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MEMORANDUM

TO: Lynn Gilleland, US EPA Region 1
Paul Susca, NH Department of Environmental Services

FROM: Mark Nelson, Horsley & Witten, Inc.

DATE: March 13, 2007 (Revised May 17, 2007)

RE: Task 3 Final Memorandum
Protecting New Hampshire Surface Drinking Water Supplies
Identify and Evaluate Alternatives to the Minimum Buffer Approach

I. Introduction

The purpose of this memorandum is to evaluate the likely effectiveness of the proposed revisions to the Comprehensive Shoreland Protection Act (CSPA) presented in House Bill 383 (HB 383) in protecting public surface water drinking water supplies in New Hampshire, and to propose and evaluate an alternative buffer approach based on available literature. HB 383 was developed based on the "Waterfront and Natural Woodland Buffer Proposal" and the "Impervious Surface Proposal" of the Comprehensive Shoreland Protection Act Commission, established under the authority of Senate Bill 83, passed on July 1, 2005.

In a previous memorandum dated January 26, 2007, revised May 17, 2007, the Horsley Witten Group, Inc (HW) evaluated existing literature about the effectiveness of a uniform buffer in protecting surface waters from primary pollutants of concern: nutrients (nitrogen and phosphorus), sediment, salt, metals and pathogens (bacteria and viruses). Based on our review, we recommended a minimum protective buffer of 300 feet from all surface waters, but acknowledged that this may not protect a water body from all of the listed pollutants of concern, and may be more or less effective based on the slope, soil type, vegetation cover type and density, contributing land uses, location of wastewater and stormwater discharges and other site specific characteristics.

The ideal method of protection of a surface drinking water supply is a comprehensive watershed approach in which the entire watershed would be protected. A number of New Hampshire's water supply sources are protected in this manner, either through the water supplier's foresights or their location in protected areas such as the White Mountain National Forest. However, given the location of many water supply intakes along large rivers and the level and extent of

development within the contributing watersheds to existing water supplies, this approach is clearly not feasible for many sources. Watershed management combines an effort to maintain natural land cover conditions and manage the hydrologic impacts and pollutants from the existing and future development within the watershed. The current approach to shoreland protection in New Hampshire is based on managing the buffer to the surface waters to reduce the level of development impact within the first 250 feet of land along the surface water.

This memorandum and HW's January memorandum focus on key elements of that buffer approach. The recommendations proposed in this memorandum attempt to combine the techniques of maintaining natural vegetation and minimizing and managing the impacts from the development that occurs within the buffer area. The proposed levels of management reflect the goal of protecting public water supplies, which require stronger protections than other surface water resources.

This memorandum provides a review of the CSPA Commission's proposals, as they became presented in HB 383, and recommends an alternative buffer approach, with the goal of protecting surface water supplies in New Hampshire from common surface water pollutants. It is important to clarify that the goal of the CSPA and any revisions thus far presented in HB 383 is to protect the shorelands of New Hampshire in general, but is not specifically focused on protecting surface drinking water supplies, a subset of the waters upon which the CSPA applies. New Hampshire Department of Environmental Services (NH DES) is interested in exploring additional recommended revisions to the CSPA or other legislation to provide special protections for this important subset of New Hampshire surface waters.

II. Evaluation of Natural Woodland Buffer Proposal

The uniform minimum buffer width presented by HW in our January 26, 2007 memorandum (revised May 17, 2007) is a vegetated buffer of 300 feet. Within this 300 foot buffer, HW assumed that the vegetation density and diversity would be the same as naturally occurring vegetation, and no disturbance such as clearing, grading, buildings, other impervious areas, septic system leach fields, stormwater practices, or conversion of vegetation to lawn area would be permitted. The goal of this buffer is to provide a reasonable assurance of pollutant removal and protection for public drinking water supplies. As described in the previous memorandum, the recommended buffer width varies for each pollutant of concern, but the recommended 300 foot buffer is the conservative buffer width that provides the most effective pollutant removal for the combination of nutrients (nitrogen and phosphorus), sediment, salt, metals and pathogens (bacteria and viruses).

A. Description of Waterfront and Natural Woodland Buffer Proposal (HB 383)

The Waterfront and Natural Woodland Buffer Proposal as it is presented in House Bill 383 includes provisions to introduce a 50-foot Waterfront Buffer measured from the reference line (defined as mean high water level in inland river, streams ponds or lakes; limit of flowage rights in reservoirs; or highest observable tide line in coastal areas), with specific limitations on uses and alteration within that zone, on changes to the 150-foot Woodland Buffer measured from the reference line, and on the amount of impervious area within 250 feet of the reference line.

Within the proposed Waterfront Buffer, generally no chemicals shall be applied, no rocks or stumps shall be removed, no natural vegetation less than 3 feet in height shall be cut, and every 50 foot by 50 foot plot shall meet a 50-point "tree score" calculated based on the number and size of trees. Trees may be cut as long as the 50-point tree score is met, or exceeded. In areas where the tree score is not currently met, no new plantings are required. Land owners may develop a permanent 6-foot wide pathway to the water, may perform normal trimming and pruning within certain parameters, and may remove dead, diseased and unsafe trees, saplings or shrubs, which are not to be counted in the tree score.

