Background
In November of 2013, the Green Infrastructure for Sustainable Coastal Communities (GISCC) provided funding to the Town of Brentwood to assist with projects that apply green infrastructure (GI) and low impact development (LID) methods on municipally-owned lands, and would include various components, including an outreach and education campaign.

To identify these projects, the GISCC project team agreed to complete the following tasks:

1. Evaluate municipal sites including the town shed, town office, library and school.
2. Develop a stormwater management plan for each site that incorporates LID projects.
3. Make presentations to town boards of these stormwater management plans to educate and improve understanding and benefits of LID (the Selectboard, Highway Department, Planning Board and Conservation Commission).
   - Representatives from these town boards would then meet and pick two to three projects to implement.
4. Implement improvement projects on town-owned lands by September 2014.
5. Conduct follow-up meetings with town boards after completion.

This hands-on approach, including implementation of direct improvements and education in the understanding of LID, has led to increased awareness of LID strategies and how to incorporate them into development and redevelopment activities in the town.

The management plans will provide an invaluable resource and roadmap for the town for future implementation of LID strategies at municipal sites, which will lead to continued improvement in the water quality in the Exeter River.

Project Results and Future Considerations
The project included optimization modeling of updated, watershed-wide impervious area data used to target pollution hotspots based on land use, zoning, soils, proximity to a water body, and other common GIS data layers.

Stormwater-derived loadings were modeled and classified to identify municipally-owned hotspot locations for installation of cost-effective stormwater solutions that maximize pollutant load reductions.

Attribute tables generated by the modeling effort were then used to sort and filter results based on specific town official interests.

Municipally owned lands were ranked by final model point total and then in descending order according to total parcel acreage. Final points indicate the pollutant potential of any parcel area with higher numbers indicating larger pollution threats. Secondary sorting by parcel size indicates opportunities where more can be done, as larger parcels with higher potential for pollution indicate larger benefits from retrofit activities. This is a quick screening method to further investigate potential implementation sites.

<table>
<thead>
<tr>
<th>RANK</th>
<th>LANDUSE DE</th>
<th>HSG</th>
<th>FINAL POINT</th>
<th>PARCEL ADDRESS</th>
<th>LOCATION</th>
<th>FINAL ACRES</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Government</td>
<td>A</td>
<td>1200</td>
<td>22 Dalton Rd</td>
<td>Brentwood Library</td>
<td>0.71</td>
<td>Managed through GISCC</td>
</tr>
<tr>
<td>2</td>
<td>Educational</td>
<td>B</td>
<td>1100</td>
<td>355 Middle Rd</td>
<td>Swasey School</td>
<td>3.02</td>
<td>Partially Managed Proposed</td>
</tr>
<tr>
<td>3</td>
<td>Government</td>
<td>B</td>
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<td>1 Dalton Rd</td>
<td>Town Hall</td>
<td>0.81</td>
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<tr>
<td>4</td>
<td>Government</td>
<td>C</td>
<td>1000</td>
<td>207 Middle Rd</td>
<td>Brentwood Highway Shed</td>
<td>0.76</td>
<td>No Management Proposed</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.30</td>
<td></td>
</tr>
</tbody>
</table>

Impervious and pervious land cover statistics for the town of Brentwood.

- **Impervious**
  - 10,256 ACRES
- **Pervious**
  - 607 ACRES
- **Total**
  - 10,863 ACRES
- **% Impervious Cover**
  - 5.6%
Project Conditions
The selected property was the town-owned Mary E. Bartlett Library. The property consists of a 3.4-acre parcel with 0.71 acres of impervious cover.

As a result of this project, 90% of the Mary E. Bartlett Library impervious cover has been disconnected via treatment through green infrastructure practices. Two GI stormwater control measures have been installed that treat 0.64 acres of drainage area and annually reduce 413 lbs of TSS, 1.6 lbs of phosphorus and 9.1 lbs of nitrogen on an annual basis.

