

## Great Bay Municipal Coalition Adaptive Management Plan

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The purpose of this document is to provide an “adaptive management” plan for addressing Great Bay use impairments related to excessive nutrient contributions and habitat loss due to invasive species. Adaptive management is used when there is significant uncertainty regarding the efficacy and scope of various remediation efforts necessary to restore impaired uses. The US Environmental Protection Agency (EPA) Watershed Academy document entitled *Watershed Analysis and Management (WAM) Guide for Tribes: Step 5 Adaptive Management* describes the concept as follows:

“Adaptive management is the process by which new information about the health of the watershed is incorporated into the watershed management plan. Adaptive management is a challenging blend of scientific research, monitoring, and practical management that allows for experimentation and provides the opportunity to “learn by doing.” It is a necessary and useful tool because of the uncertainty about how ecosystems function and how management affects ecosystems. Adaptive management requires explicit consideration of hypotheses about ecosystem structure and function, defined management goals and actions, and anticipated ecosystem response (Jensen et al. 1996).

The results of this process are essential to validate the Watershed Assessment, to ensure that ecosystem relationships were considered adequately in Synthesis, and to show that management solutions have been implemented and are effective at achieving watershed objectives.”

Thus, the approach seeks to eliminate environmental impairments by (1) identifying priority actions and areas of uncertainty, (2) monitoring, before and after, the effects of implementing the priority measures, and (3) using such information to assess the need for and scope of further remediation efforts to ensure use attainment and protection.

The Memorandum of Agreement (MOA) between the Great Bay Municipal Coalition and the NH Department of Environmental Services (DES) recognized that Great Bay is suffering from a number of significant impairments; however, the precise causes of and solutions to eelgrass-related impairments are uncertain. The MOA established that a review committee should be created to study and better understand causes of eelgrass loss in the Bay, as related to transparency, epiphytes, and macroalgae. The MOA review was conducted under the auspices of Southeast Watershed Alliance (SWA) and consisted of experts from the University of New Hampshire (UNH), engineering consultants, municipal representatives, DES, and EPA. Based on those collaborative discussions the following scientific information was brought to light:

- Eelgrass losses in Great Bay do not appear to be a result of either insufficient transparency or excessive epiphyte growth;
- Macroalgae growth has greatly increased in the Bay over the past three decades and is adversely impacting habitat and eelgrass populations;
- Macroalgae die back every winter, and their regrowth occurs primarily during warmer weather months (June to September);
- The excessive macroalgae are most likely caused by increased dissolved inorganic nitrogen (DIN) loads to the Bay; and
- The level of DIN control required to control macroalgae is not known but should be

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controllable through reduction of inorganic nitrogen loading to early 1990 levels.

Based on these observations, the Coalition is proposing a series of actions designed to achieve the following goals:

1. Reduce municipal DIN levels to pre-1990 conditions;
2. Quantify overall DIN loadings to the system since 1990;
3. Create a monitoring program capable of tracking macroalgae and DIN levels in select areas of the Bay;
4. Complete additional literature research on factors and nutrient levels affecting macroalgae growth; and
5. Reduce non-point source (NPS) inputs through land use planning changes and implementation of bioremediation projects, such as oyster replenishment.

The attached document identifies the specific components of an adaptive management approach and how those components relate to critical restoration efforts identified by the Piscataqua River Estuary Project (PREP) as part of their document entitled *2010 Comprehensive Conservation and Management Plan*. It is expected that the time frame to implement these activities will span a ten year period. The first five years of the Adaptive Management Program will focus heavily on setting up the monitoring program and completing the wastewater treatment process changes necessary to significantly reduce DIN levels in the Bay. The next five years will focus on assessing the results of those and other NPS reduction activities. Based on the improvements (or lack thereof) in macroalgae growth and eelgrass health, a reassessment of activities necessary to protect the Bay's ecological resources will occur.

The progress being achieved will be reported in an open and transparent manner through a PREP website. This will allow the public and other interest groups to receive timely information and comment on the efficacy of the program.

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Permit Condition	PREP CCMP Objective	PREP CCMP Action & Ranking
<p>For wastewater facilities that are significantly contributing nutrients to Great Bay NPDES permit limit of 8 mg/l April- October for 10 years; then assess estuary conditions on need for lower permit limits based on:</p> <ul style="list-style-type: none"> <li>• water quality improvements</li> <li>• habitat response</li> </ul>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p>	<p><b>WR-12</b> Improve nutrient removal at WWTP's and support system upgrades and expansion <b>Highest</b></p> <p><b>WR-14</b> Support inter-municipal coordination to find and implement effective solutions for reducing nutrients and other pollutant loads throughout the Great Bay watershed <b>Highest</b></p> <p><b>WR-23</b> Encourage watershed based permitting <b>Moderate</b></p>
<p>Invest in water quality and habitat monitoring</p>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p>	<p><b>WR-10</b> Support research to develop and better understanding of the nutrient (nitrogen) cycling, geochemistry, and nutrient removal in the Piscataqua watershed <b>High</b></p> <p><b>WR-14</b> Support inter-municipal coordination to find and implement effective solutions for reducing nutrients and other pollutant loads throughout the Great Bay watershed <b>Highest</b></p>

