EXECUTIVE SUMMARY

PROJECT OVERVIEW

The water quality of Moultonborough Bay Inlet (MBI) is threatened by harmful pollutants in nonpoint source (NPS) pollution from developed areas in the watershed. The desirability of MBI as a recreational destination, and increasingly as a permanent residence for newcomers, will likely stimulate continued population growth in the future. Thus, taking proactive steps to properly manage and treat NPS pollution in the MBI watershed is essential for continued ecosystem health and recreational enjoyment by future generations.

> The **Moultonborough Bay Inlet Watershed Restoration Plan** provides a roadmap for preserving the water quality of MBI, and provides a mechanism for procuring funding (e.g., Section 319 grants) to secure actions needed to achieve the water quality goal. USEPA requires that a watershed plan (or an acceptable alternative plan) be created so that communities become eligible for watershed assistance implementation grants.

QUICK FACTS

Town/State:	Moultonborough, NH (68%) Sandwich, NH (32%) Tamworth, NH (<1%)
Total Watershed Area:	50 sq. mi. (32,246 ac.)
Lake Area:	1.6 sq. mi. (1,011 ac.)
Shore Length:	24.6 miles
Max Depth:	81 ft. (Basin 3)
Mean Depth:	15.4 ft. (Basin 3)
Lake Volume:	4.5 billion gallons
Flushing Rate:	5.8 times per year (Basin 3)
Lake Elevation:	500 ft.
Trophic Classification:	Oligotrophic
Impairments:	Cyanobacteria

Invasives: Variable milfoil was found in 1965 and has been proactively managed by the Milfoil Crisis Committee since 2009. Since 2010, the area from Green's Basin to Deepwood Ledges/Hemlock Point has reduced from 90% to 40% coverage.

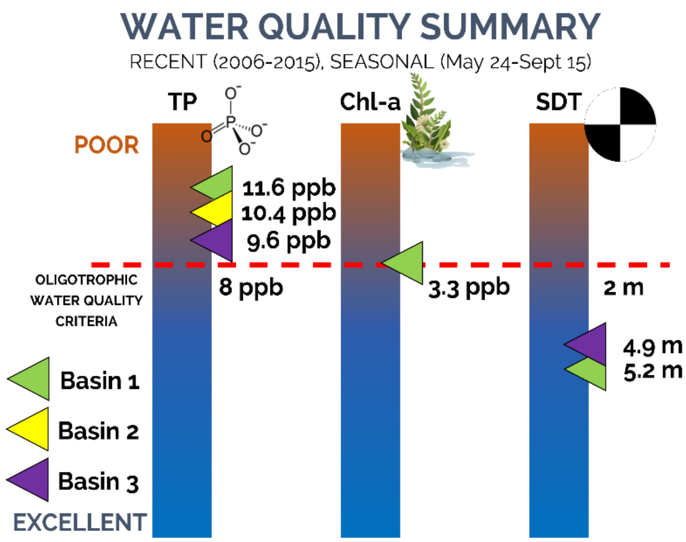
Tributaries: The area draining through Lees Pond to Basin 3 accounts for 55% of the water volume entering Basin 3. Other major inlets to Basin 3 include Shannon Brook, Halfway Brook, Middle Brook, Basins 1 & 2, and an unnamed tributary that flows north to Basin 3 from the southwest side of the Inlet.

Other Notes: The high flushing rate of 5.8 means that the entire volume of Basin 3 is replaced about six times every year, which limits time for pollutants to settle in lake bottom sediments and/or be taken up by biota.

As part of the development of this plan, a build-out analysis, water quality and assimilative capacity analysis, and volunteer shoreline and watershed stormwater surveys were conducted (Section 3). Results of these efforts were used to run a land-use model, or Lake Loading Response Model (LLRM), that estimated the historical, current, and projected amount of total phosphorus (TP) being delivered to the Inlet from the watershed (Section 3.3.2). An Action Plan (Section 5.2) with associated timeframes, responsible parties, and estimated costs was developed based on feedback from Advisory Committee members over the course of multiple meetings. Led by the Lake Winnipesaukee Association (LWA), the Advisory Committee represented a diverse range of interests: municipal staff and conservation commissions, state agency officials (e.g., NH Fish & Game, NHDES), residents and lake/pond/neighborhood associations (e.g., Milfoil Committee, Lees Pond Association, Suissevale, Balmoral), land trusts and non-profits (e.g., Lakes Region Conservation Trust, Granite State Rural Water Association), and technical experts (e.g., FB Environmental Associates, DK Water Resource Consulting). This plan was partially funded by a Watershed Assistance Grant for High Quality Waters from NHDES using Clean Water Act Section 319 funds from the USEPA, with additional financial and in-kind services provided by the Town of Moultonborough, Moultonborough Conservation Commission, residents, and stakeholders.