Proposed changes presented in HB 383 within the 150-foot Woodland Buffer include restrictions on impervious area outside the Waterfront Buffer and a provision that 50 percent of the area outside the permitted non-impervious area remain undisturbed (although this provision can preserve as little as 1/8 of the 100-foot second tier of the Woodland Buffer outside the Waterfront Buffer). Municipalities also must be notified of all cutting of trees greater than 6 inches in diameter. Within the 250-foot protected area, impervious surfaces are limited to 30 percent, 25 percent or 20 percent depending on the level of vegetation in the Waterfront Buffer and the level of stormwater management for impervious surfaces.

The proposal appears to increase the effectiveness of the CSPA in protecting the ecology and water quality of waters to which it is applied. However, HW suggests that additional improvements could be incorporated into a revision of the CSPA to strengthen the level of protection for those surface waters that serve as sources of public drinking water supply. The proposal is less stringent than the 300-foot uniform buffer developed by HW as a benchmark. The benefits and limitations of this proposal as it applies to the protection of surface drinking water supplies are described below.

B. Benefits

The proposed changes to the CSPA are an improvement upon the existing provisions in that they provide additional protections to the inner 50 foot buffer, the required vegetation density is more easily measurable than in the previous version, which applied a cutting limit over a 20-year time span, and the amount of impervious area within 250 feet of the water is limited. The new limitation on the area of the site within both 50 feet and 150 feet of the water body that must be maintained in an undisturbed state may be a positive mechanism to try to maintain existing undisturbed, vegetated areas, even if the existing vegetated buffer is smaller than 150 feet. These changes are all beneficial to the receiving water, but may not go far enough to provide protection specifically for surface water supplies.

C. Limitations

Tree-Score Approach

The proposed Waterfront Buffer, which is the first 50 feet from the reference line, is defined by a revised vegetation density requirement based on a minimum tree score point system. The buffer requires a minimum tree score of 50 points, and allows cutting in areas that exceed the tree score. However, in areas that do not meet the tree score, planting to revegetate up to the tree score is

not required if the lot does not exceed 25 percent impervious surface coverage within 250 feet of the reference line.

This tree score system appears to promote only a partially vegetated buffer around water bodies because, as stated in the CSPA Commission's final report (CSPA Commission, 2006), the 50 point tree score is based on a vegetation density of approximately 50 percent of a normal density of naturally occurring vegetated buffer area. Furthermore, this tree score method does not define the distribution of vegetation within the 50 foot by 50 foot measured plots that are used to calculate the tree score, and it does not define any ratio of small trees to large trees. As a result, an individual plot could meet the tree score by maintaining all groundcover with either all small trees or all large trees, and these could all be located within one portion of the plot rather than distributed throughout. A combination of trees, shrubs and understory creates a more effective buffer for the purposes of erosion control, infiltration and pollutant removal (CRJC, date unknown; EPA, 2005).

The Waterfront Buffer tree score proposal also allows significant thinning of the vegetation within the buffer zone. While this may be appropriate in less pristine areas used for recreation, this is not recommended in buffers to a drinking water supply. This thinning and removal of dead and diseased trees removes a significant source of carbon that helps the natural decomposition and nutrient cycle within the buffer area. Over time, the brush and organic material that decompose in a forest environment can help the buffer to provide nutrient removal services, and also helps to develop a thicker and more porous organic layer on the ground surface. This layer is effective as a sponge that retains runoff and slows the flow of stormwater as it moves toward the surface water (NRC, 2000).

Restoration Requirements

The proposal provides no mechanism to require restoration of buffers in areas that are currently developed, nor does it require improvements in the pollutant source controls, such as stormwater treatment for existing buildings and impervious areas. In areas that are currently developed, owners are allowed to continue to maintain cleared areas within the 50-foot buffer, even when such areas are not being used by structures. Therefore, if an entire buffer area has been previously cleared, it likely will stay cleared, providing no water quality benefit to the receiving water.

Impervious Cover Restrictions

For the purposes of drinking water supply, the literature suggests that the impervious cover restrictions introduced in the House Bill 383 are not strict enough and well-defined enough to protect drinking water supplies. The impervious cover model developed by the Center for Watershed Protection (CWP, 2000), suggests that stream quality begins to degrade to the point of being "impacted" when impervious cover reaches 11 to 25 percent of the contributing watershed (See Figure 1). Given that most of a contributing watershed to waters covered by the CSPA is not governed by strict impervious cover restrictions, it can be assumed that over time the watershed imperviousness can easily reach 11 percent. Therefore, to help balance off that level of development, HW suggests that the level of impervious cover that is proposed to be allowed for new development and expansions of existing development within the 250 foot Protected Area near drinking water supplies is too large to effectively protect drinking water supplies; This

percentage should be at most ten percent of a lot, with a goal of as little impervious area as possible and a watershed imperviousness of not more than 10 percent.

