has several key elements. Below each element are suggestions of ways to enhance the program:

1) **Media Coverage**

   Prepare and circulate periodic press releases to media with local and Statewide coverage explaining non point source pollution issues and documenting progress in implementing the WMP. Post the same information on local websites and newsletters, if available

2) **Web site**

   Current Program - Sanbornton and Meredith have websites that are clearinghouses for town information.

   Suggested Enhancements

   a) Provide a list of documents that would be useful to lake and watershed residents. This watershed plan which incorporates many relevant activities and documents would be a good choice for one of the documents. Other potential documents include; planning and zoning documents, NHDES fact sheets, popular articles on water quality and watersheds, forms and permit applications, lists of native plants etc.

   b) Increase traffic to the web site. The web site is only useful if people visit it. The single most viewed feature of many lake and watershed association web sites is a live web-cam image. These can be installed and maintained fairly easily and provide a place for residents who are “away” to see their lake or Black Brook and, in the process, visit the web page. A related feature is the ability to post pictures in a variety of categories. An example of a web site with a web cam and picture forums maintained by volunteers can be found at www.lwa.org. Largely because of the web cam and forums, the Lake

Wentworth Association website receives 50-100 visits a day. An up-to-date posting of lake level or stream level and lake temperature can also be an attractor to a lake association web site.

c) Consider addition of a forum specifically for water quality and watershed questions.

3) Speakers Bureau

Make knowledgeable speakers available to local organizations to explain non point source pollution issues, remedies and current progress with Black Brook WMP.

Consider the inclusion of invited speakers or special outdoor sessions to address specific topics. Examples could include specific information from a vendor who presents information on specific BMPs or a seminar on Shoreland Protection and landscaping that could feature NHDES Shoreland Protection outreach specialists, UNH cooperative extension specialist, staff from the New Hampshire Lakes Association or a local nursery staff member to talk about local, low maintenance native plants for landscaping with no fertilizer requirements.

Consider a perpetual award to be given annually to the person or organization that shows outstanding stewardship of the watershed resources or implements a particularly unique and effective project.

4) Lake Host

Current Program – Lake Winnisquam currently participates in the NH Lakes Lake Host program. This program is also currently quite successful.

Suggested Enhancements – Consider provision of information to the Lake Host on watershed issues of at least inform the lake host on current initiatives on the lake so that information can be shared with users of the boat ramp.

5) Published and Posted Materials

Current Program: Signage and public education posters at the boat launch.

Suggested Enhancements – a) stencil or put signs near storm drains or culverts in the Black Brook watershed with a message that says: " Drains to Lake Winnisquam, do not dump" or equivalent." b) prepare and distribute flyers or information sheets on specific issues related to septic systems, phosphorus in fertilizer, shoreland protection and native plantings etc. c) Present materials at local schools to engage young people. d) Provide information related to successful BMP installation. This could range from a guided or self tour of completed BMP projects to a seminar on gravel road maintenance that features a road that has been retrofitted to reduce phosphorus and sediment export to the lake and is aesthetically pleasing. e) Provide information and/or sponsor training courses for loggers, developers or public works officials on BMPs for phosphorus and sediment reduction.

8.0 Monitoring Plan

The New Hampshire Department of Environmental Services (NH DES) conducted water quality monitoring in the Pot Island Basin of Lake Winnisquam in 1979, 1984, 1990, and 2001 for Lake Trophic Studies (NHDES 2009). Lake Winnisquam has participated in the Volunteer Lake Assessment Program (VLAP) since 1987 (NH DES 2009). Lake Winnisquam also participates in the Lake Host program (NHDES 2009) to educate boaters and examine boats and trailers for exotic plants entering or leaving lakes.

The deepest site in the center of each of the three basins of the lake is the primary sampling location in Lake Winnisquam (Figure 1-1). Water quality samples collected during summer stratification are tested for epilimnetic, metalimnetic and hypolimnetic TP. In addition, a composite sample of the water column to the depth of the thermocline is tested for chl *a*. A DO profile from top to bottom is conducted and a Secchi disk transparency measurement is taken. Data from the mouth of Black Brook has been collected periodically since 1980 with additional effort in recent years. This data collection should continue. Additional sampling should be conducted throughout the Black Brook watershed to attempt to bracket locations where the bulk of the TP and sediment is entering and to confirm the influence of mitigation measures on TP concentrations Stream samples should be collected during both wet and dry periods and multiple samples should be collected during long storm events. Flow measurements associated with the sample collection would allow direct calculation of loads rather than estimation through modeling. This can be accomplished by installing staff gages in the Black Brook at various locations and developing stage/discharge relationships for each gage to relate specific gage readings with specific flows. If specific locations show consistently high concentrations or flows, visual investigation and/or additional monitoring points upstream should be considered to isolate the cause. An ideal sampling scheme would include sampling at each road crossing of the Main Stem of Black Brook as well as the North and South Branches. Reaches with the highest TP load would be the target of initial efforts to reduce TP.

An ideal tributary sampling period might include a spring snowmelt/rain sampling event prior to leaf-out, 2 wet and 2 dry summer events and a fall rain event after leaf fall. A minimum of ½ inch of rain forecast over a six hour period provides a target for a wet weather event (with the exception of a snowmelt event). A dry event would be best represented by sampling after a minimum of 72 hours with no rainfall or runoff. These data should be evaluated as a time series that can be updated as additional data are collected in the future.

It is recommended that VLAP sampling be continued to document the in-lake response, trends, and compliance with water quality criteria following implementation of TP reduction measures. As discussed in the previous section, successful implementation of this watershed management plan will be based on attaining the target and short-term goal for TP in the Pot Island Basin of Lake Winnisquam. Data collected by VLAP which includes DO, conductivity, transparency, planktonic chl *a* and the reporting of cyanobacteria scums should continue. NH DES staff will continue to sample and document the extent and severity of any potential future reported cyanobacteria blooms through microscopic identification, cell counts and toxicity tests.

With respect to implementation of specific BMPs throughout the watershed, the existing tributary monitoring program should be augmented with site specific monitoring immediately below and above the sites of proposed BMP implementation. As with the routine monitoring, the sampling program should include a spring snowmelt/rain sampling event prior to leaf-out, 2 wet and 2 dry summer events and a fall rain event after leaf fall. A minimum of ½ inch of rain forecast over a six hour period provides a target for a wet weather event (with the exception of a snowmelt event). A dry event would be best represented by sampling after a minimum of 72 hours with no rainfall or runoff. Alternatively, a monthly program from April through November could be implemented. If BMP's are located in proximity to the routine sampling sites described above, data from the routine stations can be used for either the upstream or downstream BMP effectiveness station. Pre and post BMP data as well as upstream and downstream data can be compared graphically using box and whiskers plots or statistically using a Student's t-test ($p < 0.1$).

This BMP effectiveness monitoring should commence as soon as practicable prior to the installation of BMP's and continue through construction and after construction to document that estimated removal efficiencies are obtained. At a minimum, TP should be assessed but the addition of other parameters such as total suspended solids and flow should be considered. The addition of flow will allow the calculation of phosphorus loads directly. The evaluation of individual BMP's as well as routine data collection will allow progress towards the goal for Black Brook to be quantified.

In order to evaluate the effectiveness of the public outreach and education efforts to be conducted as a part of this plan, a survey that evaluates the current state of knowledge about fertilizer, shoreland protection, septic system maintenance and stormwater management. Use the results of the survey to target specific topics and individuals for educational efforts. After implementation of the public education components of the watershed plan, conduct a follow up survey to test the effectiveness of the program by repeating the initial survey. The increase in awareness will be used as a metric to measure the effectiveness of the program. If deficiencies are still noted in the knowledge of watershed residents, the public outreach and education program can be modified to provide the appropriate information.

9.0 Potential Sources of Funding

Improvements and management techniques described in Sections 5 and 6 will require funding to install and complete. There are several primary sources of funding for non point source projects in New Hampshire. These include, but are not limited to, Section 319 funding and NHDES Small Outreach and Education Grants and several other programs detailed below. Alternative funding may be in the form of donated labor from the Meredith and Sanbornton Department of Public Works as well as local volunteer groups and contractors from communities around the lake. Brief descriptions of potential funding sources are provided below:

Section 319 Grant Funding: Funds for NH DES Watershed Assistance and Restoration Grants are appropriated through the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act (CWA). Two thirds of the annual funds are available for restoration projects that address impaired waters and implement watershed based plans designed to achieve water quality standards. A project eligible for funds must plan or implement measures that prevent, control, or abate no-point source (NPS) pollution. These projects should: (1) restore or maintain the chemical, physical, and biological integrity of New Hampshire's waters; (2) be directed at encouraging, requiring, or achieving implementation of BMPs to address water quality impacts from land-use; (3) be feasible, practical and cost effective; and (4) provide an informational, educational, and/or technical transfer component. The project must include an appropriate method for verifying project success with respect to the project performance targets, with an emphasis on demonstrated environmental improvement. Nonprofit organizations registered with the N.H. Secretary of State and governmental subdivisions including municipalities, regional planning commissions, non-profit organizations, county conservation districts, state agencies, watershed associations, and water suppliers are eligible to receive these grants. More information on the NH DES Watershed Assistance and Restoration Grants can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Small Outreach and Education Grant: The NHDES provides funding to promote educational and outreach components of water quality improvement projects. This program provides small grants of $200 to $2,000 for outreach and education projects relating to NPS issues that target appropriate audiences with diverse NPS water quality related messages. These small grants are available year round on an ongoing basis, which allows applicants to move forward with outreach and education projects without having to wait for annual application deadlines. The NH DES Watershed Assistance Section administers the grant program using $20,000 each year from the U.S. EPA under Section 319 of the CWA. More information on the Small Outreach and Education Grant can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm.

Conservation License Plate Program: To promote natural resource related programs throughout NH. Conservation Districts, Cooperative Extension, conservation commissions, schools, groups, and other non-profits can apply for funding. http://www.nh.gov/nhdhr/grants/moose/

Agricultural Nutrient Management Grant Program: The NH Department of Agriculture, Markets, and Food provides up to $2,500 grants to assist agricultural land and livestock owners with efforts to minimize adverse effects to waters of the state by better management of agricultural nutrients. Applications are accepted annually. More information can be found at: http://des.nh.gov/organization/divisions/water/wmb/was/categories/grants.htm

Land and Water Conservation Program: UNH Cooperative Extension helps New Hampshire communities and conservation groups with land and water conservation planning projects. Land & Water Conservation Program staff provide technical assistance, facilitation and guidance to communities interested in conserving their natural resources, prioritizing areas for protection, and working with local landowners to conserve land. Extension assistance is limited to project guidance and training, and does not include specific involvement in completing project tasks. http://extension.unh.edu/CommDev/CCAP.htm

Transportation Enhancement (TE) Program: The 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) called for a ten percent designated share of all Surface Transportation Program funds to be used for Transportation Enhancement Activities. The intent of the program is to afford an opportunity to develop "livable communities" by selecting projects that preserve the historic culture of the transportation system and/or enhance the operation of the system for its users. The 1998 Transportation Equity Act for the 21st Century (TEA-21) continued the Transportation Enhancement Program and expanded the eligible use of funds. One of the categories of projects eligible for funding is “Environmental mitigation to address water pollution due to highway runoff or reduce vehicle-caused wildlife mortality while maintaining habitat connectivity.” http://www.nh.gov/dot/org/projectdevelopment/planning/tecmaq/index.htm or http://www.enhancements.org/profile/new_profile_search.php

Wetlands Reserve Program: The Wetlands Reserve Program is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The USDA Natural Resources Conservation Service (NRCS) provides technical and financial support to help landowners with their wetland restoration efforts. The NRCS goal is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. http://www.nrcs.usda.gov/Programs/wrp/

Forest Legacy Program: The Forest Legacy Program helps protect environmentally important private forestlands threatened with conversion to non-forest uses. The Secretary of Agriculture is responsible for the development and administration of the Forest Legacy Program. The US Forest Service in cooperation with States and other units of government is responsible for the implementation of the program. States have been granted the authority to establish criteria for their programs within the framework of the national program to help address specific needs and goals of their state.

To help maintain the integrity and traditional uses of private forest lands, the Forest Legacy Program promotes the use of conservation easements, legally binding agreements transferring a negotiated set of property rights from one party to another. Participation in the program is entirely voluntary. http://www.nhdfl.org/land-conservation/forest-legacy-program.aspx

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Appendix A

Black Brook/Lake Winnisquam Water Quality Target Memorandum August 25, 2011

Memorandum

To: Robert Ward: Town of Sanbornton, Don Fourdriat, Black Brook Steering Committee

From: Don Kretchmer, Al Pratt; AECOM

Cc: Andy Chapman; NHDES

Date 8/25/11

Subject: Lake Winnisquam Water Quality Target

Dear Bob and Don,

As you are aware, AECOM is preparing a watershed management plan for Black Brook in order to protect Lake Winnisquam water quality and improve conditions in the brook. Some of the issues that will be addressed in the watershed management plan include: road runoff and erosion, lawn fertilization, conservation of land, development, land use, septic systems, algal blooms and practical measures individuals and the Town of Sanbornton can do to improve and protect water quality. Lake Winnisquam is among the highest quality lakes in New Hampshire and a valuable asset to Sanbornton and the lakes region of NH. By planning and conducting careful management now, the efforts, led by Sanbornton, will be a model for other watersheds around Winnisquam to follow.

Recently, AECOM staff, Don Foudriat and NH DES scientists, met informally to discuss setting the water quality target. As part of the watershed management plan process, stakeholders must reach consensus on a water quality target. The water quality of Lake Winnisquam depends on the amounts of nutrients entering it. The most critical nutrient in freshwater is phosphorus. Therefore, setting an appropriate in-lake phosphorus concentration is essential to preserving water quality.

