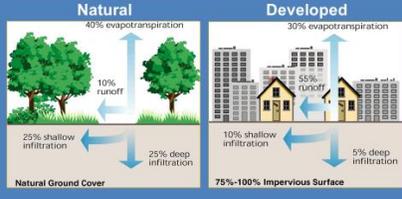


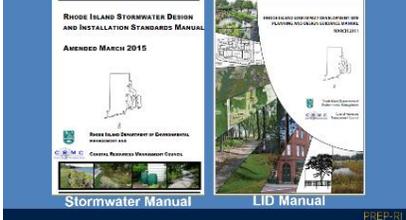


## PRESENTATION NOTES

<p><b>Managing Stormwater to Protect Rhode Island's Waters</b></p>	<p>1. Welcome to “Managing Stormwater to Protect Rhode Island’s Waters,” part of the online module series “Providing Resilience Education for Planning in Rhode Island” (or PREP RI). *** <b>Image Source:</b> Abramov Timur</p>
<p><b>Presenters</b></p>	<p>2. I am pleased to introduce our speakers for this module. I am Jennifer West with the Narragansett Bay Research Reserve, and I’m joined by Jennifer Paquet with the RI Department of Environmental Management’s stormwater program and Leah Bamberger, the City of Providence’s Sustainability Director.</p>
<p><b>By the end of this module, you will be able to:</b></p> <ul style="list-style-type: none"> <li>Identify the causes and impacts of stormwater</li> <li>Express the importance of stormwater management in Rhode Island and in your municipality</li> <li>Recognize how a changing climate impacts stormwater</li> <li>Describe how low impact development and green infrastructure techniques are used to avoid, reduce, and manage the impacts of stormwater</li> </ul>	<p>3. By the end of this module, you will be able to identify the causes and impacts of stormwater, express the importance of managing it, recognize how it’s being impacted by a changing climate, and describe how low impact development and green infrastructure techniques are used to avoid, reduce, and manage its impacts. I’m going to hand it over to Jennifer to take it from here.</p>
<p><b>Why Does It Matter?</b></p>	<p>4. So, why should we care about stormwater and its impacts?</p>
	<p>5. We need clean water to drink, and we rely on clean water to support a healthy economy and environment. We value our water resources for swimming, boating, and fishing. And it’s up to us to protect these treasured resources. As you’ll see, stormwater is the major cause of water quality impairment in Rhode Island (and it can also be a flooding hazard). It is much simpler and more cost-effective to prevent polluted runoff and mitigate flood impacts than it is to treat or repair the damage afterward. This is why it is important, as local officials, to think about efforts to improve stormwater management in our communities. *** <b>Image Source</b> (clockwise from upper right): Kayakers at Ninigret National Wildlife Refuge, USFWS;</p>

	<p>Relaxing on Misquamicut Beach in Westerly, RI Sea Grant; Casting for striped bass at Charlestown Breachway, R. H. Pos</p>
<p>Many Sources Contribute to Runoff</p>  <p>PREP-RI</p>	<p>6. So, how does it happen? Stormwater runoff results from the flow of water across a landscape. In natural landscapes, that water is filtered as it seeps through vegetation and soil to replenish groundwater supplies. However, in more developed areas where there is a higher percentage of impervious surfaces such as roads, buildings, and parking lots, the water runs right off of these surfaces, picking up pollutants- like road salt, pet waste, lawn fertilizer, you name it- before flowing into streams and rivers and then to a lake or Narragansett Bay. *** <b>Image Source:</b> Center for Watershed Protection</p>
 <p>PREP-RI</p>	<p>7. Here we see how increased impervious cover results in increased surface runoff. In an undeveloped area, almost half of the water that hits the ground infiltrates through the soil to replenish our groundwater supplies, about 40% is released back into the atmosphere through a combination of evaporation from the land surface and transpiration from plants (which has a cooling effect), and only 10% runs off. In a highly urbanized area with a large amount of impervious surface, 55% runs off. Only 15% of the water infiltrates the soil, and there is less evapotranspiration due to the lack of vegetation. *** <b>Image Source:</b> EPA</p>
 <p>More frequent flooding and higher flood levels</p> <p>PREP-RI</p>	<p>8. So, as impervious cover increases, so does the amount of stormwater runoff. During heavy rains in particular, runoff created by impervious cover contributes to more severe flooding events than less developed areas. *** <b>Image Source:</b> RI Emergency Management Agency</p>
<p>Increase in very heavy rain events</p>  <p>Observed change in very heavy precipitation from 1958 to 2012</p> <p>PREP-RI</p>	<p>9. Adding to the challenge is the steady increase in Rhode Island’s annual precipitation, particularly the increase in the frequency of heavy rain events, due to a changing climate. Very heavy events have increased by 71% in the Northeast over the past few decades. And this pattern is projected to continue. *** <b>Image Source:</b> US Global Change Research Program</p>

