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Salmon River Watershed Municipal Land Use Evaluation Project

Assessment Report

February 16, 2010

Submitted to:
The Salmon River Watershed Partnership and
The Nature Conservancy
Lower Connecticut River Program
55 Church St., Floor 3
New Haven, CT 06510-3029

Submitted by:
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Salmon River Watershed First Draft Assessment Report

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1.0 INTRODUCTION

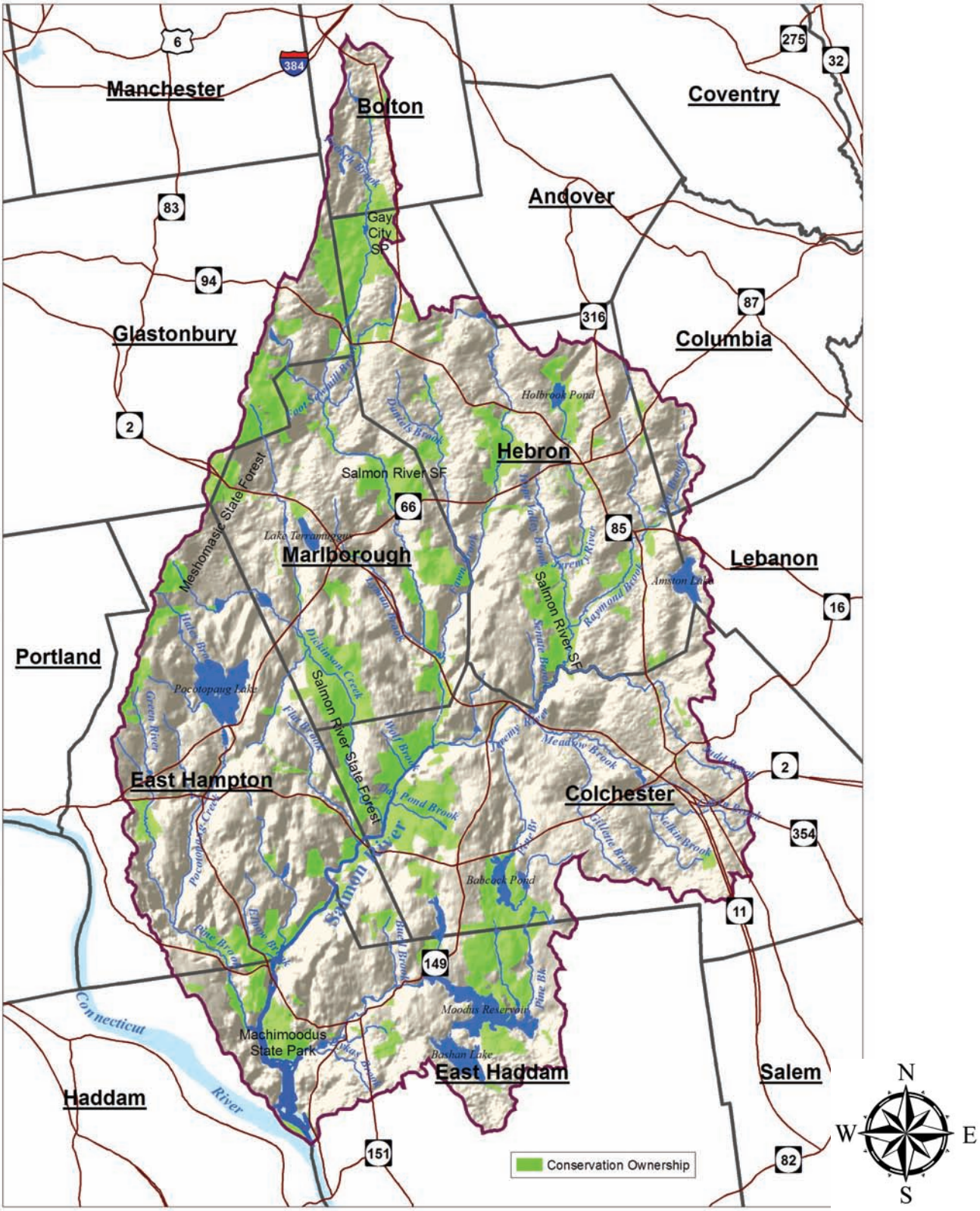
1.1 Background

The Salmon River Watershed (SRW) encompasses an area of approximately 150 square miles and drains a surface water basin that includes all or part of ten Connecticut municipalities (Figure 1). The SRW is home to a wide diversity of fish, macro-invertebrates, and high-quality cool- and cold-water stream habitat, making it one of the State's most viable trout stream systems. Like many cool- and cold-water stream systems in the eastern United States, the resource is extremely sensitive to the impacts of urbanization, particularly to development activities that contribute to increases in water temperatures and/or pollutant loading to the aquatic environment.

It is well established that the cumulative amount of impervious cover can be a robust indicator, or measure, of adverse impacts to aquatic and terrestrial ecosystems through various mechanisms, including the direct impact of converting natural habitat to pavement and buildings, and indirect impacts such as altering groundwater and surface water hydrology and chemistry. These hydrologic and chemical alterations lead to facilitating the accumulation and transport of pollutants, and decreasing aquatic community diversity, among other measurable effects (Center for Watershed Protection (CWP), 2003, Calhoun and Klemens 2002, Carter 1996, Coles, et al., 2004, National Research Council 2008, Schiff and Benoit 2007, Schueler 1987, Skidds, et al., 2007).

In January 2007, the watershed towns and The Nature Conservancy (TNC) launched the Salmon River Watershed Partnership (SRWP) as a collaborative and integrated approach to managing the watershed. As a resource which includes land within 10 municipalities, the SRWP looks to employ regional tools for engaging municipalities in the watershed and improving their capacity to protect the integrity of the freshwater resources within the watershed. Funding for the project was provided by a Long Island Sound Futures Fund grant from the National Fish and Wildlife Foundation and the Environmental Protection Agency, and contributions from the towns of Colchester, East Hampton, Hebron, Marlborough, Bolton, East Haddam, and Haddam, as well as in-kind contributions from The Nature Conservancy. The first action taken by the SRWP was the development of a Conservation Action Plan through a series of regional stakeholder workshops. Chief elected officials subsequently voted to support the plan in January 2008 and have contributed financial and human resources to the project since the development of that report. In May 2008, the watershed communities signed the Salmon River Conservation Compact, recognizing the importance of the watershed and committing each signatory community to the implementation of a regional stewardship program.

In February 2009, on behalf of the Salmon River Watershed Partnership, TNC retained the services of the Horsley Witten Group, Inc. (HW) to perform the next critical



Legend

- Salmon Watershed
- Surface Waters
- Conservation Ownership
- Roads

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Salmon River Watershed Locus Map

8126-figures.indd | Figure 1

component of this initiative within the watershed: the Salmon River Watershed Municipal Land Use Evaluation Project.

This document represents the culmination of the first phase of this project and initiates the process of developing recommendations for revising municipal codes and management practices/policies that would be more protective of watershed health and cool- and cold-water stream habitat in particular. Other materials related to this project and the SRW can be found at http://conserveonline.org/workspaces/srwp.

1.2 Buildout Analysis

The Nature Conservancy (TNC) has recently completed preliminary analyses for impervious cover within the watershed to help identify potential impairments today and into the future at full development buildout (Figures 2 and 3 and Tables 1 and 2). These maps and tables illustrate where impacts may be the greatest over time and should help communities prioritize the location for many of the management strategies in this report. A summary of TNC's buildout analysis methods is provided in Appendix A of this report. Threats from development are particularly urgent at this point for the SRW as it is located within one of the fastest growing areas in the state. It is therefore a high priority for TNC and other stakeholders to evaluate the potential sources of impact and strengthen management strategies to protect this sensitive resource.

Table 1. Summary of Potential Buildout for Subwatersheds in the SRW

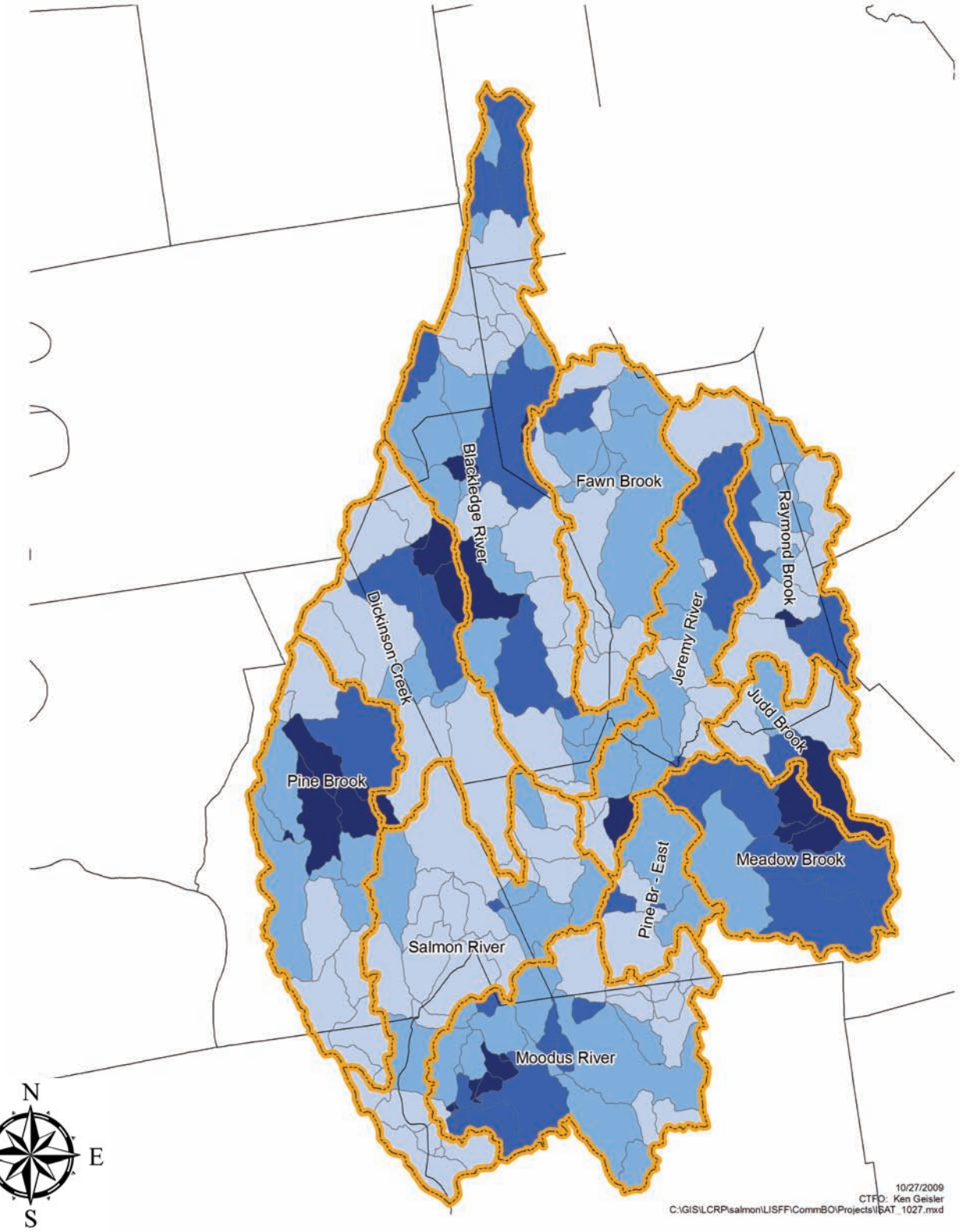
Subwatershed	Buildable Acres	Subwatershed Acres	Percent of Subwatershed that is Buildable	Percent of Total Buildable Acres in SRW
Blackledge River	5,150	16,680	31%	17%
Salmon River	3,904	11,994	33%	13%
Moodus River	3,244	11,270	29%	10%
Fawn Brook	3,224	8,195	39%	10%
Pine Brook	3,119	9,966	31%	10%
Jeremy River	2,819	8,239	34%	9%
Dickinson Creek	2,615	9,613	27%	8%
Meadow Brook	2,376	7,118	33%	8%
Raymond Brook	2,192	5,791	38%	7%
Judd Brook	1,422	3,271	43%	5%
Pine Br - East	1,116	3,211	35%	4%
Total	**31,181**	**95,349**	**33%**	**100%**

In addition to the buildout analysis on the subwatershed level, TNC summarized development potential in different zoning categories across the watershed in Table 2 and Figure 4. These analyses illustrate that the vast majority of impacts to the SRW into the future are likely to come from suburban style residential development. The residential areas zoned with a minimum lot size between one and five acres represent 97% of future land consumption potential. As a result, it will be critical for communities within the SRW to continue their efforts to manage residential sprawl to ensure the health of the aquatic system. One way to achieve this goal is through innovative design techniques that reduce the environmental footprint of new residential development. Another approach is to change zoning in a way that redistributes density in these towns, providing incentives to conserve undeveloped areas vulnerable to sprawl and intensifying development where infrastructure exists to support it.

Table 2. Summary of Potential Buildout for Zoning Categories in the SRW

Zoning Category	Buildable Acres	Zone Category Acres	Percent Buildable	Percent of Total Buildable Acres in SRW
< 1 Acre	808	2,404	34%	2%
>= 1, < 2 Acres	17,988	51,098	35%	52%
>=2, <5 Acres	15,601	39,304	40%	45%
5 Acres	190	406	47%	1%
Industrial/Business	22	6,293	0%	0%
ROW, Roads, Water	0	1,711	0%	0%
Total	**34,610***	**101,216**	**34%**	**100%**

*Note that the total Buildable Acres and the Zone Category Acres in Table 2 are greater than the total Buildable Acres and total Subwatershed Acres in Table 1. This is due to the fact that the zoning categories included parcels that crossed outside of the SRW.



Legend

Percentage of Impervious Surface

- 1, < 4% IS
- 2, >= 4% and < 6% IS
- 3, >= 6% and < 10 % IS
- 4, >= 10% IS
- Subwatersheds

Average Impervious Surface Currently = 6%

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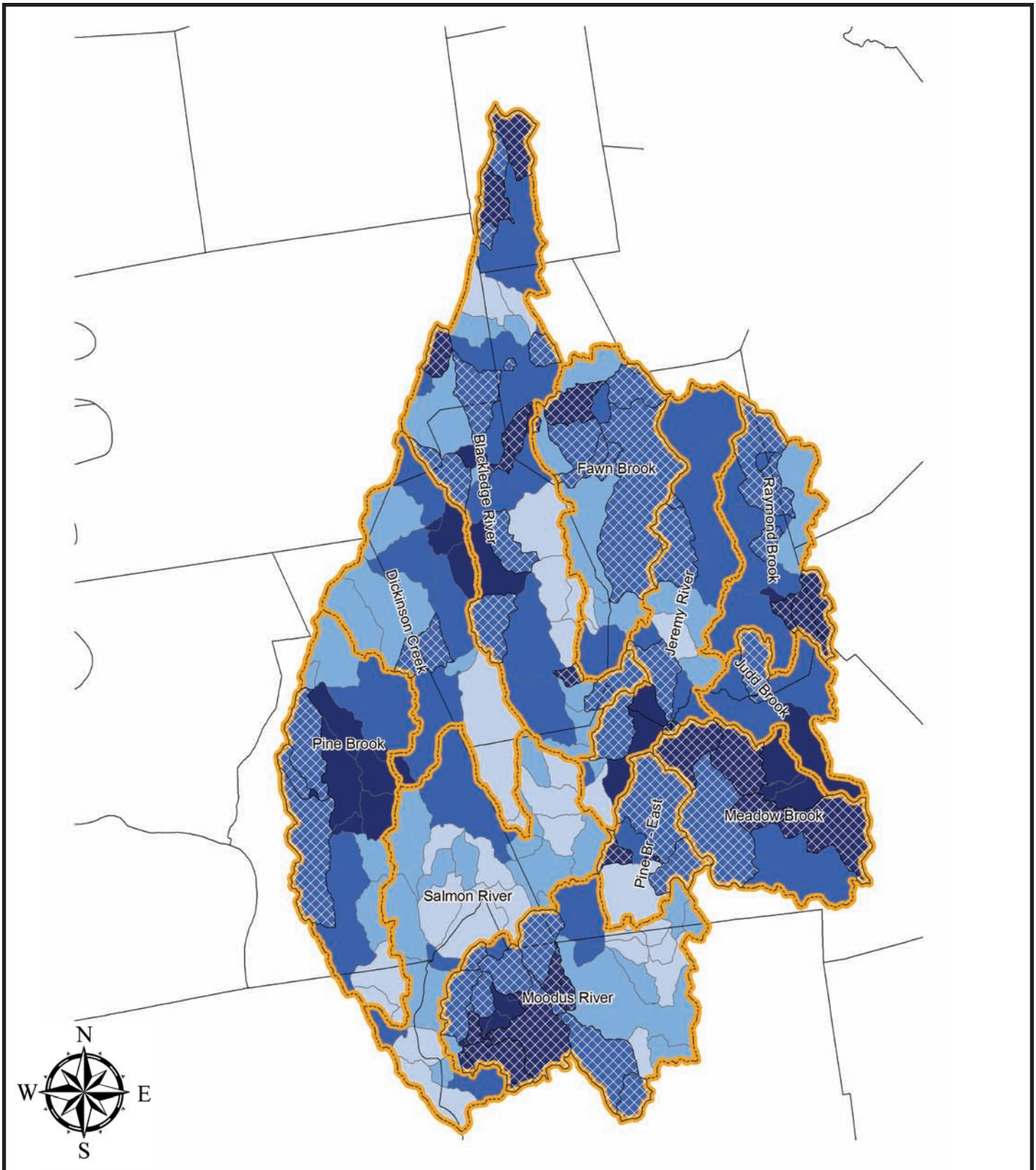
Salmon River Watershed, Current Impervious Surface



Legend

Percentage of Impervious Surface

- 1, < 4% IS
- 2, >= 4% and < 6% IS
- 3, >= 6% and < 10 % IS
- 4, >= 10% IS
- Basins at Greatest Risk
- Subwatersheds

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Average Impervious Surface at Buildout = 8%

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Salmon River Watershed, Impervious Surface at Buildout

8126-figures.indd

Figure 3

SALMON RIVER WATERSHED BUILD-OUT
10/27/2009

BUILDABLE ACRES BY SUB-REGIONAL BASIN

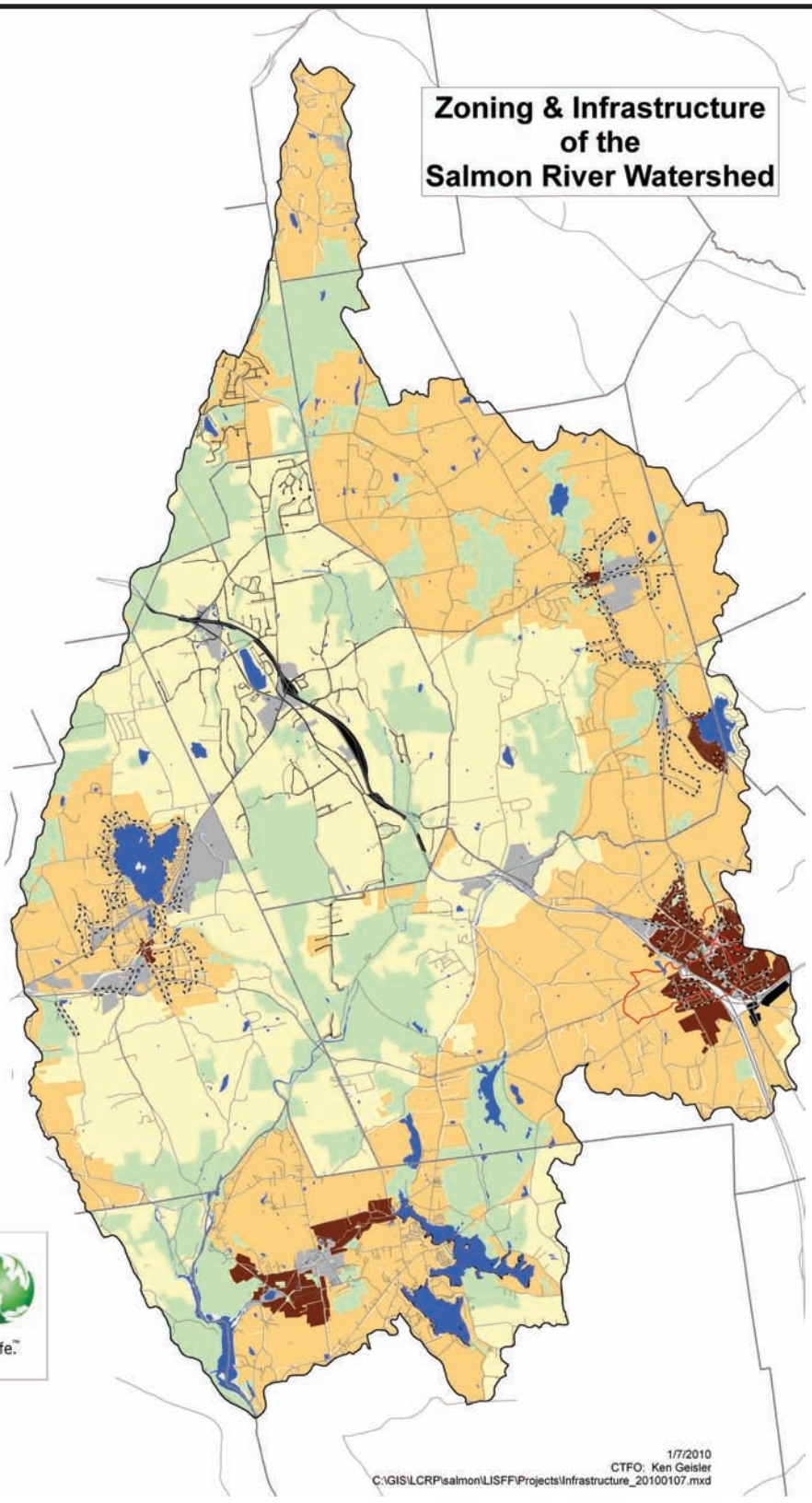
SUBREGION	Buildable Acres	Sub-region Acres	Percent of Sub-region that is buildable	Percent of Total Buildable Acres in Sub-region
Blackledge River	5150	16680	17.5%	16.5%
Dickinson Creek	2615	9613	10.1%	8.4%
Fawn Brook	3224	8195	8.6%	10.3%
Jeremy River	2819	8239	8.6%	9.0%
Judd Brook	1422	3271	3.4%	4.6%
Meadow Brook	2376	7118	7.5%	7.6%
Moodus River	3244	11270	11.8%	10.4%
Pine Br - East	1116	3211	3.4%	3.6%
Pine Brook	3119	9966	10.5%	10.0%
Raymond Brook	2192	5791	6.1%	7.0%
Salmon River	3904	11994	12.6%	12.5%
Total	31181	95349	100.0%	100.0%

BUILDABLE ACRES BY ZONING CATEGORY

Zoning Category	Buildable Acres	Zone Acres	Percent of Zone that is Buildable	Percent of Total Buildable Acres in Zone
< 1 Acre	808	2404	33.6%	2.3%
>= 1, < 2 Acres	17988	51098	35.2%	52.0%
>=2, <5 Acres	15601	39304	39.7%	45.1%
5 Acres	190	406	46.8%	0.5%
Industrial/Business	22	6293	0.4%	0.1%
OW, Roads, Water	0	1711	0.0%	0.0%
Total	34610	101216	34.2%	100.0%

Note that the total buildable acres and the Zone Category Acres in the Zoning Category section are greater than by the total buildable acres and total sub-regions acres in the first section. This is due to the fact that the zoning categories included parcels that crossed outside of the watershed.