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The Impervious Cover Model and Future Permit Compliance
Numerous watershed studies throughout the country have correlated the percentage of IC to the overall health of a watershed and its ability to meet designated uses. According to studies, it is reasonable to rely on the surrogate measure of percent IC to represent the combination of pollutants that can contribute to aquatic life impacts. Without a total maximum daily load assessment for a watershed, a general target related to the ICM is 10% Effective Impervious Cover (EIC). That is, if IC in a watershed can be disconnected through treatment through an appropriately sized BMP, it can be removed from the EIC.

This approach can serve as a surrogate for water quality criteria in the absence of any other governing regulatory limits.

The analyses performed in this project constitute major elements of any required WQRP and include the following elements:

1. Preliminary source assessment with respect to potential stormwater sources
2. Implementation of programs leading to the disconnection of DCIA
3. Structural BMP retrofits

While additional analyses and comprehensive assessment of illicit discharge detection and elimination (IDDE) programs and revision of good housekeeping and pollution practices (such as catch basin cleaning frequency and leaf litter collection programs) may be required, the analyses and action items embodied in this report represent a major contribution to any future WQRP or SWMP permit submission.

Summary of annual pollutant load reductions estimated for the retrofits at the Library.

<table>
<thead>
<tr>
<th>2014 BMPS</th>
<th>ANNUAL LOAD ‘L’ #/YEAR</th>
<th>EFFLUENT LOAD ‘L’ #/YEAR</th>
<th>ANNUAL PL REMOVED #/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSS #/year</td>
<td>456</td>
<td>42</td>
<td>413</td>
</tr>
<tr>
<td>TP #/year</td>
<td>1.95</td>
<td>0.35</td>
<td>1.61</td>
</tr>
<tr>
<td>TN #/year</td>
<td>17.6</td>
<td>8.5</td>
<td>9.1</td>
</tr>
</tbody>
</table>

This project is funded by the NERRs Science Collaborative to a project team led by the University of New Hampshire Stormwater Center and the Great Bay National Estuarine Research Reserve.

It supports Green Infrastructure implementation with local municipal, non-profit and private sector partners.

For more information please visit southeastwatershedalliance.org/green-infrastructure
What is Green Infrastructure?

Green Infrastructure is a programmatic use of Low Impact Development [LID] and other management measures to control drainage and pollution in a watershed or municipal setting.

LID techniques mimic natural processes to capture and treat stormwater close to its source and enhance overall environmental quality.

As a general principal, green infrastructure engineered systems use soils and vegetation to infiltrate and/or treat runoff.

STRUCTURAL EXAMPLES:
- bioretention systems and rain gardens,
- permeable pavements,
- tree filters and stormwater planters, and
- vegetated roofs.

NON-STRUCTURAL ELEMENTS:
- incorporating best practices into site design,
- regulations requiring better infrastructure performance, and
- incentives or education that encourages property owners to protect water quality.

Durham, New Hampshire

THE GREEN INFRASTRUCTURE PROJECT

Researchers from the University of New Hampshire and Geosyntec, as well as staff from the Southeast Watershed Alliance, Strafford Regional Planning Commission, Rockingham Planning Commission, Antioch University, and the Great Bay National Estuarine Research Reserve, partnered to deliver customized technical assistance and educational resources focused on stormwater management in the coastal watershed. One of the primary goals of this project was to communicate with municipalities on the values of green infrastructure in order to assist them in deciding where, when, and to what extent green infrastructure practices should become part of future planning, development, and redevelopment efforts.

BECOMING AN IMPLEMENTATION COMMUNITY

The Green Infrastructure Project advocates that municipalities take a Complete Community Approach to mitigate the negative effects associated with increasing impervious cover and stormwater runoff, thus minimizing impacts to water quality and protecting ecosystems and water resources.

A Complete Community Approach uses green infrastructure throughout all aspects of community planning. This approach includes: ordinances and regulations, stormwater controls, conservation strategies, reduced impervious cover, long-term commitments to fund and maintain stormwater controls, and opportunities for outreach.