WATER QUALITY ASSESSMENT & MODELING

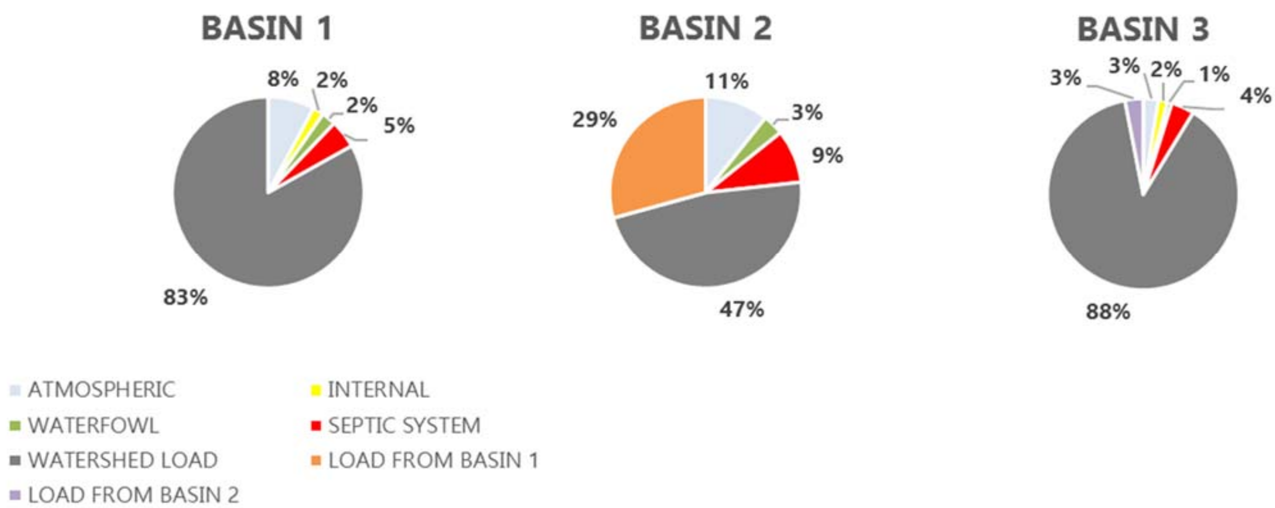
MBI is part of a larger lake system, Lake Winnipesaukee, and thus, the Inlet itself is not listed as a separate assessment unit by NHDES, but is integrated with and classified the same (oligotrophic) as Lake Winnipesaukee, which is listed on the 2014 NHDES 303(d) list as impaired for aquatic life based on the presence of cyanobacteria. Cyanobacteria are fed by excess nutrients in nonpoint source runoff from developed areas. Thus, this plan focuses on phosphorus as the overall driver of ecosystem health. Waterbodies with excess nutrients, particularly phosphorus, which is considered the limiting nutrient in freshwater systems, are overproductive and may experience symptoms of water quality decline, including algal or cyanobacteria blooms, fish kills, decreased water clarity, loss of aesthetic values, and beach closures. Decomposition of accumulated organic matter from dead algal or cyanobacteria blooms and plants, such as milfoil, can result in anoxia in bottom waters, which can release phosphorus back into the water column as food for algae and plants and can also be lethal to fish and other aquatic organisms.



