The Deal Lake Watershed Protection Plan Milestone 5 Report Grant #RP04-082

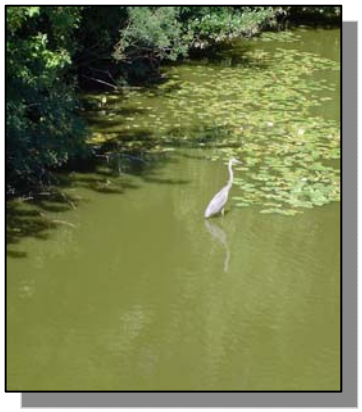

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TABLE OF CONTENTS

THE DEAL LAKE WATERSHED PROTECTION PLAN

Executive Summary

Deal Lake is the largest of the State's Coastal Lakes. With a history extending back into the 1800s, Deal Lake has provided a variety of recreational opportunities to the surrounding community. Although the lake continues to be a community focal point, it is clear that its water quality and ecology have been severely degraded over time. As documented in the Milestone 3, Characterization and Assessment Report, the majority of the lake's past and continuing problems are directly linked to the inadequate management of the stormwater directed to the lake and its tributaries from the surrounding watershed.

As is the case with many man-made lakes, there has been little effort taken over the years to manage runoff prior to its release into the lake or its tributaries. The existing stormwater infrastructure system in fact uses the lake as the primary regional means of flood attenuation. Given that there has historically been little done to address stormwater pollutant loading, the lake also serves as the sole means of passive pollutant removal prior to discharge into the ocean. If an improvement is not achieved in the overall management of stormwater, the lake's water quality will never improve.

The data and information compiled in the Characterization and Assessment Report clearly show that not only is the lake and its tributaries impacted by inadequate managed stormwater runoff, but any meaningful improvement in the condition of the lake and its tributaries will not be possible unless a series of measures are put in place to correct the existing problems. This is not only significant from the perspective of the stakeholders use and perception of the lake, but is required in order for the NJDEP to satisfy the existing phosphorus and bacteria TMDLs and to de-list the lake.

Due to the magnitude and widespread nature of these problems, the corrections must encompass the following:

1. Regional stormwater management solutions that correct, replace and/or retrofit the existing stormwater management infrastructure;
2. Stabilization of the lake's stream channels;
3. Control of the influx of pollutants, including floatables;
4. Better stormwater management planning and design, with the focus placed on stormwater recharge to help moderate base flows, decrease storm surges and flooding, and lessen the opportunity for streambed and bank scouring;

5. Upgrade and retrofit of the existing stormwater management infrastructure and use of these opportunities to address and correct localized stormwater and pollutant loading problems;
6. Reclamation of sediment-infilled areas of the lake and development of a long-term management plan to ensure that the factors responsible for the infilling are corrected and that the reclaimed areas are easily and effectively maintained over time;
7. Decrease in the occurrence of invasive species within the lake and within the riparian areas of the lake and its tributaries;
8. Decrease in the frequency and magnitude of algae blooms;
9. Improvement in the lake's fishery as a major means of improving the lake's overall use attainment; and
10. Decrease in fecal coliform loading.

With funding provided by the NJDEP through a 319(h) grant, and in accordance with the guidance provided in NJDEP Stormwater Best Management Practices Manual, N.J.A.C. 7:8 and N.J.A.C. 7:15, the DLC embarked on the development of a Regional Stormwater Management Plan (RSWMP) with the intent of preparing a mechanism for implementing the measures noted above on a watershed-wide scale. The RSWMP was completed in 2008, but has been modified herein to function is a similar context as a Watershed Protection Plan (WPP), providing as framework for the DLC and the member municipalities to collectively address and correct the lake's problems. The WPP identifies various Best Management Practices (BMPs) that can be used to better control the rate, volume and pollutant load conveyed by runoff entering the lake and its tributaries. The WPP also identifies source control (e.g., development ordinances and public education) and land use practices (e.g., buffer restoration and LID) that will not only decrease the rate, volume and pollutant content of runoff, but will help restore the ecological functions and services of the lake's riparian buffers, floodplains and stream corridors. Many of the stormwater management improvements and related BMPs identified and discussed in the WPP report reflect recommendations made over the past 20+ years as reflected in various reports, studies and documents conducted/prepared by not only the DLC but State and Monmouth County agencies.

Clearly, in order to correct the water quality and use impairments identified above, the BMPs needed for Deal Lake and its watershed must encompass both proactive as well as restorative measures. This means as we go forward we must have in place strong planning measures that prevent or ameliorate the lake's impairment problems, whether these be nutrient, sediment, pathogen, flooding or floatable related. Source control measures, which are most commonly reflected in regulatory requirements and performance and design standards supported by ordinances, are the keystone to the long-term success of the WPP. In

fact, the lack of source control measures is a direct cause of problems that impact the lake and its tributaries. Support for a WPP is inherent to creating the regulatory framework that the stakeholders, users and the DLC recognize is needed for the successful restoration of the lake and its tributaries.

Equally clear is the fact that without a regionalized approach to the management of stormwater it will be difficult to mitigate the impacts created now and in the future by inadequately controlled or treated stormwater runoff. Given the degree of development that prevails throughout the Deal Lake watershed this can only be achieved through aggressive management of stormwater making use of recharge, biorestoration and retrofit solutions capable of cost-effectively reducing the volume of runoff and improving the quality of runoff.

Furthermore, because much of the damage to the lake and its tributaries is the result of historic watershed-wide development actions are needed to remediate the scoured and eroded streams that feed the lake. This can be accomplished through the systematic biorestoration of these tributaries. The remediation begins with protection of remaining riparian buffers and the re-establishment of damaged stream corridors. It also will entail the restoration of many of these streams, which due to the erosive nature of improperly managed stormwater runoff has led to their severe erosion. Once eroded, the clayey and somewhat acidic content of the soils resist revegetation leading to the exposure of more unstable soils and the further "down cutting" of the stream and adjacent riparian areas. The bed and bank load of sediment resulting from the erosion of the lake's feeder streams currently represents the lake's largest source of continuing sediment influx. Correction of these problems is ultimately linked to BMPs that can decrease the volume of runoff.

Although the WPP identifies specific project sites for the construction of BMPs, these are by far not the only locations where such improvements are needed. In addition, although the Characterization and Assessment Report and the Milestone 4 reports detailed the causes, impacts and proposed remedies for the existing state of stormwater management, more detailed studies will be required in the future to further identify or design the needed BMP solutions. As such, we view the restoration of Deal Lake and its watershed as a constantly evolving process. Again, the WPP will provide the technical guidance and framework needed to support the future management and restoration of the lake. Without such a framework in place neither the DLC nor the NJDEP will be successful in meeting the lake's TMDL or in achieving the goals of the Clean Water Act and making the lake once again consistently swimmable and fishable. As such, the WPP is an important element of the State's plan to delist the lake. But even more important, the WPP is critical to achieving the vision of the DLC and the local stakeholders of once again elevating the lake to its rightful stature of an ecologically balanced ecosystem capable of satisfying the water-based recreational needs of the community.

1.0 Introduction / Description Of The Study Area

1.1 Regional Importance of the Deal Lake Watershed

Deal Lake is the largest coastal lake in Monmouth County, with a total surface area of approximately 155 acres. The lake's long history is evidenced by the fact that it has been called various names since it was originally impounded, notably Lake Uliquecks, Whites Pond, Drummonds Pond, Corlies Pond, Great Pond and Boyleston Great Pond (Robinson, 1997). It has a sprawling, dendritic form, tapering from the main lake basin to several tributary "arms" that extend inland as far west as Route 18 and beyond (see Map A, Appendix A). Although the main body of the lake serves as the dividing line between the City of Asbury Park and the Village of Loch Arbour, its irregularly shaped shoreline and 4,400-acre watershed is shared by five other municipalities: the Boroughs of Allenhurst, Deal and Interlaken and the Townships of Neptune and Ocean. It is located within Watershed Management Area (WMA) 12.