Zoning & Infrastructure of the Salmon River Watershed



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CTFO: Ken Geisler
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Legend

- Salmon River Watershed
- Aquifer Protection Area
- Sewer Service Area
- Street
- Waterbodies

Minimum Lot Size

- < 1 Ac
- >=1 Ac
- 2 Ac
- Conservation Ownership
- Comm/Ind/Bus
- ROW/Roads

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Salmon River Watershed,
Zoning and Infrastructure

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2.0 PROJECT SCOPE AND FRAMEWORK

The principal purpose of this project is to evaluate the municipal land use policies and practices within each of the nine participating SRW communities. HW's evaluations focused on identifying current resource protection tools and preparing watershed-wide and town-specific recommendations to ensure better protection in the future. To achieve this objective, it is critical to understand the role that local regulations can play in protecting—or not protecting—a sensitive aquatic resource system such as the SRW. Our recommendations are guided by a series of "resource oriented" goals that seek to address the issues of direct impacts on wetlands and watercourses as well as the broad municipal policies that dictate the general patterns of development. The overarching project goal was to provide information to the participating municipalities on tools and practices that would accomplish the following:

- Limit the impacts of land development projects on forested streamside (riparian) areas;
- Strategically conserve and link together a network of protected open space and maintain overall forest cover in the watershed;
- Manage and mitigate impacts from impervious surfaces within existing and new development; and
- Improve municipal operation and maintenance practices that impact water quality.

These project goals served to guide the overall assessment process including helping to direct future outreach and fulfill the content of interim and final reports.

2.1 Approach

The project approach was designed as an iterative process to incorporate input from local municipal officials of the SRW communities in order to draft recommendations that address the most critical issues facing the watershed. To this end, outreach allowed municipal officials and stakeholders to provide input at multiple points in the process to ensure that project recommendations are focused on the right issues and that assessments of local conditions are accurate. One-on-one interaction with municipal officials will continue through subsequent phases of the project leading up to the final report and watershed summit.

The first step of this project was to conduct Preliminary Municipal Audits of existing policies, regulations, and practices that impact surface water conditions. The Preliminary Municipal Audits covered an extensive range of information in each town and focused on the following documents: Zoning Regulations, Subdivision Regulations, Inland Wetland and Watercourse Regulations, and Plans of Conservation and Development. The

objective of the audits was to identify the connections between local regulations and the overarching project goals. The audits also served an important role in comparing the different regulatory approaches among the different municipalities throughout the watershed and helped to lay the groundwork for more detailed discussions with local officials as the process moved forward. The Preliminary Municipal Audits for each of the nine participating SRW communities can be found through contacting TNC's Lower Connecticut River Program.

The next phase of the project involved meeting with municipal officials from the participating SRW communities. These meetings provided an opportunity to discuss the initial findings of the Preliminary Audits and to hear from municipal officials regarding the issues that they perceived to be the most critical related to watershed protection. What emerged from these meetings was that there were a series of priority issues that link directly with specific regulatory areas that if implemented across the watershed will result in more effective water resource protection. The critical regulatory issues and/or management tools that emerged from the meetings and were continually adjusted and amended with feedback from TNC and the participating SRW communities. These critical issues include:

- Conservation Subdivision Development;
- Roadway Design Standards;
- Stormwater Management;
- Wetland / Watercourse Buffers and Associated Regulations;
- Forestry Regulations;
- Development Review Capacity;
- Land Clearing Provisions;
- Parking Regulations;
- Stream Crossing Guidelines; and
- Wastewater Considerations.

The majority of these critical issues were presented and discussed at the SRW Steering Committee on April 22, 2009 and there was a general consensus that these topics represented the core of what was needed to be addressed to help ensure sustainable cool- and cold-water stream habitat within the SRW. HW used these critical issues to frame the regulatory areas as the basis for our recommendations.

In June of 2009, TNC provided a buildout analysis (Figures 2 and 3) with respect to impervious surface coverage. This analysis added an important component to the project by providing a geographic understanding of both existing and potential impervious surface coverage across the watershed. This analysis can serve as a critical tool for SRW communities in terms of planning process and supporting the implementation of the recommendations found within this report. One of the primary objectives that the analysis can achieve is to track changes in impervious surface at the sub-watershed level over time. The information can help communities set goals relative to managing and limiting the expansion of impervious surface and lays the foundation for policy decisions

relative to major retrofit/ restoration projects or caps on impervious surface coverage on a municipal- or district-wide basis.

The final steps of this project included soliciting feedback from the Steering Committee and municipal officials on the recommendations in the Fall of 2009 and hosting a Watershed Summit meeting on December 5, 2009. Please refer to the Next Steps Section of this report for a more detailed discussion of potential future actions for the SRWP and the SWR communities following the Summit.

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3.0 FINDINGS AND RECOMMENDATIONS

The following sections summarize the findings for each town relative to the critical issues/tools identified by HW and the Steering Committee. These recommendations should be viewed as guidelines for each municipality to provide a foundation for future local regulatory code revisions. In many cases, a close approximation of a recommended policy or practice already exists in one or more of the SRW communities. This demonstrates that some municipalities can build upon their existing regulations, while others, which have yet to consider a particular technique, have a nearby example to consider when making regulatory changes. It is important to note that any proposed regulatory amendment should be carefully considered with input gathered from all affected municipal agencies as well as the community at large. Regulatory tools or standards proposed in this report should be vetted with individuals well-versed in Connecticut land use law to ensure that effective and defensible language is used during the adoption process.

3.1 Conservation Subdivision Development

Rationale:

Conservation Subdivision Development (CSD), known by many other names (e.g. Conservation Design, Open Space Residential Design), is an approach to residential development that promotes open space preservation based on a range of resource protection priorities. It provides added flexibility within development standards to promote innovative housing and infrastructure designs while minimizing disturbance to the natural features on the land. If implemented effectively, CSDs can help to accomplish the goals of conserving contiguous forested open space and reducing impervious surface coverage on the site.

The basic process of CSD is to first determine how many lots could be developed on a given tract of land using a conventional subdivision approach. This is often referred to as the "site yield." Once that yield is determined, the design process proceeds to first identify all of the areas on the land that require protection, make development challenging or provide potential amenities to future residents. Stream corridors, wetlands, floodplains or contiguous tracts of forest, for example, represent natural areas that should be preserved to the greatest extent possible. Poorly drained soils or exposed ledge represent areas that would make development difficult adding costly cut and fill operations to construction and severely disrupting existing drainage patterns in the process. Finally, scenic vistas or existing trails represent potential amenities that can add property and quality-of-life value for the future residents.

Once these areas are identified and mapped, the designer then configures the allowable number of homes in a manner that minimizes impacts to the site. Reductions in minimum lot size, reduced building setbacks and other relief mechanisms are provided in the Zoning Regulations to provide site design flexibility. Generally, a minimum amount of preserved open space is required in the regulations as a baseline for compliance. The process of designing and permitting a CSD may be more involved than a typical subdivision; however, the resulting development can be much more sensitive to the natural ecological and hydrological systems on the land and limit the impacts to sensitive resources. Another significant result of the CSD design process is that it can effectively contribute to the allocation of contiguous open space. The core regulatory elements and policy decisions that must be addressed by any community looking to effectively implement CSD include:

- Optional vs. required design by an applicant;
- Applicability (e.g., minimum parcel size, minimum number of lots);
- Minimum open space requirements;
- Density incentives;
- Establishing yield and CSD design process;
- Design flexibility; and
- Dedication and management of open space.

As outlined in greater detail within Table 3 on the following page, some form of CSD is employed by all of the watershed communities. However, the manner in which key elements are handled varies considerably from one community to another.

Optional vs. Required Design by an Applicant:

Of the watershed communities, three require at least some level of CSD design in certain subdivision applications. The remaining municipalities that allow CSD do so through a voluntary application process. The use of voluntary implementation of CSD can result in lower levels of use as developers may not realize the incentives "built in" to CSD in the form of lower infrastructure costs. Making the CSD design process mandatory in the permitting of local residential subdivisions is widely considered a much more effective way to achieve implementation of environmentally sensitive projects, but municipalities must take care to draft these regulations in a way that is legally defensible and not ruled as an unfair burden or loss of property rights to a prospective applicant. Municipalities may also wish to consider an alternative option in which CSD design is required as a discretionary action from the Planning and Zoning Commission. This could provide added flexibility from the municipality's perspective but risks reduced implementation of CSD plans. The decision to require a CSD design process is one of the foremost issues to resolve when amending CSD regulations and careful consideration should be made of local needs and conditions.

Table 3. SRW Existing Regulations-Conservation Subdivision Development

Watershed Towns	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glastonbury	Haddam	Hebron	Marlborough
Name	Open Space Conservation Development	Residential Development Flexibility for Open Space	Cluster Design	Conservation Subdivision	Conservation Subdivision	Open Space Subdivision	Conservation Subdivision	Open Space Subdivision	Open Space Conservation Area Regulation
Required or Optional	Optional	Optional	Optional	Optional	Optional	Optional	Required over 5 lots	Optional	Required over 5 lots
Permit Requirement	Planning Commission approval. Special Permit for multi-family.	Special Exception	Special Permit	Planning Commission approval and Special Exception	Special Permit	Planning Commission approval	Special Permit	Special Permit	Planning Commission approval
Applicability	10 or more acres	Any subdivision	25 or more acres	20 or more acres OR 5 or more lots	25 acres or more AND 5 or more lots	Any subdivision	Any subdivision	5 acres of more if in sewer district. Otherwise 10 areas or more	5 or more lots
Open Space Required	Standard: 20% Conservation: 40%	Standard: 10% Conservation: At least 15%	Not specified	Standard: 15% Conservation: determined by lot reductions- typically 50% in practice.	Standard: 15% Conservation: 40%	Equal to the area of land gained by reduced lot dimensions.	Standard: 20-25% Conservation: 45-55%	Standard: 20% Conservation: 30-40%	Conservation: 40%
Density Incentives	Unclear- formula driven density calculation.	Density may be increased through increasing open space	No	No	No	No	Density may be increased by dedicating open space for public access such as providing public trails, active recreation, etc.	Density may exceed underlying zoning by up to 20% or include an additional unit per acre for increased areas of open space and inclusion of affordable housing.	No
Net Buildable Area Considerations	Yes	Yes	Yes- Use of yield plan	Yes- Use of 4 step process	Yes- Use of 4 step process	In process of adopting yield plan	Yes- Use of yield plan	Yes- Use of both yield plan and formula	Yes- Use of yield plan
Design Flexibility Allowances	Reduce lot size by up to 40%, decrease setbacks by 15%.	Reduction of up to 33% for: lot size, minimum contiguous buildable area, one side of buildable square, and lot frontage. Undefined flexibility for lot coverage and setbacks.	Reductions in lot and bulk requirements shall not exceed 20%.	Reduce lot size by up to 70%, increase in lot coverage by 100%, decrease in setbacks by 25%.	Reduced lot size, increase in lot coverage by 100%, decrease in setbacks by 40%, reduced cul-de-sac widths by 25% if serving no more than 5 lots.	Lot size and setback requirement shall be reduced to next higher density residential zone (20-50% reductions). Town also provides other more discretionary, flexible allowances.	Reduce lot size by up to 70%, increase in lot coverage by 200%, decrease in setbacks by up to 50%.	Various reductions to lot size and setbacks depending on underlying zoning.	Reduction of up to 50% of minimum lot size and front setback. Increase in lot coverage by 25%.
Management of Open Space Enforceable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes- can also pay a fee-in-lieu of providing open space	Not specified

A CSD should not require a cumbersome permitting procedure, but instead, foster a partnership between the municipality and the developer to preserve existing green spaces and natural resources via an equitable, viable process that makes this style of development more attractive to the developer while meeting specific goals of the community. Requiring a CSD through a special permit or special exception is not necessarily prohibitive, however the municipality should consider how the special permit/exception process could be designed to reduce permitting time, effort, and risk from the developer's perspective. Within this process, municipal officials should seek to provide timely information and guidance to applicants from the outset through the use of a pre-application meeting. For more detailed information on pre-application meetings, refer to the Development Review Capacity section of this report. Additionally, density bonuses can also be used to offset the perceived burden of a special exception and are discussed further below.

Applicability:

Assigning a specific applicability threshold (e.g., minimum parcel size) for a CSD is an important consideration for determining which development proposals should be eligible to use this innovative process. There are a range of applicability thresholds within the SRW communities from values as high as 25 or more acres to communities that have no minimum threshold. It is recommended that communities seek to increase eligibility for CSD design by decreasing the applicability thresholds as much as possible. However, it is important that communities are comfortable enough with their CSD regulations that the added review of smaller subdivisions will not excessively burden development review capacity and that the reviewing agencies are comfortable with how the design flexibility standards will operate at a smaller scale. Communities should carefully consider how their CSD applicability threshold will impact their ability to oversee the management of small open space parcels. This can be a significant issue for communities with limited administrative capacity that may not want to oversee a large number of small open space parcels dispersed across the landscape.

Minimum Open Space Requirements:

There are a wide range of CSD open space requirements within the nine municipalities, varying from 15% to 50% (Table 3). The recommendation herein is not necessarily to determine one number that communities should target, but instead to provide guidance on what is reasonable to expect based on other requirements in the regulation. Simply put, the amount of open space that can be reasonably required is directly related to other standards that consume land in the site design process. For example, if the minimum lot size is reduced by a small or modest fraction of the lot size associated with a conventional subdivision, then the municipality cannot reasonably expect to receive high percentages of open space. However, where local regulations have dropped minimum lot sizes from the 60,000 to 80,000 square feet range to the 30,000 square feet range, these communities have been able to require significant amounts of open space. Similarly, where residential street right of way and cul-de-sac standards are excessively large, open space areas can be limited.

Communities that reduce minimum lot sizes by significant percentages (e.g., greater than 60% reduction) and also look to reduce roadway widths may very reasonably require open space set asides of at least 50%. However, it is important to note that the provision of wastewater disposal and public water supply may play an important role in the feasibility of these designs. In rural areas that typically require the construction of on-site subsurface sewage disposal systems and private drinking water supply wells for individual lots, reduction of lot size to less than 30,000 square feet may be difficult to permit given the current setback requirements of the Connecticut Department Environmental Management, Department of Public Health, and Department of Public Utility Control. Authorities must therefore be realistic about the anticipated lot sizes within CSD developments and the subsequent amount of area that will be left as open space.

Additionally, municipalities should consider the potential compatible uses for open space and link these uses to community goals. In an environmentally sensitive region such as the SRW, it is best to encourage open space requirements that truly preserve natural open space, such as forest preserves, low-impact recreation, and similar activities. Communities should seek to include language that supports their specific goals for resource protection, such as open space that provides extended buffers from wetlands and streams. Each of the SRW communities should carefully consider how they can add specific language to their CSD open space regulations to further protect sensitive water resources. In general, active recreation such as playgrounds and ball fields should receive a lower priority for meeting open space goals as these areas may be more appropriate for the "buildable area."

Another potential strategy for creating additional open space is to use a fee-in-lieu option. This strategy allows developers to pay a fee as opposed to providing the required open space on their site. This fee is held in a municipal fund that is specified for conservation efforts throughout the town. The Town of Hebron has successfully implemented such a strategy as it has aided them in reducing the number of small, separated opens spaces in favor of connected priority open space areas. This option is well suited to towns that have clearly identified priority areas for open space conservation while providing enough discretion to its Planning and Zoning Commission to determine when a fee-in-lieu option is most beneficial to the town. For a more detailed discussion on identifying and prioritizing open space, please refer to Next Steps Section of this report. When considering a fee-in-lieu option, it is important to seek local legal opinion on the potential of implementing this regulatory tool.

Density Incentives:

Density incentives can take on a wide range of values, but should always be linked to community goals. For developments near town centers, urbanized areas, or other areas with access to public services, the community may want to promote affordable housing as a viable goal for a CSD density incentive. For developments in rural areas or near sensitive natural resources, the community should shift the density incentive to reward

resource preservation. This can be a delicate balance as the goal of density incentives is to provide enough motivation to promote CSDs over traditional subdivisions, but not overburden a site with development. Often times, it may be difficult for a municipality to offer density incentives in rural areas, particularly in areas with marginal soils, due to the limitations of septic systems and the difficulty of incorporating shared wastewater systems. For further information on effective wastewater planning, please refer to the Wastewater Considerations Section of this report. When considering changes to CSD density incentives, municipalities should consult the local Plan of Conservation and Development to determine how potential CSD density bonuses may or may not fit with identified community goals.

Another important consideration is the level to which density incentives need to be offered to be attractive for developers. Sample density incentives that may illustrate a reasonable relationship between developer expense and increases in housing allowance include:

- Allowing developers the addition of a single unit of housing for every voluntary 10% increase in upland open space over the required minimum. As with the affordable housing bonus, communities may require a "cap" on the overall increase in housing;
- Allowing developers an increase in housing yield for restoration efforts related to forested buffers or wetlands. This density bonus is more site specific, as costs related to restoration will depend on the state of existing degradation, the potential for increased state-level permitting and other constraints such as steep slopes.

Establishing Yield and the CSD Design Process:

There are two potential methods for determining a property's "yield", or the number of lots that can be built on a given property. One method is to use a "formula approach" that assigns a value to the amount of land that is buildable based on a series of constraints (such as wetlands, steep slopes, critical natural resources, etc.) The second method is to require the applicant to develop a basic site plan for a property to determine the yield through the traditional development review process. The preferred method, from a resource protection perspective, is to utilize the site plan process to develop a yield plan identifying the number of buildable lots. The yield plan requirements should ask for a reasonable amount of information while not being unduly burdensome to the applicant. The yield plan should only require as much information as a basic concept plan that shows property boundaries, rights-of-way, and lots in comparison with site constraints.

Conversely, communities may wish to consider the formula approach as a means for streamlining the application process to further incentivize CSDs from an applicant's perspective. The formula approach attempts to determines a property's yield by calculating the acreage of constrained land on a property (wetlands, steep slopes, etc.) and subtracting that number from the total acreage of a property to determine the remaining amount of developable land. It is important to note that when utilizing the

formula approach, communities must be careful to ensure the formula accurately accounts for the all the buildable constraints regulated on the property, including new roadways. Regardless of whether a community opts for a site plan process or formula approach, the baseline objective is to establish regulations that ensure the definition of "buildable area" remains consistent for both conventional subdivision plans and CSD yield plans so that the base yield cannot be changed by opting for a CSD.