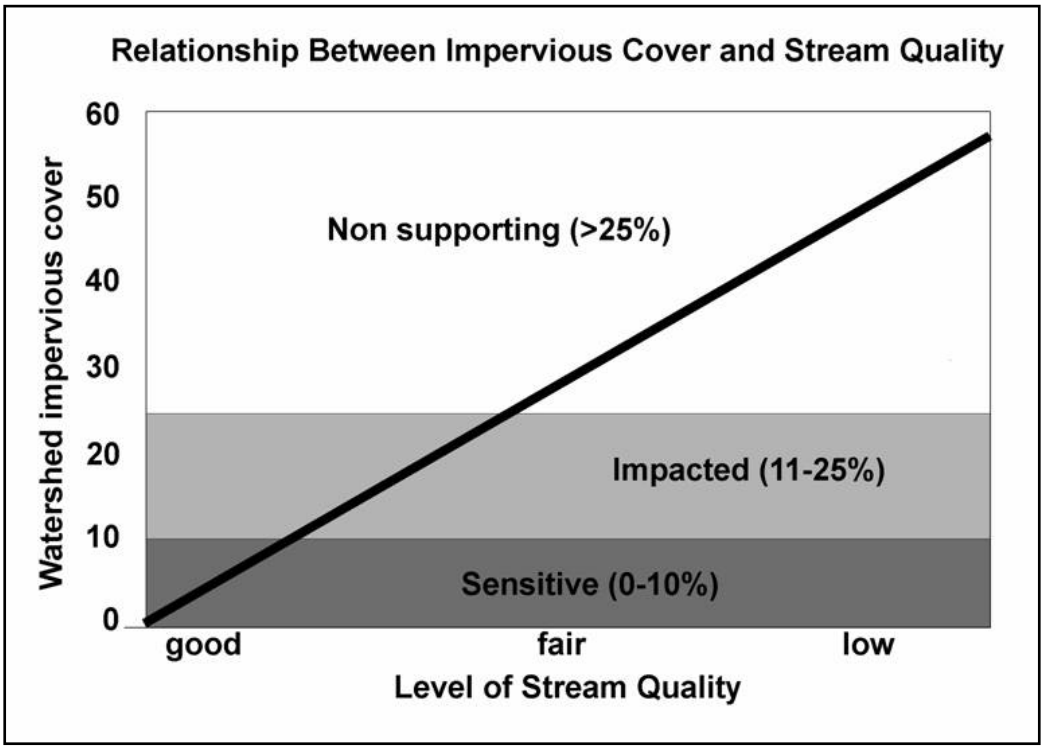

Figure 1. Impervious Cover Model (CWP, 2000)

Stormwater, Water Quality and Low Impact Design
The proposal presented in HB 383 includes some limited stormwater measures in that increases in impervious area from 20 percent to 30 percent must be essentially mitigated by two mechanisms: 1) providing additional plantings to meet or exceed the 50 point score within the proposed Waterfront Buffer, and 2) implementing a stormwater management system to limit the volume of runoff from the area so that the post-development volume equals the pre-development volume. This second mechanism only applies to areas that have a maximum impervious area of between 25 and 30 percent within the Protected Shoreland area. For areas proposed to have between 25 and 30 percent impervious cover, the land-owners are encouraged but not required to use Low Impact Development (LID) techniques.

The stormwater requirements in the proposal do not provide standards for stormwater treatment for water quality and do not provide guidance or requirements on selection of appropriate stormwater practices to be used within 250 feet of a public drinking water supply. For example, stormwater runoff from paved surfaces where cars may be parked for long periods of time, or from lawn areas where fertilizers or chemicals are being used should not be infiltrated directly into the ground without first receiving some sort of pretreatment in a bioretention area or water quality swale. Certain practices should not be used on steep slopes due to erosion potential and a reduced ability to provide treatment. The proposal, as presented in HB 383, is too general to provide sufficient protection for drinking water supplies. In addition, the mechanism for

approval of the stormwater management system by the Department of Environmental Services is unclear, as an alteration of terrain permit is only required for large projects that cover more than 50,000 square feet of land within the Protected Shoreland buffer.

Septic Leach Field Setbacks
The current setbacks for septic systems within the CSPA and maintained in the proposed HB 383 may not be adequate to protect surface waters from phosphorus and viruses that migrate through groundwater from a septic system to a receiving water. HW's January memo recommended a 300 foot buffer, based, in large part, on the need to allow for the removal of phosphorus and viruses in septic system effluent, which can travel 200-300 feet based on the subsurface geology and the rate of groundwater flow. Provisions to maximize the setback between a leach field and a water body on a lot should be considered, along with other design standards to minimize phosphorus transport. Some of these recommended design standards are described in Section IV of this memorandum.