Seven major tributaries feed into the western reaches of Deal Lake. From south to north, these are Hollow Brook, Seaview Brook, four unnamed streams and Harvey Brook (once known as Hog Swamp Brook), which extends from the lake farther west than any of the other tributaries (see Map A, Appendix A). As part of a 314 Clean Lakes Diagnostic Feasibility Study conducted in 1984, details were prepared of the lake's hydrology (Princeton Aqua Science, 1984). As per the results of that study, total inflow to the lake from these streams was calculated to be 8,080,000 cubic meters (2.14 billion gallons) annually, with an additional 1,920,000 cubic meters (507,210,338 gallons) entering the lake from stormwater runoff (via both overland flow and the local storm sewer system) for a total annual inflow of 10 million cubic meters or 2.64 billion gallons. The total volume of the lake's main basin was calculated at 928,000 cubic meters (245,151,664 gallons) (Princeton Aqua Science, 1984).

A flume structure at the eastern end of the lake is designed to permit outflow from the lake through a sluice gate, while preventing inflow from the Atlantic Ocean. The sluice gate can be opened and closed manually to allow for drawdown of the lake for dredging or cleanup activities and to allow the release of water during storm events. The flume was constructed in the late 1890s (Robinson, 1997), prior to which the lake's eastern edge was open to the sea. In addition to controlling the lake level, the flume also provides a conduit for migrating blueback herring (a food source for bass), which return to the lake from the ocean to spawn each year (Jaroszewski, n.d.).

Throughout its history, Deal Lake has been heavily utilized for recreational activities such as boating and fishing. Rowers make extensive use of the southern portions of the lake from the mouth of Harvey Brook to the main body. Power boats, jet skis and an occasional water skier use the easternmost main body of the lake. Fishing is popular throughout the lake,

both from the shore and from boats. The lake has been the site of bass fishing tournaments and has been stocked by both the DLC and NJDEP, making it very popular with local anglers.

Deal Lake's watershed can be best characterized as highly urbanized, with high- and medium-density residential development and commercial land uses dominating the local landscape (see Section II.4, below). Development of the lake's immediate watershed can be traced back to the late 1800s. Over the years, increasing development was accompanied by an increase in the amount of pollutants entering the lake. Early on, these included wastewater and sewage via combined sewer overflows (CSOs). With improvements and modernization of the watershed's sewage system and the elimination of CSOs, the primary source of pollutant loading became stormwater runoff and its primary problems directly linked to non-point source pollution (see Map B, Appendix A).

Over at least the past fifty-plus years, Deal Lake's water quality has been impacted by a variety of NPS pollutants. It has been documented that classic signs of accelerated eutrophication (i.e., algal blooms, dense aquatic weed growth, high bacterial concentrations and fish kills) were observed in the lake at least as early as 1950 (Princeton Aqua Science, 1984). This condition has persisted to the current day, despite the implementation of a variety of restoration strategies, including the chemical and mechanical control of nuisance aquatic macrophyte species and the dredging of sediment-laden areas of the lake and its tributaries.

1.2 Deal Lake Watershed Commission and Project History

The Deal Lake Commission (DLC) was chartered in 1974 by the seven municipalities that abut Deal Lake. As the lake's State-appointed steward, the DLC recognizes that the persistent water quality problems affecting Deal Lake can best be addressed on a regional basis, through the implementation of watershed-based management and mitigation measures. The Mission Statement of the DLC reflects this commitment to the restoration of the lake and the long-term proper management of the watershed. As stated:

The DLC's mission is to provide leadership, guidance and resources to preserve and restore Deal Lake and its tributaries as a healthy and stable ecosystem. By actively serving as stewards of Deal Lake and its Watershed, our goals include:

- Educating the community, including our school children, to increase awareness and appreciation for the natural environment of the lake
- Providing leadership concerning issues related to Deal Lake within and outside our community
- Helping homeowners and public groups recognize and mindfully solve problems related to water quality, siltation, and lake restoration

- Serving as the liaison between lakeside communities, County agencies, and the NJDEP to implement a Regional Storm Water Management Plan
- Proactively suggesting practical ideas to improve overall the environmental quality of properties through out the Deal Lake watershed

In 2004, the DLC was awarded a grant through the New Jersey Department of Environmental Protection's (NJDEP's) 319(h) Nonpoint Source (NPS) Pollution Control and Management program. The purpose of the grant is to develop a Regional Stormwater Management Plan (RSWMP) for the Deal Lake watershed. It was proposed that through this effort a comprehensive plan would be developed and authorized and used as a means to more effectively reduce the influx of pollutants to Deal Lake, control sedimentation and erosion in the lake's tributary streams, and control floatables and other stormwater-related pollutants throughout the Deal Lake Watershed.

The NJDEP guidance for the creation of a RSWMP includes five essential "milestones".

- The first of these, the formation of and submission for recognition as a Regional Stormwater Management Plan Committee was completed in March 2005.
- The second milestone, the NJDEP approval of a Characterization and Assessment of the Deal Lake Watershed submitted in August 2006 to the NJDEP. The Characterization and Assessment summarized relevant data to characterize the watershed and the study streams, including the initial results of the pollutant loading analyses, hydrologic analyses, and water quality and biological monitoring.
- Milestone 3, the drainage area-specific water quality, groundwater recharge and water quantity objectives were accepted by the DLC in December 2007.
- Milestone 4A, the Regulatory Standards for the Deal Lake Watershed Regional Stormwater Management Plan were accepted by the DLC in November 2007
- Milestone 4B, the Voluntary Measures for the Deal Lake Watershed Regional Stormwater Management Plan were accepted by the DLC in November 2007
- The Milestone 4A and 4B submissions were subsequently approved with comments by the NJDEP in June 2008.

Milestone 5: Submission of Completed RSWMP for review was completed in November 2008.

Given recent changes with the State's position on RSWMPs, the DLC was directed in October 2010 by the NJDEP to convert the RSWMP into a Watershed Protection Plan (WPP). The modification of the final report (Milestone 5 Report) has no affect on the data collected and developed as part the project's earlier efforts. Nor does it alter the technical merit or approach to the restoration and management of the lake and its watershed as detailed in the Milestone 4A and 4B Reports. It does however make the overall implementation of the recommended measures and specified projects as voluntary efforts to be implemented by the DLC and the municipalities and funding allows. The intent of the WPP is the same as that of the RSWMP that is to protect the lake from future watershed

based water quality impairments and to correct the lake's existing problems through the implementation of measures aimed at decreasing pollutant and pathogen loading and slowing down the lake's eutrophication.