From this point, the process for plan development is recommended to follow four basic steps:

1. Identify Conservation Areas. These areas include wetlands, floodplains, buffers to streams, wildlife habitats, and historic features. The community should analyze and evaluate the site in context to surrounding areas in order to identify the features that should be preserved within the designated conservation area. It is important for the communities to distinguish between regulatory conservation areas and non-regulated areas. The conservation identification process should focus on targeting the open space areas of highest value that are not protected under the municipality's conventional subdivision and wetland/watercourse regulations.
2. Identify Building Areas. Once the maximum number of units has been established, the development or buildable area can now be identified. House sites are located to maximize access to open space and proximity to vistas.
3. Align Roads, Trails, and Other Infrastructure. Avoid excess impervious surfaces by minimizing road length and widths. Roads should minimize disturbance to the site by following the natural terrain of the land where possible.
4. Draw Lot Lines. Lot lines will establish ownership and management of the preserved open space.

Currently, two SRW communities, East Hampton and East Haddam, utilize the four step process within their CSD regulations. Additionally, East Haddam utilizes this four step process for a conventional subdivision as well. It is important to note that steps two and three above can be interchanged if there are site constraints, such as steep slopes or challenging terrain, suggesting that aligning roads should be considered before determining housing sites.

Design Flexibility:

A major factor that allows CSD to conserve more open space than conventional subdivisions is the added design flexibility. CSD standards provide the developer with flexibility through a variety of elements such as minimizing lot sizes, lot frontages, and building setbacks, while increasing lot coverage percentages. The amount of flexibility that a municipality chooses to build into its regulations should be directly correlated to its open space goals. For example, if the municipality wants to achieve 50% open space on a site, then the design flexibility must reduce housing dimensions to take up less than half the space as the underlying regulations. Within the SRW communities, the Town of Haddam requires the highest percentage of open space in its CSD with a requirement of

attaining 45-55% open space. Notably, Haddam also provides the most design flexibility within its regulations.

Dedication and Management of Open Space:

There are many ways in which CSD regulations can address the dedication and management of open space. Dedication of open space can take place through a variety of methods such as, but not limited to:

- Conveyance of fee simple ownership to the municipality;
- Creation of a conservation easement to the municipality;
- Conveyance of fee simple ownership to a tax-exempt organization;
- Creation of a conservation easement to a tax-exempt organization; and
- Conveyance of fee simple ownership to a Connecticut non-stock corporation of which all owners of the land within the subdivision are members (i.e., a home-owners association).

Of the options presented above, it is recommended that communities identify their preferred method of dedication while also keeping an eye towards providing options for the applicant. The Town of Hebron employs an effective strategy for incorporating their preferred methods of dedication into the regulations by providing a schedule of open space credits with differing values as an incentive for compliance. For example, Hebron provides one full credit for each acre of land dedicated through conveyance of fee simple ownership to the Town or a tax-exempt organization, and provides one-half credit for each acre dedicated through any other approved methods. Regardless of the community's preferred method of dedication, it is imperative that municipalities provide language requiring the dedication of open space as a condition of the application's approval.

A CSD should also include language that explicitly discusses the responsibilities for managing the open space. This should include some basic language for delineating the boundaries of open space, the associations or groups that will be responsible for maintaining the open space, and the enforcement actions that the municipality may take for not complying with management policies. Where municipalities will not own dedicated open space lands, rights of access must be guaranteed to the municipality in these agreements for cases where prolonged neglect, illegal activities (e.g., dumping) occur, or where emergency access is required.

Implementation of CSD Review:

Communities that choose to pursue the adoption of CSD standards as described herein should carefully consider how the four-step site planning process would fit within their review structure. Where multiple resources on a single site may compete for protection, the reviewing agency may need to prioritize or make suggestions to a proponent for alternative layout schemes. In addition, the authority should be open to a flexible design process that includes the possibility of various lot sizes, frontages, and setbacks within

the site design, rather than the usual "one size fits all" approach. Preliminary planning efforts to identify and prioritize open space, as discussed within Next Steps Section of this report, can greatly enhance the effectiveness of policies or regulations that guide the siting of open space.

CSDs should be viewed as a resource-based partnership approach to site development. There should be inter-agency cooperation (such as a "multi-board" meeting requirement) formally integrated into the review process from the pre-application stage to the concept plan process to subdivision plan review. The local Conservation Commission, Open Space Committee, land trusts, Agricultural Commission, watershed association, and neighborhood organizations, can be integrated early in the process, also, either formally or informally.

Table 4. Summary of Key CSD Recommendations

Issue	Recommendation
Optional vs. required design	Establish required CSD design for any subdivision above the applicability threshold. Streamline application process.
Applicability	Decrease applicability threshold as much as possible with consideration for development review and open space management capacity.
Minimum open space requirements	Approximately 35-50%. Must first assess community open space goals and ensure that design standards allow the achievement of those goals. Encourage conservation of natural areas as opposed to active recreation.
Density incentives	Assess community goals to provide density incentives that encourage appropriate development on a site-by-site basis. Allow density bonus for restoration efforts related to forested buffers or wetlands on the site.
Establishing yield and CSD design process	Utilize the site plan process to develop the yield plan. Require the four step design process.
Design flexibility	Assess community open space goals and provide adequate design flexibility to achieve those goals.
Dedication and management of open space	Provide a range of suitable options for open space dedication methods and incentivize the preferred methods. Provide requirements for maintaining open space and specify municipal enforcement actions.
Implementation of CSD review	Incorporate formal inter-agency cooperation into the review process. Reviewing agencies must be open to a flexible design process.

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3.2 Roadway Design Standards

Rationale:

Effective roadway design standards are a critical component of managing impervious surface coverage and limiting negative impacts of stormwater runoff. When examining the standards in most local subdivision regulations, the primary goals of conventional roadway design are capacity, efficiency, and safety. While all are vitally important, there is a growing consensus that concerns regarding capacity, efficiency and safety have led to the "over-design" of many roadways. Excessive right-of-way widths and over-sized paved roadways are often constructed to service very modest subdivisions and the resulting infrastructure creates an unreasonable burden on the environment as well as municipal services. The challenge, therefore, is to balance the access and safety needs of new construction with the over-arching goals of reducing the amount of pavement and infrastructure associated with new roads.

One of the most challenging discussions that occurs on the local level involves the perceived conflict between innovative roadway design, also called low impact development (LID) roadway design, and issues of safety, access, and long-term maintenance cost. While many local planners or developers may promote smaller roadways and open section drainage, other local officials or citizens may see these designs as "unsafe" for pedestrians or insufficient for emergency vehicle access. This challenge has been the subject of considerable research in recent years as indicated by publications from national organizations such as the Institute of Transportation Engineers (ITE) and the American Association of State and Highway Transportation Officials (AASHTO). In the context of these national standards, the following section includes guidance on how to develop lower impact roads in an effort to reconcile some of the perceived conflicts between the efficiency and cost of LID as compared to conventional road design. Many publications, such as The Center for Watershed Protection's *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998), can provide further details regarding the development of lower impact roads.

Conventional Local Road Design:

Conventional design of local roads has typically focused on the efficient movement of vehicles and vehicular safety, to the detriment of other functions such as pedestrian activities, environmental concerns, cost and community aesthetics. For example, the majority of minimum paved roadway widths within the SRW communities lies between 22-28 feet. Road widths on the higher end of this range (26-28 feet) generally provide one slightly undersized 6-8 foot parking lane and two 10-foot travel lanes. These standards represent an appropriate design choice for streets with high traffic flows, and where ample on-street parking is required. In many cases, a width this wide is not needed for lower density housing developments. The "over-design" of subdivision roadways can result in a number of problems such as:

- Vehicle speeds can increase, posing a safety risk to both drivers and pedestrians;
- Capital expenditures for maintenance and reconstruction are unnecessarily high for developers and towns;
- Larger rights-of-way (ROW) increase clearing and reduce the amount of land available for tax generating development; and
- Larger impervious areas increase stormwater runoff volumes and flow rates, and reduce groundwater infiltration. Pollutant loads are also increased, especially where standard curb and enclosed drainage systems are used to convey and manage stormwater.

LID Criteria:

There is a growing consensus that better design criteria are required for local roads. As far back as 1974, the American Society of Civil Engineers (ASCE), Urban Land Institute (ULI) and National Homebuilders Association (NHBA) published *Residential Streets*, an early attempt to develop local road designs that were not based on highway standards. A subsequent edition published in 1993, and others such as *Guidelines for Residential Street Design* (ITE, 1997) and *Guidelines for Design of Very Low-Volume Local Roads* (AASHTO, 2001) further develop the design of roads tailored to the local setting. These studies and guidance reflect a growing awareness that there are tangible benefits to building shorter, narrower roads. These advantages include:

- Encouraging moderate speeds through residential neighborhoods;
- Saving capital and resources;
- Creating neighborhoods that are pedestrian friendly;
- Preserving valuable open space and agricultural land; and,
- Minimizing impervious area and associated stormwater impacts.

The authority, and responsibility, for creating and implementing LID standards for local roads is generally at the municipal level. The guidelines developed by AASHTO, ITE, and others are good starting points, but are recommendations rather than rules. The following elements of design criteria for roads are considered in this section:

- Right-of-way (ROW) width;
- Minimum travel-way width;
- Driveway design;
- Curb requirements; and
- Cul-de-sac design;

See Table 5 on the following page for a detailed comparison of existing roadway regulations within the SRW communities.

Table 5. SRW Existing Regulations-Roadway Design Standards

Watershed Towns	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glastonbury	Haddam	Hebron	Marlborough
Minimum Street Width (Local)	26 feet	30 feet. Can be 26 feet if street is less than 2,800 feet, serves less than 40 units, and geologic features prevent likelihood of expanding street beyond 2,800.	24 feet. Commission has discretion to reduce to 22 feet.	18-26 feet. Discretion given to Commission.	26-28 feet	22-26 feet	24 feet. Commission has discretion to reduce to 22 feet for short loop roads (less than 2,000 feet).	22 feet	22-28 feet. Commission has discretion to reduced further.
Right of Way (Local)	50 feet	50 feet	50 feet	50 feet	50 feet	50 or 40 feet	50 feet	50 feet. Can be more if swales included.	50 feet
Cul-de-sac Service Area	Not > 20 lots	Not > 40 lots	Not > 15 lots	Not > 20 lots	Not > 20 lots	Not specified	Not specified	Not > 20 lots	Not specified
Cul-de-sac Length	Not specified	< 1,800 feet. Can be up to 2,800 feet if temporary extension of a through road.	< 1,200 feet	< 2,000 feet	< 1,500 feet	< 1,500 feet. Can get a waiver for more for purposes of future roadway access.	< 1,000 feet. Can be longer if street will be turned into a through street.	< 2,000 feet	< 1,000 feet. Can be 2,000 feet if applicant can demonstrate no hazard to public welfare. Can be 3,000 feet if applicant can demonstrate ability to construct through street in future.
Cul-de-sac Width	26 feet	26 feet. Can be 24 feet if less than 800 feet and serves less than 10 lots.	24 feet. Commission has discretion to reduce to 22 feet.	18-26 feet. Discretion given to Commission.	24-28 feet	25 feet	24 feet. 22 feet for permanent cul-de-sac.	22-24 feet	22-28 feet. Can be reduced by 2 feet with Commission's discretion.
Cul-de-sac Minimum Turnaround Radius	50 feet	50 feet	45 feet	50 feet	40 feet	45 feet	Not specified	45 feet	60 feet
Cul-de-sac Island Allowed	Not specified	Yes	Yes	Not specified	No	Yes. "T" and "Y" turnarounds are allowed but not promoted.	Yes	Yes. "T" and "Y" turnarounds are allowed.	Yes
Minimum Driveway Width	12 feet	12 feet	12 feet	10 feet	No minimum	16-20 feet for rear lots.	Not specified	10 feet	10 feet
Common Driveways Promoted	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes

ROW Width:

The ROW is the total land area that contains all elements of a public or private road such as pavement, utilities, sidewalks, and shoulders. Therefore this area must be wide enough to enclose all of the cross-sectional features of the roadway, including the pavement width, curbing, buffers, sidewalks, stormwater management, and grading. All of the SWR communities require a 50-foot ROW for local or minor roadways with the exception of Glastonbury, which includes a provision for reducing the ROW to 40 feet, although a 50-foot ROW is more common in Glastonbury.

A 50-foot ROW is common in higher density suburban settings where traffic volumes and utility requirements may necessitate higher space requirements. In rural settings, it is not uncommon to see slightly reduced standards such as a 40-foot ROW for 22-foot wide minor streets. Institute of Transportation Engineers (ITE) guidelines are more conservative, recommending a minimum ROW width of 50 feet for low-density development and 60 feet for medium and high-density developments. Connecticut General Statutes (CGS) state that the minimum ROW width must be 50 feet unless the local Planning and Zoning Commission has adopted special regulations to allow for a reduced ROW or prior written approval has been obtained from the majority of the selectmen in the town (CGS Section 13a-71.a).

The ROW need only be wide enough to contain all of the cross-sectional elements. These elements may include sidewalks, utility easements, parking lanes, and travel lanes depending on the size, density and location of the development. For example, for two nine-foot paved lanes with five-foot sidewalks that are offset six feet from the road and one foot from the edge of the property lines, the ROW may be as narrow as 42 feet. Similar reductions can be made for higher-order streets. ROW widths of 42 to 50 feet are practical for most applications.

Regardless of the ROW width, municipalities must ensure that their regulations do not require excessive clearing and grading of the ROW. The extent of clearing and grading that is appropriate for a site is dependent on many variables, such as: minimum paved width, inclusion of sidewalk, inclusion of stormwater swales, graded shoulder width and embankment side slopes, and horizontal and vertical roadway design criteria. How these various elements will impact the extent of clearing and grading on a site must be considered on a case-by-case basis. Municipalities must ensure that their regulations allow for adequate flexibility to reduce clearing and grading depending on site conditions and typical roadway and infrastructure design practices. This is an issue that may warrant further research and debate at the local level pertaining to flexibility regarding ROW width and how it relates to current design practices.

When accounting for all of the potential elements that increase the width of a ROW, it may be helpful to consider innovative approaches to roadway design. For example, allowing utilities to be placed beneath the paved section of the street would allow for reduced ROW widths and may also create space along the edge of the ROW for conveying stormwater through open channels. Open channels can be used to meet water

quality treatment requirements and should be accounted for when determining ROW (Figures 5 and 6). For example, the Town of Hebron's ROW includes language that specifically allows for a wider ROW if the development includes roadside swales. It is important to allow flexibility with regard to cross-sectional elements when permitting a roadside swale as it may be beneficial to allow for alternative layouts such as locating the swale between the road and the sidewalk.

Minimum paved street width:

Roadways should be wide enough to accommodate travel lanes, street parking (if required), and the passage of emergency vehicles and routine delivery vehicles (e.g., UPS trucks). Minimum roadway widths within the SRW communities vary between 22-28 feet. While street widths as high as 26-28 feet are appropriate for high-density development with on-street parking, they are excessive for the majority of subdivision development occurring within the watershed. For example, AASHTO recommends that a two-lane rural road traveled at 25 mph should be 18 feet wide, while a rural major/collector road should be 20 feet wide. (AASHTO, 2001; ITE, 1997).

Communities should consider establishing flexibility in determining the minimum paved widths appropriate for the potential intensity of land use on a site. The goal of local decision makers should be to determine a minimum width for a given site that reduces excessive paving while still adequately meeting the needs of the use within certain categories of development style, density, and scale. The values that a community establishes as its minimum widths and the method for providing discretion to allow flexibility are best determined through a comprehensive decision making process involving planners, public safety officials, DPW personnel, and school transportation representatives. The recommendation of this report is for SRW communities to strongly consider the following minimum paved widths:

- 20 foot paved width for subdivisions up to 20 units;
- 22 foot paved width for subdivisions larger than 20 units; and
- Incorporate flexibility in review process to reduce to 18 foot paved width for subdivisions fewer than 5 units given appropriate conditions.

Minimizing the pavement width has several advantages. First, the developer will save money on labor and materials while, depending on ownership, the municipality or community association will save money on repair and repaving costs, snow plowing, and street sweeping. For example, based on current construction costs, municipalities can save as much as $960.00 in repaving costs for each foot of roadway width that is reduced (per 1,000 feet of road). This equates to a savings of approximately $5,760, or 20%, when repaving a roadway that is 22 feet wide as opposed to 28 feet wide. Additional advantages to reducing paved width include limiting the extent of clearing and grading, thus increasing the potential for more open space and minimizing impacts from stormwater runoff. Finally, narrower roads reduce vehicle speeds, enhancing safety and increasing the quality of life for nearby residences. See Table 6 for a summary of typical pavement width requirements and recommendations.

Table 6. Survey of Minimum Pavement Widths (ft)

	AASHTO <= 400 ADT	ITE	ULI/ASCE	Recommended Minimum
Rural Minor Road *25 mph*	18	20	20	20. Can be 18 for small cul-de-sacs serving fewer than 5 houses.
Rural Major/Collector *45 mph*	20	24	-	24
Urban Minor *Parking Dependent*	20-28	20-28	22-26	20
Urban Major/Collector	28-34	24-36	24-36	24
Urban cul-de-sac*	20-28	-	-	20
Minor Agricultural Road	18	-	-	20
Design Vehicle Dimensions: Passenger Car—7 feet wide, 19 feet long Single Unit Truck—8.6 feet wide, 30 feet long				

*In practice, often defers to the minor/local road requirement depending on subdivision size.

One way to reduce the paved width of a road is to use a queuing lane. Where traffic flow is low, two-way traffic can use a single lane, and passing vehicles can queue in the parking lane as necessary. AASHTO recommends that a single travel lane be nine to 12 feet wide, and that parking lanes be eight to 12 feet wide (AASHTO, 2004). Parking widths of six to seven feet may be appropriate at low speeds. AASHTO recommends that the use of a queuing lane be limited to those streets receiving 50 or less average daily trips (ADT) (AASHTO, 2001). However, queuing lanes can be effective for most local streets and even the smallest collector streets, (often termed 'sub-collector' streets), provided that traffic flows do not require the establishment of two clear lanes of travel.

Sufficient width must be provided for the use of emergency vehicles. The vehicle most commonly referenced as a "design vehicle" is a ladder truck used for fighting fires. This vehicle can navigate the typical nine to 10-foot lane outlined above, but needs extra space for setting up its outriggers when raising the ladder. The National Fire Protection Administration recommends that a 20-foot unobstructed way be provided; some states such as Massachusetts and Virginia require an 18-foot width. Where street parking does not occur and the shoulder is constructed of a firm, stable material, the ladder truck can set up one of its supports on the shoulder.