Lake Winnisquam qualifies as a Tier 2- High Quality Water which gives it a water quality standard of <8 *u*g/l total phosphorus. The attached figure summarizes the relevant water quality benchmarks and demonstrates that the target is well within the remaining assimilative capacity. Please note that the best possible water quality shown in the figure is not representative of background conditions for Lake Winnisquam. The best possible water quality for Lake Winnisquam is best approximated through modeling. A scenario wherein atmospheric deposition remains, all land use is returned to forest and septic loads are eliminated was evaluated with the water quality model. The LLRM model developed for Lake Winnisquam predicted a background concentration of 3.8 *u*g/L under this scenario.

Meeting attendees generally agreed that the water quality target should be set at current conditions (mean summer in-lake total phosphorus concentration= 6.6 *u*g/L and median = 6.4 *u*g/L based on the last 10 years of water quality data). A short term mean summer in-lake median total phosphorus goal of 6.1 *u*g/l (5% reduction from current) is proposed recognizing that future development will happen in the watershed. The total phosphorus numbers associated with this goal are summarized in Table 1.

Meeting this short term goal through watershed phosphorus load reductions with Best Management Practices (BMPs) will provide a buffer to this future development. Many of these BMPs will also function to reduce suspended solids loading to Black Brook and Lake Winnisquam. The load reduction that results in a 5% in-lake reduction will be allocated across the watershed of the Pot Island basin of Winnisquam (including a value for the Black Brook watershed) as well as the direct sources of phosphorus to the Pot Island Basin provided by the Winnipesaukee River and the 3 Island Basin.

Once agreement is reached on the target and short term goal, AECOM will model phosphorus loading reduction scenarios to determine a realistic phosphorus reduction in the Black Brook watershed to meet the short-term goal. The performance of proposed BMPs will be expressed in terms of the potential for total phosphorus load reduction as well as suspended solids load reduction to Black Brook. Since particulate P is attached to sediment, significant sources of Black Brook sediment pollution will be identified during the site-specific watershed evaluation to identify P load reduction sites. Additional detail on BMPs will be provided as a part of Objective 7. The short term goal of reducing the watershed phosphorus load will allow for future development loading while maintaining current water quality.

Please contact Don or Al to discuss either the water quality target or short term goal.

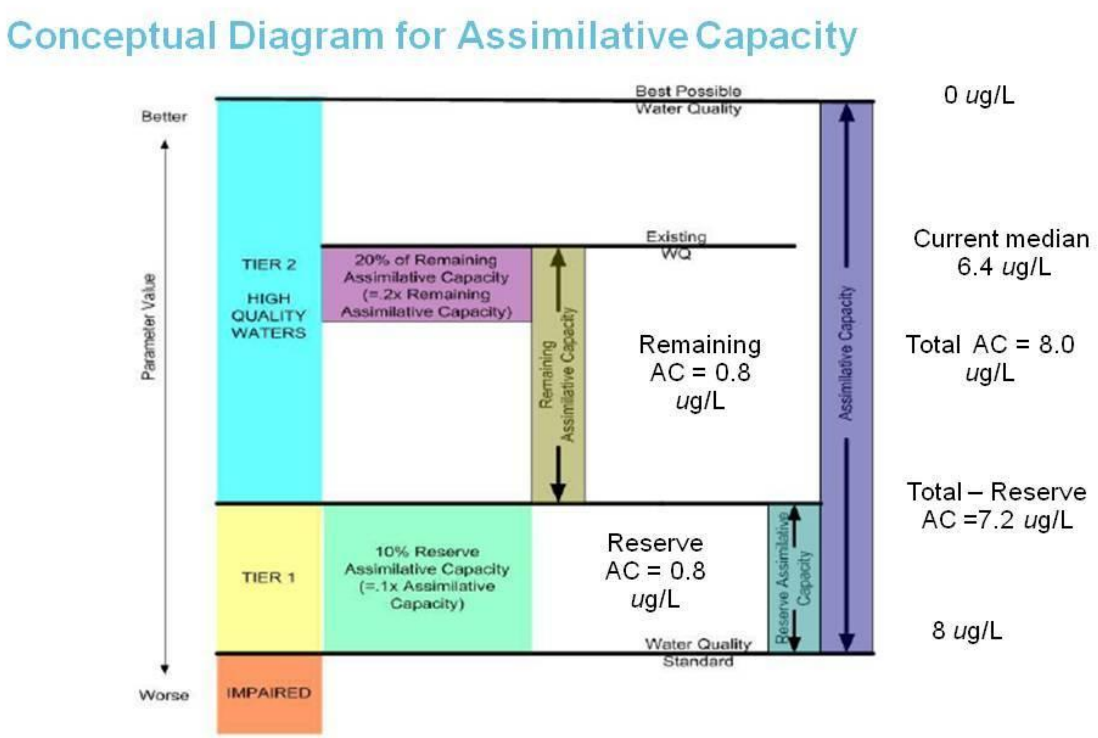


Figure 1: Conceptual Diagram for Assimilative Capacity

Table 1: Summary of reductions in total phosphorus loading associated with in-lake phosphorus target and in-lake short-term goal based on LLRM water quality model.

	Current Conditions	Proposed Target Conditions (same as current conditions)	Short-Term Goal (5% reduction in watershed and septic sources)
Median Lake Winnisquam Total Phosphorus concentration (Pot Island Basin)	6.4 *u*g/L	6.4 *u*g/L	6.1 *u*g/L
Phosphorus Load to Lake Winnisquam (Pot Island Basin)	5182 kg/yr 11,400 lb/yr	5182 kg/yr 11,400 lb/yr	4923 kg/yr 10,831 lb/yr
Phosphorus Load from Black Brook Watershed	224 kg/yr 493 lb/yr	224 kg/yr 493 lb/yr	212 kg/yr 466 lb/yr
Reduction Required in Black Brook	-	0 kg/yr 0 lb/yr	12 kg/yr 27 lb/yr

Appendix B

Model Parameter Tables

Table B-1. Land Use Categories and Export Coefficient Ranges used in the Pot Island Basin LLRM Model

LLRM Land Use	Runoff P export coefficient range	Runoff P export coefficient used	Source	Baseflow P export coefficient range	Baseflow P export coefficient used	Source
Urban 1 (Low Density Residential	0.19-6.23	0.90	Schloss and Connor 2000-Table 5	0.001-0.05	0.01	ENSR Unpublished Data; Mitchell et al. 1989
Urban 2 (Mid Density Residential/Commercial)	0.19-6.23	1.10	Reckhow et al. 1980	0.001-0.05	0.01	"
Urban 3 (Roads)	0.19-6.23	1.80	Dudley et al. 1997	0.001-0.05	0.01	"
Urban 4 (Industrial)	0.19-6.23	1.10	Reckhow et al. 1980	0.001-0.05	0.01	"
Urban 5 (Mowed Fields)	0.19-6.23	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 1 (Cvr Crop)	0.10-2.90	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 2 (Row Crop)	0.26-18.26	2.20	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 3 (Grazing)	0.14-4.90	0.80	Reckhow et al. 1980	0.001-0.05	0.01	"
Agric 4 (Hayfield)	0.35	0.64	Dennis and Sage 1981	0.001-0.05	0.01	"
Forest 1 (Deciduous)	0.29 - 0.973	0.10	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 2 (NonDeciduous)	0.01 - 0.14	0.09	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 3 (Mixed)	0.01-0.138	0.09	Schloss and Connor 2000- Table 4	0.001-0.010	0.004	"
Forest 4 (Wetland)	0.02 - 0.83	0.08	Schloss and Connor 2000-Table 4	0.001-0.010	0.004	"
Open 1 (Wetland/Lake)	0.02 - 0.83	0.07	Schloss and Connor 2000-Table 5	0.001-0.010	0.004	"
Open 2 (Meadow)	0.02 - 0.83	0.20	Reckhow et al. 1980	0.001-0.010	0.004	"
Open 3 (Excavation)	0.14- 4.90	0.80	Reckhow et al. 1980	0.001-0.010	0.004	"

Table B-2. Runoff and Baseflow Coefficients Used in the Pot Island Basin LLRM Model

	Low	Med	High
Baseflow fraction	0.10	0.40	0.95
Runoff fraction	0.01	0.20	0.40

Runoff and baseflow factions used in the model for Lake Winnisquam

Landuse Category	Runoff Fraction	Baseflow Fraction
Urban 1 (Low Density Residential)	0.30	0.25
Urban 2 (Mid Density Residential/Commercial)	0.50	0.15
Urban 3 (Roads)	0.60	0.05
Urban 4 (Industrial)	0.50	0.05
Urban 5 (Mowed Fields)	0.30	0.30
Agric 1 (Cvr Crop)	0.15	0.30
Agric 2 (Row Crop)	0.30	0.30
Agric 3 (Grazing)	0.30	0.30
Agric 4 (Hayfield)	0.15	0.30
Forest 1 (Deciduous)	0.20	0.40
Forest 2 (NonDeciduous)	0.20	0.40
Forest 3 (Mixed)	0.20	0.40
Forest 4 (Wetland)	0.05	0.40
Open 1 (Wetland/Lake)	0.05	0.40
Open 2 (Meadow)	0.30	0.30
Open 3 (Excavation)	0.60	0.30

Appendix C

Example Ordinances

Town of Windham – Cobbetts Pond

Excerpt from:
Town of Windham
Zoning Ordinances and Land Use Regulations
--- final amendment: March 13, 2012 ---

616: Cobbetts Pond and Canobie Lake Watershed Protection Ordinance

616.1 Authority and Statement of Intent

616.1.1 Pursuant to RSA 674: 21, the Town of Windham adopts a Watershed Protection Overlay District and accompanying regulations to ensure the protection and preservation of Cobbetts Pond and Canobie Lake and their watershed from the effects of point and non-point source pollution or sedimentation. The establishment of the Watershed Protection Overlay District and the adoption of these regulations are intended.

616.1.1.1 To protect public health,

616.1.1.2 To protect aquifers, which serve as existing or potential water supplies, and the aquifer recharge system,

616.1.1.3 To protect surface waters and wetlands contiguous to surface waters,

616.1.1.4 To protect the natural areas and wildlife habitats within the Watershed Protection Overlay Zone by maintaining ecological balances,

616.1.1.5 To prevent the degradation of water quality through the regulation of land uses and development within the Watershed Protection Overlay District, and

616.1.1.6 To assure proper use of natural resources and other public requirements.

616.1.2 In the event of a conflict between the requirements of this section and other requirements of the Windham Zoning Ordinance or state law, the more stringent requirements shall govern.

616.2 Applicability

616.2.1 The special provisions established in this Watershed Protection Ordinance shall apply to all development proposals and to potential contaminating activities within the Watershed Protection Overlay District. The boundaries of the Watershed Protection Overlay District have been delineated by the NH DES using current location data (see Cobbetts Pond Watershed Overlay District Parcel Map dated 1/27/10 and Canobie Lake Watershed Overlay District Parcel Map dated 11/15/11).

616.2.2 The boundaries of the Watershed Protection Overlay District are identified through drainage, groundwater and soils analyses and are considered to be essential to the protection of the watershed from the effects of point and non-point source pollution or sedimentation.

616.2.3 All development proposals occurring wholly or partly in an area within the Watershed Protection Overlay District shall be subject to the requirements of this Ordinance.

616.3 Administration

616.3.1 General: The Windham Planning Board shall have authority to create processes and procedures to administer the provisions of the Watershed Protection Ordinance.

616.3.2 Enforcement: The Code Enforcement Officer shall be responsible for enforcing the provisions and conditions of this Watershed Protection Ordinance, pursuant to the provisions of Section 1500 of Windham's Zoning Ordinance.

616.4 Definitions

Automobile Service or Repair Station: A retail establishment at which motor vehicles are refueled, serviced, and sometimes repaired.

Best Management Practices**:** As defined in the New Hampshire Stormwater Manual, Volume 1, Volume II, and Volume III, prepared by NH DES.

Buffer Zone: The undisturbed natural area sufficient in size to mitigate runoff effects harmful to water quality.

Commercial Agricultural Activities: The production of crops for sale, crops intended for widespread distribution to wholesalers or retail outlets. Commercial agriculture includes livestock production and livestock grazing. Commercial agriculture does not include crops grown for household consumption (e.g. backyard garden or from a vegetable garden or a few fruit trees).

Contamination: Sedimentation, point and non-point source pollution, septage, or the discharge of hazardous materials.

Development: Any activity resulting in a change in the physical character of any parcel of land, such as may be caused by, but not limited to: subdivisions, change in use, the construction or expansion of a building, deck, or shed; installation of a well or septic tank; land disturbing activity such as commercial agriculture or commercial forestry; paving of a previously permeable area; grading, and road building. Lot line adjustments are exempt.

Hazardous Materials: As defined in Superfund Amendment and Reauthorization Act of 1986 and Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987).

Hydrology: The study of the earth's waters, their distribution and the cycle involving precipitation, infiltration into the soil and evaporation.

Impervious Surface: Surface that is impenetrable by liquids, including, but not limited to, areas paved with conventional asphalt or concrete, sidewalks, patios, decks, and roofs which do not recharge water.

Infiltration Rate: The volume of surface water that filters into the soil per unit of time.

Low-Impact Development (LID): An approach to site development and design that provides increased opportunities for storm water infiltration and increased hydrologic function within a watershed as defined in NH DES Fact Sheet WD-WMB-17, "Low-Impact Development and Stormwater Management," 2010 or any updated versions thereof.

Non-point Source Pollution: Contaminants including, but not limited to pesticides, fertilizers, animal wastes, sediments, nutrients, and heavy metals that are deposited on the ground surface and flow into and pollute nearby surface waters.

Point and Non-point Source Pollution: Point pollution comes from a single source such as the discharge from a drainage pipe. Non-point pollution comes from multiple sources such as rain water run-off.

Potential Contaminating Activity: Activities that have the potential to create a new discharge of contaminants or to increase the discharge of contaminants to surface or ground-waters.

Public Water Body: All water bodies with a surface area of 10 acres or more.

Runoff Volume: The volume of surface water that runs off during a storm event.