Deal Lake Commission Members (as per 2008)		
John Everson	Ocean Township	Chairman
Bruce Fromer	Borough of Allenhurst	
Len Rokaw,	City of Asbury Park,	Vice-Chairman
Jim Rogers,	Borough of Deal	Secretary
Lynn Parry,	Borough of Interlaken,	Treasurer
William Kiss,	Village of Loch Arbour	
Jerry Meyer,	Neptune Township,	Deputy Treasurer
Lorrain Carafa	Village of Loch Arbour	Clerk

1.3 Relevant Regulatory Programs That Support the WPP

There are a number of relevant regulations in place today that support the implementation of the measures that make up the WPP. The most significant of those are the State's stormwater management regulations and requirements. Presently each municipality is required to comply with the NJDEP stormwater regulations and develop and submit individual Municipal Stormwater Management Plans and Ordinances in accordance with N.J.A.C. 7:8. In addition, the Department has adopted or proposed significant changes to various regulatory programs in order to protect and enhance water resources. For example, the NJDEP has recently adopted amendments to the Water Quality Management Plans N.J.A.C. 7:15 and the Flood Hazard Area regulations N.J.A.C. 7:13. These regulations and amendments have been reviewed and incorporated as appropriate within the Deal Lake WPP as a means of addressing water resources concerns on a uniform basis from town to town. For example, the Flood Hazard Area Rules established a riparian zone of 50 feet for all freshwater streams throughout New Jersey, but increased this riparian zone to 150 feet for streams with underlying acid producing soils; soil that are common in Monmouth County and are present within the Deal Lake watershed. It should also be noted that

implementation of the BMPs and related land use measures recommended within the WPP must be conducted in accordance with NJDEP rules governing wetlands, floodplains and riparian areas.

In addition, each municipality within the WPP study area has been actively involved in updating their Master Plans, ordinances and zoning amendments. Additionally some have pursued opportunities to preserve open space. Each has also been has engaged in the State-wide planning efforts of the NJ Department of Community Affairs (DCA). These actions have also been reviewed and incorporated as appropriate within the WPP recommendations to address water resources concerns in the Deal Lake subwatersheds.

2.0 NJDEP Water Resource Designations

Deal Lake is located in WMA 12, (HUC 02030104090030). The water quality of Deal Lake has been monitored since the early 1980s and has been the focus of a number of water quality monitoring programs conducted under the guidance of the DLC with assistance from both the NJDEP and Monmouth County Health Department. The data from the original Deal Lake 314 Study (Princeton Hydro, 1984) were utilized by the State as the basis for the preparation of the phosphorus and pathogen Total Maximum Daily Load (TMDL) developed for lake and Hollow Brook. The more recent monitoring of the lake and its tributaries conducted as part of this project's Characterization and Assessment study revealed, as did the earlier studies, elevated levels of several NPS pollutants, including: phosphorus, nitrogen, sediment, fecal coliform bacteria and floatables. These pollutants originate from many diverse sources and are transported into the lake and its streams largely as the result of stormwater runoff. There are more than 135 storm sewer outfalls that discharge directly to the lake[1] (Monmouth County Board of Health, 1989). Many of these outfalls were inspected and mapped as part of this project[2].

As noted in the opening chapter of this report, a TMDL was developed not only for the lake itself but for one of its primary tributaries, Hollow Brook. These TMDLs provide a mechanism for both identifying all the contributors to surface water quality impacts and for setting goals for load reductions for pollutants. The latter is of particular relevance as it is directly consequential to enabling Deal Lake and its tributaries to again become swimmable and fishable.

The NJDEP approved a TMDL for the reduction of total phosphorus in Deal Lake (NJDEP, 2003a, 2004). The phosphorus impairment of Deal Lake is almost exclusively attributed to nonpoint stormwater sources and the TMDL identifies a need for a 79% reduction. The lake is considered highly eutrophic, and is impacted quite frequently by intense blue-green algae blooms and excessive densities of invasive aquatic macrophytes. It is often very turbid, as a result of the influx of large amounts of sediments. These sediments not only originate as particulate material transported into the lake via runoff, but as the result of the scour and erosion of the beds and banks of the lake's feeder streams. Contact recreational use of the lake is impeded by fecal coliform (E. coli) levels that frequently exceeded the State's water quality standard. Further impacting the lake are large volumes of floatable, most of which again enter the lake via runoff. These floatables are transported both from the roads and urban landscape immediately adjacent to the lake. The data developed through the Characterization and Assessment element of the WPP further quantified and confirmed that NPS pollutant loads are the primary cause of the lake's documented impairments.

[1] Monmouth County is currently completing a project to update this mapping and assess the conditions of all county-owned/maintained storm sewer inlets and outfalls,.
[2] Confirmation through joint efforts of Princeton Hydro, DLC and Monmouth University; Map B, Appendix A.

With respect to the lake's tributaries, the NJDEP approved a TMDL to address the reduction of pathogens in Hollow Brook (NJDEP, 2003b). The reduction of total phosphorus loading another recommendation contained in the Hollow Brook TMDL. With regard to pathogen loading (fecal coliform), the data used to develop the Hollow Brook TMDL confirmed the State's water quality standard for contact recreation was frequently contravened. More recent Microbial Source Tracking data (MST) developed by Monmouth University (2007) showed pathogen sources to be variable and linked to goose, pet, and even human sources. Further sampling of the tributary streams conducted as part of this WPP (as detailed in the Milestone 3 Characterization and Assessment Report) once again documented especially high pathogen concentrations in Hollow Brook.

As per Appendix A of the 2008 *New Jersey Integrated Water Quality Monitoring and Assessment Report*, Deal Lake (WMA-12, HUC 02030104090030-01) appears on Sublist 5 for Aquatic Life-General, Sublist 4A for Recreation, Sublist 2 for Drinking Water Supply, and Agricultural Water Supply, Sublist 5 for Industrial Water Supply, and Sublist 3 for Fish Consumption. As per Appendix B of the same document, NJDEP also gives the lake a rank of L for pH. Also as per Appendix C of the 2008 *New Jersey Integrated Water Quality Monitoring and Assessment Report,* the lake has been delisted from Sublist 5 for pathogens. As noted above it is now on Sublist 4A. This is summarized in Table 1. It should also be noted that although Hollow Brook was listed in earlier (2004 and 2006) *Integrated Water Quality Monitoring and Assessment Reports,* it is not included in the 2008 report.

Table 1 - Existing Stream Impairments in the Deal Lake Watershed, as per the 2008 *New Jersey Integrated Water Quality Monitoring and Assessment Report.*

Waterbody	Sublist 5 (impaired)	Sublist 2	Sublist 4A	Sublist 4 (TMDL)	Sublist 3 (insufficient data)
Deal Lake	**Industrial Water Supply**	**Drinking, Agricultural Water Supply**	**Recreation**	**Phosphorus**	**Fish Consumption**
Hollow Brook	**no listing/assessment**				
Harvey Brook					
Unnamed tributary streams	**no listing/assessment**				

The purpose of the Deal Lake WPP is to effectively reduce the influx of NPS pollutants to Deal Lake through sound watershed management practices. Emphasis is given to the

reduction of pathogen loading, the control of sedimentation and erosion in the lake's tributary streams, a reduction of floatable and other particulate stormwater-related pollutant loading, and especially the reduction of phosphorus loading. The overall goals of the management and restoration measures presented in the WPP is to temper the lake's rate of eutrophication, restore its ability to consistently support contact recreation and prohibit the excessive buildup of sediments and associated loss of aquatic habitat both within the lake proper and its tributaries. Section 3, which is a summation of the Milestone 3 Report, provides greater detail of the impairments and impacts currently experienced by the lake and its tributaries. Subsequent sections of the report provide details of the measures proposed for implementation to correct the existing problems of the lake and its tributaries and to protect the entire Deal Lake ecosystem from future impacts. While the implementation or adoption of the measures outlined in the management and restoration elements of the WPP cannot be mandated, we feel that as has been realized over the lake's long history that the lake community, stakeholder groups and municipal and county governments will fully support the efforts of the DLC in seeing this plan to fruition.