Figure 5. Example of Roadway Cross-Section Detail Depicting Open Channels on Both Sides of Road (HW, 2009)

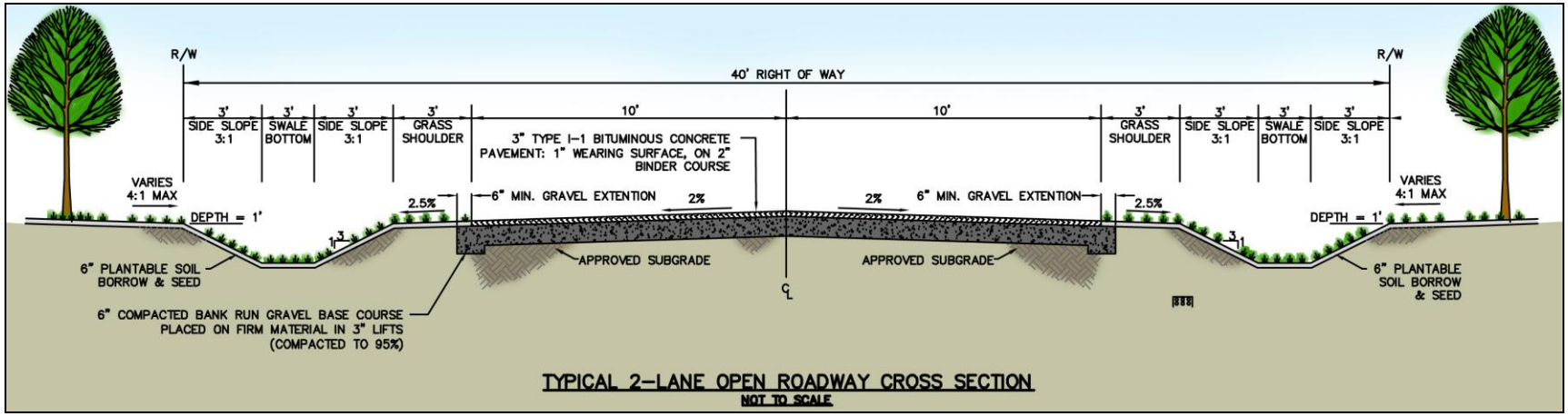
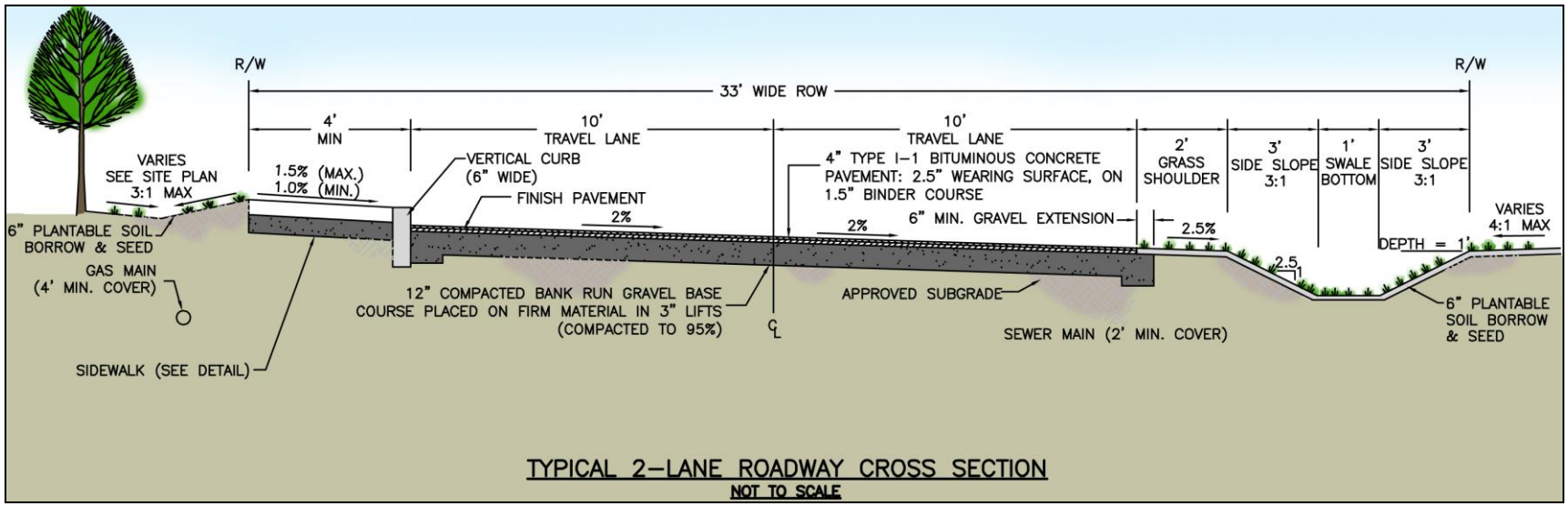


Figure 6. Example of Roadway Cross-Section Detail Depicting Open Channel on One Side of Road (HW, 2009)



Driveway Design

Driveways must be wide enough to allow for the passage of vehicles, and long enough to satisfy off-street parking requirements. Driveway widths within the SRW communities range from 10-12 feet, with some towns not providing a specific requirement. Typically, a 10-foot wide drive is more than sufficient for one vehicle, while 20-foot wide drives are often used for two-car garages connected directly to the street (ITE, 1997). Widths of nine feet may be sufficient for each automobile lane depending on the location of the driveway relative to the building. Driveways should always be designed with proper slopes, sight distances, and turning radii.

One way to reduce the total amount of impervious area required by driveways in a development is to use common or shared driveways. These are privately owned and maintained drives, typically 12 to 16 feet wide. Careful design can provide sufficient space for overflow parking while reducing the overall area required. Important considerations for common driveways include:

- The maximum allowable number of homes that may be served by a common driveway. Typical standards range from two to six homes.
- The type of shared driveway covenant that will be used by the homeowners to ensure that maintenance responsibilities are clearly described and adequately enforced.
- Depending on the number of homes shared, there is the potential for locating larger shared features such as mail repositories and trash removal pads at the end of the driveway. Communities may wish to include design specifications for these areas to ensure aesthetic appeal and the reduction of potential nuisances.

Eight of the participating SRW communities promote the use of common driveways in their regulations. It is recommended that communities evaluate their regulations as they relate to common driveways and ensure that this option is adequately encouraged as a means to reduce impervious surface coverage for new developments.

Curb Requirements

Curbs establish a clear boundary between the edge of the road and non-vehicle zones within the ROW, guarding against erosion and protecting the roadway edge. Curbs also protects pedestrians and is an integral part of a closed drainage system, effectively delivering stormwater runoff to collection inlets and drainage pipes. Vertical curbs is most commonly used in urban areas and is recommended by ITE for all medium-to high-density developments (ITE, 1997). Rolled curbing, or asphalt berm, is less expensive and is typically used in medium to low-density developments. While vertical curbs provides greater protection for pedestrians, rolled curbs allows for on-street parking to occur on part of the shoulder, and facilitates driveway construction.

Despite the apparent efficiencies associated with raised curbs, there are several disadvantages to using this design approach, particularly relative to LID implementation. One disadvantage to curbs is cost; it is much more expensive to build a road with curbs

and a closed drainage system than with vegetative shoulders and open swales. Curbs also prevent stormwater runoff from infiltrating along the side of the road, and serve to concentrate pollutants at the ultimate discharge location. As a result, more runoff occurs at higher pollutant concentrations on curbed streets. In addition, curb to pipe conveyance systems quickly carry stormwater to downstream water bodies, increasing peak flows that can cause flooding and erosion problems. More detail regarding best practices for stormwater management techniques is provided in the following section of this report. Where practical, curbs should be eliminated and open drainage swales should be used in lieu of closed drainage systems. In *Rural By Design*, Randal Arendt recommends that curbed roads only be used where higher densities prohibit the use of swales (four or more units per acre), or where roadside erosion is a concern due to steep slopes of eight percent or more (Arendt, 1994).

It is important to note that decisions affecting curb requirements should be carefully examined with consideration for the capacity of local the Public Works Department. The environmental benefits of incorporating roadside swales are well documented as a means to reduce pollutant loading and volume of surface runoff. However there can be legitimate concerns on the part of public works personnel associated with alternative roadway curbing versus swale conveyance. Many of these concerns stem from maintenance issues such as erosion along the edge of pavement, edge cracking of the pavement, repair of edge vegetation in areas where it is peeled back by snow plows during the winter months, and the clean-up of accumulated road sand within adjacent roadside swales. These are legitimate concerns, particularly given the reduction in personnel and budgets that most public works departments have had to contend with. However, it is important to note that many of these maintenance issues can be mitigated through innovative paving techniques such as hardening the pavement grass interface through the use of grass pavers, or a low-rising concrete strip (CWP, 1998). The use of such a strip also increases the visibility of the roadway edge, enhancing traffic safety at night.

Further consideration for replacing curbs with open section drainage in a community involves some basic practical design limitations that must be recognized. These include erosive velocities where roadside swales are too steep, and where the peak rate of surface runoff becomes excessive in long swales (generally above 4%). Subsurface conditions may also prove to be a limiting factor where swales intercept the seasonal high groundwater table or where shallow depths to ledge or low permeability soils are encountered. Reconciling all of these issues is a somewhat complicated but essential task. In the end, it should be understood that removing curbs and incorporating roadside swales may not be a viable town-wide option for all communities, but municipalities should incorporate roadside swales wherever site conditions make this option possible. The Town of Hebron in particular has experienced some success in select areas using roadside swales. Other SRW communities may wish to consider consulting Hebron's provisions when proposing amendments to regulations.

Cul-de-sac Design

Lanes and ways terminating in a cul-de-sac offer lower vehicle flows and speeds, increasing a sense of privacy in residential development. However, these dead end streets offer reduced access in the time of an emergency and can increase the total impervious area of a development. Building narrow through streets with sharper turns is a preferable alternative to cul-de-sacs, since it can accomplish the same goal of reducing the number and speed of through traffic disturbances, while maintaining essential connectivity between neighborhoods. Where cul-de-sacs must be built, they are generally designed for a maximum of 200 ADT. This is approximately equal to the traffic generated by 20 to 25 houses at 8 to 10 trips per day. The best method for regulating cul-de-sac size is by limiting the number of lots within a cul-de-sac service area. Many of the SRW communities have established a maximum cul-de-sac service area of 20 lots. This is an appropriate requirement for a suburban and rural environment in regards to traffic management and limiting overall cul-de-sac size. It is recommended that each SRW community evaluate its service area regulations and provide restrictions on the number of homes within a single subdivision that can be served by a cul-de-sac.

Establishing a maximum cul-de-sac length can be another mechanism for limiting impervious surface coverage. This requires developers to limit unnecessary sections of roadway and encourages a more compact development pattern. The SRW communities exhibit a wide range of maximum cul-de-sac lengths with requirements from 1,000 feet to 2,000 feet. A maximum cul-de-sac length should be determined with consideration for the maximum cul-de-sac service area and the minimum lot frontage requirement in the underlying zoning district. For example, if a community sets the maximum service area at 20 lots and the underlying zoning district requires 200 feet of frontage, then the community should set the maximum cul-de-sac length at approximately 2,000 feet or more to accommodate the maximum number of lots allowed (assuming housing occurs on each side of the street). Communities may want to consider establishing different cul-de-sac length requirements within different zoning districts depending on the variation of lot frontage requirements. Another consideration for establishing a maximum cul-de-sac length is to allow exceptions based on the opportunity to extend the cul-de-sac into a through street. Several SRW communities have regulations similar to this such as Colchester, Marlborough, Haddam, and Glastonbury. The regulations help support the overall integrity of water resources by encouraging a more compact pattern of development that reduces development pressure on undisturbed open spaces.

A cul-de-sac can terminate in a variety of designs such as a circular turnaround, a "T" turnaround, or a "Y" turnaround. The most typical design is the circular turnaround. A circular cul-de-sac terminus must have a turning radius wide enough to accommodate large vehicles such as fire trucks or school buses. Many communities have interpreted this need as requiring an external minimum radius of 50 to 60 feet, which can result in paved areas over 11,000 square feet just for the turning portion of the roadway. The range of values within the SRW communities varies from 40 to 60 feet. There are a range of fire truck manufacturers that produce vehicles that have reduced turning radii, and the paved radius may therefore be reduced to 35 to 45 feet in some cases (ASCE,

1990). Each community should work with its emergency services personnel, public works department, and school transportation representatives to determine a minimum radius that provides for adequate safety and mobility while also minimizing impervious surfaces.

Another strategy to minimizing impervious area within a circular turnaround is to allow a vegetated island in the center, provided that a sufficient paved width is maintained, (ITE recommends a minimum of 25 feet). A simple change such as this can reduce the paved area by as much as 2,000 square feet (approximately 20% in some cases) and provide some aesthetic relief from the hardscape of a large cul-de-sac. Landscaped islands, such as bio-retention facilities, can also be used to receive and treat stormwater to meet stormwater quality requirements (Figures 7 and 8). Figures 9 and 10 illustrate bio-retention facilities after construction. Of the nine SWR communities, five contain regulations that specifically allow for cul-de-sac islands (Table 5). It is recommended that all the communities consider allowing landscaped islands within their regulations to expand options for innovative design. While landscaped center islands can provide excellent opportunities for stormwater management, they are perceived to present long term maintenance issues with regard to snow plowing operations and maintenance of vegetation and soil within the island. It is important that communities carefully evaluate any potential capacity issues with regard to their Public Works Department when determining the feasibility of promoting or requiring landscaped islands. Another potential solution is to allow landscaped islands under the condition of private maintenance agreements.

Aside from circular turnarounds, other alternative cul-de-sac designs include "Y" or "T" turnarounds. These alternative designs are more appropriate for streets shorter than 200 feet in length and offer significant reductions in impervious area over the standard cul-de-sac. A loop road is also a good option; these provide multiple access points for emergency vehicles and can carry double the traffic volume of a cul-de-sac. Loop roads also favor the construction of "T" style turnarounds, which offer numerous benefits. Alternative terminus design such as "T" or "Y" turnarounds are currently allowed by the Towns of Hebron and Glastonbury. Note that while Glastonbury allows "T" or "Y" turnarounds, they do not promote such turnarounds in new subdivisions due to perceived concerns regarding increased potential for vehicle accidents. It is recommended that all the SWR towns explore the option of allowing alternative cul-de-sac terminus designs to potentially provide developers with additional options for environmentally friendly design.

Figure 7. Example Cross-section of a Bio-Retention Facility and Materials (HW, 2009)

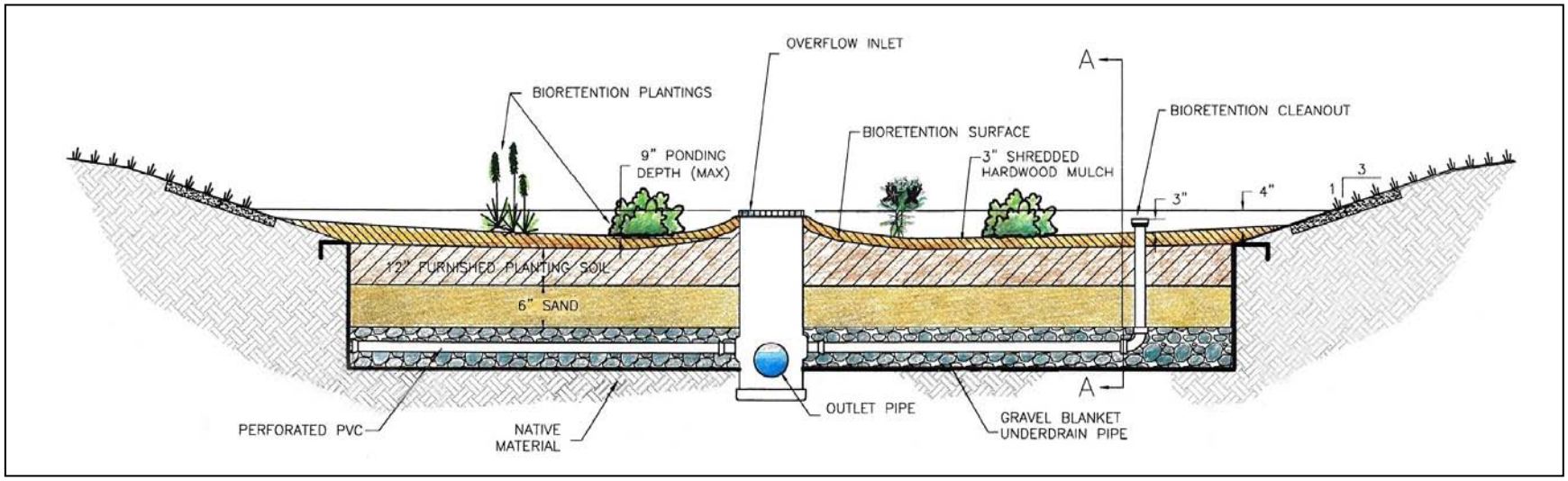


Figure 8. Example of Bio-Retention Facility Incorporated within Cul-De-Sac Design (HW, 2009)

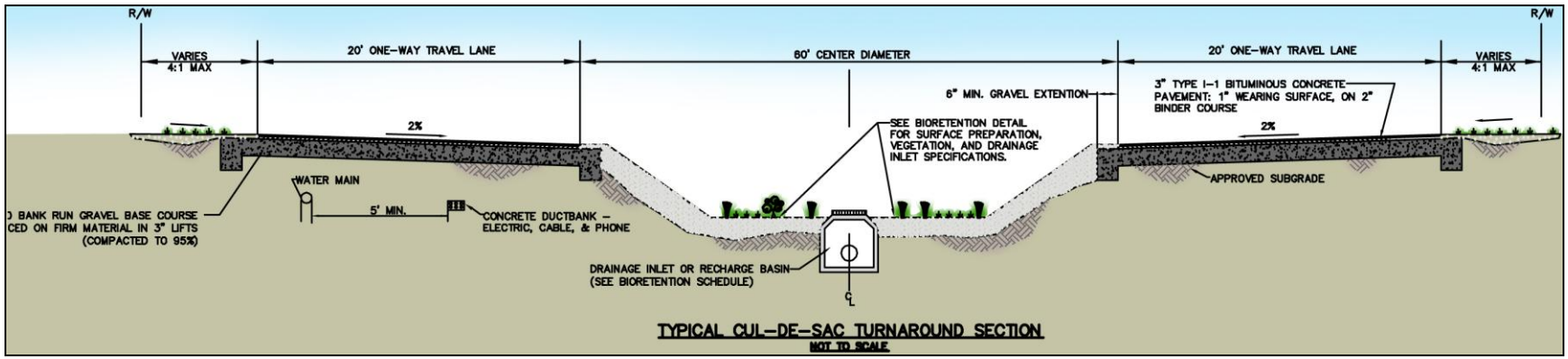


Figure 9. Example Bioretention Facility (HW, 2009)

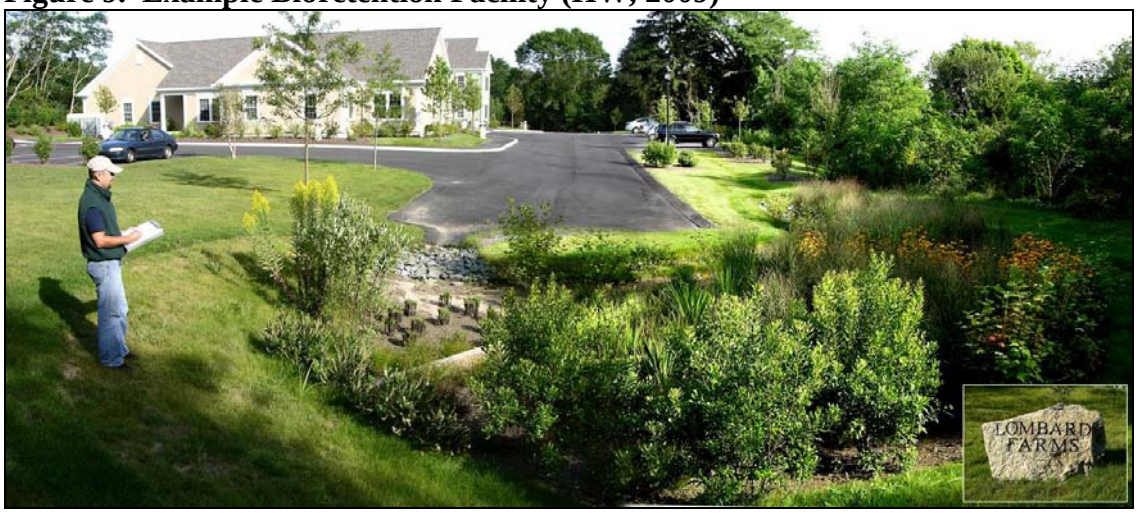


Figure 10. Example Bioretention Facility (HW, 2009)

Table 7. Summary of Key Roadway Design Requirements and LID Recommendations

Design Criteria		Units	Guidelines		
			AASHTO	ITE	**Recommended**
ROW	Width	ft	-	50 to 60	**Approximately 42-50 feet. Allow flexibility to account for various cross-section elements**
Pavement Width	Single Lane	ft	10-12	-	**9**
	Parking Lane	ft	8-12	-	**6-8**
	Minor Rural Road	ft	18	-	**20 (Can be 18 for cul-de-sac serving fewer than five homes)**
	Minor Urban Road	ft	20-28	20-28	**20-24**
Driveways	Width	ft	16	-	**12 feet with pullover areas for driveways serving more then four lots**
	Max number of lots	#	6	-	**6**
Curb	Required at Density	Units/ acre	-	2	**Approximately 4. Allow flexibility if including LID**
Cul-de-sac	Traffic flow	ADT	200	200	**200**
	Maximum service area		-	-	**20 lots**
	Maximum length	ft	-	700-1,500	**Varies based on lot frontage requirements**
	Minimum radius	ft	-	45	**35-45**

3.3 Stormwater Management

Rationale

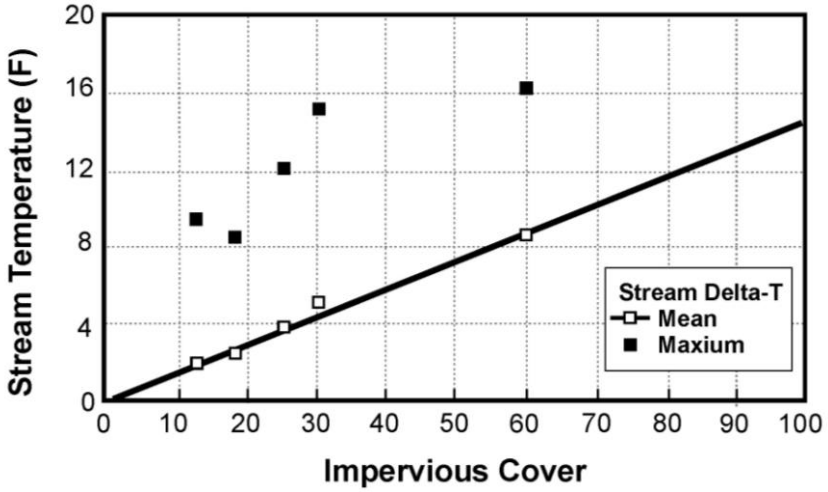
The primary goals of effective stormwater management are to manage and mitigate impacts from conversion of the natural landscape to altered surfaces within existing and new development and improve municipal maintenance practices that impact surface water runoff quality. Differences in how stormwater is managed can have a significant impact on water quality and temperature within the SRW. Fast-running, cool- and cold-water stream systems, like those within the SRW, are extremely sensitive to changes in benthic habitat, stream temperature, and water quality; which make them highly susceptible to the impacts of urban stormwater runoff. Table 8 summarizes the various impacts of stormwater runoff as a result of increased watershed impervious cover on fish and other aquatic species. Increased peak flows and reduced baseflows associated with watershed development can widen channels and reduce benthic habitat (i.e., loss of riffle/pool structure that provides foraging habitat and cool water refugia). Sediment deposition from construction sites, channel erosion, and road sanding can smother benthic habitats and result in loss of critical fish spawning areas, clog fish gills, and harm the aquatic insects on which fish depend for food. In fact, increased watershed impervious cover and associated increases in stormwater runoff have been shown to negatively impact salmonid (trout and salmon) populations throughout the Pacific Northwest, Canada, and the Mid-Atlantic region. Reports on the subject determined that trout were rarely found in watersheds exceeding 15% impervious cover (May et al., 1997). Additional studies looked at over 1,000 Maryland streams and only found sensitive brook trout in streams with less than 4% watershed impervious cover (Boward et al., 1999). It is important to note that while brook trout are a particularly sensitive species, and an excellent indicator of the health of cool- and cold-water streams, they are only one part of a more complex system. The goal of this project, and the recommendations contained herein, is to protect the entire steam ecosystem and all of the habitats that it supports.