DURHAM’S COMMITMENT TO GREEN INFRASTRUCTURE

2010  Incorporated stormwater regulations with low impact development incentives in site plan review and subdivision regulations

2011  Partnered with the UNH Stormwater Center to retrofit a custom designed state-of-the-art nitrogen treatment bioretention structure in a busy downtown parking lot

2012  Partnered with the Oyster River High School to design and construct a 1,000 square foot rain garden to collect and treat stormwater runoff from 10,000 square feet of the school’s main parking lot

2013  Adopted a new water ordinance, which includes protection of all the town’s water resources from discharges of polluted stormwater runoff and illicit discharges

GREEN INFRASTRUCTURE FOR SUSTAINABLE COASTAL COMMUNITIES
LOCAL PLANNING: TOWN OF DURHAM

Design and Construction of a Stormwater Retrofit at the Intersection of Oyster River Road and Garden Lane

The goal of this public infrastructure repair and improvement project was to disconnect the stormwater runoff generated from the neighborhood and reduce non-point source pollution on the Oyster River.

IDENTIFIED NEED

The Town of Durham’s Department of Public Works recognized that a stormwater outfall in a residential neighborhood had fallen into serious disrepair and was discharging directly into the Oyster River. The existing drainage structure and outlet pipe were under capacity and severely degraded. The site contained a highly eroded trench that had undermined a 20’ section of corrugated metal pipe (see picture, middle left), which according to the UNH Stormwater Center, was responsible for releasing approximately 30 dump truck loads of fine sediment per year into the river. The undercutting from the existing pipe resulted in massive erosion, slope instability, and water quality issues. Due to these factors, staff from the Durham Public Works Department submitted a grant application to evaluate the contributing drainage area and existing stormwater management infrastructure, design an engineered green solution, and install a control measure.

SPECIFIC RESULTS OF THIS PROJECT

• Stabilization of 50 feet of heavily eroded and entrenched gully discharging directly to the Oyster River

• Installation of a subsurface gravel wetland system at the outfall to slow flow and provide water quality treatment from 6 acres of untreated residential/and uses

• Employ a regenerative stormwater conveyance approach that will use the existing eroded gully as the excavation for the treatment area and will result in less than 750 square feet of temporary disturbance associated with an access for construction; no additional impervious area is proposed

• Overall improvement to the aesthetics of the site, which in its former condition had become a dumping ground for nutrient laden lawn and leaf debris from local yards

The UNH Stormwater Center assisted by developing design plans and provided building oversight for the project. The town of Durham and their selected contractors finalized the construction in the spring of 2015.

The Value of Green Infrastructure

Investing in Green Infrastructure can provide municipalities with a range of long-term economic, environmental, and social benefits including:

• The potential to reduce municipal costs for stormwater management by decreasing a reliance on costly grey infrastructure

• Reducing stress to aging municipal grey infrastructure and minimizing the need for capacity increases (i.e., gutters, storm sewers)

• Improving water quality in our streams, rivers, ponds, and estuaries

• Increasing groundwater aquifer recharge to support drinking water and stream baseflow

• Minimizing flooding and building resiliency to extreme storm events

• Increasing the usage of green spaces for water management and improving community aesthetics

• Cultivating public education opportunities by connecting people more directly with natural resources

This project is funded by the NERRs Science Collaborative to a project team led by the UNH Stormwater Center and the Great Bay National Estuarine Research Reserve. It supports Green Infrastructure implementation with local municipal, non-profit and private sector partners. For more information, visit southeastwatershedalliance.org/green-infrastructure.
THE PROBLEM

Brickyard Pond, once a community gathering place and natural playground, has deteriorated steadily over the years. As excess fertilizer, soil, oils, salt, and other components of stormwater pollution flow through stormdrains from a neighboring community and enter the pond, a food smorgasbord is created for unwanted plants and algae. The plants and algae grow in excess, reducing the overall water quality and degrading the habitat for fish.