3.0 Characterization And Assessment Of The Deal Lake Watershed (Summary of Milestone 3 Report)

3.1 Introduction

The Deal Lake watershed encompasses all or part of seven municipalities: Ocean Township, Neptune Township, Asbury Park City, Interlaken Borough, Deal Borough, Allenhurst Borough and Loch Arbour Village; each of which is located within Monmouth County. The majority of the watershed (approximately 2,419 acres (3.8 square miles) or 55%) lies within Ocean Township. Smaller but significant portions of the study area also lie within Neptune Township and Asbury Park (755 and 580 acres (1.2 and 0.9 square miles), respectively). Loch Arbour Village, a small municipality which lies almost entirely within the watershed (with the exception of its easternmost portion, where stormwater outfalls discharge stormwater runoff directly into the ocean), comprises the smallest portion (less than 2%) of the study area, with only 72 acres (just over a tenth of a square mile) within the study area boundary. Table 2 describes the breakdown of the Deal Lake Watershed area by municipality.[3]

Table 2 - Municipal Areas within the Deal Lake Watershed.

Municipality	Acres within the Deal Lake Watershed	Square miles within the Deal Lake Watershed	Percentage of total watershed area
Ocean Township	2,419.44	3.78	54.91
Neptune Township	754.87	1.18	17.13
Asbury Park City	579.74	0.91	13.16
Interlaken Borough	247.27	0.39	5.61
Deal Borough	193.94	0.30	4.40
Allenhurst Borough	138.14	0.22	3.14
Loch Arbour Village	72.76	0.11	1.65
TOTAL WATERSHED	**4,406.16**	**6.88**	**100%**

[3] Note: the narrative text and data tables within this report include acreages, pollutant load estimates and other data that have been rounded to the nearest 0.01, 0.1 or whole number. Rounding has been utilized to clearly illustrate a variety of data comparisons and simplify the reporting of detailed calculations and data summaries. Minor discrepancies in data totals and percentages are an unavoidable result of this rounding process but do not affect the validity of the results and conclusions reported. Copies of the comprehensive GIS database and detailed spreadsheets related to data calculations discussed herein are also available for review.

Between 1990 and 2004, Monmouth County as a whole grew in population by 15% (from 553,124 to 636,298 people) (US Census Bureau, 2004). This was slightly higher than the 13% rate of population growth during the same time period statewide (US Census Bureau, 2004). Although the Deal Lake Watershed represents just 1.5% of the county's total land area (301,805 acres), in some ways it reflects the pressures of a growing population and increasing development experienced throughout Monmouth County. Though none of the watershed municipalities have experienced particularly large population increases over the past two decades (and in several cases have lost population, as in Deal, Allenhurst, Interlaken and Loch Arbour), the high population density, urbanized nature of the watershed and proximity of development to the lake and its tributaries are associated with a number of water quality impacts.

3.2 Demographics

Table 3 shows the population change between 1990 and 2004 for each of the Deal Lake Watershed municipalities. Ocean Township, covering slightly more than half of the watershed (54.9%), also had the largest increase in population of any of the watershed municipalities with an increase of 2,321 residents (9%) between 1990 and 2004, the most recent year for which Census data exists (US Census Bureau, 2004). The City of Asbury Park and Neptune Township were the only other municipalities in the watershed that had a positive increase in population (+0.2%) during the same time period (US Census Bureau, 2004). The population of Neptune Township increased by 59 people, while the population of Asbury Park, the most densely populated municipality in the county (Monmouth County Department of Economic Development & Tourism, 2006), increased by just 40 residents.

Asbury Park's relatively stagnant growth over the past two decades is partly a legacy of the economic slowdown experienced by the city since the 1970s, when a variety of social and economic factors led to decreases in both the population and the tax base. Recent redevelopment activities in the city, spurred in part by its designation as a State Urban Center (Shields, 2005) have begun to result in an upswing in the local population.

Slow growth or decreases in population among the watershed municipalities during this time period is also a reflection of the fact that much of the watershed study area was developed before the 1990s, leaving little open space for new residential and commercial development (with some exceptions, such as the areas along State Routes 66 and 35 in the western portion of the watershed). Instead, as noted above, watershed municipalities such as Asbury Park are currently focused on redeveloping their downtown and waterfront commercial and residential districts. Such efforts are likely to ultimately result in significant population increases in the watershed and underscore the importance of implementing retrofit stormwater management measures in these redeveloping areas.

Table 3 - Total Population of Deal Lake Watershed Municipalities.[4]					
Municipality	**Acres**	**% total watershed area**	**2004 (current) population**	**1990 population**	**Change 1990 to 2004**
City of Asbury Park	579.8	13.2%	16,819	16,779	+40 (+0.2%)
Borough of Allenhurst	138.1	3.1%	714	759	-45 (-6%)
Borough of Deal	193.9	4.4%	1,055	1,179	-124 (-11%)
Village of Loch Arbour	72.8	1.7%	279	380	-101(-27%)
Borough of Interlaken	247.3	5.6%	895	910	-15 (-2%)
Ocean Township	2,419.4	54.9%	27,379	25,058	+2,321 (+9%)
Neptune Township	754.9	17.1%	28,207	28,148	+59 (+0.2%)

3.3 Land Use and Land Cover (LU/LC)

Before initiating watershed analyses based on land use and land cover relationships or characteristics, maps of land use and land cover (LU/LC) for the Deal Lake Watershed based on NJDEP's 1995/97 LU/LC GIS database were updated. This was accomplished by overlaying the LU/LC data onto the 2002 aerial photograph of the project area and superimposing on that the most recent parcel (block and lot) data and other development information obtained from the watershed municipalities, the Monmouth County Planning Department and the DLC engineer, Leon S. Avakian, Inc. (LSA). The LPA and LSA then conducted a detailed cross-reference of the composite map, identifying and rectifying changes in the LU/LC database that have occurred as a result of recent land development activities. As a result of this analysis, several large-scale urbanized areas, including the expansion of the Seaview Square Mall and construction of the Cedar Village residential development, both located in the western portion of the watershed along State Route 66, were added to the LU/LC database.

[4] Source: US Census Bureau, American Factfinder website (http://factfinder.census.gov). Population counts reflect the total population of each watershed municipality, not the portion of the population actually residing within the watershed boundary.

In addition, the original boundary of the watershed, which was delineated at the outset of the project as the boundary of HUC-14 02030104090030, was modified to accurately reflect current drainage patterns associated with existing stormwater infrastructure (i.e., detention basins and storm sewers). The small drainage area (94 acres or 0.15 square miles) associated with Sunset Lake in Asbury Park was also added to the study area, based on the LPA's identification of an "overflow" pipe that can be opened and used to convey runoff from Sunset Lake to Deal Lake during storm events. Maps depicting the updated soils, LU/LC categories, and wetlands within the watershed are provided in Appendix A (Maps C, D, and E).

Review and analysis of the refined LU/LC coverage reveals that high- and medium-density residential development is the dominant land use in the watershed, covering approximately 1,844 acres or 42% of the total watershed area. The majority of this residential development (948 acres) lies within Ocean Township, the largest municipality in the study area.

Both commercial development and forested lands also comprise significant portions of the Deal Lake watershed, at 494 acres (11.21%) and 484 acres (11%), respectively. Most of the forested lands are concentrated in the western portion of the watershed, particularly the southwest area in Neptune Township around State Route 18. Commercial development is found throughout the study area, with the most densely developed areas concentrated along the transportation corridors of State Routes 35 and 66 in Ocean and Neptune Townships and the City of Asbury Park.

Approximately 374 acres of wetlands (8.5% of the total study area) are found within the Deal Lake watershed. Wetlands are largely clustered around the lake's tributary streams, with the largest areas found in close proximity to existing forested lands in the western portion of the watershed.