Sedimentation: The deposition of sand, silt, soil or other matter into a watercourse or wetland, including that resulting from post-development surface runoff.

Storm Event: A period of sustained rainfall with a minimum total accumulation of 0.25 inches of precipitation over a 24 hour period.

Storm Water: Surface water run-off from a non point source caused by a storm event.

Tributary Stream: Any perennial or intermittent stream, flowing either directly or indirectly into a public water body. This shall include any tributary stream section contained within a pipe system.

Watershed: The area lying within the drainage basins of public water bodies.

616.5 Use Regulations

616.5.1 Allowed uses established by the underlying zoning district shall apply, except as modified below:

616.5.2 The following uses shall be specifically prohibited within the Watershed Protection Overlay District:

616.5.2.1 Storage or production of hazardous materials as defined in either or both of the following:

616.5.2.1.1 Superfund Amendment and Reauthorization Act of 1986.

616.5.2.1.2 Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987)

616.5.2.2 Disposal of hazardous materials or solid wastes.

616.5.2.3 Treatment of hazardous material, except rehabilitation programs authorized by a government agency to treat hazardous material present at a site prior to the adoption of this ordinance.

616.5.2.4 Any business that stores, uses or disposes of hazardous material, unless all facilities and equipment are designed and operated to prevent the release or discharge of hazardous materials and have undergone an inspection by the Town of Windham Building Inspector and Fire Inspector to certify they are in compliance with hazardous material regulations.

616.5.2.5 Disposal of septage or septic sludge, as defined by New Hampshire Solid Waste Rules Env-Wm101-300 & 2100 - 3700.

616.5.2.6 Automobile service and repair stations.
616.5.2.7 Junkyards and Salvage Yards as defined by RSA 236:112.

616.6 Review Requirements for Development in the Watershed Protection Overlay District

616.6.1 General. Applications for Subdivisions and Site Plans shall be accompanied by a hydrologic study as outlined in Section 616.7. The Hydrological study must document, in a manner acceptable to the Planning Board, that the proposed land development would provide the same or greater degree of water quality protection as existed on the site (s) at the time the application was made. Change of Use Applications that do not propose any new construction, paving, alterations to grading, or other alteration to the terrain are exempt from the requirements of the hydrological study.

616.6.2 Applications for new home construction and additions and reconstruction of existing homes need New Home Construction Applications and must include an erosion and sedimentation control plan prepared by an engineer licensed in the State of New Hampshire or a qualified professional familiar with erosion control measures and procedures and acceptable to the Town Engineer.

616.6.3 All development within the Watershed Protection Overlay District shall be evaluated to ensure that:

616.6.3.1 Non-point source pollution is prevented to the maximum extent possible, taking into account site conditions such as slope, soil type and erosivity and vegetative cover.

616.6.3.2 Best Management Practices (BMPs) are in place and are sufficient to remove or neutralize those pollutants that present a potential impact to the water body. The use or creation of detention ponds is not allowed for runoff control, except in those cases where an extended detention pond may be necessary to develop a site.

616.6.3.3 Grading and removal of vegetation at a development site is minimized and erosion and sedimentation control measures are in place and properly installed.

616.6.3.4 If two or more dwelling units share a common sewage treatment system a perpetual maintenance agreement from the building's owner is required.

616.6.3.5 Uses that may potentially cause contamination within the Watershed Protection Overlay District, must submit a spill prevention control and countermeasures plan for approval. This plan shall include the following elements:

616.6.3.5.1 Disclosure statements describing the types, quantities, and storage locations of all contaminants that will be part of the proposed project.

616.6.3.5.2 Contaminant handling and spill prevention techniques.

616.6.3.5.3 Spill reporting procedures, including a list of affected agencies to be contacted in the event of a spill.

616.6.3.5.4 Spill recovery plans, including a list of available equipment.

616.6.3.5.5 Spill cleanup and disposal plans.

616.7 Hydrologic Study and Plan

616.7.1 A hydrologic study shall be done by a professional engineer or hydrologist licensed in the State of New Hampshire and shall include the following information:

616.7.1.1 Description of the proposed project including location and extent of impervious surfaces; on-site processes or storage of materials; the anticipated use of the land and buildings; description of the site including topographic, hydrologic and vegetative features.

616.7.1.2 Characteristics of natural runoff on the site and projected runoff with the proposed project, including its rate and chemical and/or biological characteristics deemed necessary to make an adequate assessment of water quality.

616.7.1.3 Measures proposed to be employed to reduce the rate of runoff and pollutant loading of runoff from the project area, both during construction and after.

616.7.1.4 Proposed runoff control and watershed protection measures for the site. These measures shall be designed with the goal of ensuring that the rate of surface water runoff from the site does not exceed pre-development conditions and that the quality of such runoff will not be less than pre-development conditions. Special emphasis shall be placed on the impacts of proposed encroachments into the required buffer.

616.7.1.5 Where the developer of property subject to the terms of this Watershed Protection Ordinance seeks to utilize existing or planned off-site storm-water quality management facilities, the developer shall provide a written certification that the owner of the off-site facilities will accept the runoff and be responsible for its adequate treatment and that the arrangement will run with the land in a manner that will be acceptable to the Planning Board.

616.7.2 The study shall make use of existing Cobbett's Pond and Canobie Lake water quality historical data to the maximum extent possible. If new data is to be relied upon, the Town reserves the right to have the data reviewed by an independent expert at the expense of the developer, before the study is deemed complete and ready for review.

616.7.3 The study shall be submitted to the Planning Board for review and approval concurrently with the submission of applications for review as required by this Ordinance.

616.8 Buffer Requirements

616.8.1 A 100-foot wide buffer zone shall be maintained along the edge of any tributary stream discharging into Cobbett's Pond and Canobie Lake along the edge of any wetlands associated with those tributary streams. The required setback distance shall be measured from the centerline of such tributary stream and from the delineated edge of a wetland. Streams shall be delineated from their mean high water mark. The buffer zone shall be maintained in its natural state to the maximum extent possible.

616.8.2 Any reduction in the required buffer zone width may be granted by the Planning Board upon presentation of a hydrologic or other study that provides documentation and justification, acceptable to the Planning Board, that even with the reduction, the same or a greater degree of water quality protection would be afforded as would be with the full-width buffer zone. In granting such a reduction, the Planning Board may require certain conditions of approval which may include, but are not limited to, restrictions on use, type of construction, and erosion, runoff or sedimentation control measures as deemed necessary to protect water quality.

616.8.3 All development shall be located outside of the required buffer zone.

616.8.4 The following uses shall not be permitted within the buffer zone:

616.8.4.1 Septic tanks and drain-fields;

616.8.4.2 Feed lots or other livestock impoundments;

616.8.4.3 Trash containers and dumpsters which are not under roof or which are located so that leachate from the receptacle could escape unfiltered and untreated;

616.8.4.4 Fuel storage in excess of fifty (50) gallons [200L];

616.8.4.5 Sanitary landfills;

616.8.4.6 Activities involving the manufacture, bulk storage or any type of distribution of materials hazardous to Cobbett's Pond and Canobie Lake as defined in the Hazardous Materials Spills Emergency Handbook, American Waterworks Association, 1975, as revised, including specifically the following general classes of materials:

616.8.4.6.1 Oil and oil products,

616.8.4.6.2 Radioactive materials,

616.8.4.6.3 Any material transported in large commercial quantities that is a very soluble acid or base, highly biodegradable, or can create a severe oxygen demand,

616.8.4.6.4 Biologically accumulative poisons,

616.8.4.6.5 The active ingredients of poisons that are or were ever registered in accordance with the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 USC 135 et seq.),

616.8.4.6.6 Substances lethal to mammalian or aquatic life,

616.8.4.6.7 Road salt,

616.8.4.6.8 Lawn fertilizers.

616.9 Septic Systems

616.9.1 For any new construction, an Effluent Disposal System (EDS) shall be installed in accordance to NH DES regulations requiring a 75 foot setback from Hydric-A soils and a 50 foot setback from Hydric-B soils from any surface water or wetland area.

616.9.2 For any expansion of an existing structure, or the seasonal conversion of an existing structure, the owner shall conform to RSA 485-A: 38 and the associated Code of Administrative Rules for Subdivision and ISDS Design Rules, as amended.

616.9.3 For a new subdivision development for which EDS's are proposed, if the lots are less than 5 acres, then all plans and permit application shall conform to all relevant NH DES rules and regulations. For lots that are greater than 5 acres, all plans and permit applications shall show an area of 4000 sq. ft., within which the EDS may be located, with test pit and percolation test data to verify the site's suitability for a septic system.

616.9.4 If any septic assessment or an on-site inspection indicates that the existing system is in failure, a plan for a replacement system shall be submitted to NH DES within 30 days from the date of the onsite inspection.

616.10 Site Construction (Commercial / Industrial or Residential)

616.10.1 No new impervious driveways are allowed within 75 feet of any surface water or wetland area. Accessory structures are allowed when permitted by the NH DES.

616.10.2 The impervious area of any building lot is limited to 30%. Impervious area includes building area, gravel or asphalt driveway and parking area. For lots that currently exceed 30% impervious area, re-development must decrease the percent of impervious area.

616.10.3 For any use that will render impervious more than 20% or more than 2,500 square feet of any lot, whichever is greater, a storm water management and erosion control plan, consistent with Storm water Management and Erosion and Sediment Control Handbook for Urban and Developing Areas in New Hampshire, Rockingham County Conservation District, August 1992, as amended, shall be prepared and submitted to the Planning Board. No building Permit shall be issued until such time as the Planning Board has reviewed and approved said plan.

616.11 Commercial Agriculture Activities

616.11.1 Livestock are not allowed direct access to Cobbetts Pond and Canobie Lake or their tributaries.

616.11.2 Application of fertilizers or pesticides is not allowed within 200 feet from Cobbetts Pond and Canobie Lake or their tributaries or wetlands.

616.11.3 All livestock grazing and feeding areas shall be a minimum of 200 feet away from Cobbetts Pond and Canobie Lake or their tributaries.

616.11.4 All runoff from livestock feeding areas shall be directed away from Cobbetts Pond and Canobie Lake or their tributaries or wetland area.

616.11.5 The storage and use of all animal manure for fertilization purposes must be conducted in accordance with the Best Management Practices for the Handling of Compost, Fertilizer, and Manure in New Hampshire, NH Department of Agriculture, Markets and Food.

616.11.6 Unless stricter setbacks or operational requirements are outlined above, all agricultural operations shall be conducted in accordance with the Manual of Best Management Practices for Agriculture in New Hampshire, NH Dept. of Agriculture, June 1993, as amended, and in accordance with all appropriate sections of the Comprehensive Shore land Protection Act, NH RSA 483-B.

616.12 Commercial Forestry Activities

616.12.1 A minimum 75-foot undisturbed natural vegetated buffer shall be maintained adjacent to all surface waters or wetland areas.

616.12.2 Unless stricter setbacks or operational requirements are outlined above, all forestry operations shall be conducted in accordance with the Best Management Practices for Erosion Controls on Timber Harvesting Operations in New Hampshire, NH Division of Forests and Lands, February 2004, as amended, and in accordance with all appropriate sections of the Comprehensive Shore land Protection Act, as detailed in RSA 485-A: 17.

616.13 Emergency Exceptions

616.13.1 Emergency situations relating to public health, safety, and welfare will be temporarily relieved of the provisions of this ordinance in order to correct the emergency and restore the property to its previous condition as soon as possible.

616.13.2 The determination as to whether or not a situation is classified as an emergency shall be made by the Code Enforcement Officer and Building Inspector.

616.13.3 Within ten (10) business days of the determination being made as listed in Section 616.13.4, an application must be submitted as required by the provisions of this ordinance.

Watershed Protection Ordinance-preamble

Deering Lake, Deering, New Hampshire

Are you in favor of amending the Zoning Ordinance to add Section 12 Watershed Protection Ordinance as proposed by the Planning Board, to help protect Deering Lake from the effects of pollution and runoff caused by new development within its watershed?

Explanation:

- This Section will create an overlay to the Zoning Ordinance that applies minimal but essential requirements primarily to new development within the Deering Lake watershed that will protect the lake and its water quality from the increased sediment and nutrient run-off that enters the watershed when reasonable practices are not followed.

- Although there have been increases in sediment and nutrient loading caused by new development involving Lake properties, Deering Lake has been able to withstand these increases with little diminishment in water quality. Our lake has water quality that is among the best in NH.

- This will not remain the case as the rapid pace of development continues. A newly-commissioned study calculated the likely damage caused by new development scenarios. This ordinance reflects the findings of that study.

- Deteriorated water quality diminishes wildlife, scenic beauty, and recreational uses and destroys the values of Lake properties.

- Diminished property values affect the tax base of the town.

- This Overlay Ordinance would apply primarily to new development within the defined watershed of Deering lake and would require new subdivisions to demonstrate that they would “do no harm” to the lake and new home construction to include a soil erosion plan. Other development would be required to put in place “best practices” to protect the lake.

Deering Lake Watershed Protection Ordinance

10.1.1.1 SECTION 12: WATERSHED PROTECTION ORDINANCE

(Adopted March 9, 2005)

12.1 Authority and Statement of Intent

a. Pursuant to RSA 674: 21, the Town of Deering adopts a Watershed Protection Overlay Zone, and accompanying regulations to ensure the protection and preservation of Deering Reservoir, hereafter referred to as Deering Lake, the Deering Lake watershed and the water bodies within the Watershed Protection Overlay Zone from the effects of point and non-point source pollution or sedimentation . The establishment of the Watershed Protection Overlay Zone and the adoption of these regulations are intended:

(1) to protect public health,

(2) to protect aquifers, which serve as existing or potential water supplies, and the aquifer recharge system

(3) to protect surface waters and wetlands contiguous to surface waters,

(4) to protect the natural areas and wildlife habitats within the Watershed Protection Overlay Zone by maintaining ecological balances, and

(5) to prevent the degradation of the water quality through the regulation of land uses and development within the Watershed Protection Overlay Zone.

b. Within this district, and in the event of a conflict between the requirements of this section and other provisions of the Deering Zoning Ordinance or state law, the more stringent requirement shall govern.