THE SOLUTION

Neighbors in the Marshall Farms community expressed their concerns. Working with the town and with support from a Green Infrastructure grant, they learned what small changes they could make on their property to work toward improving the pond’s condition. Their focus was on making these changes using three Green Infrastructure tools: Lawn Care, Rain Barrels and Rain Gardens.
LAWN CARE

In a neighborhood workshop, residents learned about the importance of letting soil conditions, not past habits, dictate what their lawns need for fertilizer. By committing to the Happy Lawns-Blue Waters campaign, residents agreed to opt for slow release, phosphorus-free fertilizers unless soil tests indicate otherwise. In addition, they committed to cleaning up after their pets, reducing yet another source of excess nutrients. When mowing lawns, they would cut to three inches or higher to encourage stronger grass root growth and leave the cut grass on the lawn to take advantage of the free fertilizer provided as clippings decompose.

RAIN BARRELS

Residents were offered the opportunity to purchase SkyJuice rain barrels at a discounted rate. Rain barrels capture clean water from rooftops through gutter downspouts and store it for use whenever houseplants, gardens, or flowerbeds need watering. The result is not only a free water source for the residents, but a reduction in the amount of stormwater that leaves the property. So how much water can you save? A half-inch rainfall falling on a 1,000 square foot roof will provide 300 gallons of water.

RAIN GARDENS

A rain garden in its simplest form is a depression in your yard that uses soil, mulch, and plants to capture, absorb, and treat stormwater. This helps reduce the amount of stormwater coming from your property and to recharge groundwater.

Two neighborhood rain gardens were installed in this community. They were designed by Ironwood Design Group LLC with donations and assistance from Rye Beach Landscaping and Churchill's Gardens. Residents were invited to participate in construction to gain hands-on experience. They then applied their newly acquired skills to construct a rain garden on their own property.
What Is Green Infrastructure?

Green infrastructure is the utilization of natural processes to help control rain runoff. This can include constructed systems such as raingardens or buffers along streams that treat runoff by filtering the water. There are also non-structural strategies such as incentives or education to encourage homeowners to protect water quality, and regulations that require better stormwater control for new construction. A complete community approach uses green infrastructure throughout all aspects of community planning.

The Peirce Island Municipal Snow Dump Project

THE PROBLEM

The Peirce Island snow dump site in Portsmouth, NH covers approximately 0.54 acres and serves as the dumping location for snow removed from the urban core of the city. This is a known high load contribution site or pollution “hot spot” and is a frozen monument to the brew of salt, trash, nutrients, oil and sediment that are deposited on urban city streets. Snow plowing activities collect, convey and concentrate these pollutants into a single large location.

THE PROJECT

The Peirce Island Snow Dump Project was developed to address this issue. The project’s objectives:

1. Research a Low Impact Development/Green Infrastructure (LID/GI) solution to mitigate water quality impacts associated with snow removal.
2. Quantify the pollutant load and future reductions associated with LID/GI implementation.
3. Recommend a design for a LID/GI system for this location.

UNHSC staff developed a sampling plan over the course of the 2013-2014 and 2014-2015 winter seasons to quantify the pollutant load potential from snow dump facilities. A series of grab samples...
were collected from December 2013 through April 2014 and January through April 2015 from the snow dump site. Grab samples were taken from snow that was recently delivered to the snow dump facility (i.e. new snow) and of the snow that had been stored for an extended period of time (i.e. old snow). During each sample event the snow pile was measured to provide an estimation of the total volume of snow. The density of the snow pile was calculated using the snow to water equivalency ratio (SWE), which is a percentage of the volume of water contained within the snow pile. This SWE ratio was then multiplied by the measured snow volume to generate the volume of water (gallons) tracked over two winter seasons (Figure 1).

To quantify this pollutant removal potential, an assessment of the annual pile volume, the total pollutant mass delivered to the snow dump area, the exported pollutant mass, and the pollutant removal potential by a properly designed GI system were quantified and modeled. The results of this assessment are shown in Table 1 and Figure 2.

In addition to standard practices associated with snow dump activities, it was proposed that an appropriately sized bioretention system could be installed to manage the exported mass from rain and melt events.