Two other land use types each make up more than 5% of the total watershed area. These are low density/rural residential development (355 acres, 8% of the total watershed) and recreational land (287 acres, 6.5% of the total watershed). In addition to parks, recreational lands include golf courses, which are an important land use and recreational amenity in the watershed, particularly in Ocean Township and Deal Borough.

Other land use types in the watershed include industrial (2.4%), transportation (2%), barren/transitional lands (<1%), agricultural (<1%) and beaches (<0.5%). The small beach acreage may seem counterintuitive, given the location of the watershed on the Atlantic coastline, but it is a reflection of the existing stormwater infrastructure. The watershed's eastern boundary has been delineated to reflect the large storm sewer outfalls which discharge stormwater runoff from portions of the eastern section of the watershed directly to the ocean, thereby altering the natural hydrology of the area. Since this land area (including the beach) does not drain to Deal Lake, it is not included in the watershed.

Table 4 provides a breakdown of existing LU/LC categories (based on the refined 1995/97 NJDEP database) and their relative proportions within the Deal Lake Watershed, while Table 5 provides a breakdown of the same LU/LC categories by municipality. A map depicting these LU/LC categories within the watershed is provided in Appendix A, Map D.

Table 4 - General Land Use/Land Cover Categories in the Deal Lake Watershed.[5]

LU/LC Category	Acres within the Deal Lake Watershed	Percentage of total watershed area
High/Medium Density Residential	1,843.78	41.85%
Commercial	493.96	11.21%
Forest	483.65	10.98%
Wetlands	374.15	8.49%
Low Density/ Rural Residential	355.01	8.06%
Recreational Land	286.77	6.51%
Water/Lakes	175.98	3.99%
Other Urban/Built-up Area	153.33	3.48%
Industrial	105.75	2.40%
Transportation	84.69	1.92%
Barren/Transitional	32.09	0.73%
Agricultural	14.30	0.32%
Beaches	2.70	0.06%
TOTAL WATERSHED AREA	**4,406.16**	**100%**

[5] General LU/LC categories are based on Anderson et al. 1976. Discrepancies in totals are due to rounding.

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
OCEAN TOWNSHIP		
High/Medium Density Residential	948.34	39.20%
Commercial	290.83	12.02%
Forest	276.58	11.43%
Wetlands	213.39	8.82%
Low Density/ Rural Residential	187.58	7.75%
Recreational Land	206.94	8.55%
Water/Lakes	58.01	2.40%
Other Urban/Built-up Areas	95.58	3.95%
Industrial	74.08	3.06%
Transportation	37.93	1.57%
Barren/Transitional	25.14	1.04%
Agricultural	5.05	0.22%
Beaches	0	0%
TOTAL OCEAN TOWNSHIP	**2,419.44**	**100%**
NEPTUNE TOWNSHIP		
High/Medium Density Residential	189.42	25.09%
Commercial	81.98	10.86%
Forest	202.13	26.78%
Wetlands	146.31	19.38%

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
Low Density/ Rural Residential	12.64	1.67%
Recreational Land	6.79	0.90%
Water/Lakes	<1.0	<1.0%
Other Urban/Built-up Areas	46.59	6.17%
Industrial	18.93	2.51%
Transportation	33.11	4.39%
Barren/Transitional	6.96	0.92%
Agricultural	9.24	1.22%
Beaches	0	0%
TOTAL	**754.87**	**100%**
ASBURY PARK CITY		
High/Medium Density Residential	380.97	65.71%
Commercial	102.03	17.60%
Forest	1.24	0.21%
Wetlands	2.84	050%
Low Density/ Rural Residential	0	0%
Recreational Land	24.93	4.3%
Water/Lakes	51.89	8.95%
Other Urban/Built-up Areas	3.17	0.55%
Industrial	<1.0	<1.0%

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
Transportation	10.29	1.77%
Barren/Transitional	0	0%
Agricultural	0	0%
Beaches	1.69	0.29%
TOTAL	**579.74**	**100%**
INTERLAKEN BOROUGH		
High/Medium Density Residential	146.15	59.10%
Commercial	0	0%
Forest	1.49	0.60%
Wetlands	9.81	3.97%
Low Density/ Rural Residential	38.64	15.63%
Recreational Land	12.58	5.10%
Water/Lakes	34.45	13.93%
Other Urban/Built-up Areas	2.73	1.10%
Industrial	0	0%
Transportation	1.42	0.57%
Barren/Transitional	0	0%
Agricultural	0	0%
Beaches	0	0%
TOTAL	**247.27**	**100%**
DEAL BOROUGH		
High/Medium Density	51.98	26.80%

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
Residential		
Commercial	6.96	3.59%
Forest	0	0%
Wetlands	1.79	0.92%
Low Density/ Rural Residential	91.76	47.31%
Recreational Land	32.01	16.51%
Water/Lakes	5.04	2.60%
Other Urban/Built-up Areas	4.00	2.06%
Industrial	0	0%
Transportation	<1.0	<1.0%
Barren/Transitional	0	0%
Agricultural	0	0%
Beaches	0	0%
TOTAL	**193.94**	**100%**
ALLENHURST BOROUGH		
High/Medium Density Residential	83.38	60.36%
Commercial	7.57	5.48%
Forest	2.20	1.59%
Wetlands	0	0%
Low Density/ Rural Residential	22.92	16.59%
Recreational Land	3.53	2.56%

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
Water/Lakes	5.89	4.26%
Other Urban/Built-up Areas	<1.0	0.28%
Industrial	11.18	8.09%
Transportation	1.08	0.78%
Barren/Transitional	0	0%
Agricultural	0	0%
Beaches	0	0%
TOTAL	**138.14**	**100%**
LOCH ARBOUR VILLAGE		
High/Medium Density Residential	43.55	59.85%
Commercial	4.59	6.31%
Forest	0	0%
Wetlands	0	0%
Low Density/ Rural Residential	1.49	2.05%
Recreational Land	0	0%
Water/Lakes	19.92	27.38%
Other Urban/Built-up Areas	<1.0	<1.0%
Industrial	<1.0	<1.0%
Transportation	<1.0	<1.0%
Barren/Transitional	0	0%
Agricultural	0	0%

Table 5 - General Land Use/Land Cover Categories by Municipality.		
LU/LC Category	**Acres within the Deal Lake Watershed**	**Percentage of total municipal watershed area**
Beaches	1.00	1.37%
TOTAL	**72.76**	**100%**
TOTAL DEAL LAKE WATERSHED		
TOTAL WATERSHED AREA	**4,406.16**	**---**

3.4 Groundwater Recharge

A map showing groundwater recharge rates throughout the Deal Lake Watershed, as interpreted by NJDEP and the New Jersey Geological Survey (NJGS) on the basis of the Geological Survey Report GSR-32, is provided in Appendix A (Map F). The data presented on this map represents the total anticipated recharge in inches per year. The depicted recharge rates are based on the predicted permeability rates of prevailing soils, with adjustments made by NJGS for slope. The depicted rates have not been refined or altered to account for existing land disturbance or any impervious areas. The rates reflect the total amount of precipitation expected to infiltrate beyond the root zone over the course of a one-year period, based on average rainfall and soil moisture index properties.

As defined in the GSR-32 User's Guide, groundwater recharge is "that water which infiltrates vertically downward from the land surface to below the unsaturated zone. This water may then move laterally to discharge in streams or to enter an aquifer" (Hoffman, 2002). The GSR-32 methodology has been converted to a simplified, user-friendly Excel® spreadsheet available through NJGS or via NJDEP's stormwater management website (www.NJStormwater.org). The data depicted in Map C are based on the input of soils data as interpreted from the soil survey, as discussed above in Section II.3. As such, there is a direct relationship between the soils map (Map C) and the groundwater recharge map (Map F) provided in Appendix A. The groundwater recharge map shows the best recharge areas within the Deal Lake Watershed. These tend to be located in the western portion of the watershed, particularly along the western boundary. Some of the lowest recharge areas occur adjacent to stream corridors and in areas characterized by wetlands and hydric soils.