Continued Exemptions
The largest deficiencies in the proposal appear to be the continued exemptions in the CSPA. Rivers that are included in the Rivers Management and Protection Program are exempted from coverage under the CSPA. According to the RMPP, rivers in the program are managed through a watershed management plan that is developed jointly by communities in the watershed, and implemented by each individual community on a local level. While these management plans may address the concerns of protecting a water supply along the river, and may provide or recommend more effective controls than those in the CSPA, it is difficult to ensure at least a minimum level of uniform protection for all other drinking water supplies along the rivers under the RMPP. This exemption has already been removed for most rivers in the Rivers Management and Protection Program; HB 665 would remove this exemption for the remaining rivers in the Program.

In addition, "forest management not associated with shoreland development or land conversion, and conducted in compliance with RSA 227-J:9; forestry involving water supply reservoir watershed management; or agriculture conducted in accordance with best management practices; shall be exempt from the provisions" of the CSPA. This exemption reduces the effectiveness of the CSPA in protecting water bodies because it further splits the application of the act, allowing a different set of standards to apply for different land uses. This exemption also allows a significant reduction in oversight of these exempted forestry and agricultural land uses. The forestry exemption turns the oversight responsibilities to the State Forester, and the agricultural exemption simply relies on individuals to follow agricultural best management practices. Each of these groups has varying goals and concerns that may conflict with the even stricter goal of protecting drinking water quality.

According to NRC (2000), agriculture and forestry practices can be harmful to the receiving water as they can increase runoff, compaction of the soils, soil erosion, and introduction of pollutants such as sediment, bacteria, nutrients and industry chemicals. These blanket exemptions should be better coordinated with forestry programs and agricultural programs in the state to ensure that mutual goals are met and the most appropriate best management practices are

selected for areas within the 250-foot Protected Area. In addition, it would be significantly more effective to prohibit such activities within the 50-foot Waterfront Buffer.

The greatest shortfall of the current CSPA and the proposed revisions to the CSPA in HB 383 is the exemption of all streams smaller than 3rd and 4th order streams. Therefore, most contributing streams to lakes and ponds, as well as tributary waters that may be sources of water supply themselves or may contribute to water supply rivers are not covered by the CSPA. These smaller streams far outnumber the number of river miles of the fourth order and larger streams, and contribute a very large proportion of flow to the larger streams, as function of contributing area (see Table 1) (CSPA Commission, 2006, River Miles Calculation). As stated in Magee (2006), included in the CSPA Commission's final report, "Because the majority of stream miles in New Hampshire is in 1st, 2nd, and 3rd order streams, protecting the stability and ecological integrity of them is of paramount importance to protecting water quality in all waterbodies of the state and to providing the continued use of biological resources by the people of New Hampshire."

Table 1. Approximate River Miles per Stream Order (Perennial Streams Only)

Stream Type	Approximate River Miles
1st Order	4066
2nd Order	3616
3rd Order	2188
4th Order	2458

(Source: Derived from CSPA Commission, 2006, Strahler River Miles)

Providing natural vegetated buffers to upstream areas will help to protect upstream areas from erosion and gullying from stormwater as it flows down into the smaller streams. This will help to limit excessive sedimentation in the stream, which will improve water quality downstream at lakes and riverine water supply intakes. In addition to preventing erosion from overland flow, it is also important to provide buffers that can help slow the flow of runoff and minimize instream erosion, caused by high peak flows during episodic storms. (CRWA, 2006)

III. Evaluation of Alternative Buffer Proposal

A. Description of Alternative Buffer Proposal

An alternative buffer approach recommended by HW to specifically address the protection of surface drinking water supplies is based on a review of existing literature regarding the effectiveness of vegetated buffers in removing the group of pollutants of concern to a public water supply: nutrients (nitrogen and phosphorus), sediment, salt, metals and pathogens (bacteria and viruses). This proposed approach includes a combination of:

1. Preserving or restoring a 300-foot naturally vegetated Primary Buffer extending 1 mile upstream of the intake in river and streams, and around the lake or reservoir for intakes in those waters *;
2. Widening the Primary Buffer based on the slope of the buffer;
3. Extending the Primary Buffer around adjacent contiguous wetlands;

4. Extending a 100-foot vegetated Secondary Buffer upstream of the 1-mile Primary Buffer along all tributary perennial streams;
5. Providing stricter limitations on impervious cover and stormwater management using LID techniques in areas within and contributing to the Secondary Buffer, and;
6. Incorporating additional requirements for septic system leach fields in areas within and contributing to the Primary and Secondary Buffers.

(* Note: In rivers and streams, the buffer should also be extended downstream of the intake on a case by case basis if engineering data from the water supplier show that the downstream area of influence from the withdrawal extends beyonds the intake.)

The first three provisions listed above can be evaluated using geospatial analysis to understand the areal extent to which such a proposed buffer would apply, and the last two provisions are items that will be discussed in more detail in Section IV of this memorandum.