<p>Erosion and sedimentation...</p>  <p>... and low groundwater and stream flow levels</p> <p>PREP-RI</p>	<p>10. Higher flows also cause stream bank erosion and sedimentation of stream beds that negatively impact habitat. Additionally, runoff often has a higher temperature, which can affect cold water fish. There’s also the issue of too little water getting into the ground. Where impervious cover prevents water from replenishing groundwater, stream flow is often very low because streams draw from the groundwater supply. In addition to impacting wildlife, this compromises our drinking water supply.</p> <p>***</p> <p><b>Image Source:</b> Center for Watershed Protection</p>
<p>Negative Impacts on Public Health</p>  <p>PREP-RI</p>	<p>11. Then there are the water quality and health impacts. While the pollutants in runoff are picked up from many diffuse sources, they have a noticeable cumulative effect. Harmful pollutants found in stormwater runoff include bacteria that can close our beaches and shellfishing areas, and nutrients that can cause algal blooms, leading to extremely low oxygen conditions and then to events such as fish kills. There’s also pesticides, oil and grease that can be harmful to humans and deadly to aquatic life and heavy metals that are toxic to organisms and accumulate within them, rendering them unsafe for human consumption.</p> <p>***</p> <p><b>Image Source</b> (clockwise from upper right): 2003 Greenwich Bay fish kill, Narragansett Bay Estuary Program; Toxic shellfish sign, NOAA; Algal bloom, wpri.com; Beach closed sign, P. Burka</p>
<p>What Can We Do?</p>  <p>PREP-RI</p>	<p>12. So what can we do? I’m going to hand it over to Leah to take it from here.</p>
<p>Grey Infrastructure can have Drawbacks</p>  <p>PREP-RI</p>	<p>13. Traditional approaches to managing stormwater runoff included using storm sewer systems, AKA “pipe-to-pond” or “grey infrastructure” For decades stormwater has been managed by piping it away from a site into the nearest water body or a man-made detention basin as quickly as possible. This approach has led to the flooding and pollution problems described earlier.</p> <p>***</p> <p><b>Image Source:</b> Storm drain, P. Rubinoff; Pipe, Sickter6</p>