12.2 Applicability

a. The special provisions established herein shall apply to all development proposals and to potential contaminating activities within the Watershed Protection Overlay Zone, and all such proposals and activities shall be subject to the review requirements set forth in Section 12.6. The boundaries of the Watershed Protection Overlay Zone have been delineated by the Planning Board using current location data. The Watershed Protection Overlay Zone is shown on the master zoning map kept on file in the Town Hall.

b. The boundaries of the Watershed Protection Overlay Zone may be identified through drainage, groundwater and soils analyses and are considered to be essential to the protection of the watershed from the effects of point and non-point source pollution or sedimentation. These boundaries may be modified as necessary by the Planning Board as new data becomes available.

12.3 Administration

a. General: The Deering Planning Board shall have sole and exclusive authority to administer the provisions of the Watershed Protection Ordinance. The Planning Board is further authorized to adopt amendments to the subdivision regulations in order to further administer the requirements of this section. All development proposals and other potential contaminating activity occurring wholly or partly in an area within the Watershed Protection Overlay Zone shall be subject to this Ordinance and to review and approval by the Planning Board as specified herein. Such review and approval shall be in addition to that required by statute, other provisions of the Deering Zoning Ordinance or Planning Board's rules or regulations. Such review, approval, and all conditions attached to the approval shall be properly documented before issuance of any building permit by the Town. Initial reviews and evaluations required by Section 12.6 c. shall be conducted by the Town of Deering Planning and Zoning Administrator on behalf of the Planning Board. If it is desired to have the full Planning Board consider an initial review or evaluation, a request for full Board consideration must be filed with the Planning and Zoning Administrator within 3 weeks of its issuance. If no such request is filed, the initial evaluation will become final.

b. Enforcement: The Board of Selectmen shall be responsible for the enforcement of the provisions and conditions of this Watershed Protection Ordinance, pursuant to the provisions of Section 7.

12.4 Definitions

a. Buffer Zone. The undisturbed natural area sufficient in size to mitigate runoff effects harmful to water quality.

b. Contamination. Sedimentation, point and non-point source pollution, septage, or the discharge of hazardous materials.

c. Development. Any construction, change in use, external repair, land disturbing activity, grading, road building, pipe laying, or other activity resulting in a change in the physical character of any parcel of land.

d. Hazardous Materials. As defined in Superfund Amendment and Reauthorization Act of 1986 and Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987).

e. Hydrology**.** The study of the earth's waters, their distribution and the cycle involving precipitation, infiltration into the soil and evaporation.

f. Impervious surface. An area whose water absorbing characteristics are greatly reduced as compared to the natural land and therefore less easily penetrated by moisture including, but not limited to, dirt and paved roads, driveways, parking lots, sidewalks, and roofs.

g. Infiltration rate. The amount and measure of time for surface water to filter into the soil.

h. Potential Contaminating Activity. Activities that have the potential to create a new discharge of contaminants or to increase the discharge of contaminants to surface or ground-waters.

i. Runoff Volume. The measure of surface water runoff during a storm event.

j. Sedimentation. The deposition of sand, silt, soil or other matter into a watercourse or wetland, including that resulting from post-development surface runoff.

k. Storm event. A period of sustained rainfall with a minimum total accumulation of 0.25 inches of precipitation over a 24 hour period.

l. Storm water. Surface water runoff from a non point source caused by a storm event.

m. Tributary stream. Any perennial or intermittent stream, flowing either directly or indirectly into Deering Lake.

n. Watershed. The area lying within the drainage basins of Deering Lake.

o. Non-point Source Pollution. Contaminants including, but not limited to; pesticides, fertilizers, animal wastes, sediments, nutrients, and heavy metals that are deposited on the ground surface and that may flow into and pollute nearby surface waters.

p. Best Management Practices. As defined in "Innovative Stormwater Treatment Technologies, Best Management Practices Manual-May 2002" and "Best Management Practices to Control NonPoint Source Pollution, A Guide for Citizens and Town Officials-January 2004" prepared by the New Hampshire Department of Environmental services and "Buffer for Wetlands and Surface Waters, a guidebook for New Hampshire Municipalities" May 1997 or any updated versions thereof.

12.5 Use regulations

a. Permitted uses, special exception uses, accessory uses, dimensional standards and special requirements established by the underlying zoning district shall apply, except as modified below:

b. The following uses shall be specifically prohibited within the Watershed Protection Overlay Zone:

(1) Storage or production of hazardous materials as defined in either or both of the following:

(a) Superfund Amendment and Reauthorization Act of 1986.

(b) Identification and Listing of Hazardous Wastes, 40 C.F.R. §261 (1987)

(2) Disposal of hazardous materials or solid wastes

(3) Treatment of hazardous material, except rehabilitation programs authorized by a government agency to treat hazardous material present at a site prior to the adoption of this ordinance.

(4) Dry-cleaning, dyeing, printing, photo processing and any other business that stores, uses, or disposes of hazardous material, unless all facilities and equipment are designed and operated to prevent the release or discharge of hazardous materials and have undergone an inspection by the Town of Deering Code Enforcement Officer to certify they are in compliance with hazardous material regulations.

(5) Disposal of septage or septic sludge, as defined by New Hampshire Solid Waste Rules Env-Wm101-300 & 2100 - 3700.

(6) Automobile service and repair stations

(7) Junkyards and Salvage Yards

12.6 Review requirements for Development in the Watershed Protection Overlay Zone

a. **General.** Applications for subdivision of land and for site plan review and approval are subject to all review requirements of this Section, including the requirement in 12.6 b. that they shall be accompanied by a hydrologic study. Applications for new home construction, and additions, modifications and repairs of existing homes, need not be accompanied by a hydrologic study, but must meet the other review requirements of this Section. New home construction applications must include a soil erosion plan as set forth in 12.6 c. This Watershed Protection Ordinance does not establish any pre-approval requirements for other land development proposals that do not involve potential contamination.

b. Any application for a land development proposal involving the subdivision of land or site review and approval, occurring wholly or partly in the Watershed Protection Overlay Zone, shall be submitted to the Planning Board for approval and shall be accompanied by a hydrologic study prepared in accordance with the requirements set forth in subsection 12.7 below. Said study must document, in a manner acceptable to the Planning Board, that the land development proposed would provide the same or a greater degree of water quality protection as existed on the site(s) in question at the time the application is made.

c. All development within the Watershed Protection Overlay Zone will be evaluated by the Planning Board to ensure that:

(1) Non-point source pollution is prevented to the maximum extent possible, taking into account site conditions such as slope, soil type and erosivity, and vegetative cover. The amount of lawn is limited to 10% of all dry land.

(2) Best Management Practices (BMPs) are in place sufficient to remove or neutralize those pollutants that present a potential impact to the water body. In the case of proposals for new home construction, the proposal shall include an erosion and sedimentation control plan prepared by a licensed engineer. The use or creation of holding-ponds is not allowed for runoff control.

(3) Grading and removal of vegetation at a development site is minimized and erosion and sedimentation control measures are in place and properly installed.

(4) All septic tanks will be pumped and inspected by a State of New Hampshire licensed septic services provider to ensure proper functioning and a copy of the pumping and inspection report shall be sent to the Town of Deering Planning and Zoning Administrator within 30 days of its occurrence. Such pumping and inspection shall occur at least every three years or at the interval recommended by the licensed septic service provider in writing at the time of last service. If two or more dwelling units share a common sewage treatment system, a perpetual maintenance agreement binding the dwelling owner is required.

(5) Activities involved in potential contamination within the Watershed Protection Overlay Zone, but which have received a special exception, must submit a spill prevention control and countermeasures plan (SPCC Plan) for approval. This plan shall include the following elements:

(a) Disclosure statements describing the types, quantities, and storage locations of all contaminants that will be part of the proposed project.

(b) Contaminant handling and spill prevention techniques

(c) Spill reporting procedures, including a list of affected agencies to be contacted in the event of a spill

(d) Spill recovery plans, including a list of available equipment

(e) Spill clean-up and disposal plans

d. Existing land uses located within the Watershed Protection Overlay Zone and identified as potential contaminating activities by the Planning Board shall comply with the requirements of Section 12.6, Subsection c.(5) listed above.

12.7 Hydrologic Study

a. A hydrologic study shall be performed by a registered professional engineer or hydrologist and it shall include, at a minimum, the following information:

(1) Description of the proposed project including location and extent of impervious surfaces; on-site processes or storage of materials; the anticipated use of the land and buildings; description of the site including topographic, hydrologic, and vegetative features.

(2) Characteristics of natural runoff on the site and projected runoff with the proposed project, including its rate and chemical characteristics deemed necessary to make an adequate assessment of water quality.

(3) Measures proposed to be employed to reduce the rate of runoff and pollutant loading of runoff from the project area, both during construction and after.

(4) Proposed runoff control and watershed protection measures for the site. These measures shall be designed with the goal of ensuring that the rate of surface water runoff from the site does not exceed pre-development conditions and that the quality of such runoff will not be less than pre-development conditions. Special emphasis shall be placed on the impacts of proposed encroachments into the required buffer.

(5) Where the developer of property subject to the terms of this Watershed Protection Ordinance seeks to utilize existing or planned off-site storm-water quality management facilities, the developer shall provide a written certification that the owner of the off-site facilities will accept the runoff and be responsible for its adequate treatment and that the arrangement will run with the land in a manner that will be acceptable to the Planning Board.

b. The study will make use of existing Deering Lake water quality historical data to the maximum extent possible. If new data is to be introduced, the Town reserves the right to have the data reviewed by an independent expert at the expense of the property developer.

c. The study shall be submitted to the Planning Board for review and approval concurrent with the submission of applications for review and approval of site or subdivision plans or applications for land disturbing or erosion and sediment control permits.

12.8 Buffer Requirements

a. A 75 foot wide buffer zone shall be maintained along the edge of any tributary stream discharging into Deering Lake and along the edge of any wetlands associated with those tributary streams. The required setback distance shall be measured from the centerline of such tributary stream and from the delineated edge of a wetland. Streams and wetlands shall be delineated from their mean high water mark. The buffer zone shall be maintained in its natural state to the maximum extent possible.

b. A reduction in the required buffer zone width down to an absolute minimum of fifty-feet (50') may be granted by the Planning Board upon presentation of a hydrologic or other study that provides documentation and justification, acceptable to the Planning Board, that even with the reduction, the same or a greater degree of water quality protection would be afforded as would be with the full-width buffer zone. In granting such a reduction, the Planning Board may require certain conditions of approval which may include, but are not necessarily limited to, restrictions on use or type of construction, and/or additional erosion, runoff or sedimentation control measures, as deemed necessary to protect water quality.

c. All development shall be located outside of the required buffer zone.

d. The following uses shall not be permitted within the buffer zone or within twenty-five feet (25') of any required buffer zone:

(1) septic tanks and drain-fields;

(2) feed lots or other livestock impoundments;

(3) trash containers and dumpsters which are not under roof or which are located so that leachate from the receptacle could escape unfiltered and untreated;

(4). fuel storage in excess of fifty (50) gallons [200L];

(5). sanitary landfills;

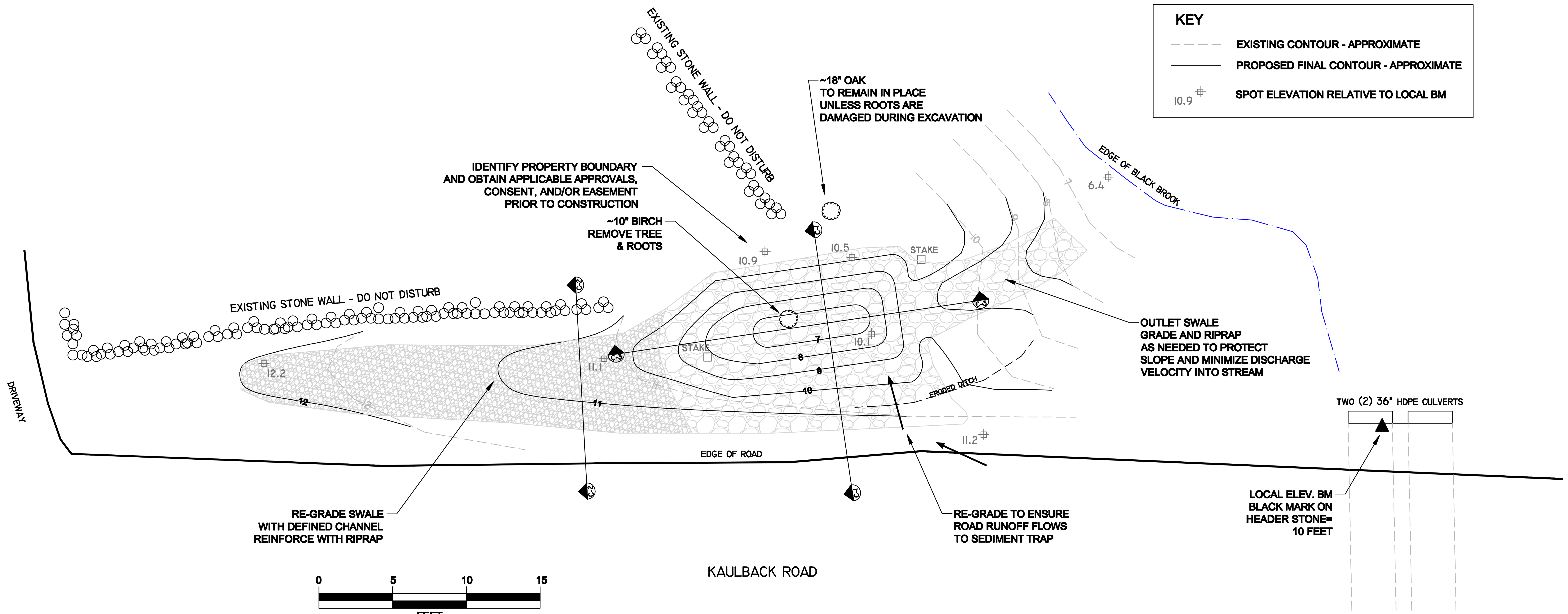
(6). activities involving the manufacture, bulk storage or any type of distribution of petroleum, chemical or asphalt products or any materials hazardous to Deering Lake (as defined in the Hazardous Materials Spills Emergency Handbook, American Waterworks Association, 1975, as revised) including specifically the following general classes of materials:

(a) oil and oil products
(b) radioactive materials
(c) any material transported in large commercial quantities that is a very soluble acid or base, highly biodegradable, or can create a severe oxygen demand
(d) biologically accumulative poisons
(e) the active ingredients of poisons that are or were ever registered in accordance with the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended (7 USC 135 et seq.)
(f) substances lethal to mammalian or aquatic life.
(g) road salt
(h) lawns

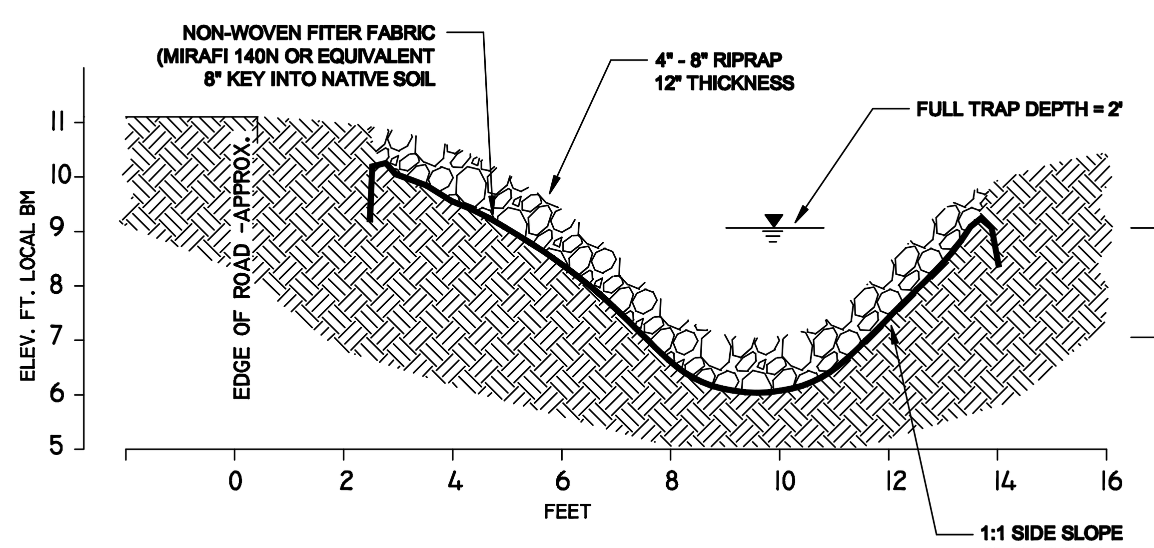
(7). No more than 50 % of basal area of timber may be cut over a twenty (20) year period

Appendix D

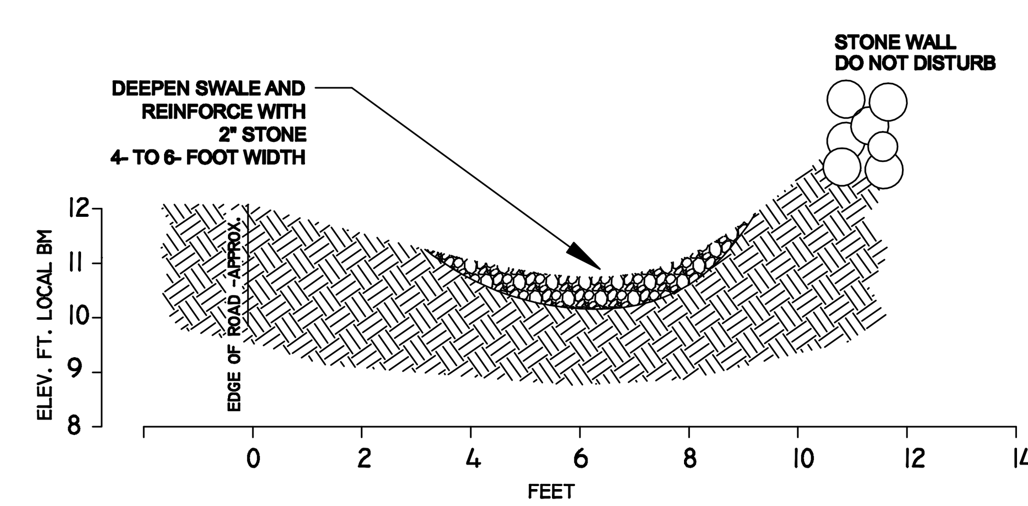
Selected BMP Designs



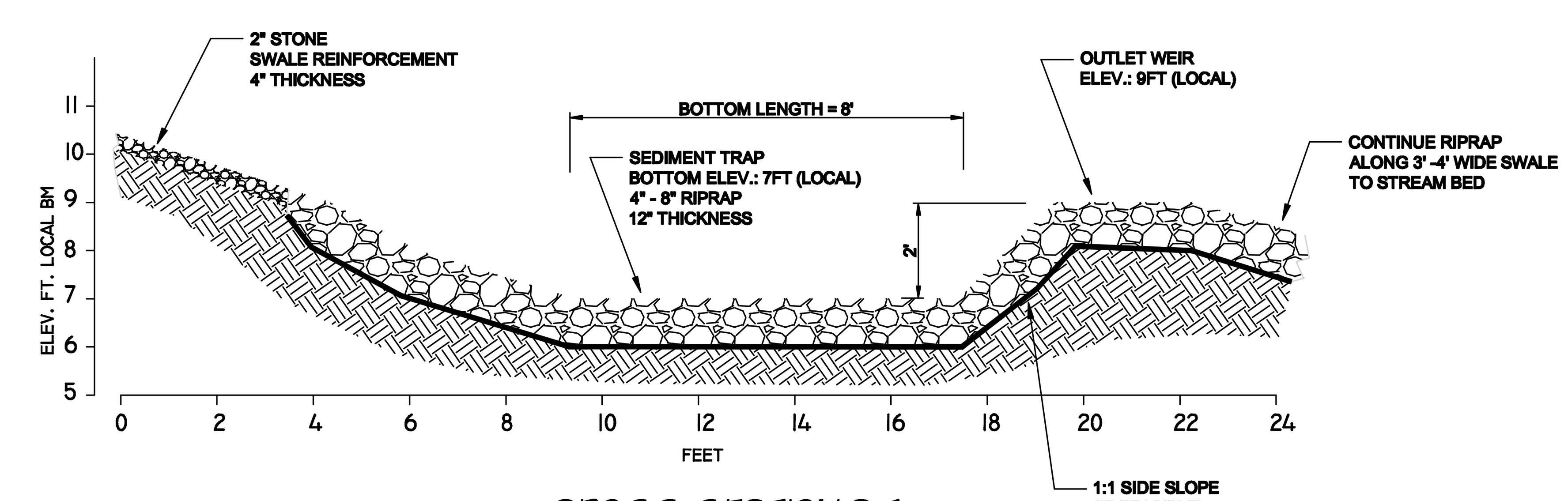
PLAN VIEW SKETCH



CROSS-SECTION C-1



CROSS-SECTION C-2



CROSS-SECTION C-3

NOTES:
1. SURVEY LOCATIONS ARE APPROXIMATE. FIELD ENGINEERING WILL BE REQUIRED TO ENSURE THE FOLLOWING DESIGN CRITERIA ARE INCORPORATED: FULL TRAP VOLUME AT WEIR ELEVATION SHALL BE AT LEAST 9 CUBIC FEET; RIPRAP PLACED TO PREVENT EROSION OF SWALE AND TRAP, SPECIFIED FILTER FABRIC USED UNDER ALL STONE AND APPROPRIATELY KEYED INTO NATIVE SOIL;
2. PROPERTY BOUNDARIES MUST BE IDENTIFIED AND APPLICABLE APPROVAL, CONSENT, OR EASEMENT GRANTED PRIOR TO CLEARING AND CONSTRUCTION.
3. EROSION CONTROL MEASURES SHALL BE IMPLEMENTED TO ENSURE NO SEDIMENT IS DISCHARGED TO BLACK BROOK DURING CONSTRUCTION (IN ACCORDANCE WITH TOWN OF SANBORNTON RULES AND SHORELAND PROTECTION REQUIRMENTS.
4.THE CONTRACTOR IS RESPONSIBLE FOR REMOVING AND PROPERLY DISPOSING OF UNNECCESARY SOIL AND WOODY DEBRIS FROM THE SITE.
5. DUE TO THE LIMITED SURVEY ACCURACY AND UNKNOWN SUBSURFACE CONDITIONS, THE CONTRACTOR IS RESPONSIBLE FOR SEEKING APPROVAL FROM THE TOWN OF SANBORNTON FOR ANY DEVIATIONS FROM GENERAL REQUIREMENTS OF THIS DESIGN PLAN.

AECOM

PROJECT

BMP# 22
SEDIMENT TRAP DESIGN

LAKE WINNISQUAM
PHASE 1: BLACK BROOK
WATERSHED MANAGEMENT PLAN

CLIENT

TOWN OF SANBORNTON
NEW HAMPSHIRE

CONSULTANT

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REGISTRATION

ISSUE/REVISION

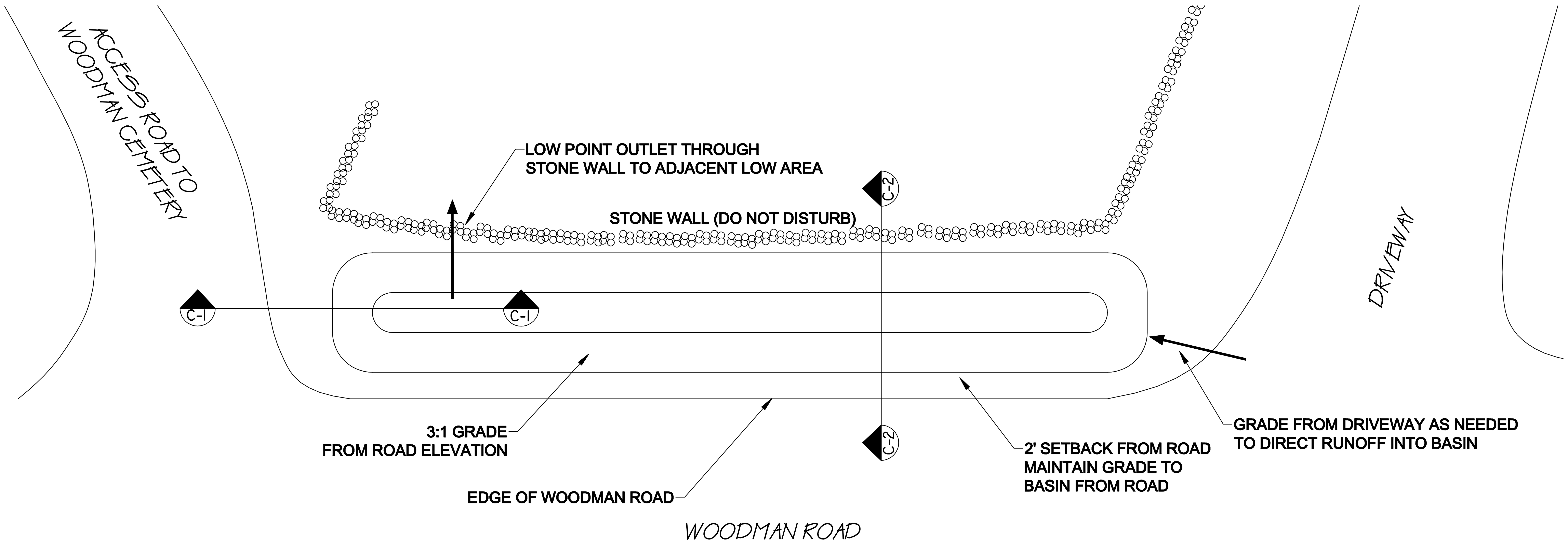
1	JULY 2012	ORIGINAL
I/R	DATE	DESCRIPTION