Based on the recommended buffer width of 300 feet described in our January memo, HW recommends that the baseline buffer width for surface drinking water supplies and their upstream tributaries should be 300 feet. Further, HW recommended that this buffer should not be altered and should remain completely natural. However, this appears to be a somewhat unrealistic option, given the broad statewide application of this recommendation, the variety of local regulations, and the variety of development patterns around lakes and rivers. Therefore, HW recommends limiting the upstream extent of the 300-foot minimum buffer application, and combining a smaller upstream 100-foot buffer width with other controls, such as stormwater management, prohibited uses, impervious cover limitations, extension of the buffer upstream of the intake, and adjustments for slope.

Given these adjustments, HW recommends a minimum Primary Buffer width of 300 feet extending upstream one mile in rivers, and extending around the entire reservoir or lake for intakes in those water bodies. This is on the high end of buffer widths supported by research reviews presented in Wenger (1999)(100 feet), Desbonnet et al. (1994) (150 feet), (Capiella and Schueler, 2001) (50-150 feet), Chase et al. (1995) (25-300 feet), (CRJC, date unknown) (100-600 feet, first 150 feet to treat runoff) and Klapproth and Johnson (2000)(50 to 300 feet). However it is also the distance needed to be protective of phosphorus and virus impacts from septic system and large stormwater discharges to groundwater that can travel through the buffer and enter a receiving water.

In addition, HW recommends an upstream Secondary Buffer of 100 feet extending along all contributing perennial streams upstream of the limit of the 300-foot buffer. This upstream Secondary Buffer will be augmented with additional controls, as described in this section. In addition, HW recommends the removal of the exemption for agriculture and forestry practices that is currently outlined in section 483-B:9(V) of the CSPA so that the proposed natural forest buffer will not be permitted to be impacted around drinking water supplies.

The Primary and Secondary Buffers recommended in this memorandum are characterized by naturally vegetated forest areas, with a combination of groundcover, shrubs and trees of various ages and sizes. Within this buffer, snags, stumps and dead wood will not be permitted to be

removed, in contrast to section 483-B:9(V)(2)(D) in the existing CSPA. To the extent that existing development already occurs within the proposed Primary or Secondary Buffer area, HW recommends that any expansion of impervious area or cleared area within the buffer should be prohibited and redevelopment restrictions should be implemented to shift development, including septic system leach fields, upgradient and further from the reference line.

Slope

Slope can significantly affect the ability of a buffer to remove sediment and nutrients from water that flows through the buffer (Wenger, 1999; Klapproth and Johnson, 2000). Several studies recommend an increase in buffer width that corresponds to an increase in slope. For example, Wenger (1999) suggests an increase of 2 feet for every 1 percent increase in slope. Palone and Todd (1997), referenced in Klapproth and Johnson (2000), recommend an increase of 5 feet for every one percent increase in slope. HW recommends that the width of the Primary Buffer be increased by two feet for every one percent increase in slope in the buffer for third order and higher streams. Smaller streams are expected to be located in either more mountainous areas where the increase in slope will be very steep, or in more heavily developed areas where a buffer beyond the 300 or 100 foot width would not be implementable. Slope is measured as the total rise over run across the entire 300 foot buffer. For example, if the slope in the 300 foot buffer is 15 percent, then the buffer width is increased to 330 feet for that portion of the buffer. This slope adjustment would be applied to the buffer for each parcel along the waterfront or for every 150 feet of waterfront.

Soils

The type of soils and the depth to bedrock or amount of bedrock outcrop in a buffer zone can affect the ability of a vegetated buffer zone to remove pollutants of concern. The removal of sediments, bound phosphorus, and bound metals and bacteria depends significantly on the ability of soils to filter out these pollutants from runoff. The filtration capacity of soils can be estimated relative to the NRCS hydrologic soil group (HSG) of the soil. HSG A soils are very sandy and allow runoff to flow quickly through the soil and infiltrate down toward the groundwater. HSG B and HSG C are more organic soils that provide infiltration capacity, but at a slower rate than HSG A soils. The organic material often found in these types of soils helps to bind sediments, metals, phosphorus and bacteria as the water filters through. HSG D is generally very clayey soil that provides very little infiltration. In addition, in areas that have significant bedrock outcrops and very shallow depth to bedrock (less than 2 feet), the ability to filter pollutants in runoff is hampered.

However, based on the existing level of site-specific detail provided by the NRCS Soils Survey maps, HW does not recommend trying to amend the buffer width based on soils. As stated in the New Hampshire Attribute Data Dictionary (NRCS, 2002), the maps are produced at a broad scale of 1:20,000 or 1:24,000 and do not display sufficient precision for site specific accuracy. The smallest soil areas shown on the maps are 3 to 5 acres in size and these areas do not account for possible inclusions within the mapped soils. Therefore, it is not recommended to use this soils information to evaluate the potential effectiveness of a buffer based on mapped soils.