The results of the GSR-32 recharge estimates and the accompanying map should not be confused with well yield data. In contrast to the ability to provide or sustain a potable water supply, the recharge data reflect those areas where interflow (the lateral movement of

groundwater from soil storage reservoirs) into streams and wetlands is likely to be maximized. As such, it is possible and plausible that an area designated as having high recharge capability can at the same time have poor well yields.

Groundwater is a critical concern for the Deal Lake Watershed, as well as Monmouth County as a whole, because of the population's reliance on groundwater as a primary potable water source. Drinking water within the Deal Lake Watershed is provided by New Jersey American Water's Shrewsbury Public Water System (PWS ID# NJ1345001), which serves the watershed communities of Allenhurst, Asbury Park, Deal, Interlaken, Loch Arbor, Neptune and Ocean Township. Sources for the Shrewsbury PWS include both groundwater from the Potomac-Raritan-Magothy Aquifer (PRM) and surface water from the Glendola Reservoir, the Manasquan River/Reservoir, the Shark River, and the Swimming River/Reservoir (New Jersey American Water, 2005).

Based on the field surveys and observational data, the results of the water quality monitoring effort, and the output of the UAL and WinSLAMM modeled data, some of the more significant problems affecting the lake and its tributaries can be summarized as follows:

1. Excessively high fecal coliform counts in each of the lake's tributaries, and at times within the lake itself.
2. Elevated total phosphorus concentrations in the lake and its tributaries. The measured concentrations greatly exceed that needed to stimulate and sustain algae blooms.
3. The lake's tributary streams are all characterized by deeply incised stream channels. Along a number of these channels (in particular, the lower reaches of Harvey Brook), erosion-prone and acid-producing soils have become exposed. The friable nature of these soils, combined with the difficulty for vegetation to become re-established once denuded, exacerbates the impacts of streambank erosion caused by storm flows and storm surges.
4. There are significant in-stream sediment bed loads associated with the lake's tributaries. Evidence of these loads is in the form of broad sediment deltas that occur most commonly adjacent to road crossings. These sediments are easily mobilized during storms and are subsequently transported into the lake, accelerating the lake's infilling. Sedimentation and infilling are most pronounced in the upper reaches of the lake's arms where road crossings, which act like "mini-dams," facilitate sediment settling and increase the rate of in-filling in these naturally shallow portions of the lake.
5. The lighter, finer sediments which settle in the lake become re-suspended during storm events. Many of these sediments have almost colloidal properties. As a result, the lake frequently has a very turbid appearance.

4.0 Watershed Problem Identification And Analysis

4.1 Overview of Impacts

Overall, stormwater management throughout the watershed can be characterized as largely inadequate. Granted, the more recently developed (post-2004) areas of the watershed have improved stormwater management infrastructure, including stormwater management basins and related BMPs. In addition, the member municipalities through their stormwater management plan and related ordinances have been reducing NPS loading from existing sources. This is being accomplished via street sweeping, the installation of eco-grates, the passage and enforcement of pet waste and yard waste ordinances, and increased review of new developments.

However, due to the age and history of most of the development within the Deal Lake watershed, especially the development immediately adjacent to the lake and east of Route 18, stormwater management and NPS control BMPs tend to be lacking or severely under designed. Specifically, there is an overall lack of measures and BMPs that facilitate:

1. The mitigation of storm surges and the control of peak flows (contributing to flooding and stream erosion problems),
2. The compensatory recharge or infiltration of precipitation and runoff (contributing to the increased volume of runoff, the magnitude of peak flows and alterations in baseflow conditions), and
3. The proper management and reduction of pollutant loading (contributing to problems with the accumulation of floatables in the lake, the deposition of sediments and the influx of nutrient-laden runoff responsible for the lake's eutrophication.

There has also been a non-reversible loss of riparian areas, encroachment into floodplains, and historic filling, draining or piping of wetlands and open waters. Some of this riparian loss is attributable to the construction of lengthy bulkheads and filling of the lake's shoreline, but some of this extends up into the tributaries. The loss of these natural areas and their stormwater mitigation properties again exacerbates the lake's stormwater-related impacts. Impaired riparian areas also detract from the ecological characteristics of the lake and its tributaries, and has resulted in a loss is the ecological services of these areas, the loss of essential habitat aquatic and semi-aquatic birds and other species and the spread of non-native, invasive emergent vegetation.

The lake itself has also been subject to the establishment of invasive aquatic macrophytes (aquatic weeds). Plants such as Eurasian watermilfoil and coontail compromise habitat needed for the maintenance of a healthy, ecologically balanced fishery. The composition and density of these weeds has negatively altered the quality of refuge and spawning areas for game fish and anadromous fish. The "weed" growth often reaches proportions that inhibit flow and circulation and exacerbates DO depression, especially in the upper reaches

and arms of the lake. These invasive plants also reduce the recreational use of the lake, specifically with respect to boating, which tends to be a very popular use.

The volume and frequency of floatable loadings creates a significant problem for Deal Lake. The future control of floatables must be considered a priority management issue, equally important as the control and reduction of nutrient, sediment and fecal coliform loading. The influx of large amounts of floatables and other urban litter and debris creates a number of serious problems with water quality, flooding and ecological ramifications, including:

1. These floatables impact the lake's aesthetic properties by resulting in the accumulation of large amounts of trash in windward areas of the lakes and small coves.
2. The accumulated trash also impedes flow and at times blocks the outlet flume, thus adding to flooding problems throughout the lake.
3. The floatables become so concentrated at times so as to impact riparian habitat in certain areas.
4. The floatables add to the lake's inorganic pollutant loading.
5. The removal of the floatables is difficult and costly.

Besides measuring and quantifying water quality impacts, the stream surveys conducted as part of this project also document that the benthic infauna present in the lake's tributaries is dominated by stress- and pollutant-tolerant species. This may be a reflection of both historically poor water quality and physically degraded conditions owing to storm-related scour and unstable bed and bank conditions. The lack of large numbers of mayfly, stonefly and caddisfly (Ephemeroptera, Plecoptera and Tricoptera [EPT]) may be more a function of inadequate, inappropriate or degraded habitat as opposed per se to degraded water quality. Factors that would decrease the use of these streams by EPT species include shifting stream bottoms, low pH and high dissolved iron concentrations, periodic elevated turbidity and storm event scour.

4.2 Pollutant Loading

Details of the pollutant loading analysis and the subsequent interpretation of that data are presented in the Deal Lake Characterization and Assessment report. The following highlights the analysis, emphasizing through the data the need for immediate improvements in non-point source (NPS) pollutant load controls. For this project, a Unit Area Loading (UAL) model (Uttormark et al., 1974; USEPA, 1980, 1990) was integrated with the GIS database for the Deal Lake Watershed and used to estimate pollutant loading on an annual basis following an AVGWLF styled approach to the prediction of past and current watershed based pollutant loading. Pollutant export coefficients developed by Uttormark et al. (1974), Reckhow et al. (1980), USEPA (1980) and Schueler (1986) were refined based on local soils, vegetation and land cover conditions, and used to quantify existing and future

annual pollutant loads. Details of the loading analysis are provided in the Characterization and Assessment Report (Milestone 3). Based on the approved project work plan, three pollutants of concern were modeled for the Deal Lake watershed using this methodology: Total Phosphorus (TP), Total Nitrogen (TN) and Total Suspended Solids (TSS).