Table 8. Effects on Fish and Stream Habitat from Increased Watershed Imperviousness and Stormwater Impacts (CWP, 2003)

Stream Change	Effects on Organisms
Increased flow volumes/Channel forming storms	Alterations in habitat complexity. Changes in availability of food organisms, related to timing of emergence and recovery after disturbance. Reduced prey diversity. Scour-related mortality. Long-term depletion of LWD and accelerated streambank erosion.
Decreased base flows	Crowding and increased competition for foraging sites. Increased vulnerability to predation. Increased fine sediment deposition.
Increase in sediment transport	Reduced survival of eggs and alevins, loss of habitat due to deposition. Siltation of pool areas, reduced macroinvertibrate reproduction.
Loss of pools and riffles	Shift in the balance of species due to habitat change. Loss of deep water cover and feeding areas.
Changes in substrate composition	Reduced survival of eggs. Loss of inter-gravel fry refugial spaces. Reduced aquatic insect production.
Loss of LWD	Loss of cover from predators and high flows. Reduced sediment and organic matter storage. Reduced pool formation and organic substrate for aquatic insects.
Increase in temperature	Changes in migration patterns. Increased metabolic activity, increased disease and parasite susceptibility. Increased mortality of sensitive fish.
Creation of fish blockages	Loss of spawning habitat for adults. Inability to reach overwintering sites. Loss of summer rearing habitat. Increased vulnerability to predation.
Loss of vegetative rooting systems	Decreased channel stability. Loss of undercut banks. Reduced steambank activity.
Channel straightening or hardening	Increased steam scour. Loss of habitat complexity.
Reduction in water quality	Reduced survival of eggs and alevins. Acute and chronic toxicity to juveniles and adult fish. Increased physiological stress.
Increase in turbidity	Reduced survival of eggs. Reduced plant productivity. Physiological stress on aquatic organisms.
Algae blooms	Oxygen depletion due to algai blooms, increased eutrophication rate of standing waters.

Research also shows a direct correlation between the amount of watershed imperviousness and stream temperature fluctuations (Figure 11), and that stormwater runoff from hot parking lots and rooftops can elevate stream temperatures from 5-18 degrees Fahrenheit (Paul, et al., 2001; Johnston, 1995; Leblanc et al. 1997; Galli, 1990; Roa-Espinosa *et al*. 2003; SSL SWCD, 2001). Measurable increases in water temperature have also been documented in unshaded streams lacking forested buffers, and in streams where stormwater detention ponds discharge warmer waters (MCDEP, 2000; SWAMP, 2000a; Galli, 1990). Optimal temperatures for adult trout range from 57°F to 65°F, and juvenile trout, fry and eggs are more sensitive to minor temperature shifts than adults. Stream warming reduces dissolved oxygen availability and can lead to an increased sensitivity to other pollutants and diseases. The correlation between watershed imperviousness and resulting impacts to stream systems is particularly important to consider in the SRW as increases of impervious surfaces are a noted threat within this watershed (see Figures 2 and 3). Additionally, the increased frequency and severity of flooding caused by climate change is a real issue that affects SRW communities and bolsters the case for stomwater management improvements.

Figure 11. Stream Temperature Increase in Response to Increased Watershed Impervious Cover in the Maryland Piedmont (Adapted from Galli, 1990 from CWP, 2003)



Water quality impairments from road salts, polycyclic aromatic hydrocarbons (PAH), nutrients, and other urban stormwater contaminants can be toxic to trout and other biological assemblages. It is precisely these impacts to sensitive aquatic resources that prompts regulatory control over stormwater discharges. Federal Clean Water Act requirements pertaining to stormwater management and non-point source pollution are administered in Connecticut by the Department of Environmental Protection (DEP) as part of the National Pollution Discharge Elimination System (NPDES). To obtain NPDES permit coverage, all construction sites disturbing over one acre, most industrial sites, and all designated municipal separate storm and sewer systems (MS4s) are required to treat stormwater to the maximum extent practicable and remove 80% of total suspended solids (TSS) prior to discharge. MS4s are a conveyance system (typically including roads with drainage systems, municipal streets, catch basins, curbs, gutters,

ditches, manmade channels, or storm drains) owned by a state, city, town or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a publicly owned treatment works. Small MS4s must develop local stormwater programs to implement erosion and sediment control standards, regulate stormwater discharges, eliminate illicit connections, practice good housekeeping, and involve and educate the public on stormwater management. East Hampton, Marlborough, Hebron, Haddam, Bolton, and Glastonbury are all included under the small MS4 NPDES program.

Guidance for managing stormwater runoff is outlined in the 2004 Connecticut Stormwater Quality Manual and the 2002 Connecticut Guidelines for Soil Erosion and Sediment Control. Local regulatory programs should meet the basic standards and design criteria as outlined in these manuals; however, neither manual has specific treatment criteria for protection of cold-water streams. Due to the extreme sensitivity of cool- and cold-water stream habitat to stormwater impacts, we recommend communities within the SRW evaluate their regulations and programs in the following areas:

- Stormwater management requirements;
- Stormwater practice, design, selection, and maintenance; and
- Environmentally sensitive design/LID.

Table 9 on the following page illustrates a comparison of existing stormwater regulations within the SRW.

Stormwater Management Requirements:

The current CT stormwater manual requires treatment of the first inch of runoff, maintenance of pre-development groundwater recharge volumes and peak discharge rates for 10-, 25-, and 100-year storm, as well as channel protection criteria. Water quality volumes (WQV) are used to help remove pollutants through filtration, settling, or plant uptake from the "dirtiest" portion of the rain event (typically the first inch of rainfall). Recharge volumes are used to infiltrate a portion of runoff back into the ground to maintain baseflow and groundwater supplies. Channel protection criteria are intended to prevent erosion of stream channels from stormwater detention practices and peak controls are to help prevent downstream flooding. For discharges within 500 feet of tidal wetlands, CT also requires the first inch of runoff be retained on-site (runoff capture volume). This effectively reduces the volume of runoff leaving the site and requires infiltration, storage/reuse, evapotranspiration, or other mechanism. There are no additional criteria for discharges to cold-water resources. Maine, Minnesota, and Rhode Island all have special stormwater criteria for trout waters. We recommend that each of the nine communities consider implementing special stormwater criteria within the SRW as summarized in Table 11 later in this section.

Table 9. SRW Existing Regulations-Stormwater Management

Watershed Towns	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glastonbury	Haddam	Hebron	Marlborough
"Open" Drainage Systems	Drainage swales, ditches and channels shall be designed to convey the maximum flows computed without erosion or overtopping.	Use of "channels" to carry stormwater shall not be allowed except with approval of Town Engineer.	Design of the storm water management system shall consider reducing runoff by use of such techniques as minimizing impervious areas and maximizing travel times by using grass or rock-lined channels in lieu of storm sewers.	SW practices should seek to utilize pervious areas for stormwater treatment and to infiltrate stormwater runoff from driveways, sidewalks, rooftops, parking lots, and landscaped areas to the maximum extent possible to provide treatment.	Use of "channels" to carry stormwater shall not be allowed except in special cases with Town approval.	SW Management Plan in 2004 that discusses implementation of several regulatory changes. Unclear status of regulatory changes.	Allowances for use of open “ditches” to convey stormwater. Paved gutters shall be designed along the edge of any street pavement with a grade of 5% or as deemed necessary by the Town Engineer.	Allowances for alternative drainage systems that incorporate off-road swales in lieu of catch basins and piping. Regulations include design criteria for “open channels”. Listing of culvert crossing standards based on different structure sizes.	Development shall use best available technology to minimize off-site runoff, increase in-site infiltration, simulate natural drainage systems, and minimize off-site discharge of pollutants, and encourage natural filtration systems.
SW Management Plan must meet performance criteria in 2004 DEP manual?	Yes- for basins	No	Yes- for basins and methods to estimate peak flows and runoff	Yes	Yes	Yes; extensive requirements in SW Management Plan	No	Yes	No
SW Maintenance plan required	No	No	Yes	Yes	Case by case	Yes if detention/catch basin	Unclear	Yes if more than 1 acre disturbed	No
ESC Disturbance thresholds	1/2 acre or >10% grade	1/2 acre (single lot SFR exemption, unless part of subdivision)	1/2 acre (single lot SFR exemption)	1/2 acre (single lot SFR exemption)	1/2 acre; WQ protection strategies mention limiting clearing during construction; and Lake Pocotopaug Protection Area requires strict ESC.	1/2 acre (single lot SFR exemption)	1/2 acre (single lot SFR exemption)	1/2 acre (single lot SFR exemption)	Zoning permit not given until ESC practices installed, inspected, and approved.
Reference 2002 ESC Guidance Manual	No. Reference CT Guidelines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No. Reference CT Guidelines
On DEP Small MS4 list (NPDES Phase II)	Yes	No	No	No	Yes*	Yes	Yes*	Yes	Yes

*** Population under 1,000 in urbanized area (waiver option)**

Communities within the SRW should also consider updating local rainfall averages based on more recent data if current rainfall numbers are over 20 years old. Ongoing research on climate change impacts to cool- and cold-water streams in the region suggests general risks to cold-water salmonids, particularly given that dams and poorly-designed culverts (see section on Stream Crossing Guidelines for more information) can prevent fish from moving in response to changes in flows and water temperature (Xu et al., 2010- Accepted for publication, Xu et al., In review, Nilsow et al., 2004, Sotiropoulos et al., 2006). Research on climate change impacts to runoff conditions in the region, for example, suggests that there will be a lower total volume of runoff and earlier maximum flows (Huntington, 2009).

Each community, particularly those designated as MS4s should complete an internal review of pollution prevention activities (good housekeeping at maintenance yards, street sweeping, road deicing, etc.) to minimize pollutant generating behaviors. In particular, all stormwater hotspots (land uses with higher pollutant loading potential) in the SRW should be evaluated for retrofit or non-structural pollution prevention opportunities. Each community should evaluate road deicing procedures and practices to minimize chloride and sediment impacts on cool- and cold-water stream habitat. Consider establishing criteria for equipment and materials, as well as for pretreatment of road drainages and inlets draining directly to cool- and cold-water streams. Many communities within the watershed are switching to an all salt mixture for winter roadway maintenance. While this may have a positive impact in terms of reducing sediment clean-up demands, the research is still inconclusive if an all salt mixture is preferable to a sand-salt mixture, or if there are preferred types of salt, in terms of the impacts to cool- and cold-water stream habitat. For more detailed information of the use of deicing materials, refer to *Storm Water Management Fact Sheet: Minimizing Effects from Highway Deicing* (EPA, 1999) and *Snow, Road Salt, and the Chesapeake Bay* (Schueler, 2007).

Stormwater Practice, Design, Selection, and Maintenance:

Because thermal impacts from Best Management Practices (BMPs) can be detrimental to cold-water fisheries, the practice design guidance in the CT stormwater manual recommends taking receiving waters into account when designing ponds and wetlands. Currently, however, a design supplement does not exist that summarizes specific design adaptations for cold-water fisheries that can be referenced by practitioners in the SRW. Some possible design features for BMPs are listed in Table 10.

Selection of practices should be based on individual site characteristics, TSS removal efficiencies, and thermal considerations. We recommend inserting language into local regulations that clearly gives preference to infiltration and bioretention practices (refer to Figures 7, 8, 9, and 10) and requires demonstration of hardship or thermal design adaptations for alternative practices. Additionally, long-term maintenance of stormwater practices is critical to maintaining assumed levels of performance of individual practices. The operation and maintenance of stormwater facilities, whether in public or private hands, should be evaluated at the local level. The stormwater recommendations outlined herein will likely increase the administrative and inspection duties that the municipality

must undertake to regulate LID stormwater systems. Although municipalities should first ensure they are keeping up with existing practices for inspecting/cleaning conveyance systems, they should also carefully evaluate their administrative capacity in adhering to potential regulatory changes. If municipalities do not have adequate capacity or staffing to enforce their regulations, then the municipality should consider requiring a yearly inspection and status report from property owners or homeowners associations. Table 11, found later in this Section, summarizes recommendations for municipalities related to practice design and selection.

Table 10. Best Management Practices Design Features (adapted from 2005 MD Stormwater Manual)

Do's	Don'ts
• Use infiltration and bioretention to the maximum extent possible. • Use micropools and forested wetland designs rather than large unshaded permanent pools or shallow wetlands. • Construct BMPs "off-line" (not in middle of stream flow). • Shade pilot and outflow channels and micropools by planting trees and shrubs. • Plant trees to the maximum extent possible in the stormwater practices and along stream buffers. • Outfall taken from bottom of pond rather than at surface. • Underground gravel trench outlets from detention basins. • Maximize use of better site design techniques. • Manage buffers to maximize forest cover and shading in riparian areas. • Pre-treat roadway runoff to reduce sediment and road sand discharges to streams.	• Large, unshaded permanent pool or shallow wetland. • Extensive and unshaded pilot and outflow channels within the BMP. • An extended detention time longer than 12 hours. • Extensive exposed riprap or concrete channel. • An on-line or in-stream location. • A location within the forested buffer. • Infiltration practices that are undersized or lack pre-treatment.

Environmentally sensitive design/LID

Site development techniques that minimize impervious cover, protect natural areas, and mimic natural hydrology on-site should be required in sensitive water resource areas. Often termed LID, or better site design, these environmentally sensitive design techniques can significantly reduce the volume of stormwater runoff generated on-site, provide significant opportunities for infiltration, and reduce off-site runoff volumes. Many communities unintentionally make this type of development difficult to approve due to barriers in zoning and subdivision regulations. As part of any development application review, communities should ensure that developments in cold-water basins are eligible for more "habitat-friendly" stormwater designs. Table 11 summarizes key site design elements local communities should incorporate into local development standards.

Table 11. Summary of Recommended Criteria for Municipal Stormwater Management for Cool- and Cold-Water Stream Habitat Protection in the Salmon River Watershed

Issue	Recommendation
Criteria	• Adopt more stringent stormwater criteria to: • Increase total suspended solids (TSS) removal requirements from 80 to 90% since sediment loads are one of the primary pollutants of concern in cool- and cold-water stream habitat; • Require infiltration of excess runoff volume above that produced from the predevelopment 2- year, 24-hour storm event as a temperature control option for designated cool- and cold-water stream habitat, where soils conditions permit. If soils do not permit infiltration of the channel protection volume, then provide 12-hour extended detention of 1-year, 24-hour runoff volume in a thermally acceptable pond option; • Apply the volume reduction (capture volume) criteria (which currently only applies to tidal areas) throughout the SRW to require use of filtering and infiltration practices rather than surface detention practices (ponds, wetlands) that are subject to thermal heating; • Require bioretention, dry swales, infiltration, rainwater harvesting, and better site design practices to manage stormwater and restricting new ponds and wetlands is recommended; • Prohibit discharges from stormwater ponds or wetlands within 200 feet of designated cold-water fisheries to reduce thermal impacts; and • Require underground gravel trench outlets or other thermal designs for stormwater discharges beyond 200 feet of cold-water fisheries.
Practice Selection and Design	Municipalities should require: • Filtering and infiltration practices rather than surface detention practices (ponds, wetlands) that are subject to thermal heating; • A demonstration of hardship or provide for thermal design adaptations for alternative practices; • Practices designed for ease of maintenance as called for in the CT Stormwater Manual; • Detailed maintenance plans submitted as part of the development review process (see Hebron Zoning Regulations as well as East Haddam, Glastonbury, and Columbia Subdivision Regulations); • "As built" plans be submitted upon completion of facility construction; and • Performance bonds are adequate to ensure a given stormwater management practice functions appropriately in the short-term.
Environment -ally sensitive site design	Ensure that local development regulations allow for the following: • Thermally-acceptable open drainage designs such as dry swales in lieu of curb and gutter (see Hebron, that allows for alternative drainage systems within Section 8.24 of its Zoning Regulations); • Minimal impervious cover through use of pervious pavements,

	narrow road widths, alternative turnarounds, minimal parking ratios and stall dimensions, and shared parking and driveways (see sections on Roadway Design Requirements and Parking Regulations); • Temporary ponding of water in yards to encourage rain gardens and other rooftop disconnection practices on individual residential lots; • Use of landscape islands in parking lots and cul-de-sacs for bioretention (see section on Roadway Design Requirements) • Shade/canopy cover targets for parking lots and riparian buffers; • Alternative layouts for sidewalks (more pedestrian friendly); • Alternative paving materials that have a higher solar reflective index (white surfaces being the best, black surfaces being the worst); • Setback and frontage distance flexibility to allow for increased housing density, shortening of road lengths, and preservation of more natural vegetated areas (see section on CSD); • Incentives to encourage additional stormwater treatment and/or volume reduction during redevelopment that provides an opportunity to improve existing stormwater management; • Open space management provisions preventing removal of forested buffer or requiring deforestation of impacted buffers (see section on Wetland/Watercourse Buffers); and • By-right or fast-track approval for Conservation Subdivision Design (see section on CSD).
Other	• Update rainfall averages using more recent, localized data; • Conduct internal review of pollution prevention activities at public facilities; • Evaluate road deicing procedures, equipment, and materials; • Establish a BMP tracking database to locate all existing and new BMPs and track scheduled maintenance inspections (at least in the SRW); • Educate Home Owners Associations and other parties responsible for maintenance of private BMPs on proper maintenance procedures; and • Ensure publicly-owned stormwater facilities are properly maintained.

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3.4 Wetland / Watercourse Buffers and Associated Regulations

Rationale:

One of the primary goals outlined within this project is to limit the impacts of land development projects in areas near wetlands and watercourse. Preserving native trees and shrubs along riparian corridors may be one of the most important factors in maintaining the integrity of cool- and cold-water stream habitat. Loss of forested riparian buffers can result in increased water temperature from lack of shading, destabilized stream banks, loss of large woody debris, and diminished food supply. Large woody debris is extremely important as it provides protective cover from predators, creates pools and resting areas, and provides habitat for the aquatic insects and small fish that trout eat. Vegetated riparian buffers, in some situations, also can provide water quality benefits by removing pollutants when runoff is directed as sheet flow across surface vegetation. Riparian buffers can also serve as excellent wildlife movement corridors and support many important functions of the ecosystem. Additionally, the increasing occurrence of flooding as a result of climate change is an emerging issue that calls for improved management of riparian areas.

In Connecticut, non-tidal streams, wetlands, and the buffer areas protecting them are regulated, in part, by the Inland Wetland and Watercourses Act (the Act), and potentially by Zoning Regulations as well. Direct impacts of filling and dredging in wetlands under federal jurisdiction are permitted through the U.S. Army Corp of Engineers (USACOE) and the DEP regulates stormwater discharges. The Act authorizes municipalities to establish Inland Wetland Commissions responsible for reviewing and approving regulated activities that may harm adjacent streams and wetlands. Each municipality establishes a jurisdictional boundary called the Upland Review Area (URA) through local regulations. This area is not necessarily a prohibitive buffer, it merely triggers review by the Commission. A more detailed description of the existing regulations within the SRW communities is provided in Table 12 on the following page. Most of the communities within the SRW have established the URA within 50-100 feet of inland wetlands and watercourses, with a few notable exceptions:

- Hebron has established a 200 or 300 foot URA for specified wetlands and watercourses (includes wetlands at the headwaters of the Salmon River);
- East Hampton extends the URA to 500 feet for the Salmon River and 150 feet for the Connecticut River;
- Marlborough URA is 200 feet in the Salmon River Corridor Wetland/Watercourse Conservation Area; 150 feet elsewhere;
- Columbia extends the URA to 200 feet in special areas of concern or if slopes are greater than 20%; and
- Glastonbury has proposed to increase the URA from 100 feet to 150 feet with standards related to impervious surfaces.