 <p>Low Impact Development &amp; Green Infrastructure</p> <p>Avoid → Reduce → Manage</p> <p>PREP-RI</p>	<p>14. To address this, we have learned to mimic natural hydrology through the use of low impact development (or “LID”) and green infrastructure. LID aims to <i>avoid and reduce</i> the impacts of stormwater runoff by protecting natural areas and minimizing impervious surfaces and <i>manage</i> runoff by capturing and treating it as close as possible to where it hits the ground through the use of nature-based engineered systems, also referred to as green infrastructure.</p>
 <p>RHODE ISLAND STORMWATER DESIGN AND INSTALLATION STANDARDS MANUAL AMENDED MARCH 2015</p> <p>Stormwater Manual LID Manual</p> <p>PREP-RI</p>	<p>15. The Rhode Island Stormwater Design and Installation Standards Manual requires LID as the primary method of stormwater control. It is a comprehensive approach best implemented early in the planning process, when the configuration of the site design, and therefore the amount of impervious cover created, is subject to local development regulations. Therefore, community staff and officials, such as planning board members, play an important role in ensuring that these standards are met when reviewing development proposals. The LID Site Planning and Design Guidance manual provides communities with specific guidance needed to revise their applicable land use regulations to avoid and minimize the impacts of stormwater runoff.</p>
 <p>South Kingstown Scituate North Kingstown Narragansett</p> <p>PREP-RI</p>	<p>16. By implementing LID, you’re capitalizing on nature’s free services. Intact floodplains provide flood protection and reduce infrastructure damage; healthy forests protect drinking water at the source and absorb heat-trapping gas emissions; wetland vegetation filters pollutants and reduces erosion. Along the coast, salt marshes help mitigate flooding and prevent erosion in addition to filtering polluted runoff. By protecting and enhancing these natural systems we’re also providing habitat, increasing property values, preserving community character, and saving money.</p> <p>***</p> <p><b>Image Source</b> (clockwise from upper right): Scituate reservoir, Dmcdevit; Salt marsh, Narragansett Bay National Estuarine Research Reserve; Annaquatucket R., NK, P. Rintels; Great Swamp, SK, RI, P. Rintels</p>
 <p>Step 1. Avoid (Protect Critical Natural Areas)</p> <p>Existing conditions Conventional development Conservation development</p> <p>PREP-RI</p>	<p>17. The first “line of defense” is to avoid stormwater runoff by protecting critical natural areas. Development may be directed away from important assets and into areas more suitable for development. Instead of carving up the landscape into large, cookie-cutter lots through conventional development, conservation development uses a flexible site design process that conserves sensitive ecological features and provides meaningful open space. Site clearing standards and tree protection standards further avoid impacts.</p>

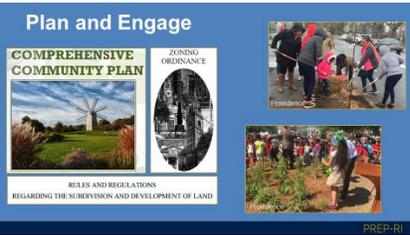
	<p>***</p> <p><b>Image Source:</b> P. Flinker (RI Conservation Development Manual)</p>
 <p><b>Step 2. Reduce</b> (Minimize Impervious Surface)</p> <p>South Kingstown, North Kingstown, South Kingstown</p> <p>PREP-RI</p>	<p>18. Stormwater runoff can be reduced by minimizing the amount of impervious surface created by development. For example, standards may be amended to decrease the width of roads, length of driveways, and the area of cul-de-sacs. As you can see in these local examples, these techniques reduce impervious cover while beautifying the site. Requiring natural vegetation, such as mature trees, and encouraging native landscaping to minimize the need for fertilizers and pesticides further reduce the impacts of stormwater runoff.</p> <p>***</p> <p><b>Image Source</b> (clockwise from upper right): Narrow roads, reduced driveway length, and native vegetation at S. Kingstown’s Brown Farm subdivision: J. West; Vegetated cul-de-sac in North Kingstown’s Shady Lea subdivision, J. West; Mowed path at S. Kingstown’s Brown Farm subdivision, Jen West;</p>
 <p><b>Step 3. Manage</b> (Capture, Absorb &amp; Treat)</p> <p>Providence, Providence, Providence, Providence, Providence</p> <p>PREP-RI</p>	<p>19. Finally, after taking steps to avoid and reduce the impacts, the remaining runoff is managed through capture and absorption on site. This may be achieved through green infrastructure practices such as rain gardens, bioswales, infiltration trenches, permeable pavement, and green roofs (which also happen to reduce heating and cooling costs and extend roof life).</p> <p>***</p> <p><b>Image Source</b> (clockwise from upper right): Rain capture at Woony River Park, Leah Bamberger; Groundwork Providence’s GroundCorp crew members performing maintenance on a green infrastructure installation, L. Carson; Potter League animal shelter green roof in Middletown, Apex Green Roofs; Permeable parking lot, Elmwood Ave., Providence, RIPTA; Cottages on Greene, East Greenwich rain gardens, Morris Beacon Design</p>



20. So far we've talked mainly about new development, but green infrastructure may easily be incorporated into redevelopment projects. On the left, you can see that some of the pavement in this parking lot was replaced with attractive vegetated bioinfiltration swales. In the middle, roofs, pavement, and compacted turf at this local school sent polluted runoff directly into a nearby creek that flows into a harbor. The impervious surface was replaced with bioretention areas and buffer plantings, providing water quality treatment while accommodating all necessary school activities and improving aesthetics. On the right, removal of pavement and the installation of infiltration basins has resulted in fewer closures at a local beach.