Upstream Extent of Buffer
As described above, the recommended buffer option includes two tiers of buffer protections. A 300-foot Primary Buffer measured from the reference line for river and stream intakes, extending upgradient for one mile along all tributary streams, and for lake and reservoir intakes, extending around the perimeter of the lake or reservoir. A 100-foot Secondary Buffer should also extend protections upgradient in the watershed to all perennial streams, including all streams 1st order and greater. As described in Section II.C above, the upstream perennial streams play a key role in supplying water to the intakes located in downstream lakes, reservoirs and rivers. Protecting the water quality and integrity of these streams provides downstream water quality benefits, as well as habitat and ecological benefits, including a reduction in nutrients, sediments, bacteria and other stormwater-related pollutants (Wenger, 1999; Osborne and Kovavic, 1993, Hubbard and Lowrance, 1994, and Lowrance et al., 1997 in Wenger, 1999; Magee, 2006). HW recommends that a Secondary 100- foot buffer, measured from the reference line, be extended along all tributary perennial streams upgradient of the extent of the Primary Buffer.

Adjacent Wetlands Protection
In addition to extending the buffer to all upgradient contributing streams, HW recommends also extending a 100-foot buffer to all wetland systems that are both directly connected to the surface water supply (upstream of et supply, in the case of river intakes) and extend beyond the 300-foot Primary Buffer. Wetland systems should be treated with the same protections as other surface water bodies as they are hydrologically connected, and play a key role in the nutrient and metals uptake and cycling, sediment removal capacity and cycling of organic materials (Wenger, 1999; NRC, 2000; Cappiella and Schueler, 2001; Klapproth, 2000).

Stormwater Management Requirements
The stormwater management requirements proposed in this memorandum address the way in which stormwater flows into and through the Primary and Secondary Buffer, as well as the management of stormwater that originates in the Primary or Secondary Buffer. Vegetated buffers can be effective in removing pollutants from overland and shallow subsurface flow only if the water passing through the buffer is traveling as sheetflow (NRC, 2000; CRWA, 2006). If water enters the buffer as channelized flow, the water will not flow through the surface soil structure and will not infiltrate into the soils within the buffer.

Therefore, HW recommends that stormwater management standards be instituted for discharges to the vegetated Primary Buffers, flowing from areas upgradient of the buffer. These standards should include a requirement that level spreaders be used for all discharges to the 300-foot Primary Buffer and the 100-foot Secondary area. An alternative to the use of level spreaders is to use LID techniques in the area upgradient of the Buffer so that discharges are minimized or avoided through the use of infiltration, disconnection of impervious surfaces, and minimization of impervious cover.

In addition, there should be no new impervious cover allowed in the Primary or Secondary Buffer with the possible exception of allowing a walkway to the water. However, in cases where the buffer has existing development, the buffer requirements should include a provision to retrofit existing development to manage stormwater runoff from existing impervious areas, provide treatment, and promote infiltration. Stormwater should be treated to meet a pollutant

removal goal of 80 percent of total suspended solids (TSS), 40 percent of total phosphorus (TP) and 30 percent of total nitrogen (TN), and runoff from parking areas and other areas with potentially hazardous chemicals, oils, greases, or metals should be pre-treated before being infiltrated into the ground. TSS is a commonly used target pollutant for stormwater management (used in Massachusetts, Vermont, Maine, Georgia, and other states to manage stormwater), because in addition to being a pollutant of concern, phosphorus, bacteria and some heavy metals often bind to or act similarly to sediments as they are filtered or settled out of stormwater runoff.

Septic System Setbacks
HW recommends that the Primary Buffer also serve as the minimum setback distance for septic system leach fields. The use of the 300 foot undisturbed Primary Buffer will serve to protect drinking water supplies from septic system discharges. The 300-foot distance is sufficient for phosphorus from the septic system effluent to be adsorbed by sediments within and above the aquifer and prevent it from traveling to the receiving water. Viruses will also be removed from groundwater or inactivated before they can travel the full 300 foot distance. HW recommends the following set of septic system leach field setbacks and design standards for consideration to maximize pollutant removal:

- Require a 300 foot setback for all properties that extend far enough back from the shoreline to allow this to take place;
- Require the maximum feasible setback for all properties that do not extend 300 feet from the shoreline;
- Require septic system leaching systems to be built as trenches running parallel to the shoreline and therefore perpendicular to the likely direction of groundwater flow. This maximizes the subsurface area available to remove phosphorus from septic effluent before it can reach a receiving water, and;
- Consider the use of clustered or community wastewater systems that could provide a greater level of treatment than a conventional septic system and may also provide opportunities to place the leaching facility outside of the 300 foot buffer.

HW recommends that this 300 foot setback distance be applied in areas upstream of the Primary Buffer, even though the recommended Secondary Buffer is only 100 feet. As described in HW's January memorandum, viruses can travel long distances and continue to be viable, and once entrained in the surface water, virus transport (assumed to be similar in scope to the dye testing conducted by USGS) can be very rapid in New Hampshire's rivers (USGS, 2002).