Table 12. SRW Existing Regulations-Wetland/Watercourse Buffers and Associated Regulations

Watershed Towns	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glastonbury	Haddam	Hebron	Marlborough
Revision Date	2006	2007	2008	2004	2007	1989- Under revision	2000	2005	1993- Under review
Upland Review Area	100 feet Wetlands or Watercourse	75 feet Wetlands	100 feet Wetlands or Watercourse	100 feet for Conservation Subdiv or Eightmile River Watershed. (IWWR)	100 feet Wetland or Watercourse	100 feet Wetlands or Watercourse	100 feet from any major watercourses or contiguous wetlands, and all wetlands and watercourses in the Salmon River watershed and in Public Supply watersheds.	100 feet Wetlands or Watercourse	150 feet Wetlands or Watercourse
	50 feet for buildings or structures (ZR Section 3.A.7)	100 feet Watercourse High Waterline	200 feet for any wetland or watercourse listed in areas of special concern or if the slope is greater than 20%.	50 feet from high waterline (ZR)	Any development within 500 feet of Salmon River requires special permit (ZR p102) 150 feet within Salmon River Protection Area (see IWWR definitions) 150 feet for Connecticut River (see IWWR definitions)	Proposed: 150 feet review area with standards relating to impervious surface coverage	50 feet for any other wetland or watercourse. If the average slope of the upland review area exceeds a 10% grade, an additional 50 feet shall be added.	300 feet for specified group of wetlands. (see IWWR for details) 200 feet for another specified group of wetlands. (see IWWR for details)	
Language to Regulate Impacts from Outside Upland Review Area	No	No	Yes	No	Not in IWWR. However, the IWWR Agency can review certain E&S Control Plans through Zoning (ZR page 158)	Yes	Yes	Yes	Yes

We recommend communities evaluate their buffer protection regulations in the following areas:

- Buffer Width, Uses and Vegetative Targets;
- Specified Resource Protection; and
- Capacity to Review Activities Beyond the Buffer.

Buffer Width, Uses and Vegetative Targets:

The effectiveness of various riparian buffer widths has received much attention from the scientific and regulatory community, particularly in relation to protection of overall water resource quality and local land use policy. Riparian buffers are defined as the vegetated area adjacent to streams. Buffer regulations typically define a width (as measured from the centerline of stream or the median high water elevation), designated and excluded uses, and vegetative targets for untouched or managed portions of the buffer. Vegetative targets define the type and density of vegetation in the buffer zone based on the predevelopment plant community. These targets are critical for establishing long-term landscape maintenance procedures and invasive species control. The URA widths establish review authority only, and should not be confused with the protection provided by a "no-touch" riparian buffer zone regulation. Many local buffer regulations across the country create setbacks for vegetative removal, structures, impervious surfaces, septic drain fields, and stormwater facilities. Standards for selective clearing and preferred vegetative composition (i.e. forested, native plants, turf) are often included, as well as criteria for stream crossings.

A summary of over 150 scientific studies of effective riparian buffer widths for a variety of biological, hydrologic, and physical functions is summarized by the Environmental Law Institute (2003). The USACOE released national recommendations for riparian buffer design in 2000 (Fischer and Fischneich, 2000). Table 13 summarizes the results of these studies. The majority of research indicates that a vegetative buffer greater than 100 feet is needed to protect cool- and cold- water stream habitats. Meyer et al. (2005) studied the correlation between forested buffers, in-stream temperature, and benthic substrate conditions in over 8,000 trout streams across northern Georgia to evaluate the impact of a state policy to reduce required buffer widths from 100 to 50 feet. They found that the reduction of forested riparian buffers widths from 100 to 50 feet resulted in a 3-4 degree increase in stream temperatures and 11% increase in sediment in riffle habitats. While this change seems insignificant, this shift is expected to reduce the young trout population by 81-88%. For additional summaries of recommendations on this topic, please refer to *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998).

We recommend a minimum 100-foot "no disturbance" buffer zone requirement for all SRW communities based on the research correlating cool- and cold-water stream habitat quality and temperature fluctuations with buffer integrity. Schueler and Holland (2000) summarize the basic architecture of effective stream buffers including widths (no less than 100 feet), important design elements, and vegetative targets. Vegetative targets for

buffers in the Salmon River should primarily focus on maintaining native trees that provide canopy cover (temperature control) and large woody debris (habitat), as well as groundcover and shrubs to protect stream banks from eroding.

As mentioned earlier, the authority provided to Inland Wetlands Commissions is for review of impacts only, not prohibitions of use. Towns within the SRW have therefore relied on Zoning Regulations to establish these protections. Connecticut General Statue 8-2 clearly provides local zoning authorities with the power to establish wetland and watercourse setbacks. The towns of Haddam and Bolton, for example, prohibit construction of buildings and septic systems within 50 feet to ensure a greater degree of protection of wetland and watercourse resources. The Town of Hebron prohibits the placement of septic systems within 100 feet of any wetland or watercourse. Marlborough is exploring the possibility of incorporating a 50-70 foot "no structure" wetland buffer into their zoning code. The use of zoning to regulate wetland and watercourse buffers is an effective way to review and potentially limit different types of activities that cannot be regulated within the URA. This may include providing the local Zoning Enforcement Office with the authority to issue permits for activities within the designated zoning buffer. The inclusion or adjustment to buffer regulations within zoning regulations must require careful evaluation on the part of the municipality and should involve local legal counsel. Reviewing the existing regulations within the Towns or Haddam, Bolton, Hebron, and the potential regulations in Marlborough, may serve as an effective starting point for these evaluations.

A more comprehensive approach to the use of zoning as a means to regulate buffer areas includes a dedicated overlay district specifying stringent buffer standards that are protective to wetlands and watercourses. Incorporating an overlay district requires careful consideration by the community and should include input from a broad range of commissions, boards, and municipal review officials. A sample overlay district entitled the Eightmile Watershed Overlay District from the Town of Lyme, Connecticut is provided for further review in Appendix E.

Table 13. Reported Ranges of Recommended Buffer Widths Based on Watershed Function (adapted from Environmental Law Institute, 2003)

Function	Range of Riparian Buffer Widths	
	Environmental Law Institute (2003)	Fischer and Fischneich (2000)
Stream Stabilization	30-170 feet	30-65 feet
Protection of Water Resource Quality	15-300 feet (remove nutrients) 10-400 feet (remove sediment)	15-100 feet
Flood Attenuation	65-500 feet	65-500 feet
Riparian/Wildlife Habitat	10 feet-1 mile	100 feet-0.3 mile
Temperature/Microclimate Regulation	30-1,000 feet	--
Trout and Salmon/ Cold Water Fisheries	≥100 feet (5 studies) 50-200 feet (1 study)	--

Specified Resource Protection

As noted previously, East Hampton and Marlborough both have expanded the URA jurisdiction in the SRW to 500 and 200 feet, respectively. Haddam increased the URA from 50 to 100 feet in the Salmon River watershed and in drinking water supply watersheds. Ideally, the other communities in the watershed will establish special criteria within the watershed to provide for a consistent watershed-wide management approach. Research has shown that the continuity of forested buffers along a stream corridor is related to stream quality, and that patchy buffer systems increase potential for invasive species establishment. As urbanization increases, more roads and utilities cross streams, creating additional fish barriers.

Inland wetland protection can also play a critical role for cool- and cold-water streams as wetlands help attenuate flood waters, filter pollutants, and recharge baseflows. Isolated wetlands not regulated by the USACOE (due to jurisdictional restrictions) are only protected at the local level, and therefore subject to the Inland Wetland and Watercourse Regulations (IWWR). Recent research on the importance of these small isolated and/or intermittent wetlands to overall watershed function are well-documented by the Center for Watershed Protection in the six part *Wetlands and Watershed Article* series *(Cappiella and Fraley-McNeal, 2007).*

Capacity to review activities Beyond the Buffer:

Marlborough, Hebron, Haddam, Glastonbury, and Columbia all have included provisions within their regulations to allow for review of activities outside of the URA. Communities within the Salmon River watershed should consider the feasibility and legality of incorporating this type of language into IWWR to allow Commissions to review major development activities within the watershed that may be outside the URA, but will have a direct or indirect impact on the wetlands and watercourses downstream.

The Town of East Hampton also provides their Inland Wetland and Watercourse Agency with the authority to review all Erosion and Sedimentation Control Plans for disturbances over one acre regardless of proximity to wetland buffer.

Table 14. Summary of Recommendations for Local Wetland and Watercourse Buffers to Protect Cool- and Cold-Water Stream Habitat

Buffer Design	• Minimum 100 feet, no disturbance, vegetated buffer within URA's in the Salmon River Watershed; • Minimum 300 feet URA for all activities in the Salmon River Watershed; and • Establish vegetative targets and excluded uses.
Special Resource Protection	• Designate Salmon River Watershed as a Special Resource Area and expand URA boundaries to 500 feet; • Coordinate across all jurisdictions to provide consistent buffer protection across the watershed to help provide for a continuous riparian corridor; and • Consider providing additional authority for Inland Wetlands Commission to review development activities in the watershed that may be outside the URA that will have a direct impact on aquatic resources.

3.5 Development Review Capacity

Rationale:

Within any municipality, it is important that the plan review process is as efficient as possible to support an accurate and effective application of the regulations. An effective application and review process can help a municipality in achieving all of the goals outlined within this report. A municipal planning department has many responsibilities to applicants in the development review process, such as ensuring the process is timely and fair, information requests are reasonable and clear, and that fees are appropriate. They also have responsibilities to adjacent property owners and the general public, such as ensuring the review process protects the public interest, allows for public comment and discourse, and does not waste municipal resources.

With regard to the SRW, the capacity for any municipality to effectively administer development applications can be critical to protecting this resource. Not only are the standards for development and design critical to the long-term health of the River, but the processes governing the exchange of information between local authorities, applicants and the general public can make the difference between an application that successfully mitigates impacts to the River and one that ignores them. The key elements that were evaluated as a means to support the development review process are:

- Pre-application meetings;
- Development application checklist; and
- Schedule of fees relating to development review.

Pre-application Meetings:

A thorough review of development applications is a critical component to achieving a community's goals. The first step in the process is the use of a pre-application meeting to address any potential issues before they become obstacles in the application process. A number of SRW communities use informal pre-application meetings as a means to open lines of communication with applicants early in the development review process. Communities such as Bolton, Colchester, and Hebron use scheduled, routine meetings in which municipal staff meet with potential applicants and discuss future development plans. These meetings are open opportunities for applicants and their professional representatives to discuss their plans in an informal setting to gain a better understanding of areas where plans my need adjustment before beginning the formal submission process. For many communities, an informal process helps to foster an atmosphere that welcomes applicants and property owners to work together. This allows staff to provide early informal input and guidance into the process before heavy design work begins. If the applicant chooses not to use the pre-application meeting, the Planning and Zoning Commission can always have discussions prior to setting the public hearing dates by fully utilizing the 65 day period allowed under Connecticut General Stature 8-7.

The Town of Marlborough has the most formalized pre-application procedure with written guidelines on what pre-application meetings shall entail and areas of the regulations with which developers should be familiar when submitting a plan. Marlborough's Pre-Application Procedures are provided within Appendix B of this report. As an example, one important issue that may arise during a pre-application meeting is the determination of compliance with the Town's minimum open space regulations relative to a particular site. There may be a need for added flexibility or negotiation to account for such a circumstance.

Development Application Checklist:

Development application checklists serve an important role in terms of building plan review capacity. Municipalities must rely on accurate and timely information to make sound decisions regarding applications. To ensure the most efficient transfer of information from the applicant to the review authorities, communities should incorporate clear requirements into their regulations and ensure that their development application checklist match those requirements exactly. Checklists should be easily assessable and clarify the process for applicants, thus increasing accuracy and timeliness of information and reducing wasted time for all parties involved. At least four SRW communities have one or multiple formal development application checklists: Bolton, Columbia, East Haddam, and Hebron. These checklists are provided for further review in Appendix C of this report.

With regard to the SRW, there are several pieces of information that can be added to development checklists that will enhance the capacity of local authorities to measure potential impacts to the resource. Where applicable, these include:

- Whether property is located within the Salmon River Watershed;
- Function of existing buffer zones (e.g. passive recreation, flood zone, bordering wetland habitat, etc.);
- Condition of existing buffer zones (e.g. heavily disturbed, mature forest, predominance of invasive species, etc.);
- Maps of slopes leading to the river; and
- The "order" of the nearest receiving stream (i.e., first order, second order, etc.).

Schedule of Fees Relating to Development Review:

It is important that municipalities have a clear, fair and adequate fee structure to support the use of municipal resources in review development plans. Many municipalities can use fees to help fund professional peer reviews of developments when necessary. Peer reviews can be a very effective tool to incorporate more technical evaluations of the development proposal when needed. Examples of SRW municipal fee structures are provided in Appendix D.

3.6 Forestry Regulations

Forestry regulations are intended to protect forest lands from improper harvesting practices and to ensure that the resource is managed in a sustainable fashion. Clear cutting and temporary road and skid construction can expose soil and create erosion, reduce shade canopy along riparian buffers, and encroach on wetlands ultimately contributing to thermal and habitat impacts on cool- and cold-water streams. Under CGS § 23-65j, DEP is authorized to establish certification standards for loggers and foresters and adopt regulations to ensure BMPs are implemented during clearing, logging, and post-harvesting forest practices specifically to "afford protection to and improvement of air and water quality" on undeveloped forest parcels >1 acre. In 2007, DEP issued a Field Guide to Best Management Practices for Water Quality While Harvesting Forest Products. The field guide is intended to educate practitioners, landowners and municipal officials on the minimum standards for BMPs associated with the harvest of forest products to minimize impacts on wetlands and water resources. Some of the BMPs recommended for forestry activities to minimize sediment load and temperature increases that are critical for cool- and cold-water stream habitat protection include:

- Preparation of an operational/harvest plan that accounts for topography, soil, prevailing weather conditions, and location of sensitive aquatic resources and existing roads in advance of initiating clearing and harvesting activities. These plans should include provisions for erosion and sediment control practices.
- Minimize number of new landings (cleared areas where loading and transfer takes place) and use existing clearings where feasible. Locate landings away from drainage ways, streams, and wetlands. Construct roads and skid trails after landing locations have been established. Use stabilized construction entrances/gravel pads to minimize tracking of sediment off-site.
- Minimize the number of stream crossings by identifying crossing locations prior to road layout. Stream crossings should be constructed at 90 degrees from the direction of flow, in low gradient areas, and where the stream is straight (not at a bend or curve which is subject to erosion). Temporary crossings that can be easily removed with minimal disturbance to stream are preferred. Crossing approaches should be stabilized with stone, slash, or other materials to prevent sediment erosion. All culverts should be kept clear of debris. The 2007 Field Guide states that "local Inland Wetlands Agency must be contacted to determine if the stream crossing is permitted as a right or if a permit is required."
- Locate roads and trails (both truck and skid roads) to minimize the length of exposed area and amount of cut and fill; easily divert runoff; and avoid unstable or steep slopes. It is important to provide adequate buffer between roads and streams, ponds, lakes, vernal pools, and wetlands. Utilize design features such as water bars, broad-based dips, cross drains, and up-turns to minimize runoff volume and velocities from road surfaces and roadside ditches.
- Maintain a vegetated buffer strip around streams and wetlands where clearing and heavy equipment are prohibited (except for crossings). The 2007 Field Guide

recommends protecting 50-foot around vernal pools at a minimum. If the buffer must be disturbed, activities should be scheduled when the ground is frozen or snow covered to minimize disturbance of leaf litter and soils. The guide recommends maintaining a minimum of 50 percent crown cover to minimize increases in stream water temperatures. Runoff from skid trails and roads should be managed to prevent sediment from entering the buffer zones where feasible.

- Minimize clearing on steep, erodible slopes.
- Employ erosion and sediment control practices (stabilized construction entrances, silt fences, hay bales, erosion control blankets, etc.) to prevent erosion in disturbed areas, and to keep sediment out of streams, wetlands, and public roads. Temporary roads, skids, and landings should be stabilized (preferably seeded) and blocked off at end of activities. Use soil stabilization practices on exposed soil at stream crossings.
- Reforest disturbed areas as soon as harvesting in that area is completed (don't wait until end of entire operation), at a minimum, in areas susceptible to erosion and/or serving as aquatic buffers.

Many, but not all, forestry activities in wetlands and watercourses are permitted "as of right" and are not regulated activities. Due to statutory limitations (per CGS § 23-65k), municipalities without existing forestry regulations prior to January 1, 1998 cannot legally adopt new local forestry regulations. East Haddam, East Hampton, Haddam, and Glastonbury have existing municipal forestry regulations and have authority through local Inland Wetland Commissions to determine if activities are regulated or non-regulated. The best model for Forestry within the SRW communities is found within the Town of East Hampton. This model requires a special permit be obtained to conduct timber harvesting unless disturbing less than ¾ acres or part of an approved site plan. The special permit is only valid for one year and renewals require a report showing measures taken to operate in a sustainable and environmentally friendly fashion.

Recommendations of the Connecticut Statewide Forest Resource Plan 2004-2013 call for expanding forestry BMPs recommended by DEP and unifying state requirements, which may provide an opportunity to develop practices and standards geared specifically to protect cold-water fisheries. Table 15 provides recommendations for the communities in the SRW for reducing the impact of forestry activities on sensitive cool- and cold-water streams.

Table 15. Summary of Recommendations for Forestry Activities to Minimize Impact on Cool- and Cold-Water Stream Habitat

Issue	Recommendation
For communities with local forestry regulations (East Haddam, East Hampton, Haddam, and Glastonbury)	• Ensure that local regulations contain application criteria that require a suitable amount of information for the review board to make a sound determination. Application requirements should request information such as: the extent and intensity of the use, wildlife considerations, and operational considerations such as machinery used and wetland crossings. • Educate review agency members on the issues of healthy forest management to provide for credible reviews of applications.
For communities without local forestry regulations	• Improve communication with DEP on ensuring proper BMP implementation, particularly in areas adjacent to streams. • Explore with DEP the potential to establish or adopt a multi-jurisdictional (regional) set of standards for forestry in the SRW.

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3.7 Land Clearing Provisions

Within the SRW, the regulatory tool that is primarily responsible for regulating the clearing and grading of land is the Erosion and Sedimentation Control (ESC) standards. Preventing rampant clearing of land as well as loading of sediment from construction activities is critical to protecting cold water streams, both in terms of preserving natural vegetation on the land as well as managing the impacts of stormwater runoff during construction periods. To ensure water resource protection, many communities within these sensitive resources require ESC Plans for activities disturbing less than the one acre federal threshold. The large majority of SRW communities have a disturbance threshold of 0.5 acre. In most of the towns audited, individual single family lots are exempted from this standard regardless of area disturbed. We recommend revisiting this exemption to the extent allowable under state law to ensure that single lot development, redevelopment, or infill is not a potential source of sedimentation.

The 2002 *CT Guidelines for Soil Erosion and Sediment Control* is cited as the technical manual by most of the communities for the purposes of establishing standards. East Hampton has specifically called out limited clearing and grading as one of their Water Quality Protection Strategies and as requirements within the special Lake Pocotopaug Protective Area. Limits on clearing are critical to protecting native vegetation and soil conditions that provide stormwater interception and infiltration capacity. Where Salmon River Protection Areas or Overlays exist, we recommend inserting specific language to support adherence to ESC standards. Depending on the local capacity to review, inspect, and enforce the local ESC programs, there are a variety of measures communities can take to improve construction activities with regard to ESC.

Table 16. Summary of Recommendations for Erosion and Sedimentation Control Standards

- Require a pre-construction meeting on-site with contractor, engineer, and plan reviewer to ensure effective implementation of ESC plan.
- Require operations and routine maintenance plan as part of ESC plan.
- Increase frequency of site inspections (every 14 days and/or after every rain event) and critical periods (i.e. ensure practices are properly installed prior to significant land clearing activities, practice removal does not occur until site is permanently stabilized).
- Increased enforcement of temporary and permanent stabilization, particularly during sensitive trout spawning periods.
- Require adequate performance bonds to ensure ESC practices remain functional throughout the entire construction process.
- Establish requirements for phased clearing and soil compaction, and recommend limiting mass grading operations so disturbed area for any phase is limited to a maximum of 5 acres, unless a hardship can be demonstrated by an applicant and approved by the local authority.
- Consider requiring contractor/project manager training (see CT Construction Industries Association ESC training) for projects within the watershed.