Using the updated GIS LU/LC database compiled and refined for this project and the pollutant export coefficients described above, current loading estimates for the three pollutants of concern noted above were calculated for each subwatershed, each municipality and the Deal Lake Watershed as a whole. The results of the UAL analysis for existing watershed development conditions are provided in Tables 6 through 11. Summarizing the results of the modeling effort in terms of the three primary pollutants of concern (TP, TN and TSS), the watershed-wide total estimated loads of each, respectively, are: 9,278 (TP), 999 (TN) and 1,365,995 (TSS) lbs/year. Predictably, Subwatershed 1, the main lake basin, has the highest estimated attributed pollutant load for each of the modeled pollutants. Subwatershed 1 is the largest delineated subwatershed, comprising approximately 50% of the total watershed area. Largely as a result of its relative size as compared to the total watershed area and intensely urbanized landscape, this subwatershed contributes approximately 48% of the total watershed pollutant load. This is significant as it shows that direct runoff of NPS pollutants to the lake is the major source of contaminants, nutrients and sediments. This emphasizes the need for retrofit stormwater management and the correction of existing stormwater management deficiencies.

Table 6 - Current TN Loading by Subwatershed.

Subwatershed	Total Acreage	% of total watershed area	TN Load (lbs /year)	% TN load
1-Main Lake Basin	2,224.13	**50.47%**	4,572.78	**49.29%**
2-Harvey Brook	971.53	**22.05%**	2,033.55	**21.92%**
3-Lollypop Pond	204.14	**4.63%**	479.76	**5.17%**
4-Colonial Terrace	149.82	**3.41%**	398.54	**4.29%**
5-Tributary	464.88	**10.55%**	1,080.12	**11.64%**
6-Hollow Brook	391.66	**8.89%**	713.37	**7.69%**
TOTAL WATERSHED	**4,406.16**	**100.00%**	**9,278.12**	**100.00%**

Subwatershed 2 (Harvey Brook), the second-largest drainage area within the study area at approximately 972 acres, comprises 22% of the total watershed area and contributes nearly 22% (2,034 lbs/year) of the total estimated TN load, 20% (204 lbs/year) of the estimated TP load and just over 25% 343,362 lbs/year) of the estimated TSS load for the watershed area.

Again, these results are expected based on the size of this subwatershed relative to the total study area; however, the slightly higher TSS contribution relative to the subwatershed acreage is a reflection of the agricultural land uses unique to this subwatershed. The role of road runoff and stream scour will also be examined with respect to determining specific pollutant sources and developing management recommendations for this subwatershed.

Table 7 - Current TP Loading by Subwatershed.

Subwatershed	Total Acreage	% of total watershed area	TP Load (lbs /year)	% TP load
1-Main Lake Basin	2,224.13	**50.47%**	472.36	**47.28%**
2-Harvey Brook	971.53	**22.05%**	203.78	**20.40%**
3-Lollypop Pond	204.14	**4.63%**	58.34	**5.84%**
4-Colonial Terrace	149.82	**3.41%**	53.01	**5.31%**
5-Tributary	464.88	**10.55%**	139.46	**13.96%**
6-Hollow Brook	391.66	**8.89%**	72.03	**7.21%**
TOTAL WATERSHED	**4,406.16**	**100.00%**	**998.98**	**100.00%**

Table 8 - Current TSS Loading by Subwatershed.

Subwatershed	Total Acreage	% of total watershed area	TSS Load (lbs /year)	% TSS load
1-Main Lake Basin	2,224.13	**50.47%**	642,547.92	**47.04%**
2-Harvey Brook	971.53	**22.05%**	343,361.98	**25.14%**
3-Lollypop Pond	204.14	**4.63%**	62,183.55	**4.55%**
4-Colonial Terrace	149.82	**3.41%**	65,269.47	**4.78%**
5-Tributary	464.88	**10.55%**	147,498.00	**10.80%**
6-Hollow Brook	391.66	**8.89%**	105,133.84	**7.69%**
TOTAL WATERSHED	**4,406.16**	**100.00%**	**1,365,994.76**	**100.00%**

Table 9 - Current Annual TN Loads - Deal Lake Watershed, by Municipality.				
Municipality	**Total Acreage**	**% watershed area**	**TN load (lbs /year)**	**% TN load**
Ocean Township	2,419.44	**54.91%**	5,138.50	**55.58%**
Neptune Township	754.87	**17.13%**	1,493.35	**16.15%**
Asbury Park	579.74	**13.16%**	1,342.13	**14.52%**
Interlaken	247.27	**5.61%**	433.67	**4.69%**
Deal Borough	193.94	**4.40%**	400.51	**4.33%**
Allenhurst Borough	138.14	**3.14%**	312.53	**3.38%**
Loch Arbour Village	72.76	**1.65%**	124.09	**1.35%**
TOTAL WATERSHED	**4,406.16**	**100%**	**9,244.78**	**100%**

Table 10 - Current Annual TP Loads - Deal Lake Watershed, by Municipality.				
Municipality	**Total Acreage**	**% watershed area**	**TP load (lbs/year)**	**% TP load**
Ocean Township	2,419.44	**54.91%**	556.12	**55.82%**
Neptune Township	754.87	**17.13%**	159.17	**15.98%**
Asbury Park	579.74	**13.16%**	156.51	**15.71%**
Interlaken	247.27	**5.61%**	38.27	**3.84%**
Deal Borough	193.94	**4.40%**	38.90	**3.90%**
Allenhurst Borough	138.14	**3.14%**	35.04	**3.52%**
Loch Arbour Village	72.76	**1.65%**	12.27	**1.23%**
TOTAL WATERSHED	**4,406.16**	**100%**	**996.28**	**100%**

Table 11 - Current Annual TSS Loads - Deal Lake Watershed, by Municipality.				
Municipality	**Total Acreage**	**% watershed area**	**TSS load (lbs/year)**	**% TSS load**
Ocean Township	2,419.44	**54.91%**	779,415.77	**57.47%**
Neptune Township	754.87	**17.13%**	221,098.19	**16.30%**
Asbury Park	579.74	**13.16%**	175,967.96	**12.97%**
Interlaken	247.27	**5.61%**	57,126.91	**4.21%**
Deal Borough	193.94	**4.40%**	52,829.43	**3.90%**
Allenhurst Borough	138.14	**3.14%**	52,288.46	**3.86%**
Loch Arbour Village	72.76	**1.65%**	17,553.07	**1.29%**
TOTAL WATERSHED	**4,406.16**	**100%**	**1,356,279.79**	**100%**

4.3 "Manageable" vs. "Unmanageable" Pollutant Loads

Tables 12 and 13 provide a refined breakdown of the current pollutant loads presented as manageable and unmanageable loads. The term "manageable" refers to the portion of the pollutant load associated with developed lands (residential, commercial, industrial). This pollution is considered manageable because it is associated with an alteration of the natural landscape that has resulted in a stormwater-related pollutant load that is higher than ambient or reference (undeveloped) conditions. This portion of the pollutant load can presumably be mitigated in some way, such as through the use of pollutant-removing stormwater BMPs and similar retrofits. Stormwater management efforts (e.g., BMP retrofits) should be targeted to these "manageable" lands in order to reduce NPS pollution in the watershed.