B. Benefits

This vegetated buffer option meets the "measuring stick" of providing a 300 foot buffer as described in HW's January memorandum. It provides more comprehensive and scientifically-based approach to protecting the water quality at public water supply intakes than the proposed amendments to the CSPA in HB 383. While HB 383 is an improvement upon the current CSPA requirements, it does not provide extended protections for water supply surface waters, which call for more pollutant removal and source reduction strategies than other waters used for recreation or ecological purposes.

C. Limitations

This option is limited by its ability to address existing development impacts within the buffer zone. The buffer is significantly wider and more restricted than the buffer provided by the existing CSPA. This can be difficult to implement in areas where current development is already located, or in areas where forestry or agriculture are already vested.

A buffer width of 300 feet in upgradient streams may be difficult to implement in towns that do not benefit from the downstream water supply source. Connecting upstream communities to the downstream communities is a key hurdle in most watershed management plans. Why should people in upstream waters be restricted to protect resources that do not appear to benefit them? However, everybody can benefit from better watershed management to protect drinking water sources, as the costs of treatment can increase immensely in watersheds where the level of forest cover is diminished. A study performed by the Trust for Public Land showed that water treatment costs can decrease by approximately 20 percent for every 10 percent increase in forest cover in the source watershed, up to about 60 percent forest cover (Ernst et al., 2004).

D. Considerations for Spatial Analysis

The goal of this memorandum was to prepare a recommended buffer width proposal that would provide improved protection of surface drinking water supplies in New Hampshire, and that could be evaluated using available GIS data to understand the areal extent to which this recommended buffer would be applied and would impact existing development. The results of this analysis could potentially be compared to a spatial analysis of the existing CSPA and to the HB 383 proposal to estimate the extent to which each option would provide protection.

The recommended buffer approach can be partially analyzed using spatial analysis by applying a 300-foot Primary Buffer and 100-foot Secondary Buffer to all surface supplies and upstream tributaries as described above. In addition, the buffer should be extended around all wetlands that are located adjacent to surface waters to the extent that the Primary Buffer applies. In addition, slope should be analyzed for areas within and adjacent to the Primary Buffer, and the buffer should be increased by two feet for every one percent increase in slope. As stated above, soils have not been incorporated into the buffer recommendation because the available soil information is not of a small enough scale and therefore cannot be used for this analysis. The other pieces of this recommendation, described above, including stormwater management requirements, septic system setbacks and impervious cover limitations, cannot be analyzed using GIS data and analysis.

IV. Other Protective Approaches to Consider in Conjunction with Buffers

In addition to providing and maintaining a naturally vegetated buffer, other protective approaches are essential to protecting the water quality in public surface water supplies. These include source reduction, stormwater management standards, and land use restrictions. The existing CSPA includes many provisions to reduce pollutant sources within the Protected Area, the 250-foot buffer from the water, and most of those provisions are proposed to change under the HB 383 revisions.

These provisions fall into three primary categories:

- Source Reduction;
- Stormwater Management Standards/ Best Management Practices, and;
- Land Use Restrictions.

Source Reduction

The current CSPA and proposed HB 383 include septic system setbacks between 75 and 125 feet, depending on soil characteristics. There are no requirements for good housekeeping of existing development, such as a requirements for maintenance of waste sites and storage locations within the Protected Shoreland, nor is there a requirement limiting the use of road salts in or near the Protected Shoreland area. HW recommends that the following source reductions be included in the recommended shoreland buffer as a precaution for areas contributing to public drinking water supplies:

- A provision restricting or prohibiting the use of road salt within the contributing watershed to a public surface water supply;
- Restrictions on hazardous materials use and storage above normal household quantities.
- An increased septic system leach field setback around areas contributing to public surface water supplies. As described in Section III above, no septic system leach fields should be allowed within the protected buffer area, and existing leach fields should be encouraged to be moved outside the protected area, through redevelopment or expansion triggers.

Stormwater Management Standards/ Best Management Practices

The current CSPA includes a limited requirement for stormwater management and erosion and sediment control within the Protected Shoreland. Disturbance of land of greater than 50,000 contiguous square feet triggers a Terrain Alteration permit that is approved by NH DES. The proposed HB 383 would also include an additional stormwater management requirement if a land owner wants to have greater than 20 percent impervious cover within the Protected Shoreland area. In such cases, land owners can mitigate for the increase in impervious area up to 30 percent impervious cover by infiltrating the runoff so that the volume of runoff does not increase over existing conditions. The stormwater management plan must be approved by NH DES and would likely be required to use practices described in the manual Stormwater Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire (NH DES, 1996).