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<p>Invest in bio-extraction through oyster restoration and aquaculture projects, eelgrass restoration, and other habitat enhancement projects. Funds could be directed to SWA and be used as grant match for suitable projects to leverage funds and extend scope of efforts.</p>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p> <p><b>LR 1.1</b> Increase abundance of adult oysters at the 6 documented beds in Great Bay Estuary to 10 million oysters and restore 20 acres of oyster reef habitat by 2020.</p> <p><b>LR 1.3</b> Increase the extent of eelgrass cover to 2,900 acres and restore connectivity of eelgrass beds throughout the Great Bay estuary by 2020</p> <p><b>LR 1.11</b> Monitor and control the extent of invasive nuisance species throughout the Piscataqua region watershed and estuaries.</p> <p><b>LR 1.14</b> Improve implementation capacity for restoration projects</p>	<p><b>WR-14</b> Support inter-municipal coordination to find and implement effective solutions for reducing nutrients and other pollutant loads throughout the Great Bay watershed <b>Highest</b></p> <p><b>LR-1</b> Develop and implement a comprehensive resource action plan for native oyster populations in the Great Bay Estuary and other suitable sites in the Piscataqua region. <b>Highest</b></p> <p><b>LR-3</b> Implement a comprehensive recovery strategy for eelgrass throughout the Great Bay Estuary. <b>Highest</b></p> <p><b>LR-16</b> Support the development and implementation of marine aquatic nuisance species management plans for Piscataqua Region estuaries. <b>High</b></p>
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<p>Implement local stormwater and development ordinances and regulations that require Low Impact Development (LID) techniques through out the watershed.</p> <p>Engage NHDES to encourage and require non MS4 communities to adopt stormwater BMP's</p> <p>Partner with the UNH Stormwater Center to design, implement, and test in the field innovative stormwater management practices that reduce nitrogen as pilot projects within the Coalition communities.</p>	<p><b>LU 1.1</b> Promote sustainable land use practices in both new and redevelopment of existing sites.</p> <p><b>LU 1.2</b> Promote regional strategies for consistent use of ecologically protective planning, regulation, development and enforcement.</p>	<p><b>LU-1</b> Promote inclusion of natural resource chapters in municipal Master Plans, adoption of compact development and conservation subdivision ordinances, and creation of open space plans. <b>Highest</b></p> <p><b>LU-2</b> Employ best management practices and low impact development approaches in new, existing and redevelopment to minimize stormwater runoff impacts and limit changes to pre-development site hydrology. <b>Highest</b></p> <p><b>LU-3</b> Refine and support existing outreach and training programs that promote LID, LEED and sustainable development practices and adopt relevant ordinances for environmental resource protection. <b>High</b></p>
<p>Adopt and implement stream and wetland buffer protection for new development and re-establishment of buffers where they have been destroyed as a result of past development</p>	<p><b>LU 1.1</b> Promote sustainable land use practices in both new and redevelopment of existing sites.</p> <p><b>LU 1.2</b> Promote regional strategies for consistent use of ecologically protective planning, regulation, development and enforcement.</p> <p><b>LU 2.1</b> Protect floodplains, wetlands, shorelands and associated fluvial erosion hazard zones to maintain their function and value</p> <p><b>LU 2.2</b> Promote improved protection of low order streams</p>	<p><b>LU-6</b> Promote and implement measures to protect floodplains, and riparian shoreland areas from detrimental impacts associated with development. <b>High</b></p> <p><b>LU-10</b> Develop and implement consistent municipal ordinances to protect 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order streams and buffers throughout the watershed. <b>Highest</b></p>

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<p>Consider implementation of fertilizer control regulations and work with NHDES to get enabling legislation approved</p>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p>	<p><b>WR-11</b> Promote low impact and low nutrient commercial and residential landscaping techniques. <b>High</b></p> <p><b>WR-14</b> Support inter-municipal coordination to find and implement effective solutions for reducing nutrients and other pollutant loads throughout the Great Bay watershed <b>Highest</b></p>
<p>Cooperate with NHDES and other stakeholders to determine the best resolution of the septic system nitrogen contribution in the watershed.</p>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p>	<p><b>WR-13</b> Reduce watershed nutrient loading from on-site septic systems.</p> <p><b>WR-14</b> Support inter-municipal coordination to find and implement effective solutions for reducing nutrients and other pollutant loads throughout the Great Bay watershed <b>Highest</b></p>
<p>Work with NHDES to develop nutrient reduction trading program within the watershed</p>	<p><b>WR 1.3</b> Reduce nutrient loads to the estuaries and the ocean so that adverse, nutrient-related effects do not occur.</p>	<p><b>WR-23</b> Encourage watershed based permitting for NPDES discharges</p>
<p>Undertake an international literature review of research relating to macro algae growth and nutrient concentrations in estuarine waters.</p>	<p><b>LR 1.11</b> Monitor and control the extent of invasive nuisance species throughout the Piscataqua region watershed and estuaries.</p> <p><b>LR 1.14</b> Improve implementation capacity for restoration projects</p>	<p><b>LR-3</b> Implement a comprehensive recovery strategy for eelgrass throughout the Great Bay Estuary. <b>Highest</b></p> <p><b>LR-16</b> Support existing program, initiatives, and partnerships to limit the introduction and control the spread of terrestrial and aquatic nuisance species in the Piscataqua Region watersheds</p> <p><b>LR-16</b> Support the development and implementation of marine aquatic nuisance species management plans for Piscataqua Region estuaries. <b>High</b></p>