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**Image Source:** Left (top and bottom): Before: Bristol Town Beach parking lot, Wright-Pierce; After with vegetated bioinfiltration swales, Town of Bristol; Middle (top and bottom): Guiteras school, Town of Bristol; Right (top and bottom): Barrington Town Beach, Town of Barrington



21. As mentioned earlier, through Comprehensive Plans, Zoning Ordinances, Land Development Regulations and other important planning documents, communities have the ability to accommodate growth while avoiding, reducing and managing the impacts of stormwater runoff, preserving community character, saving money, and improving quality of life. It's important to re-evaluate your ordinances to increase opportunities for LID, and also to consider maintenance logistics when planning what's best for your community. And last but not least, involving the community early in the process is essential to achieving successful and equitable outcomes. Community input and participation helps ensure that the projects will be valued by the community. I'm going to hand it back over to Jen to finish it up.

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**Image Source** (clockwise from upper right): Community planting, Prairie Avenue, Providence, RI, Leah Bamberger; Oasis Project at Reservoir Ave School, Providence, RI, Leah Bamberger; Zoning ordinance cover, Town of Warren; Comp plan cover, Town of Middletown



22. Thanks for viewing this module. Go to the PREP-RI website to see the resources document and presentation notes, to fill out the survey, get your certificate, and view the other modules.

 <p><b>Acknowledgements</b></p> <p><b>Support</b> Governor Gina Raimondo, RI Legislature, and the University of Rhode Island</p> <p><b>Oversight Committee</b> Janet Coit, RI Department of Environmental Management Gwen Fugate, RI Coastal Resources Management Council Representative Lauren Carson, District 75, Newport Parag Agrawal, RI Division of Planning (formerly) Michelle Burnett, RI Emergency Management Agency (formerly) Kelly Mahoney, University of Rhode Island</p> <p><b>Stormwater Module Advisors</b> Ernie Penciera, Eric Beck, Jennifer Stolt, Margarita Chatterton (RISEM), Scott Miller (Grow Grant RI), Lee Pihl, Lorraine Joubert (URI, NEU)</p> <p>PREP-RI</p>	<p>23. The PREP-RI team acknowledges the support of statewide leaders, experts and practitioners who helped to make this module a reality.</p>
 <p><b>PREP-RI Team</b></p> <p>A partnership of the URI Coastal Resources Center, RI Sea Grant, the Graduate School of Oceanography, and the Narragansett Bay National Estuarine Research Reserve</p> <p>Pam Rubinoff, Jennifer West, Jennifer McCann, Teresa Crean, Dawn Kotowicz Mary-Kate Kins, Kevin Profit, Sue Kennedy, Cathy Dwyer, Monica Allard Cox</p> <p>PROVIDING RESILIENCE EDUCATION FOR PLANNING IN RHODE ISLAND PREP-RI.SEAGRANT.GSO.URI.EDU</p>	<p>24. And thanks to the PREP-RI Team for pulling this all together!</p>
 <p><b>PREP-RI</b> PROVIDING RESILIENCE EDUCATION FOR PLANNING IN RHODE ISLAND</p> <p>MODELS ABOUT CONTACT</p> <p>Welcome to RI Municipal Resilience Modules!</p> <ul style="list-style-type: none"> <li>Climate Change in RI</li> <li>Flooding</li> <li>Infrastructure</li> <li>Mapping Tools</li> <li>Stormwater</li> <li>Adaptation</li> </ul> <p>PREP-RI.SEAGRANT.GSO.URI.EDU</p>	<p>25. Providing Resilience Education for Planning in Rhode Island <a href="http://PREP-RI.Seagrant.gso.uri.edu">PREP-RI.Seagrant.gso.uri.edu</a></p>