Further guidance is recommended to ensure that LID techniques are implemented to reduce and treat stormwater runoff, and to ensure that stormwater treatment practices are designed using vegetated practices that treat nutrients to a greater extent than more traditional practices. HW recommends a water quality standard of removal of 80 percent of the average annual post development total suspended solids, 40 percent of total phosphorus and 30 percent of total nitrogen for all discharges, in addition to the stormwater volume requirement proposed in HB 383. The only mechanisms to meet the stormwater volume requirement proposed in HB 383 are to reduce impervious areas and infiltrate stormwater runoff. Pre-treatment should also be provided for non-rooftop runoff prior to infiltration. Finally, level spreaders or other practices

should be used at all discharge locations so that water flows via sheetflow through the protected buffer area, rather than via channel flow.

In addition to the recommendations above, HW also recommends expanding requirements beyond the proposed Buffers to limit effective impervious cover throughout the watershed. The relationship between the percent of impervious cover in a watershed and the level of resource impairment, as described in Figure 1 (CWP, 2000), suggests that a key measure to protect a water resource is to limit impervious cover in the watershed, and in particular effective impervious cover. Effective impervious cover refers to the impervious area such as rooftops, driveways, parking areas, and other areas that drain directly to receiving waters. Conversely, ineffective impervious cover is impervious areas that are disconnected from other impervious areas and drain to vegetated land surface, allowing the runoff to slow and infiltrate. The impacts of effective impervious cover can also be further mitigated through the use of LID techniques to essentially mimic a watershed with a lower percentage of impervious cover. Therefore, HW recommends that a combination of impervious cover limits on a per lot basis combined with requirements to implement LID techniques throughout the watershed will strengthen the surface water protection provided by the proposed Primary and Secondary Buffers.

Mechanisms to implement LID techniques could be in the form a set of standards in CSPA, or a reference in the CSPA to a guidance document that can be updated as new techniques are evaluated and instituted. In either case, technical design guidance should be provided to allow landowners, engineers and regulators to properly size practices to meet minimum pollutant removal requirements, infiltration volume requirements, and peak flow detention requirements, as well as address soil, slope and depth to groundwater characteristics of each site. The guidance document should also provide maintenance information, particularly for homeowners with LID practices on their lots. Many states, including Maine, Vermont, Massachusetts, Georgia and New York, provide stormwater management guidance documents, and the state of Rhode Island has recently instituted a Master Design Certification program for LID designers through the Coastal Resources Management Council. In addition, the University of New Hampshire Stormwater Center is evaluating several stormwater management practices, including LID practices, under real-world conditions, and could provide valuable supporting data for LID design and performance requirements.

Land Use Restrictions

Protection standards in Section 83-B:9 restrict against the establishment of salt storage sheds, junk yards, and waste facilities within the Protected Shoreland area. The proposed HB 383 does not propose to change these restrictions. However, HW recommends that a more detailed list of prohibited uses be developed for lands within the protected buffer area. This list would include such land uses as storage or use of toxic/hazardous materials, gas stations, auto salvage yards, vehicle maintenance, DPW facilities, marinas, auto fleet storage, and others.

V. Conclusions

According to HW's review of the available literature, HW suggests that the provisions in the existing CSPA and the proposed revisions to the CSPA presented in HB 383 could be improved to more fully protect public surface drinking water supplies in New Hampshire. The proposed

revisions in HB 383 do not meet the uniform buffer width of 300 feet presented in HW's January memorandum. While the proposed amendments to the CSPA are an improvement upon the existing requirements under the CSPA, and will provide better protections to surface waters in general in New Hampshire, the proposed amendments will not provide the required elevated level of protection that is needed for surface water supplies. HW presented in this memorandum an alternative buffer approach that combines a minimum buffer of 300 feet with additional provisions to extend protections upstream of third order streams, and reduce the pollutant sources impacting public surface water supplies.

The Recommended Buffer Approach for Surface Water Supply Sources (Rivers and Lakes) includes:

- Preserving or restoring a 300-foot naturally vegetated Primary Buffer extending 1 mile upstream of the intake in river and streams, and around the lake or reservoir for intakes in those waters;
- Widening the Primary Buffer based on the slope of the buffer;
- Extending the Primary Buffer around adjacent contiguous wetlands;
- extending a 100-foot vegetated Secondary Buffer upstream of the 1-mile Primary Buffer along all tributary perennial streams;
- Providing stricter limitations on impervious cover and stormwater management using LID techniques in areas contributing to the Secondary Buffer; and
- Additional requirements for 300-foot setback for septic system leach fields in areas within and contributing to the Primary and Secondary Buffers.

The next step in this buffer assessment process will be a spatial analysis and comparison of the proposed CSPA revisions presented by HB 383 and the recommended approach by HW in this memorandum. The goal of this analysis will be to evaluate the spatial extent of the buffer coverage, and the level of development that currently exists within the proposed buffer options in order to evaluate the potential impacts and benefits of implementation of these approaches. Ultimately, a final report will be prepared incorporating HW's two memoranda and NH DES's spatial analysis to recommend a buffer approach for the improved protection of surface drinking water supplies in New Hampshire.

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