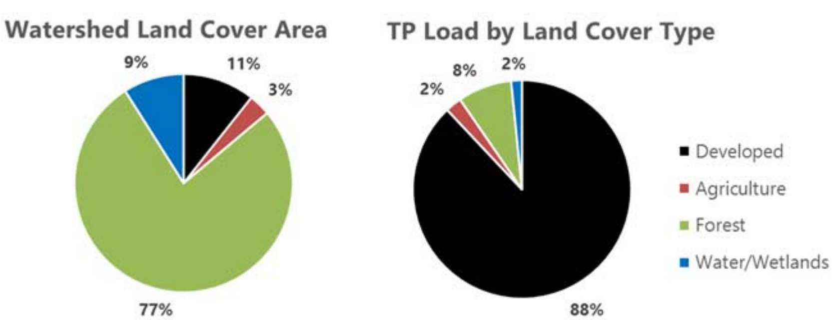
Visual summary of existing water quality in MBI. Data represent recent (2006-2015) and seasonal (May 24-Sept 15) median or average calculations. TP = total phosphorus; Chl-a = chlorophyll-a; SDT = Secchi Disk Transparency. No data are available for Chl-a and SDT at Basin 2 and Chl-a at Basin 3.

Because the morphology (shape) and bathymetry (depth) of MBI is irregular, causing the formation of individual basins, bays, or inlets within the study system that impact water and nutrient movement (flushing), and subsequently, system function and health, MBI was divided into three individual basins (Basin 1, 2, and 3) for modeling, data analysis, and goal setting purposes. Basin 1 is considered impaired for both TP and chlorophyll-a (Chl-a), while Basins 2 and 3 are potential non-supports due to insufficient, but likely lower than reserve capacity, Chl-a data (Section 3.2.2). The analysis revealed that Basin 1 requires the most reductions in TP and is at most risk for elevated nutrient input and algal blooms that can impact Basin 2 (and Basin 3 minimally), while Basins 2 and 3 may also have considerable reductions needed for TP if Chl-a levels are in fact a significant issue. However, data from multiple sites within Basin 3 show that Chl-a is better than the criterion (3.3 ppb) and reserve capacity threshold (3.0 ppb) for oligotrophic systems. Until more Chl-a data are collected for Basin 2 and 3 sites, the water quality goal will be based on the achievement of 7.2 ppb for TP with the understanding that this goal may change given the likely acceptable Chl-a levels in MBI.

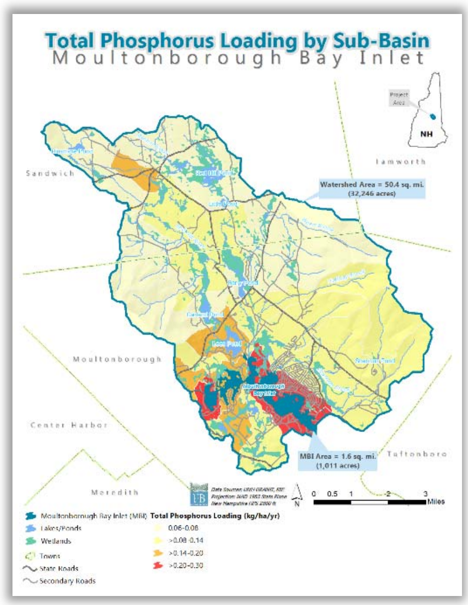
The land use model results indicate that the greatest phosphorus load comes from watershed runoff, which accounts for 83%, 47%, and 88% of the total loading to Basins 1, 2, and 3, respectively. Atmospheric deposition accounts for <11%, septic systems <10%, waterfowl <3%, and internal loading <2% of the TP entering the three basins. While the load from Basin 1 to Basin 2 accounts for 29% of the total load to Basin 2, the load from Basin 1 and Basin 2 accounts for only 3% of the total load to Basin 3. This suggests that the higher TP concentrations observed at Green's Basin, while important locally, may not have a large impact further downstream.



Percentage of total phosphorus (TP) loading (kg/yr) by source (atmospheric, internal loading, waterfowl, septic systems, watershed load).



Watershed land cover area by general category (developed, agriculture, forest, and water/wetlands) and total phosphorus (TP) load by general land cover type.



The direct drainage area of MBI contributes the most phosphorus per hectare per year compared to the other sub-basins (see Appendix B for larger map).