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3.8 Parking Regulations

Rationale:

Mounting research from state and federal agencies continues to link auto-dependent patterns of development to negative impacts on the quality of the natural environment. Parking regulations have been identified as playing a critical role in driving the site design process in documents such as *Parking Spaces / Community Places: Finding the Balance through Smart Growth Solutions* (EPA, 2006) and *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998). Parking regulations can have a profound impact in establishing the overarching patterns of growth as well as the amount and quality of stormwater runoff. This can impact water quality and temperature within the SRW through the loss of open space and increases in impervious surface coverage. Municipalities must strive to achieve a balance between accommodating parking demand while also supporting a walkable, compact environment that limits impervious surface coverage. Innovative parking regulations can play a significant role in achieving several smart growth principles such as: reducing development costs, creating more walkable environments, improving the quality of stormwater runoff, and decreasing development pressure on valuable open space. Addressing parking standards, particularly for the centrally located SRW communities have a large majority of their land within the watershed, is a critical component to supporting a healthy surface water system.

There are a wide variety of parking regulations within the nine participating SRW communities. Currently, many of these communities have antiquated parking standards that result in an overabundance of parking at the costs of community character, loss of recharge to aquifer systems, and more polluted runoff. Changes to parking regulations can play a significant role in protecting the integrity of surface water through minimizing impervious surface coverage, improving stormwater management, and encouraging redevelopment as opposed to new development. There are a variety of parking strategies that communities can utilize that address these issues by emphasizing parking efficiency over supply. Those covered in this report include:

- Tailoring parking ratios;
- Shared parking;
- Off-site parking allowances;
- Parking lot landscaping; and
- Use of pervious pavements.

Tailoring Parking Ratios:

The most direct way for communities to control the supply of parking is by tailoring local zoning regulations to more accurately reflect local parking demand and circumstances. Rather than imposing inflexible requirements that result in more impervious surface

coverage than necessary, local zoning ordinances should look to incorporate mechanisms that tailor parking requirements to specific development projects. Currently only three of the SRW communities, Colchester, East Haddam, and Marlborough, have language with their regulations that allow for significant flexibility in determining parking requirements. East Haddam provides a range of potential values for the parking ratios while Colchester and Marlborough explicitly grant their Commissions the ability to reduce the parking requirements if deemed appropriate. Allowing for a healthy degree of flexibility is critical to achieving maximum parking efficiency and limiting unnecessary impervious surface coverage.

Communities should consider incorporating guidelines for the elements it will review when considering reductions to parking ratios. Reductions could be allowed for factors such as: mixed-land uses, access to alternative transportation, demographics, and utilization of Transportation Demand Management (TDM) Programs including subsidized mass transit and parking cash out programs. Such reductions could fluctuate depending on the conditions around the site so the best approach is to allow flexibility within the regulations and subsequently require the developer to demonstrate the appropriate amount of parking needed.

When tailoring parking standards, it is wise to concurrently require a maximum parking requirement that restricts the total number of spaces allowed at a development site. Only one SWR community, East Haddam, currently implements a parking maximum. Communities may wish to consider the values that East Haddam has established for its parking maximum. Another potential strategy for setting a maximum parking requirement is for each community to use its current minimum parking ratio as the new maximum requirement. In this case, the municipality should also determine a lower value that will become the new minimum requirement, thus providing applicants with a range of parking values. Current minimums can be used as a viable number for a maximum requirement as a large majority of current minimum requirements are based on the extremely conservative estimates provided by ITE. Recent examination of the ITE parking rates shows that they were derived from a small number of studies located in suburban environments with high car dependency (Shoup, 2005). The broad application of ITE standards to cities and towns as a minimum requirement often handcuffs developers and municipalities and results in a surplus of parking that is only necessary during, for example, the winter holiday season.

Before making any sweeping changes to parking requirements, communities should carefully examine each requirement and assess the implications for reductions within the local context. The general approach of providing a firm maximum and an adjustable or low minimum gives developers flexibility to achieve innovative site designs while protecting the community from over- or under-supply.

Shared Parking:

Since most parking spaces are only used part time, shared parking arrangements are designed to more efficiently meet the needs of areas that exhibit a mix of uses with

varying peak parking demands. For example, many businesses or government offices experience their peak business hours during the daytime on weekdays, while restaurants and bars peak in the evening hours and on weekends. This presents an opportunity for shared parking arrangements where several different groups can use an individual parking lot without creating conflicts between their peak usage times. Currently, three SWR communities, East Haddam, Hebron, and Glastonbury, allow for shared parking within their regulations. Each community has established a different value, or "cap", that the total amount of parking can be reduced by if the applicant's analysis shows significant variation in peak parking demands. Hebron allows for a reduction of 25% in total parking, Glastonbury allows for a 30% reduction, and East Haddam, the most progressive of the three, allows for a range of 30-75% reduction in parking.

There is a limited amount of analysis needed to determine the appropriate amount of parking that should be reduced under shared parking arrangements. Table 17 provides an example of a shared parking analysis based on two uses (office and retail) and five different time periods. One strategy for shared parking without requiring significant amendments to the regulations is to allow applicants to submit their own analysis showing the peak parking demands that will occur at different times within a proposed development to determine the appropriate number of spaces.

Table 17: Example Shared Parking Analysis (MAEEA, 2009)

	Office Use			Retail Use			
	Minimum Parking Requirement	**Percentage of Parking Requirement**	**Adjusted Parking Requirement**	**Minimum Parking Requirement**	**Percentage of Parking Requirement**	**Adjusted Parking Requirement**	**Parking Requirement by Time Period**
Weekday Daytime	210	100%	210	500	60%	300	510
Weekday Evening	210	10%	21	500	90%	450	471
Weekend Daytime	210	10%	21	500	100%	500	521
Weekend Evening	210	5%	10.5	500	70%	350	360.5
Night Time	210	5%	10.5	500	5%	25	35.5

Off-Site Parking Allowances:

An integral piece to providing adequate flexibility within parking regulations involves allowing off-street parking requirements to be met through off-site facilities. These off-site allowances are particularly important in redevelopment sites and compact mixed-use centers where lot geometry and pre-existing development patterns can make it impossible for existing structures to comply with conventional on-site parking demands. Allowing business owners to negotiate with each other across property boundaries encourages a more integrated private sector approach and a much more efficient use of land. Recommended zoning provisions for off-site parking include the following:

- Establish a small set of design standards that require well-marked, safe pedestrian travel from the parking lot to the target site; and

- Establish a maximum distance that the parking lot may be from the target site. Typical values range from 350 – 1,000 feet (walking distance). Before settling on a value for this maximum distance, communities should use maps to get a sense of where existing parking lots are situated relative to other buildings. Unnecessarily strict maximum distances may provide barriers to quality redevelopment.

Finally, a condition of any approval should be a legally defensible agreement between property owners that guarantees access to the parking lot, outlines any shared maintenance agreements, and deals with issues of shared liability.

Parking Lot Landscaping:

Communities should explore measures to allow for greater flexibility within parking lot landscaping standards in cases where applicants are seeking to include LID techniques for managing stormwater. LID facilities such as open sections, vegetative swales, and bioretention basins exhibit unique design characteristics can be difficult to fit into a regimented landscaping formula. Currently, among the SWR communities, East Haddam and Hebron have achieved the highest degree on inclusion of LID standards into parking lot design. East Haddam in particular provides an excellent model for incorporating standards into local regulations. If a community does not wish to include the level of detail contained within Hebron's or East Haddam's regulations, a more basic approach to LID parking lot landscaping standards includes the following:

- Use of open section drainage to encourage sheet flow to open channels where pollutants are removed through infiltration and natural filtering prior to discharge;
- Use of vegetative swales to direct stormwater into shallow bioretention areas that temporarily detain the water to allow for partial infiltration while filtering the remaining stormwater before it is discharged into waterways;
- For parking lots of 10 or more spaces, require that 10% of parking lot area be dedicated to landscaped areas including stormwater practices as described here;
- For parking lots of 10 or more spaces, require that canopy trees be provided along edges and in landscaped intervals to reduce the "heat island" effect and create a more hospitable and pedestrian friendly site. It is important to provide opportunities for relief from tree requirements when it limits the use of landscaping as part of stormwater management practices;
- Mandate landscaping within parking areas that "breaks up" pavement at fixed intervals. It is important to provide relief from these frequencies when a developer wishes to use landscaping as part of stormwater management practices so that they can have the flexibility necessary to adequately site and design vegetated BMPs; and
- Prohibit non-native invasive species from being part of any approved landscape plan for commercial, industrial or residential site plans.

Local communities should carefully consider any changes to parking lot landscaping standards. The effective use of LID techniques not only reduces stormwater runoff, it can

also reduce construction and maintenance costs by 25-30% compared to conventional gutter and pipe approaches. Further technical details on implementing LID techniques can be found with the Stormwater Management section of this report.

Another emerging issue regarding parking lots (and other impervious surfaces) deals specifically with thermal impacts. With all of the recent concern with impacts from heating and cooling systems and associated costs, considerable research has been performed on the thermal impacts from different surfacing materials. Although the general focus of this research has been to identify ways to reduce the "heat island" effect from roofs and parking lots, these studies should also be considered in the context of stormwater runoff. What data have shown, is that materials with a high solar reflectance index (SRI) absorb far less heat than those with a low SRI. The primary factor in determining the SRI is the color of the material. New black-top, for example can have a temperature that is approximately 40 degrees higher than that of lighter materials, such as concrete. Where runoff is directed to surface waters through catch basin systems, these thermal impacts can be exacerbated through the use of conventional black-top asphalt treatments. Communities can therefore explore incorporating SRI values into their regulations for walkways, parking lots or even road way surfaces as a means to reducing thermal impacts. Draft standards under public review within the Leadership in Energy and Environmental Design- Neighborhood Design (LEED-ND) program suggest minimum SRI values of 29 as reasonable for many rooftop and driving surfaces.

Use of Pervious Pavements:

Within cold weather climates such as Connecticut, a perceived challenge to implementing permeable pavements is the winter roadway maintenance needs that can damage or disrupt the performance of pervious materials. Currently there are no communities within the SRW that have specific regulation regarding the use of pervious pavements. Any future incorporation of permeable pavements in local regulations must come with the understanding that municipal-wide winter roadway maintenance standards may need to be amended or that specific areas with permeable pavements must receive specialized maintenance. Another challenge to encouraging pervious pavements is the question of increased cost. This challenge can be addressed through the proper selection of material. There are a variety of materials and types of permeable surfaces available and municipalities should research which material best fits their needs. The following are examples of pervious pavement:

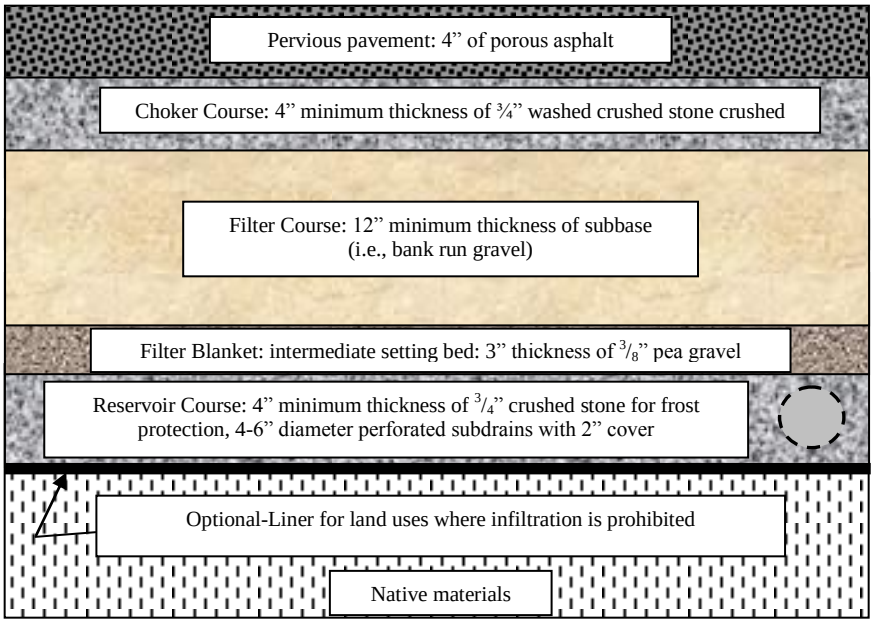
- Porous asphalt and pervious concrete: Although they appear to be the same as traditional asphalt or concrete pavement, they are mixed with a very low content of fine sand, so that they have 10%-25% void space and a runoff coefficient that is almost zero.
- Paving stones (also known as unit pavers): These stones are impermeable blocks made of brick, stone, or concrete, set on a prepared sand base. The joints between the blocks are filled with sand or stone dust to allow water to percolate to the subsurface. Runoff coefficients range from 0.1 – 0.7, depending on rainfall

intensity, joint width, and materials. Some concrete paving stones have an open cell design to increase permeability.

- Grass pavers (also known as turf blocks): These are a type of open-cell unit paver in which the cells are filled with soil and planted with turf. The pavers, made of concrete or synthetic material, distribute the weight of traffic and prevent compression of the underlying soil. Runoff coefficients are similar to grass, 0.15 to 0.6.

Each of these products is constructed over a base course that doubles as a reservoir for the stormwater before it infiltrates into the subsoil (Figure 12).

Figure 12. Typical Cross-section of Porous Asphalt (UNHSC, 2008)



In term of site design criteria, alternative paving surfaces are best used in low traffic areas such as overflow parking, residential driveways, sidewalks, plazas and courtyard areas. Areas with high amounts of sediment particles and high traffic volumes may cause system failures. Do not construct adjacent to areas subject to significant wind erosion. Contributing drainage areas should be minimal (runoff from upgradient impermeable or permeable surfaces should be minimal). Typically, reservoirs consist of uniformly sized washed crushed stone, with a depth sufficient to store all of the rainfall from the design storm. Some designs incorporate an "overflow edge," which is a trench surrounding the edge of the pavement. The trench connects to the stone reservoir below the surface of the pavement and acts as a backup in case the surface clogs.

There are several maintenance practices that should be considered when allowing for permeable paving surfaces. A legally binding and enforceable maintenance agreement shall be executed between the facility owner and the responsible authority. The ESC Plan for the site shall specify how sediment will be prevented from entering the pavement

area, the construction sequence, drainage management, and vegetative stabilization. The following list of BMPs for maintenance of permeable pavers should be considered before implementing regulations:

- Alternative paving surfaces require regular vacuum sweeping or hosing (minimum every three months or as recommended by manufacturer) to keep the surface from clogging. Maintenance may be more frequent or less depending on the traffic volume at the site.
- Minimize use of sand and salt in winter months.
- Keep adjacent landscape areas well maintained and stabilized (erosion gullying quickly corrected).
- Post signs identifying permeable pavement.
- Grass pavers need mowing and often need reseeding of bare areas.
- For paving stones/bricks, periodically add joint material (e.g., sand) to replace material that has been transported.
- Attach rollers to the bottoms of snowplows to prevent them from catching on the edges of grass pavers and some paving stones.

Table 18. Summary of Key Parking Recommendations

Issue	Recommendation
Tailoring parking ratios	Incorporate flexibility for adjusting minimum requirements based on local conditions. Require a maximum parking requirement that is potentially based on current minimum requirement.
Shared parking	Allow for shared parking provisions. Provide at least 30% potential reduction in parking requirements based on shared parking analysis.
Off-Site parking allowances	Allow for off-site parking. Evaluate potential maximum off-site distance requirements and require safe pedestrian pathways.
Parking lot landscaping	Allow for flexibility within landscaping standards to achieve LID goals. Specifically allow use of open section drainage, vegetative swales, and bioretention areas. For lots over 10 spaces, require that at least 10% of parking lot be dedicated to landscaping including stormwater practices.
Use of pervious pavements	Evaluate municipal winter roadway maintenance and ESC standards for feasibility of incorporating pervious pavements. Evaluate various pervious pavement material and design options to determine appropriate fit.

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3.9 Stream Crossing Guidelines

Rationale

When looking at measures to protect overall stream health, it is essential to consider the regulations and guidelines relating to the new construction of stream crossings or the replacement of culverts. Stream crossing guidelines in Connecticut are well documented within DEP's *Stream Crossing Guidelines* (CTDEP, 2008). Many of the guidelines and standards included within this report are reflected in that document. These guidelines are also consistent with USACOE Connecticut Programmatic General Permit guidance.

For new or replacement stream crossing projects, the DEP Inland Fisheries Division (IFD) typically recommends the installation of clear span bridges or bottomless arch culverts for the crossing of perennial watercourses. These structures are "fish passage friendly" since they do not create barriers or impediments to fish migration and they best preserve physical in-stream habitats. Intermittent watercourses are evaluated for fish passage needs based upon the potential for seasonal utilization of the watercourses by fish. In certain situations, IFD has accepted the installation of culverts for stream crossings. However, several modifications to culvert design may be required to ensure fish passage and maintenance of aquatic resource integrity. The modifications recommended are each described in further detail within the following sections.

Single Culvert:

The invert of a box culvert should be set no less than 1 foot below the existing streambed elevation. This installation technique is referred to as a sunken or embedded culvert. The invert of a round culvert less than 10 feet in diameter should be set 1 to 2 feet below the existing streambed elevation. For round pipe greater than 10 feet in diameter, the culvert invert should be set a minimum of 20% of the pipe diameter below the streambed elevation.

Multiple Culverts:

Multiple culverts are discouraged where design criteria can be met with a single culvert. For multiple culvert situations, one or more of the culverts should be installed as per the guidelines for single culverts (Figure 13). Deflectors may need to be installed to concentrate low stream flows into, and through, the recessed culvert. Recessed culvert(s) should be installed in the thalweg, or deepest, section of the channel and be aligned with the low flow channel.

Figure 13. Sunken Culvert (Left) and "At Grade" Culvert (Right) (IFD, 2008)

Gradient:

The culvert gradient should be no steeper than the streambed gradient upstream or downstream of the culvert matching the overall stream gradient as closely as possible. Gradient for sunken culverts should not exceed 3%. Bottomless arch culverts or clear span bridges should be utilized in all cases where gradient exceeds 3%.

Alignment:

Culvert alignment should be similar to that of the stream and not placed at a skew, which lengthens the enclosed crossing. This will ensure proper water conveyance and will protect against excessive channel erosion or scour.

Length:

Culvert length should be as short as possible. Vertical headwalls rather than fill slopes are recommended at the culvert inlet and outlet to reduce the total culvert length (Figure 14). Narrowing and lowering the roadway along with steepening embankments can also help reduce culvert length.

Figure 14. Example of Vertical Headwater that Reduces Length of Culverts (IFD, 2008)

Width:

The culvert should have a width that spans an area 1.2 times the bankfull width of the stream. In Connecticut streams, bankfull width equates to the channel width wetted at the 1.5 to 2 year storm frequency flow. This standard also applies to arch (bottomless) culverts.

Openness Ratio:

The culvert should have an Openness Ratio (OR) of > 0.25. The OR is calculated by dividing a culvert's cross sectional area (height x width) by its length. All measurements are in meters.

Calculation for Embedded Culverts:

$$OR = \frac{[(\text{Cross-sectional culvert area pre-embedded}) - \text{Embedded area}]}{\text{Culvert length}}$$

Calculation for Arch Culverts (bottomless):

$$OR = \frac{\text{Height x Width}}{\text{Length}}$$

Preservation of Streambed Substrates:

Native streambed material excavated for culvert placement should be stockpiled and replaced within the culvert following its installation. Streambed material should be

replaced in a manner replicating the original stream cross section with a well-defined low flow channel contiguous with that existing in the stream.

Replacements of Existing Small to Moderate Size Diameter Culverts:

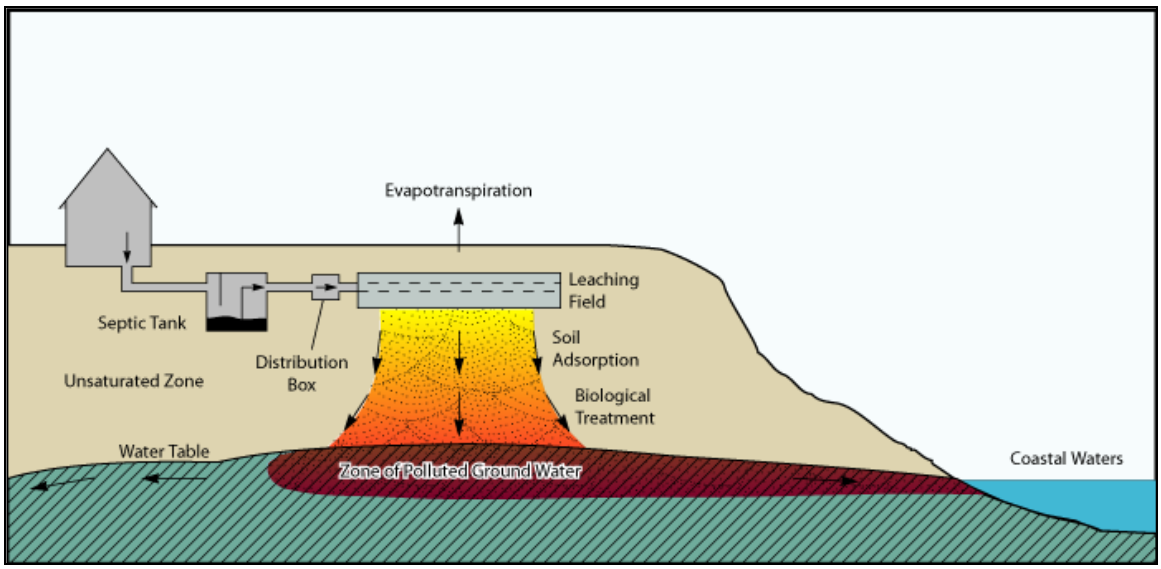
One of the biggest opportunities for SRW communities to remove fish and aquatic species migration barriers is during regular maintenance and repair of existing stream crossings. Municipal staff should conduct a hydrologic and adjacent stream geometry assessment of all replacements of culverts exceeding 18 inches in diameter, and where feasible, upsize the culverts to match the width and openness ratio's specified above.