KEY PLAN

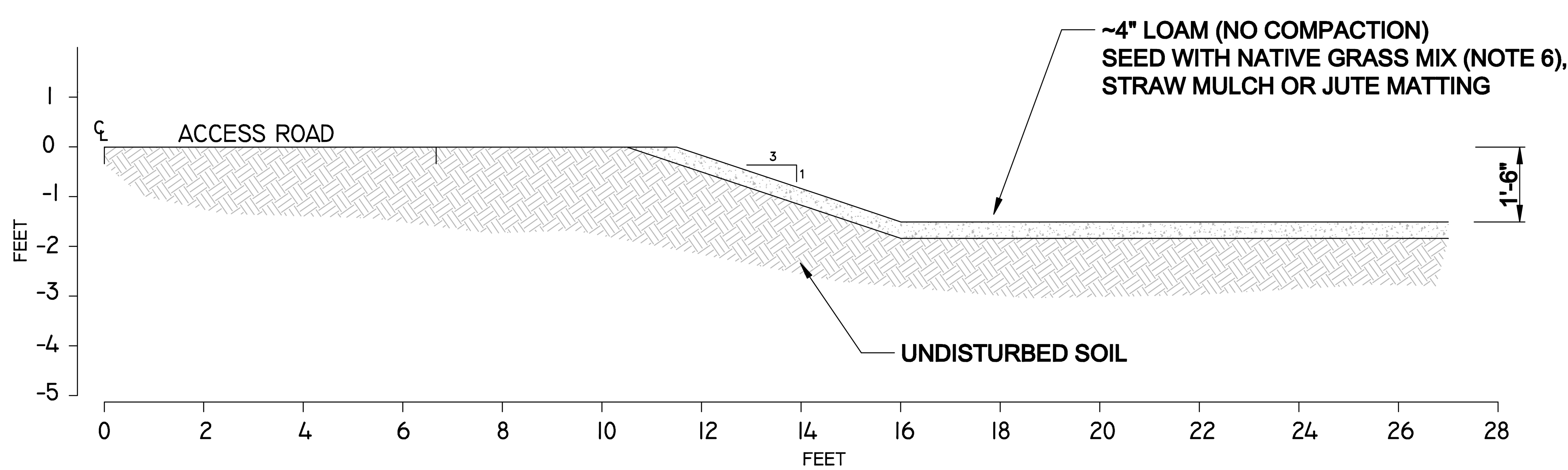
PROJECT NUMBER
60163921

SHEET TITLE
BMP#22 DESIGN

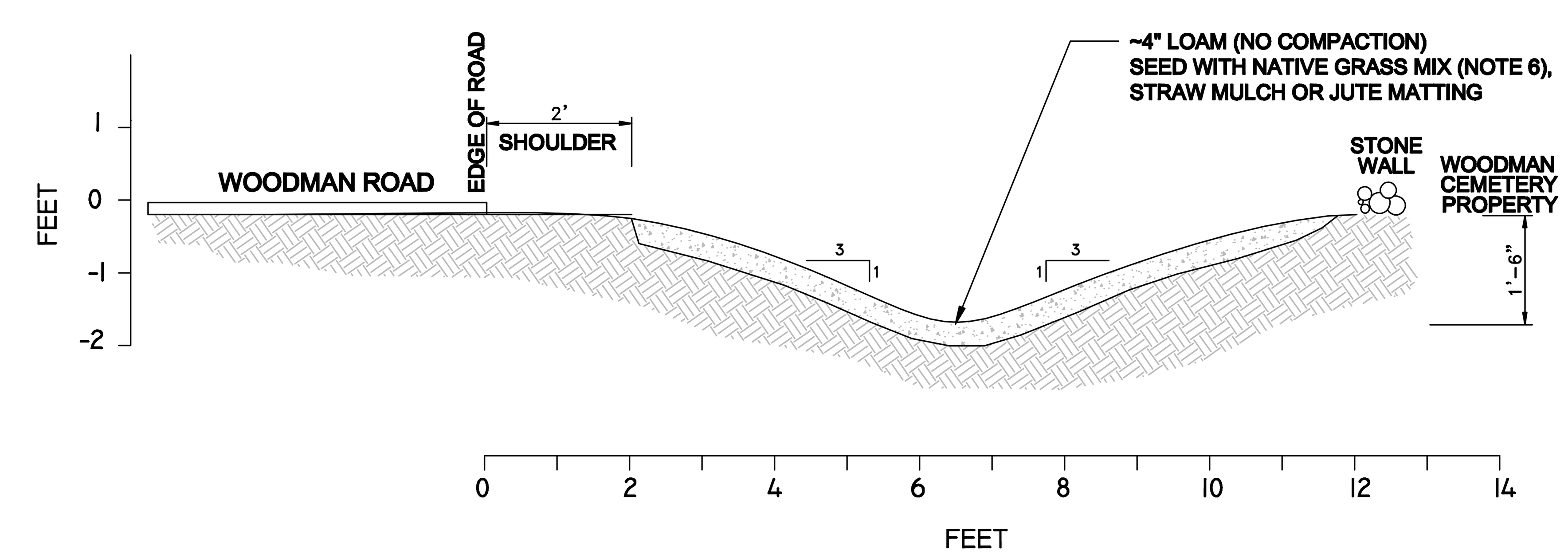
SHEET NUMBER
1 OF 1



PLAN VIEW SKETCH



CROSS-SECTION C-1



CROSS-SECTION C-2

NOTES:

1. LOCATION OF SWALE IS APPROXIMATE. FIELD ENGINEERING WILL BE REQUIRED TO ENSURE THE FOLLOWING DESIGN CRITERIA ARE INCORPORATED: SIDE SLOPES SHALL NOT EXCEED 3:1, DEPTH OF SWALE SHALL BE AT LEAST 18-INCHES BELOW ROAD SURFACE ELEVATION, LOW POINT IN SWALE SHALL DRAIN TO WOOMAND CEMETERY PROPERTY, AND AREA IN RIGHT-OF-WAY ADJACENT TO THE UP-SLOPE DRIVEWAY SHALL BE GRADED TO ENSURE RUNOFF FROM DRIVEWAY IS DIRECTED INTO SWALE.
2. WOODMAN CEMETERY PROPERTY BOUNDARIES MUST BE IDENTIFIED AND APPLICABLE APPROVAL, CONSENT, OR EASEMENT GRANTED PRIOR TO CLEARING AND CONSTRUCTION.
3. EROSION CONTROL MEASURES SHALL BE IMPLEMENTED TO ENSURE NO SEDIMENT IS DISCHARGED TO SURFACE WATER DURING CONSTRUCTION (IN ACCORDANCE WITH TOWN OF SANBORNTON RULES AND SHORELAND PROTECTION REQUIRMENTS.
4. THE CONTRACTOR IS RESPONSIBLE FOR REMOVING AND PROPERLY DISPOSING OF UNNECESSARY SOIL AND WOODY DEBRIS FROM THE SITE.
5. DUE TO THE LIMITED SURVEY ACCURACY AND UNKNOWN SUBSURFACE CONDITIONS, THE CONTRACTOR IS RESPONSIBLE FOR SEEKING APPROVAL FROM THE TOWN OF SANBORNTON FOR ANY DEVIATIONS FROM GENERAL REQUIREMENTS OF THIS DESIGN PLAN.
6. SEED MIX SHALL CONSIST OF TALL FESCUE (~33%), CREEPING RED FESCUE (~33%) & RED CLOVER (~33%) AT 1.4 POUNDS PER 1,000 SQFT.
7. MAINTAIN HEIGHT OF GRASS BELOW 4-INCHES TO ENSURE HEALTHY STAND OF VEGETATION.

AECOM

PROJECT

BMP# 34
SEDIMENT TRAP / SWALE

LAKE WINNISQUAM
PHASE 1: BLACK BROOK
WATERSHED MANAGEMENT PLAN

CLIENT

TOWN OF SANBORNTON
NEW HAMPSHIRE

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REGISTRATION

ISSUE/REVISION

I/R	DATE	DESCRIPTION
1	JULY 2012	ORIGINAL

KEY PLAN

PROJECT NUMBER
60163921

SHEET TITLE
BMP#34 DESIGN

SHEET NUMBER
1 OF 1

Appendix E

NHDES Watershed Management Fact Sheets

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMB-19 2006

Why Watersheds Are Important to Protect

What is a Watershed?

A watershed can be defined as an area of land that drains down slope until it reaches a common point. "Watershed" is synonymous with other terms you may have heard such as "drainage basin" and "catchment area." Perhaps a simpler way of defining a watershed is by saying that it is an area of land where all of the water that falls in it ends up in the same place. All precipitation that falls within a watershed, but is not used by existing vegetation, will ultimately seek the lowest points. These low points are bodies of water such as rivers, lakes, and finally the ocean. This means that every stream, brook, tributary, and river that we see will eventually reach a larger body of water within its associated watershed. Even groundwater that we cannot see moves towards a common low point. One way to picture it is as a giant funnel that catches and directs all of the water that falls into it towards the bottom. On a topographical map, a watershed can be determined by connecting all of the points of highest elevation around a lake.

Who lives in watersheds?

Everyone lives in a watershed! No matter where we live we will always be part of a watershed. Major watersheds span across county, state and national boundaries. Therefore, a resident of New Hampshire can affect a lake in Massachusetts, Maine or Vermont and vice versa. It doesn't matter if the lake is in your front yard or miles away. Pollution anywhere within the watershed has the potential to affect all waterbodies located downstream from it.

How significant are watersheds?

Watersheds are *extremely* important. Watersheds provide many of us with our drinking water supply, plus recreational opportunities and aesthetic beauty. Unfortunately, the replacement of vegetation by impervious surfaces like roads, parking lots and rooftops has a negative impact on watersheds. This increases the velocity and amount of runoff flowing into surface waters and causes erosion, turbidity and degraded wildlife habitats. Not only that, but this runoff carries pollutants such as oil, bacteria, nutrients, sediment and metals into surface waters along with it. Forested areas play a very important role in the health of a watershed. The plant cover and leaf litter absorb moisture and help maintain soil structure, while root masses keep soil permeable and stable so moisture can move into it for storage. This is more desirable, because it allows water to be filtered and released slowly into the stream system rather than rapidly running overland.

Want help locating the watershed that you call home?

An easy way to locate your watershed is via the U.S. Environmental Protection Agency's website at cfpub.epa.gov/surf/locate/index.cfm, or at the U.S. Geological Survey website at water.usgs.gov/wsc.

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WMB-16 2005

Watershed Districts and Ordinances

What are Watershed Districts and Ordinances?

Watershed district and ordinances are methods of zoning that recognize watershed boundaries instead of political boundaries, as a means of regulating land uses that may affect surface water quality. A watershed district or ordinance may set rules or regulations that restrict certain activities within the watershed in order to protect surface water resources, such as lakes, ponds and rivers. Regulations could include setback requirements, buffer requirements, land use restrictions, implementation of best management practices (BMP) and implementation of low impact development (LID) techniques. Typically, a watershed district or ordinance is proposed by a town or city planning board and must be approved by the voters. Often, the ordinance or district modifies or amends zoning regulations already in place in the towns or cities involved. Watershed districts and ordinances may vary by town and can be tailored to suit the needs of the particular watershed.

How Can Watershed Districts and Ordinances Protect New Hampshire Lakes and Ponds?

This approach to watershed management is beneficial to New Hampshire's surface waters, especially those with expansive watersheds. Within a watershed district or ordinance, towns work together to protect their common water resource(s). A watershed district or ordinance may decrease sedimentation, and nutrient loading to surface waters by taking measures to reduce or eliminate stormwater runoff. In addition, reduction or elimination of the use of hazardous materials within the watershed may prevent dangerous substances from reaching lakes and ponds. In densely developed watersheds, this approach may help to improve water quality. In relatively undeveloped watersheds, this approach may help to protect water quality in the face of future development.

How To Form a Watershed District or Ordinance in Your Community

Forming a watershed district or ordinance involves bringing a lot of different groups together under a shared goal. Often, DES will work with the interested communities and provide as much assistance as possible throughout the process. The first step is to determine which towns are included in the lake or pond's watershed. Town planning boards and conservation commissions should be included in the planning process. Watershed districts and ordinances formed to protect lakes and ponds often involve local lake associations as well. These groups, as well as any other interested groups or individuals, determine what activities will be regulated. Regulated activities may include agriculture, forestry and construction, as well as standards for septic systems. Standards for wetlands and surface water protection may be included as well. Regulations or standards are set for the watershed district or ordinance, and put to a vote within each town. Once the voters of each town in the watershed accept the regulations and standards, the ordinance or district may go into effect.

For more information, or examples of watershed districts or ordinances that have been implemented in New Hampshire, contact Jody Connor, DES Limnology Center Director, at (603) 271-3414 or jconnor@des.state.nh.us.

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NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMB-17 2010

Low Impact Development and Stormwater Management

What is Stormwater

Stormwater is water from rain or melting snow that does not soak into the ground. In a forest, meadow, or other natural environment, stormwater usually soaks into the ground and is naturally filtered. When forests and meadows are developed, they are commonly replaced with residential neighborhoods, shopping centers, and other areas that introduce impervious surfaces such as houses, buildings, and roads and parking lots. Impervious surfaces prevent rain or melting snow from soaking into the ground and create excess stormwater runoff.

Excess stormwater runoff creates problems when stream channels have to accommodate more flow than nature designed them to. When this happens, flooding is more frequent, banks erode, and the groundwater table is lowered. Stormwater can also become polluted with trash and debris, vehicle fluids, pesticides and fertilizers, pet waste, sediment, and other pollutants when it flows over impervious surfaces, lawns, and other developed areas. These pollutants get picked up with the stormwater runoff and eventually flow untreated into nearby lakes, streams and other bodies of water.

Stormwater has been identified as a major source of water pollution in the United States. In New Hampshire, stormwater has been identified as contributing to over 80 percent of the surface water quality impairments in the state. All across New Hampshire, communities, businesses, and property owners are experiencing the challenge of managing stormwater to maintain transportation and storm drainage infrastructures, protect water quality, and to simply keep their driveways and landscaping from washing out each year.

Low impact development can be used to reduce the amount of stormwater that runs off impervious surfaces and protect nearby surface waters from stormwater pollution.

What is Low Impact Development?

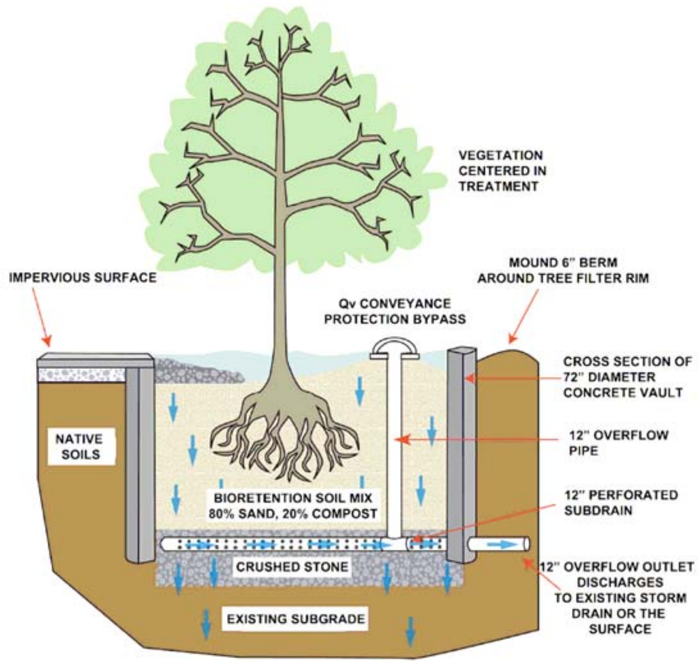
Low impact development (LID) is a stormwater management approach. Unlike conventional stormwater management, which focuses on piping stormwater away from a site to large centralized stormwater treatment areas, LID focuses on controlling stormwater by using small, decentralized methods to treat stormwater close to the source. The primary goals of LID are accomplished through LID site planning and LID treatment practices and include:

- Lessening the impact of development, and the impact of stormwater resulting from that development, on the natural environment.
- Using the land more efficiently.
- Lowering capital and operating costs associated with development.