Although developed areas cover only 11% of the watershed, these areas are contributing 88% of the phosphorus load to MBI (Section 2.2.2). The direct drainage area of MBI contributes the highest phosphorus load per unit area to MBI (Appendix B). Direct shoreline areas are usually high phosphorus contributors because of their proximity to lakes and high-density development. Given this, the direct shoreline of a lake deserves special attention in any lake protection plan.

The build-out analysis identified an estimated 5,253 acres (26%) of the portion of the watershed in the Town of Moultonborough is developable (Appendix B; Section 3.2.4). Up to 2,184 new buildings (a 93% increase from current conditions) could be added at full build-out by the year 2058, using a conservative growth rate of 1.58%. This predicted increase in development was then input to the model; the future in-lake phosphorus concentration was estimated at 22.5, 14.5, and 16.6 ppb for Basins 1, 2, and 3, respectively. Shannon Brook is most at risk for increases in TP loading because of increased development. Results of the build-out analysis reinforce the concept of comprehensive planning at the watershed level to address future development and its effect on the water quality of MBI. Future development will increase the amount of polluted runoff that drains to MBI; therefore, it is recommended that town officials revisit zoning ordinances to ensure that existing laws encourage smart, low-impact development. Land-use and zoning ordinances are among the most powerful tools municipalities can use to protect their natural resources.

MBI may experience a 40-43% increase in phosphorus loading at full build-out by 2058. The direct drainage area and Shannon Brook sub-basins are most at risk for increases in phosphorus loading because of anticipated development.

WATER QUALITY GOALS

The over-arching goal for the watershed is to improve the water quality of MBI and to protect MBI from future, unaccounted-for inputs of phosphorus because of new development in the watershed over the next twenty years.

The Advisory Committee set a water quality goal of 7.2 ppb TP (for summer median epilimnion TP) for Basins 1, 2, and 3, along with adaptable interim goals and milestones that will help achieve this goal over the next twenty or more years. This will require a phosphorus loading reduction of 42% (26 kg/year) in Basin 1, 31% (27 kg/year) in Basin 2, and 20% (242 kg/year) in Basin 3 based on current conditions.

Over the next twenty years, new development using business-as-usual regulations will likely increase current phosphorus loading by 16, 22, and 294 kg/yr to Basins 1, 2, and 3, respectively. This will hinder progress toward achieving the water quality goals. Given this consideration, it will be just as important to focus on updating municipal regulations to incorporate more stringent water quality protections during new development as it will be to minimize TP loading from existing development. It is also important to note that there are several larger ponds within the Basin 3 drainage that should set their own water quality goals and TP reduction goals to help improve water quality in MBI.

POLLUTANT SOURCE IDENTIFICATION

During the 2015 watershed survey, 56 NPS sites were identified and rated for impact level based on location, slope, amount of soil eroded, and proximity to water. Recommendations ranged from installing buffer plantings and infiltration swales to replacing culverts and reconstructing concrete aprons. The following showcases select hotspot NPS sites in the MBI watershed.

SITE ID #1: a driveway and boat access ramp were identified as having moderate surface and road shoulder erosion that runs off directly into the lake. It is recommended that new surface material (e.g., recycled asphalt) be added, the road crown reshaped, and an open top culvert installed.

SITE ID #2: a commercial property was identified as having moderate surface and roof runoff erosion and lack of streambank vegetation that allows stormwater to enter the stream. It is recommended that an infiltration trench at the roof dripline be installed, and a buffer planted along the stream.

SITE ID #3: a town road was identified as having severe surface erosion with several large gullies that flow directly into the lake. It is recommended that runoff diverters are installed, a foot path is stabilized, and a buffer is planted with erosion control mulch.

SITE ID #4: a private road was identified as having moderate surface erosion, lack of adequate shoreline vegetation, and significant shoreline erosion that was depositing stormwater runoff into a stream. It is recommended that a buffer be planted along the stream for stabilization.

During the 2015 shoreline survey, 60% of the MBI shoreline (or 330 parcels) scored 10 or higher, indicating shoreline conditions that are likely detrimental to lake water quality. These shoreline properties tended to have inadequate buffers, evidence of bare soil, and structures within 75 ft. of the shoreline.