3.10 Wastewater Considerations

Rationale:

One of the chief goals of this project is to identify ways in which communities can reduce the impacts of development and increase open space conservation. This often suggests an approach to development that encourages a more compact model of building. However, achieving higher density development in areas without public water or sewer service presents special circumstances and unique challenges. Conventional individual septic systems require permeable soils, adequate depth to groundwater and numerous setbacks to lot lines, drinking water wells and wetlands (Figure 15). These physical and regulatory requirements can sometimes preclude the clustering of development, particularly when clustered lots sizes fall much below about 30,000 square feet.

Figure 15. Conventional Individual Septic System (MAEEA, 2009)



For those communities with or without existing centralized wastewater infrastructure, creating new, or re-invigorating older, walkable neighborhoods requires a thoughtful approach to wastewater management. There are several steps a community can take to assist in encouraging more centralized approaches, such as:

- Develop a Comprehensive Wastewater Management Plan;
- Identify larger projects as anchor opportunities;
- Be aware of groundwater hydrology implications;
- Provide density incentives where appropriate; and
- Be aware of TMDL programs and nitrogen sensitive areas in your community.

Develop a Comprehensive Wastewater Management Plan:

As a stand-alone document or as part of a larger Plan of Conservation and Development, comprehensive wastewater planning is an integral component of a local smart growth program. Among other items, these plans will help to delineate growth center boundaries, lay the ground work for Transfer of Development Rights, help to shape CSDs and provide the foundation for significant environmental benefits. The essential sections of a Comprehensive Wastewater Plan include:

- Maps of growth centers, preservation lands and transitional areas;
- A detailed discussion of the types of wastewater management strategies applicable to the community's housing, environmental, fiscal and commerce-related goals;
- A discussion of the different densities of development that will occur within and surrounding identified growth centers;
- An examination of the community's administrative capacity with regard to permitting innovative systems and/or establishing wastewater authorities;
- Cost estimates associated with construction, permitting, design, administration and maintenance of any intended public facilities;
- Identification of any existing bylaws or regulations that would conflict with the intended wastewater strategies; and
- Identification of any public funding opportunities associated with infrastructure development or financing.

Identify Larger Projects as Anchor Opportunities:

Communities in which a larger development project is being proposed may have an opportunity to leverage this investment toward a more inclusive wastewater service envelope. Due to the level of initial investment being provided by a third party, local officials may be able create a public/private partnership to help service surrounding properties with a slightly larger system than what would be needed for the expanded project alone. Development of municipal or institutional wastewater plants may also provide options as there may be funding opportunities to develop facilities for schools or similar uses.

Be Aware of Implications for Groundwater Hydrology:

When considering large-scale wastewater treatment solutions, it is important to be aware of how the movement of wastewater can have a significant impact on groundwater resources. Wastewater planning should consider balancing the local water budget within watersheds and sub-watersheds given the collective locations of individual drinking water wells and wastewater treatment discharges. This is of particular concern given the rapid pace of new sewer connections within the SRW from communities such as Marlborough,

Colchester, Hebron, and East Hampton that are directing their wastewater flows to a treatment plant located outside of the SRW in East Hampton. This has the net effect of draining the groundwater from the watershed and disturbing the natural hydrologic balance. Future infrastructure improvements regarding wastewater in the Salmon River region should target solutions that help to minimize disturbance in the SWR and promote a balanced water table.

Provide Density Incentives Where Appropriate:

Planning for more compact patterns of development generally includes the identification of one or more growth centers or villages in a community. Depending on the densities communities are comfortable allowing, incentives could be included for developers willing to use more centralized wastewater approaches. This strategy may be particularly effective in smaller suburban or rural settings where village centers could operate on a single or several "neighborhood-scale" treatment plants.

Be Aware of TMDL Programs and Nitrogen Sensitive Areas in Your Community:

State and federal programs continue to study, and place legal limits upon, loading/discharging into water bodies and natural resource areas through the federal TMDL program. As nitrogen sensitive areas continue to be identified, and TMDL allocations continue to be established, local authorities will need to be aware of their obligations and the potential leverage these standards will provide toward more advanced forms of wastewater treatment. Issues of environmental protection and existing regulatory programs are rapidly creating awareness within the development community that compact development have less of an environmental impact and can also be more profitable.

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4.0 COMMUNITY COMPARISON TABLES

The following Community Comparison Tables provide an evaluation of existing regulations in each SRW community in comparison to the recommendations in the report. The tables also provide a reference for comparing each community's existing regulations across the watershed. This exercise utilized a three-tiered assessment process to categorize the existing regulations:

O: Similar to project recommendations.
/: Somewhat comparable to project recommendations.
X: Not similar to project recommendations.

Each table addresses a critical issue discussed in this report for which specific recommendations were provided. This includes the categories of:

- Conservation Subdivision Development;
- Roadway Design Standards;
- Stormwater Management;
- Wetland / Watercourse Buffers and Associated Regulations;
- Forestry Regulations;
- Land Clearing Provisions; and
- Parking Regulations

For guidance on the following critical issues, see corresponding sections in the text:

- Development Review Capacity;
- Stream Crossing Guidelines; and
- Wastewater Considerations.

Recommendations Table 1. Conservation Subdivision Development

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

/ = Existing regulations are less similar but somewhat comparable to recommendation. Town should consider moderate adjustments to regulations.

X = Existing regulations are least similar to recommendation in comparison to other SRW communities. Town should consider substantial amendments to regulations.

Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Optional vs. required design	Establish required CSD design for any subdivision above the applicability threshold. Streamline application process.	X	X	X	/	/	/	O	O	/
Applicability	Decrease applicability threshold as much as possible with consideration for development review and open space management capacity.	/	O	X	/	X	O	O	/	/
Minimum open space requirements	Approximately 35-50%. Must first assess community open space goals and ensure that design standards allow the achievement of those goals. Encourage conservation of natural areas as opposed to active recreation.	O	X	X	O	O	/	O	/	X
Density incentives	Assess community goals to provide density incentives that encourage appropriate development on a site-by-site basis. Allow density bonus for restoration efforts related to forested buffers or wetlands on the site.	/	O	X	X	X	X	O	O	X
Establishing yield and CSD design process	Utilize the site plan process to develop the yield plan. Require the four step design process.	/	/	/	O	O	X	/	/	/
Design flexibility	Assess community open space goals and provide adequate design flexibility to achieve those goals.	/	/	X	O	O	/	O	/	/
Dedication and management of open space	Provide a range of suitable options for open space dedication methods and incentivize the preferred methods. Provide requirements for maintaining open space and specify municipal enforcement actions.	/	/	/	O	O	/	/	O	/

Recommendations Table 2. Roadway Design Requirements

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

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Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Minimum street width (local)	20 feet. Can be 18 feet for small cul-de-sacs serving fewer than 5 houses.	X	X	/	O	X	X	/	/	/
Right of way (local)	50 feet with flexibility to reduce to 42 depending on various ROW elements.	X	X	X	X	X	O	X	X	X
Cul-de-sac service area	20 lots	O	X	O	O	O	/	X	O	X
Cul-de-sac length	Create flexibility to account for fronatge requirements and potential for expanding the roadway.	X	O	/	/	/	O	O	/	O
Cul-de-sac minimum turnaround radius	35-45 feet	X	X	O	X	O	O	X	O	X
Cul-de-sac terminus	Allow for cul-de-sac islands and alternative to circular termius.	X	/	/	X	X	/	/	O	/
Minimum driveway width	12 feet with pullover areas for driveways serving more then four lots	/	/	/	O	/	/	/	O	O
Common driveways	Promote common driveways	O	O	O	O	O	O	X	O	O

Recommendations Table 3. Stormwater Management

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

/ = Existing regulations are less similar but somewhat comparable to recommendation. Town should consider moderate adjustments to regulations.

X = Existing regulations are least similar to recommendation in comparison to other SRW communities. Town should consider substantial amendments to regulations.

Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Criteria	Increase total suspended solids (TSS) removal requirements from 80 to 90% since sediment loads are one of the primary pollutants of concern in trout waters.	X	X	X	X	X	X	X	X	X
	Require infiltration of excess runoff volume above that produced from the predevelopment 2-year, 24-hour storm event as a temperature control option for designated trout streams, where soils conditions permit. If soils do not permit infiltration of the channel protection volume, then provide 12-hour extended detention of 1-year, 24-hour runoff volume in a thermally acceptable pond option.	X	/	X	X	X	X	X	X	X
	Apply the volume reduction (capture volume) criteria (which currently only applies to tidal areas) throughout the SRW to require use of filtering and infiltration practices rather than surface detention practices (ponds, wetlands) that are subject to thermal heating. Requiring bioretention, dry swales, infiltration, rainwater harvesting, and better site design practices to manage stormwater and restricting new ponds and wetlands is recommended.	X	X	X	X	X	X	X	X	X
	Prohibit discharges from stormwater ponds or wetlands within 200 feet of designated cold-water fisheries to reduce thermal impacts.	X	X	X	X	X	X	X	X	X
	Require underground gravel trench outlets or other thermal designs for stormwater discharges beyond 200 feet of cold-water fisheries.	X	X	X	X	X	X	X	X	X
Practice Selection and Design	Filtering and infiltration practices are used rather than surface detention practices (ponds, wetlands) that are subject to thermal heating. Require a demonstration of hardship or provide for thermal design adaptations for alternative practices.	X	X	X	/	X	X	X	/	/
	Practices are designed for ease of maintenance as called for in the CT Stormwater Manual.	/	X	/	O	O	O	X	O	X
	Detailed maintenance plans are submitted as part of the development review process (see Hebron Zoning Regulations as well as East Haddam, Glastonbury, and Columbia Subdivision Regulations).	X	X	O	O	/	/	X	O	X
	"As built" plans be submitted upon completion of facility construction.	?	?	?	?	?	?	?	?	?
	Performance bonds are adequate to ensure a given stormwater management practice functions appropriately in the short-term.	?	?	?	?	?	?	?	?	?

Environmentally sensitive site design	Thermally-acceptable open drainage designs such as dry swales in lieu of curb and gutter (see Hebron, that allows for alternative drainage systems within Section 8.24 of its Zoning Regulations).	/	X	O	O	X	/	/	O	O
	Minimal impervious cover through use of pervious pavements, narrow road widths, alternative turnarounds, minimal parking ratios and stall dimensions, and shared parking and driveways (see sections on Roadway Design Requirements and Parking Regulations).	/	/	/	/	/	/	/	/	/
	Temporary ponding of water in yards to encourage rain gardens and other rooftop disconnection practices on individual residential lots.	X	/	/	/	X	X	X	/	/
Other	Conduct internal review of pollution prevention activities at public facilities.	X	X	X	X	X	X	X	X	X
	Evaluate road deicing procedures, equipment, and materials.	X	X	X	X	X	X	X	X	X
	Establish a BMP tracking database to locate all existing and new BMPs and track scheduled maintenance inspections (at least in the SRW).	X	O	X	X	X	X	X	X	X
	Educate Home Owners Associations and other parties responsible for maintenance of private BMPs on proper maintenance procedures.	X	X	X	X	X	X	X	X	X
	Make sure publicly-owned stormwater facilities are properly maintained.	X	X	X	X	X	X	X	X	X

Recommendations Table 4. Wetland / Watercourse Buffers and Associated Regulations

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

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Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Buffer Design	Minimum 100 feet, no disturbance, vegetated buffer within URA's in the Salmon River Watershed.	/	X	X	X	/	/	X	X	X
	Minimum 300 feet URA for all activities in the Salmon River Watershed.	X	X	X	X	X	X	X	/	X
	Establish vegetative targets and excluded uses.	/	X	X	X	X	/	X	X	X
Special Resource Protection	Designate Salmon River Watershed as a Special Resource Area and expand URA boundaries to 500 feet.	X	X	X	X	O	X	X	/	X
	Coordinate across all jurisdictions to provide consistent buffer protection across the watershed to help provide for a continuous riparian corridor.	X	X	X	X	X	X	X	X	X
	Consider providing additional authority for Inland Wetlands Commission to review development activities in the watershed that may be outside the URA that will have a direct impact on aquatic resources.	X	X	O	X	X	O	O	O	O

Recommendations Table 5. Forestry Regulations

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

/ = Existing regulations are less similar but somewhat comparable to recommendation. Town should consider moderate adjustments to regulations.

X = Existing regulations are least similar to recommendation in comparison to other SRW communities. Town should consider substantial amendments to regulations.

Issue	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
For communities with local forestry regulations (East Haddam, East Hampton, Haddam, and Glastonbury)	Ensure that local regulations contain application criteria that require a suitable amount of information for the review board to make a sound determination. Application requirements should request information such as: the extent and intensity of the use, wildlife considerations, and operational considerations such as machinery used and wetland crossings.	N/A	N/A	N/A	/	O	/	/	N/A	N/A
	Educate review agency members on the issues of healthy forest management to provide for credible reviews of applications.	N/A	N/A	N/A	X	X	X	X	N/A	N/A
For communities without local forestry regulations	Improve communication with DEP on ensuring proper BMP implementation, particularly in areas adjacent to streams.	X	X	X	N/A	N/A	N/A	N/A	X	X
	Explore with DEP the potential to establish or adopt a multi-jurisdictional (regional) set of standards for forestry in the SRW.	X	X	X	N/A	N/A	N/A	N/A	X	X

Recommendations Table 6. Land Clearing

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

/ = Existing regulations are less similar but somewhat comparable to recommendation. Town should consider moderate adjustments to regulations.

X = Existing regulations are least similar to recommendation in comparison to other SRW communities. Town should consider substantial amendments to regulations.

Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Land Clearing and Erosion and Sedimentation Control	Require a pre-construction meeting on-site with contractor, engineer, and plan reviewer to ensure effective implementation of ESC plan.	X	O	X	X	X	X	X	X	X
	Require operations and routine maintenance plan as part of ESC plan.	X	/	X	X	X	X	X	X	X
	Increase frequency of site inspections (every 14 days and/or after every rain event) and critical periods (i.e. ensure practices are properly installed prior to significant land clearing activities, practice removal does not occur until site is permanently stabilized).	X	X	X	X	X	X	X	X	X
	Increased enforcement of temporary and permanent stabilization, particularly during sensitive trout spawning periods.	X	X	X	X	X	X	X	X	X
	Require adequate performance bonds to ensure ESC practices remain functional throughout the entire construction process.	?	?	?	?	?	?	?	?	?
	Establish requirements for phased clearing and soil compaction, and recommend limiting mass grading operations so disturbed area for any phase is limited to a maximum of 5 acres, unless a hardship can be demonstrated by an applicant and approved by the local authority.	X	X	X	X	X	X	X	/	X
	Consider requiring contractor/project manager training (see CT Construction Industries Association ESC training) for projects within the watershed.	X	X	X	X	X	X	X	X	X

Recommendations Table 7. Parking Regulations

Table Key:

O = Existing regulations are similar to recommendation. Town should consider potential minor improvements to regulations where appropriate.

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Standard	Recommendation	Bolton	Colchester	Columbia	East Haddam	East Hampton	Glaston-bury	Haddam	Hebron	Marl-borough
Tailoring parking ratios	Incorporate flexibility for adjusting minimum requirements based on local conditions. Require a maximum parking requirement that is potentially based on current minimum requirement.	X	O	X	O	X	X	X	/	O
Shared parking	Allow for shared parking provisions. Provide at least 30% potential reduction in parking requirements based on shared parking analysis.	X	/	X	O	X	O	X	/	X
Off-Site parking allowances	Allow for off-site parking. Evaluate potential maximum off-site distance requirements and require safe pedestrian pathways.	X	X	X	X	X	X	X	X	X
Parking lot landscaping	Allow for flexibility within landscaping standards to achieve LID goals. Specifically allow use of open section drainage, vegetative swales, and bioretention areas. For lots over 10 spaces, require that at least 10% of parking lot areas area be dedicated to landscaped areas including stormwater practices.	X	X	X	O	X	/	X	O	/
Use of pervious pavements	Evaluate municipal winter roadway maintenance and ESC standards for feasibility of incorporating pervious pavements. Evaluate various pervious pavement material and design options to determine appropriate fit.	X	/	X	/	X	/	X	X	X

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5.0 NEXT STEPS

The following are proposed next steps to be taken in the project through support of TNC, the SRWP Steering Committee, Town Staff, and others as indicated below. Further updates to the project and other materials related to the Salmon River Watershed can be found at http://conserveonline.org/workspaces/srwp. Notes from the SRW Watershed Summit that provide the complete list of implementation items from different brainstorming sessions can be found in Appendix F.

- Hold a series of watershed-wide workshops with stakeholder groups critical to reviewing and implementing stormwater management/LID and municipal pollution prevention/good housekeeping. Purposes would be to a) identify the impediments (real and perceived) to implementation of the recommendations in this report, and get feedback on how to address them, and b) provide land use commissioners who approve projects a level of confidence that key stakeholders have provided input to the recommendations. The workshop should include visits to in-the-ground examples of successful LID projects in the region.
    - Responsible parties: TNC (Lead), with NEMO, and SRWP Steering Committee.
- Identify and work in-depth with two pilot municipalities to guide implementation of the recommendations in this report and provide peer review to draft regulations. The towns should be selected based on a balance of readiness and conservation need. Towns should be sought where there is a clear staff leader with skill and time to devote to the project, including drafting changes to regulations, and where elected officials are interested in promoting LID.
    - Responsible parties: TNC (Lead), with Town Planners, consulting planning firm, and NEMO.
- Identify lands essential for conservation at the watershed scale. Responsible parties should gather and evaluate information on current conservation land and priorities for towns and land trusts throughout the watershed and pursue joint strategies. Responsible parties should incorporate priority areas into towns' plans and priority parcel lists.
    - Responsible parties: SRWP Steering Committee, Town Land Acquisition Committees, land trusts, and Town Planners.
- Identify sub-watersheds in critical need of minimizing actual and effective impervious cover, and restoration/retrofit opportunities, through using maps of current and projected impervious cover (Figures 2 and 3).
    - Responsible parties: TNC (Lead), Town Planners, and Town Engineers.
- Ensure the continued engagement of planners and other municipal officials in the education and implementation of project recommendations.
    - Responsible party: SRWP Steering Committee and TNC.
- Identify additional opportunities for efficiencies of scale and regional collaboration across the regional watershed (e.g., sharing public works equipment).

    - Responsible parties: SWRP Steering Committee, Town Planners, Town Engineers, and Town Public Works.
- Identify and pursue opportunities to educate and involve other community groups (e.g., land trusts, angler groups, student groups) in order to build a constituency of supporters.
    - Responsible parties: SWRP Steering Committee.

6.0 GLOSSARY OF ACRONYMS

AASHTO: American Association of State and Highway Transportation Officials
ADT: Average Daily Trips
ASCE: American Society of Civil Engineers
BMP: Best Management Practices
CGS: Connecticut General Statutes
CSD: Conservation Subdivision Development
CWP: Center for Watershed Protection
DEP: Connecticut by the Department of Environmental Protection
ESC: Erosion and Sedimentation Control
HW: Horsley Witten Group, Inc.
IFD: Inland Fisheries Division
ITE: Institute of Transportation Engineers
IWWR: Inland Wetland and Watercourse Regulations
LEED-ND: Leadership in Energy and Environmental Design- Neighborhood Design
LID: Low Impact Development
MS4s: Municipal Separate Storm and Sewer Systems
NHBA: National Homebuilders Association
NPDES: National Pollution Discharge Elimination System
PAH: Polycyclic Aromatic Hydrocarbons
ROW: Right-of-Way
SRI: Solar Reflectance Index
SRW: Salmon River Watershed
SRWP: Salmon River Watershed Partnership
TDM: Transportation Demand Management
TNC: The Nature Conservancy
TSS: Total Suspended Solids
ULI: Urban Land Institute
URA: Upland Review Area
USACOE: U.S. Army Corp of Engineers
WQV: Water quality volumes

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APPENDICES

All report appendices and other project materials, such as the Preliminary Municipal Audits, are available for download at the following website:

http://conserveonline.org/workspaces/srwp

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