LID Site Planning
LID site planning reduces the amount of stormwater generated on a site through source control and protection of the site's existing hydrologic features, such as topography, vegetated buffers, wetlands, floodplains and high-permeability soils. More information on LID site planning can be found in Chapter 6 of the *New Hampshire Stormwater Manual: Volume 1 Stormwater and Antidegradation*.

Objectives of LID site planning include:

- Minimizing areas of disturbance
- Maintaining and restoring natural buffers
- Minimizing impervious cover
- Disconnecting impervious cover
- Minimizing soil compaction



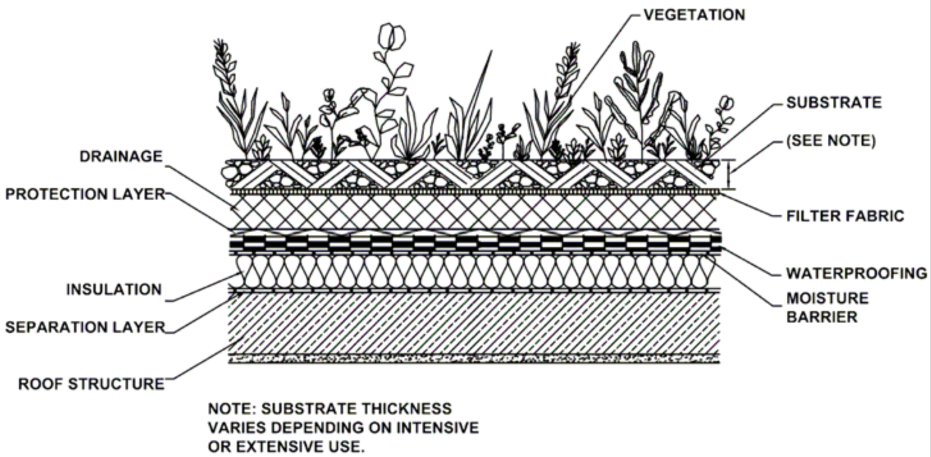
Example tree box filter design (UNH Stormwater Center 2007a) and installation in the Hodgson Brook Watershed in Portsmouth, NH.

LID Practices
Once LID site planning has been used to minimize the amount of stormwater generated on the site, site-level, decentralized LID treatment practices are used to treat any stormwater runoff that resulted from development. LID treatment practices are typically designed as open, vegetated systems that rely on plants and their root systems as well as permeable soils to slow the flow of water and encourage infiltration and filtration. This reduces both the velocity and volume of stormwater, as well as provides treatment of stormwater pollutants.

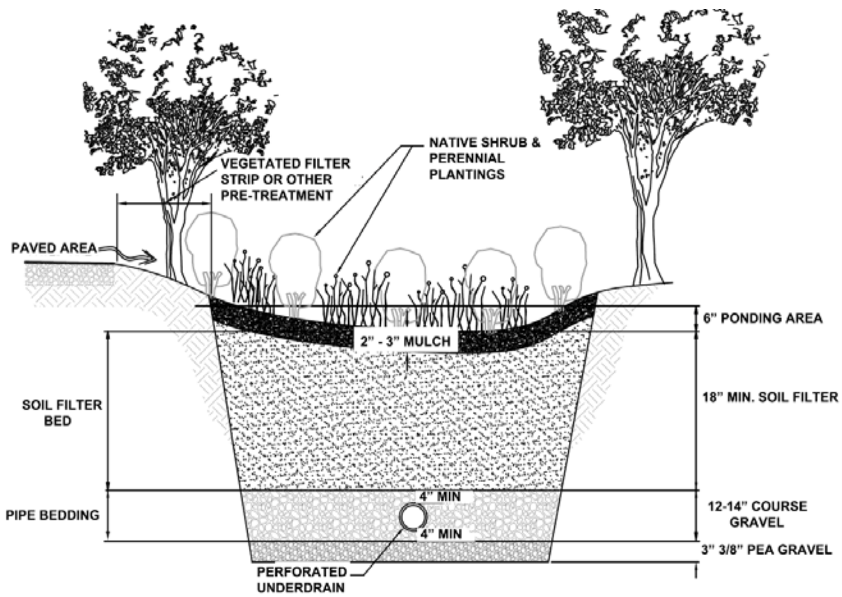
LID treatment practices can be used in existing development and can also be used in redevelopment projects to improve existing stormwater management. In redevelopment situations, LID focuses on minimizing and disconnecting existing impervious surfaces and implementing LID treatment practices for water quality, where feasible. More information on LID treatment practices can be found in Chapter 4 of the *New Hampshire Stormwater Manual: Volume 2 Post-Construction Best Management Practices Selection & Design*.

Examples of LID treatment practices include:

- Bioretention and Rain Gardens
- Dry Wells
- Rooftop Gardens and Green Roofs
- Vegetated Swales, Buffers, and Strips
- Soil Amendments
- Permeable Pavement
- Tree Box Filters
- Rain Barrels and Cisterns



Example green roof design (Maine DEP 2006, EPA 2006a) and installation at the Mount Washington Hotel, Bretton Woods, NH.



Rain garden and pervious pavement installation in downtown Peterborough, NH.

Barriers to LID

Although LID is not new, it is still considered innovative. Because of this, there are several potential barriers to implementing LID. For example:

- *Cost Concerns* – Many people are deterred from using LID practices because they believe they are more costly than conventional stormwater management practices, when in reality, LID practices can actually cost less than conventional stormwater management due to a reduced need for catch basins and piping. Also, with less infrastructure involved, LID can reduce the long-term cost of operation and maintenance.

- *Conflicting Local Ordinances* – Municipal ordinances and bylaws, such as minimum roadway widths, minimum parking requirements, and curb and gutter conveyance design, can conflict with LID principles. Local regulations can be modified or waivers or variances can be granted to allow for LID, or municipalities can adopt stormwater ordinances that require LID. More information on New Hampshire local ordinances can be found at: des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
- *Lack of Confidence* – Many people lack confidence in the performance of LID practices. LID has been used successfully in New England and across the country. Specifically, the University of New Hampshire Stormwater Center (UNHSC) has tested several LID practices and has data showing their efficiency in New Hampshire's climate. (www.unh.edu/erg/cstev/)
- *Site Constraints* – There are concerns that LID practices do not work in cold climates or on sites that have poorly draining soils, are close to groundwater, or other site constraints. The UNH Stormwater Center has shown that properly designed and installed LID practices perform well in New Hampshire.
- *Maintenance Concerns* – All best management practices need maintenance. The type of maintenance required for LID practices is often different than conventional systems. Because most LID practices are vegetated, maintenance focuses on maintaining healthy vegetation as well as removing sediment and other debris as necessary. LID practices tend to be smaller and usually do not require the use of heavy equipment to conduct maintenance.

For More Information

Additional information on Low Impact Development can be found in the following resources:

- DES Innovative Land Use Planning Techniques Handbook – http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm
- The University of New Hampshire Stormwater Center – www.unh.edu/erg/cstev/
- EPA's National LID website – www.epa.gov/owow/nps/lid
- EPA New England Stormwater website – www.epa.gov/region1/topics/water/stormwater.html
- Center for Watershed Protection website – www.cwp.org
- Low Impact Development Center website – www.lowimpactdevelopment.org

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-WMB-10 2009

Potential Dangers of Cyanobacteria in New Hampshire Waters

What are Cyanobacteria?
Cyanobacteria are bacteria that photosynthesize. Many species of cyanobacteria grow in colonies to form surface water "blooms." Blooms are usually blue-green in color and consist of thousands of individual cells.

Cyanobacteria are some of the earliest inhabitants of our waters, and naturally occur in all of our lakes, often in relatively low numbers. However, research indicates that cyanobacteria abundance increases as lake nutrients increase. As part of the aquatic food web, they can be eaten by various grazers in the lake ecosystem, such as zooplankton and mussels.

Although most often seen when floating near the surface, many cyanobacteria species spend a portion of their life cycle on the lake bottom during the winter months. Increased water temperature and light in the spring promote the upward movement of cyanobacteria through the water column toward the surface where blooms or scums are formed. These scums are often observed in mid to late summer and sometimes well into the fall.

Why are Cyanobacteria a Concern?
Some cyanobacteria produce toxins that adversely affect livestock, domestic animals, and humans. According to the World Health Organization (WHO), toxic cyanobacteria are found worldwide in both inland and coastal waters. The first reports of toxic cyanobacteria in New Hampshire occurred in the 1960s and 1970s. During the summer of 1999, several dogs died after ingesting toxic cyanobacteria from a bloom in Lake Champlain. The WHO has documented acute impacts to humans from cyanobacteria from the US and around the world as far back as 1931. While most human health impacts have resulted from ingestion of contaminated drinking water, cases of illnesses have also been attributed to swimming in cyanobacteria infested waters.

The possible effects of cyanobacteria on the "health" of New Hampshire lakes and their natural inhabitants, such as fish and other aquatic life, are under study at this time. The Center for Freshwater Biology (CFB) at the University of New Hampshire is currently examining the potential impacts of these toxins upon the lake food web. The potential human health hazards via exposure through drinking water and/or during recreational water activities are also a concern to the CFB and the state.

Do Cyanobacteria Exist in New Hampshire Waters?
Yes, they occur in lakes world wide. Cyanobacteria have been found in a majority of lakes in New Hampshire, but most often cyanobacteria numbers present in our lakes are near the minimum level of detection. Four of the most common cyanobacteria found in New Hampshire are: Anabaena, Aphanizomenon, Oscillatoria, and Microcystis. Anabaena and Aphanizomenon produce neurotoxins (nerve toxins) that interfere with nerve function and have almost immediate effects when ingested. Microcystis and Oscillatoria are best known for producing hepatotoxins (liver toxins) known as microcystins. Oscillatoria and Lyngbya (another type of cyanobacteria) also produce dermatotoxins, which cause skin rashes.

Should You be Concerned about Swimming in or Drinking from a New Hampshire Lake?
Both DES and UNH have extensive lake monitoring programs. Generally, the water quality of New Hampshire's lakes is very good. However, the state strongly advises against using lake water for consumption, since neither in-home water treatment systems nor boiling the water will eliminate cyanobacteria toxins if present.

If you observe a well-established cyanobacteria bloom or scum in the water, please comply with the following:

- ✓ Do not wade or swim in the water!
- ✓ Do not drink the water or let children drink the water!
- ✓ Do not let pets or livestock into the water!

Exposure to toxic cyanobacteria scums may cause various symptoms, including nausea, vomiting, diarrhea, mild fever, skin rashes, eye and nose irritations, and general malaise. If anyone comes in contact with a cyanobacteria bloom or scum, they should rinse off with fresh water as soon as possible.

If you observe a cyanobacteria bloom or scum, please call DES at (603) 419-9229. DES will sample the scum and determine if it contains toxin-producing bacteria. An advisory will be posted on the immediate shoreline of a designated beach indicating that the area may not be suitable for swimming. If the affected area extends into water that is not part of a designated beach, DES will issue a warning for the entire lake. DES will continue to monitor the water and will notify the appropriate parties regarding the results of initial and subsequent testing. Public notification occurs through press releases and the DES website. When monitoring indicates that cyanobacteria are no longer present at levels that could harm humans or animals, the advisory or warning will be removed.

Please visit http://des.nh.gov and search term "Beach" to access the most current advisories and warnings.

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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WMB-4 1996

Road Salt and Water Quality

Background

The amount of snowfall in northern New England and the necessity of overland travel require the use of plows and de-icing materials to keep highways safe in the winter. Salt, or sodium chloride, is the most commonly used de-icing material in New Hampshire. In general, the purpose of salt is to: 1) reduce adherence of snow to the pavement; 2) keep the snow in a "mealy" condition and thereby permit nearly full removal by plowing; and 3) prevent the formation of ice or snow ice (hard pack).

Sodium chloride can negatively impact drinking water and aquatic life. Sodium is a drinking water concern for individuals restricted to low-sodium diets due to hypertension (high blood pressure), although a review of scientific evidence by the U.S. Environmental Protection Agency showed that the vast amount of sodium ingestion (90 percent) was from food rather than drinking water and that the linkage between sodium and hypertension was still not well documented. Chloride can affect the taste of drinking water, but is not a health concern. If levels of either sodium or chloride approach 250mg/l in drinking water, an alternative source should be found. Chloride ions were found by the U.S. Environmental Protection Agency to be toxic to certain forms of aquatic life at a four-day average concentration of 230 mg/l. Some plant species at the base of the food chain can be impacted at much lower concentrations.

Roadside vegetation is visibly impacted from road salt. Burned grass and shrubs, as well as burned foliage on roadside trees from salt spray are common in New Hampshire.

Road Salt Management Issues

The New Hampshire Department of Transportation's (DOT) winter maintenance goal is to obtain bare and dry pavements on most roads at the earliest practical time following cessation of a storm. Many municipal highway departments have similar goals. Traffic volume, speed, and gradient are the primary factors in determining the level of winter maintenance service for particular roads. When the temperature is 20^{o} F or greater, DOT applies 250-300 lbs. of salt per lane-mile and/or abrasive (sand) as needed. At temperatures below 20º F, DOT uses various combinations of salt, sand, and calcium chloride, depending on road conditions.