Lack of vegetative buffer (left) results in delivery of excess nutrients and sediments in the Inlet compared to vegetated shoreline areas (right). (Photo: FB Environmental)

PLAN IMPLEMENTATION STRATEGY & RECOMMENDATIONS

Management strategies for achieving the water quality goals involve using a combination of structural and non-structural BMPs, as well as an adaptive management approach (refer to Section 4). The recommendations of this plan should be carried out by an advisory committee like the one assembled for development of this plan. The following presents short-term recommendations for achieving the goal and objectives:

- WATERSHED & SHORELINE BMPS: Work with shorefront residents to encourage participation in shoreline residential BMP implementation efforts, with initial focus on the six high impact shoreline properties around Basins 2 and 3 and the 38 medium impact shoreline properties around Basin 1. A funding subcommittee should be created to help find and apply for funding that supports all aspects of the Action Plan. Begin implementing recommended BMPs at the 20 high priority sites identified in the watershed survey.
- SEPTIC SYSTEMS: Distribute educational information and lists of septic service providers to watershed residents. Host “septic socials” to start the conversation around septic system maintenance and replacement. Investigate grants and low-interest loans as a first step to upgrading identified problem systems in the watershed. Develop a septic system database.
- ROADS: Work with private road associations to begin a discussion about four season road maintenance and management. Coordinate with NHDOT to identify and replace priority culverts identified during the watershed survey.
- PLANNING & LAND CONSERVATION: Have towns formally adopt the plan. Provide information on LID and BMP descriptions to Selectmen, town staff, and Planning Board members. Encourage towns to consider making changes to ordinances to protect water quality. Suggestions include: increasing setbacks to 100 feet within the shoreland zone and wetlands, increase the amount of land set aside in conservation subdivisions to a minimum of 50% of the developed area, and include LID language. Given future development potential, it is critical for municipalities to develop and enforce stormwater management measures that prevent an increase in pollutant loadings from new and re-development projects, particularly as future development may offset reduced loads from other plan implementation actions.
- WATER QUALITY MONITORING: Take regular, annual DO and temperature profile readings, Secchi disk readings, and epilimnion and hypolimnion total phosphorus and epilimnion chlorophyll-a samples at a minimum of one station per basin. Recommend WMO00GL (Green’s Basin), WMO01BL (Blanchard’s Island), and WMO01LL (Little Ganzy). Aim for biweekly Secchi disk readings and monthly DO and temperature profile readings combined with chemical sampling. Assumes a sampling season from June-September.

ESTIMATED COSTS

The cost of successfully implementing this watershed plan is estimated at over $1,000,000 over the next twenty years (Section 5.4). However, many costs are still unknown and should be incorporated into the Action Plan as information becomes available. A sustainable funding plan should be developed within the first year of this plan and revisited on an annual basis to ensure that the major planning objectives can be achieved over the long-term.

This funding strategy would outline the financial responsibilities at all levels of the community (landowners, towns, community groups, and State and federal governments).

Estimated one-time or initial costs and 20-year total costs for watershed restoration.

Category	Estimated Costs	20-year Total
Watershed & Shorefront BMPs	$559,286	$613,536
Septic Systems*	$24,250	$27,500
Roads	$23,750	$23,750
Planning & Conservation	$22,500	$22,500
WQ Monitoring	$22,200	$406,000
Total Cost	**$651,986**	**$1,093,286**

**Septic system action items do not include design or replacement costs because these should be covered by private landowners. Action items cover assistance to secure grant funding for those individuals who cannot afford these costs.*

EVALUATING PLAN SUCCESS

The success of this plan is dependent on the continued effort of volunteers, and a strong and diverse advisory committee (like the one established for plan development) that meets regularly to coordinate resources for implementation, review progress, and make any necessary adjustments to the plan to maintain relevant action items and interim benchmarks. Measurable milestones (number of BMP sites, volunteers, funding received, etc.) should be tracked by an advisory committee and reported to NHDES on a regular basis.

A 20-42% reduction in phosphorus is no easy task, and because there are many diffuse sources of phosphorus reaching MBI from existing residential development, roads, septic systems, and other land uses in the watershed, it will require an integrated and adaptive approach across many different parts of the watershed community to be successful.