### CONCLUSIONS

This study demonstrated that standard snow dump facilities by themselves remove a large mass of pollutants from the urban core. The process of collecting, trucking, and dumping snow into a dedicated location dramatically reduces pollutants otherwise exported to receiving waters by up to 87%. This practice itself should be considered a best management practice (BMP) for urban stormwater pollution.

These pollutant removal potentials can be increased even further, by up to 98%, through the design and installation of appropriately sized GI systems. (The lone exception is with respect to chloride loads, which may be an issue if discharging to freshwater areas.)

As a result of this project, a bioretention system has been designed for this location in Portsmouth. The total cost estimates for the materials and installation of the facility are between $13,500 - $17,400, and the City has committed to installing the system within the next two to three years.
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Rochester, New Hampshire

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**ROCHESTER’S COMMITMENT TO GREEN INFRASTRUCTURE**

The goal of this project was to improve the quality of life of Rochester’s citizens and visitors, protect natural resources and reduce municipal costs by:

- Updating the stormwater regulations so the City can consistently require the implementation of the current best management practices using low impact development and green infrastructure
- Establishing recommendations for developing a database to track and account for best management practices, maintenance, impervious cover, and other elements of future permit reporting requirements.
INTEGRATING UPDATES TO STORMWATER MANAGEMENT IN THE CITY ORDINANCE AND LAND USE REGULATIONS

IDENTIFIED NEED

The City of Rochester’s Planning and Community Development Department recognized that their current approach to stormwater management needed major revisions and updating. Many of the best management practices referenced in documents including Site Plan Regulations, Subdivision Regulations, and Chapter 50 of the City Ordinance were outdated and no longer the best options for management of stormwater runoff. The City’s stormwater regulations were created at different times and have many inconsistencies and outdated references. Conventional stormwater management had resulted in many of the problems the City has experienced, which include: flooding, stressing the existing public drainage systems, and degrading wetlands, rivers, and aquifers. All of the impacts represent economic and health cost to the City’s population.

As one of the fastest developing communities in the NH Seacoast, it is important that the documents be revised so that the City can take advantage of low impact development and green infrastructure stormwater best management practices moving forward.

REGULATION UPDATE PROCESS

The city staff, their technical consultant, and a subcommittee of the city’s planning board review used the following process:

- Review of stormwater components of the existing city documents including the Site Plan Regulations, Subdivision Regulations, Public Works Design Standards, and Chapter 50 of the City Ordinance
- Collection and review of other available information including the 2012 Southeast Watershed Alliance Stormwater Standards
- Provide recommendations for regulation updates to improve consistency, clarify the review process, and include revisions to best management practices requiring the usage of low impact development and green infrastructure for stormwater management
- Facilitate public outreach efforts

SPECIFIC OUTCOMES PROPOSED IN THE REVISED STORMWATER ORDINANCE

- Low Impact Development (LID) site planning and design strategies will be required to the maximum extent practicable
- Unique regulatory standards will be created for projects that meet the definition of “redevelopment project” thus fostering responsible redevelopment while reducing regulatory burden
- Offsite mitigation will now be permissible when onsite mitigation is impractical
- The 50-year, 24-hour storm event will be required to be modeled, in addition to the 2-year, 10-year, and 25-year events, 24 hour events.
- Specific water quality standards will become part of the minimum design standards
- Stormwater systems will not be allowed in sensitive areas
- Stormwater standards will now be in a single regulatory location (Chapter 50 of the General Ordinance)

Green Infrastructure design is good design.

"Thanks to Green Infrastructure stormwater standards, Rochester will begin to see developments creating gardens, shallow ponds that drain quickly, and other vegetated areas instead of ponds and pipes. This will really be a win-win for all parties: The City will have cleaner and less stormwater to pay for and treat; developers will reap economic benefits in the means of less maintenance and greater flexibility to retrofit a built site, and residents/visitors will enjoy more attractive and welcoming developments. Green Infrastructure design should simply be called good design.”

—Seth Creighton, Staff Planner, City of Rochester

THE VALUE OF GREEN INFRASTRUCTURE

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