Salt storage facilities can have a greater potential for causing water pollution than roadway application. For maximum environmental protection, salt storage facilities should be roofed and paved, with adequate drainage controls to prevent runoff water from contacting salt.

Alternatives to Road Salt

Salt is the most commonly used highway de-icer. Its effectiveness decreases as temperatures drop. Salt is most effective at temperatures above 20º F. Below 10º F, salt cannot dissolve and cannot break the ice-pavement bond.

The second most commonly used de-icing chemical, calcium chloride, is effective in much lower temperatures than salt (as low as 0º F). Liquid calcium chloride can be used to pre-wet salt and sand, which can facilitate de-icing at lower temperatures. The disadvantages to calcium chloride are: 1) it costs more than salt; 2) it is difficult to handle and store; 3) if used alone it may contribute to slippery, black-ice conditions; and 4) the presence of chloride ions makes calcium chloride at least as corrosive to structural materials and toxic to aquatic life as salt.

Sand is sometimes considered an alternative to salt. Sand does provide additional traction in slippery conditions but it cannot melt snow and ice on the road surface. A disadvantage to sand is that great effort must be expended to clean the sand from road surfaces at the end of winter to prevent clogging of roadside ditches and catch basins, and eventually sedimentation in water bodies.

Calcium magnesium acetate (CMA) is another alternative to salt. CMA is made from limestone and acetic acid, the principal ingredient of vinegar. CMA is less damaging to soils, less corrosive to concrete and steel, and non-toxic to aquatic organisms. It is also benign to roadside vegetation. The components of CMA are not harmful to groundwater, although CMA, like salt, has the potential to mobilize trace metals (Fe, Al, Zn, Cu) through cationic exchange reactions in soil. A drawback of CMA is its cost, about $600/ton, compared to about $40/ton for salt. However, a full cost analysis, comparing CMA to salt is needed to determine the full cost of both alternatives. CMA use should lead to longer lasting bridges and cars and less environmental damage. Including avoided costs, CMA may be an economically viable alternative to salt, even though its initial cost is 15 times greater.

DOT Reduced Salt Pilot Program

Chapter 239, Laws of 1994, authorized and required the DOT, in cooperation with the Nashua Regional Planning Commission, to implement a pilot program to minimize salt use during the winters of 1994-95 and 1995-96. Three test sections were found on low traffic volume highways in the Nashua region, public hearings were held, and warning signs were posted on the roads. During the two winters, test sections were treated with approximately one half the amount of salt used on the control sections, which were treated using standard DOT procedures. DOT evaluated road conditions, accidents, costs, environmental benefits, and public acceptance of the pilot program. Monitoring wells were installed along test and control highway sections to measure chloride levels in groundwater.

The results of the pilot program were:

1. While poorer driving conditions were noted on the test sections, safety was not significantly compromised by the reduction in salt use. This was attributed to the absence of curves, hills, and heavy traffic on test sections, as well as the highway signing and public notification of the program.
2. While substantial savings for salt were noted, other costs such as sand and labor were higher. Additional costs were estimated by DOT at $16,774 during the two-year test period for the 8.3 lane-miles in the test sections. It was noted that additional costs could

be incurred due to sand cleanup for lawns, drainage ditches, and culverts. DOT also noted that the higher costs were partially due to the short length of the test sections.

3. Public acceptance of the test was mixed. Very few complaints were from the public, but local police were less than satisfied with road conditions during storms.
4. In each test section chloride levels in monitoring wells were substantially lower than those in corresponding control sections. Application of additional sand in test sections created environmental concerns due to sediment deposition, but these impacts were not measured.

DOT concluded that reduced salt application for winter maintenance is beneficial within very specific parameters. The type of highway to be included in a reduced salt program needs to be carefully considered. The highway must be relatively flat, without hills and curves, and in a low speed/low volume section. Based on the results of the pilot program, DOT will consider conducting other reduced salt programs in communities which request consideration and on roads which meet the specific requirements of the program. Local officials interested in the reduced salt program should contact the DOT Bureau of Highway Maintenance at 271-2693.

Best Management Practices for Road Salt Application

Storage and Handling

- Facilities should be located on flat sites away from surface water and on impervious surfaces that are easily protected from overland runoff.
- Salt should be stored under cover to prevent a loss due to runoff.

Application of Road Salts

- Sensitive areas, such as public water supplies, lakes and ponds, should be identified and made known to salt applicators. Consider de-icing alternatives in sensitive areas.
- Ground-speed controllers should be used for all spreaders.
- Give salt time to work; time plowing operations to allow maximum melting by salt, before snow is plowed off the highway.
- Know when to plow and reapply salt. The need for another salt application can be determined by watching melting snow kicked out behind vehicle tires. If the slush is soft and fans out like water, the salt is still working. Once the slush begins to stiffen and is thrown directly to the rear of vehicle tires, it is time to plow.
- For lesser traveled roads, consider applying salt in a windrow in a four to eight foot strip along the centerline of a two lane road. Less salt is wasted with this pattern and quickly gives vehicles clear pavement under at least two wheels. Traffic will soon move some salt off the centerline and the salt brine will move toward both shoulders for added melting across the entire road width.
- Determine levels of service for all roads in a service area. Salt application rates and frequency should be based on traffic volume, road grade and curvature, intersections, and weather conditions. Sand or sand/salt mix should be used based on the level of service requirements.

Snow Dumping

Dumping plowed snow directly into waterbodies is illegal. For recommended snow dump areas, please see DES Fact Sheet **WD-WMB-3.**

Appendix F

NHDES Septic System Fact Sheets

ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-SSB-2 2010

Care and Maintenance of Your Septic System

What is a septic system?
A septic system is a two part treatment and disposal system designed to condition untreated liquid household waste (sewage) so that it can be readily dispersed and percolated into the subsoil. Percolation through the soil accomplishes much of the final purification of the effluent, including the destruction of disease-producing bacteria.

A septic tank provides the first step in the process by removing larger solid materials, decomposing solids by bacterial action, and storing sludge and scum. The liquid between sludge and scum is then passed along to the leaching area for final treatment and absorption into the ground. Remember: A properly maintained septic system will adequately treat your sewage.

What should I do to maintain my septic system?
Know the location of your septic tank and leaching area.

- Inspect your tank yearly and have the tank pumped as needed and at least every three years.
- Do not flush bulky items such as throw-away diapers or sanitary pads into your system.
- Do not flush toxic materials such as paint thinner, pesticides, or chlorine into your system as they may kill the bacteria in the tank. These bacteria are essential to a properly operating septic system.
- Repair leaking fixtures promptly.
- Be conservative with your water use and use water-reducing fixtures wherever possible.
- Keep deep-rooted trees and shrubs from growing on your leaching area.
- Keep heavy vehicles from driving or parking on your leaching area.

For Further Information

If you have any questions concerning septic systems, contact DES Subsurface at (603) 271-3501, or 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; Fax: (603) 271-6683; http://des.nh.gov/organization/divisions/water/ssb/index.htm.

ENVIRONMENTAL
Fact Sheet
NEW HAMPSHIRE DEPARTMENT OF Environmental Services
29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-SSB-1 2010

Replacement of A Failed Subsurface Disposal System

What is a Failed Subsurface Disposal System?
New Hampshire RSA 485-A:2 defines failure as "the condition produced when a subsurface sewage or waste disposal system does not properly contain or treat sewage or causes or threatens to cause the discharge of sewage on the ground surface or into adjacent surface or groundwater."

Special Requirements for Replacing a Failed Subsurface Disposal System.
To ensure prompt and effective replacement of a failed subsurface system, the following steps must be taken.

1. The town health officer, or other local official responsible for health code enforcement, must prepare a written statement verifying that the existing system is in failure. This statement must be submitted to DES with the application to replace the existing system.
2. If construction approval is granted, the construction must be completed within 90 days. Failure to complete construction and obtain operational approval of the system within the 90-day period will result in invalidation of DES approval.
3. In the event that your construction approval becomes invalid as a result of exceeding the 90-day construction period, a request for extension must be submitted to the Department of Environmental Services, Subsurface Systems Bureau. DES shall grant one 90-day extension. The request for extension must include all the information required by New Hampshire Administrative Rule Env-Wq 1004.11 (b).

This fact sheet is intended as a basic source of information concerning the replacement of a failed subsurface disposal system; it is not intended to replace the administrative rules contained in Env-Wq 1000. It is also important to remember that some municipalities have additional requirements, and you should check with your local officials before beginning any project.

For Further Information
If you have any questions concerning septic systems, contact DES Subsurface at (603) 271-3501, or 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; Fax: (603) 271-6683; http://des.nh.gov/organization/divisions/water/ssb/index.htm.

ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

WD-SSB-12 2010

Approved Technologies for Septic Systems

Over the past several years, the N.H. Department of Environmental Services has approved many new innovative technologies for the treatment and disposal of wastewater to subsurface systems. All new "innovative/alternative" systems for on-site treatment or disposal of wastewater below the ground (usually referred to as "septic systems") need approval from DES under the provisions of NH Administrative Rule Env-Wq 1024, which allows general and provisional approvals. The following is an overview of the various products and technologies that DES has approved to date. But before listing the currently approved systems, we must present these caveats and warnings:

- Systems are listed in random order.
- Mention of a company name, system or device in this list does not constitute DES approval to use that system or device to address any specific problem. Consult a licensed septic system designer to determine what solutions may be appropriate for your problem.
- PUMP OUT YOUR SEPTIC TANK **BEFORE** THERE'S A PROBLEM. Many times, a "technological" solution is not necessary because ordinary maintenance may solve the problem. See Env-Wq 1023 for operating requirements. Also see the other Fact Sheets in DES's SSB series for useful information on septic system operation.
- Where a designer specifies a certain product, such as a brand of septic tank effluent filter, and a different (but similar) brand is used in the actual installation, DES requires the written concurrence of the system designer before approving the tank/septic system for operation.

Leaching Systems

Stone/pipe - field, trench, drywell	"Standard" systems.
Chambers - concrete, plastic	"Standard" systems, but field sizing may be product-specific. See approved design manual.
"Enviro-Septic" system	A "standard" system, field sizing is product-specific. See approved design manual.
"Geo-Flow" system	A "standard" system, field sizing is product-specific. See approved design manual.
Eljen "In-Drain"	A "standard" system, but field sizing is product-specific. See approved design manual. Manufacturer's review for larger commercial systems.
Ruck "A-Fin"	A "standard" system, field sizing is product-specific. See approved design manual. Manufacturer's review required for larger commercial systems.

Mechanical treatment devices , with general DES Approval for leach field reduction:

Norweco "Singulair"	Biological treatment.
Amphidrome Recirculating Batch Reactor	Biological treatment.
Wastewater Alternatives Inc. "The Clean Solution"	Biological treatment.
Jet Package Sewage Treatment Plant	Biological treatment.
Spec Industries AIRR trickling filter	Biological treatment.
SeptiTech Recirculating Trickling Filter	Biological treatment.
BioMicrobics FAST system	Biological treatment.
Zabel SCAT biofilter	Biological treatment.
Orenco AdvanTex system	Biological treatment.
MicoSepTec EnviroServer system	Biological treatment.
CMS ROTORDISK	Biological treatment.
Aeration Systems, LLC, OxyPro system	Biological treatment.
BioClere system	Biological treatment.

Mechanical treatment devices, provisional DES Approval for leach field reduction:

Provisional approval is granted for newer technologies per Env-Wq 1024.06(d) for cases where DES finds that "… there is not sufficient operating history or other valid data to allow general use of the technology …." Provisional approvals are granted for a limited number of applications for a limited period of time. The applicant is required to do performance monitoring of each installation and report the results to DES.

SeptiTech Recirculating Trickling Filter	Biological treatment. The provisional approval is for leach field size reductions beyond that in SeptiTech's General approval.
BioMicrobics FAST System	Biological treatment. The provisional approval is for leach field size reductions beyond that in BioMicrobic's General approval.
WasteTech STM 2000 unit	Physical treatment.

For new construction where a mechanical treatment device with a reduced-size leach field, under a General or Provisional approval, is proposed for use on a lot that was created prior to adoption of DES subdivision rules, the design submitted shall demonstrate sufficient capacity to construct a full sized leaching facility on the lot.

All mechanical systems require on-going professional maintenance. The person doing the maintenance must be a licensed treatment plant operator. See DES fact sheet WD-WEB-2 for information in the licensure program. A Grade 1-OIT license is usually considered sufficient for systems listed here.

Other approved, or approvable, treatment devices and methods:

M.C.C. Inc. "Cajun Aire"	Mechanical unit, approved under Env-Wq 1024.
Cromaglass Sequencing Batch Reactor	Mechanical unit, approved under Env-Wq 1024.
"White Knight," "Pirana"	These are mechanical devices that are inserted into an existing septic tank to provide treatment of the effluent leaving the tank. They are allowed for rehabilitation of failed systems.
Constructed Wetlands	Innovative, has been approved for a few sites. Significant engineering required.
Spray Irrigation	Has been approved for a few sites. Very significant engineering and Groundwater Discharge Permit required. A major issue is control of access to the area where spraying occurs. There are significant public health concerns with coming into contact with partially-treated wastewater.
Sand Filters	Innovative, has been approved for a few sites. Significant engineering required.

Other systems & devices

Septic tank effluent filters	Allowed and encouraged.
Presby "Maze"	Device inserted into septic tank. 30 percent reduced field size allowed for commercial systems.
Holding Tank	Only applicable in very limited circumstances, see Env-Wq 1022.03
Composting toilets	Allowed, but no leach field reduction allowed for the remaining wastewater whenever the building has running water.
"Mini dry well" and privies	Only allowed for buildings with no running water (Env-Wq 1022.01 Prives & Env-Wq1022.02 Mini Drywell).

For more information

For more information about the above list, or to apply for approval of an innovative/alternative product from DES, please contact: Subsurface Systems Bureau, NH Department of Environmental Services, 29 Hazen Drive, PO Box 95, Concord, NH 03302-0095; (603) 271-3501.