Conversely, "unmanageable" pollutant loads are associated with currently undeveloped lands (forest, water, wetlands). Although these lands exist in a natural state, they are still responsible for some degree of NPS pollutant loading (with the exception of most wetlands, which are considered to be a "sink" for TP and TSS and neutral with regard to TN). However, it is assumed that this portion of the pollutant load cannot be reduced significantly below the existing, ambient level. Stormwater management efforts targeted to these lands should focus on open space preservation, mitigation and restoration projects (e.g., stream bank stabilization, wetland enhancement).

Predictably, given the intensely developed nature of this watershed, the manageable portion of the estimated pollutant load (8,546 lbs/yr TN, 1,002 lbs/yr TP and 1,319,700 lbs/yr TSS)

far exceeds the unmanageable portion (699 lbs/yr TN, -6 lbs/yr TP and 36,580 lbs/yr TSS). In general, the largest watershed municipalities, Ocean and Neptune Townships, have the corresponding largest manageable and unmanageable pollutant loads. When considered on a subwatershed basis, the two largest subwatersheds (#1 and #2) are also associated with the highest unmanageable pollutant loads.

However, with respect to the manageable portion, subwatersheds #2 and #6 have the highest estimated TN loads (225 and 209 lbs/yr, respectively); #6 and #5 have the highest estimated TP loads (4 and 3.5 lbs/yr, respectively); and #6 and #2 have the highest estimated TSS loads (15,701 and 15,460 lbs/yr, respectively). This modeled data will be used to target stormwater management efforts appropriately within the watershed.

Table 12 - Current Manageable Vs. Unmanageable Pollutant Loading Analysis, by Municipality.

Municipality	Manageable Pollutant Load (lbs/yr)			Total Manage-able Acreage	Unmanageable Pollutant Load (lbs/yr)			Total Unman-ageable Acreage
	TN	TP	TSS		TN	TP	TSS	
Ocean Township	4,736	556	756,763	1,871	402	-0.74	22,652	547
Neptune Township	1,201	152	199,572	398	291	6.27	21,525	356
Asbury Park	1,341	161	178,890	522	1.12	-4.85	-2,922	57
Interlaken	432	42	60,187	201	1.35	-3.89	-3,060	45
Deal Borough	400	39	53,622	187	0.00	-0.62	-493	6
Allenhurst Borough	310	35	52,515	130	1.98	-0.37	-227	8
Loch Arbour Village	124	14	18,447	124	0.00	-1.80	-894	20
TOTAL	8,546	1,002	1,319,700	3,434	698	-6.00	36,579	1,043

Table 13 - Current Manageable Vs. Unmanageable Pollutant Loading Analysis, by Subwatershed.

Sub-watershed	Total Acreage	Manageable Pollutant Loading (lbs/yr)			Total Manage-able Acreage	Unmanageable Pollutant Loading (lbs/yr)			Total Unmanage-able Acreage
		TN	TP	TSS		TN	TP	TSS	
1- Main Lake Basin	2,224 50.47%	4,530	490	654,379	1,933.32	41	-18.52	-11,831	290
2- Harvey Brook	971 22.05%	1,808	201	327,901	710.80	224	2.47	15,460	260
3- Lollypop Pond	204 4.63%	452	59	60,011	163.97	27	-0.76	2,172	40
4- Colonial Terrace	149 3.41%	351	51	61,293	109.76	47	1.17	3,976	40
5- Tributary	464 10.55%	940	135	137,743	283.55	139	3.55	9,754	181
6- Hollow Brook	391 8.89%	504	68	89,432	161.26	208	3.82	15,701	230
TOTAL	4,406 100%	8,588	1,007	1,330,762	3,362.66	689	-8.27	35,232	1,043

4.4 Projected Future Land Use (Buildout)

Similar to the UAL analysis conducted under existing LU/LC conditions in the watershed, annual pollutant loads were also calculated for projected future development ("buildout") conditions. These conditions are represented by the maps presented in Appendix A, Map G. To estimate future development, a review of current municipal zoning regulations and maps was performed. After compiling the necessary GIS and regulatory data, the restrictions and requirements (i.e., minimum lot size, maximum percent impervious coverage, development type) governing development within each zone in each of the three watershed municipalities were assessed in order to determine the future LU/LC category of each zone assuming full buildout under current zoning regulations. Next, the GIS database for the watershed was queried to identify any lands with characteristics, such as steep slopes (≥15%), wetlands, FEMA flood hazard areas, mines and quarries, and permanently preserved parcels (i.e., county and municipal parklands and schools), that render that land unsuitable and/or unavailable for development. These lands were considered "undevelopable," and as such were assigned LU/LC categories identical to their existing categories.

In contrast, lands without development constraints such as those described above were considered "developable," and were reclassified according to the land uses each would have if built out fully to the most intensive state possible under current zoning. Based on this methodology, it was determined that a total of 3,451 acres in the Deal Lake watershed, or 78% of the total watershed area, is available for development. The remaining 955 acres was considered "undevelopable," either because it is part of a permanently protected open space or farmland preservation parcel, or because steep slopes, wetlands or other unsuitable conditions preclude development. A breakdown of these "developable" and "undevelopable" lands by subwatershed is provided in Table 14.

Table 14 – Developable/Undevelopable Lands, by Subwatershed.

Subwatershed	Total Sub-watershed Acreage	Developable Acres	Percent Developable	Protected/ Undevelopable Acres	Percent Undevelopable
1-Main Lake Basin	2,224.13	1,806.15	81.20%	417.98	18.79%
2-Harvey Brook	971.53	729.21	75.06%	242.32	24.94%
3-Lollypop Pond	204.14	181.51	88.91%	22.64	11.09%
4-Colonial Terrace	149.82	126.12	84.18%	23.69	15.81%
5-Tributary	464.88	360.20	77.48%	104.68	22.52%
6-Hollow Brook	391.66	248.13	63.35%	143.53	36.65%
TOTAL WATERSHED	**4,406.16**	**3,451.32**	**78.33%**	**954.84**	**21.67%**

Based on this analysis of projected development in the Deal Lake watershed, a UAL analysis was then conducted to estimate future pollutant loads assuming full buildout under current municipal zoning. Zoning maps for each municipality within the watershed are provided in Appendix A. To account for variations in specific future land development, several assumptions were made in assigning pollutant loading values to project future land uses. For lands currently zoned for agricultural uses (other than those identified as protected under a farmland preservation program), future pollutant loading coefficients for TP, TN and TSS were calculated as an average of all agricultural coefficients. In contrast, future pollutant loading for protected farmland was estimated using the coefficients assigned to the existing LU/LC codes. Similarly, for lands identified as permanently protected and those with steep slopes (≥15%), wetlands, FEMA floodplain areas, mines and quarries, future pollutant loads were calculated according to the existing LU/LC codes assigned to those lands. Summaries of the results of the "buildout" pollutant loading analysis conducted for each pollutant of concern are provided in Tables 15-17.

Table 15 – Buildout TN Load By Sub-Watershed

Sub-watershed	Total Acreage	Percent of total watershed area	Projected Future TN Load (lbs /year)	Percent of total TN load
1-Main Lake Basin	2,224.13	50.47%	4,751.88	**48.00%**
2-Harvey Brook	971.53	22.05%	1,958.79	**19.79%**
3-Lollypop Pond	204.14	4.63%	572.34	**5.78%**
4-Colonial Terrace	149.82	3.41%	467.85	**4.73%**
5-Tributary	464.88	10.55%	1,267.38	**12.80%**
6-Hollow Brook	391.66	8.89%	881.00	**8.90%**
TOTAL WATERSHED	**4,406.16**	**100%**	**9,899.24**	**100%**

Table 15 – Buildout TP Load By Sub-Watershed				
Sub-watershed	**Total Acreage**	**Percent of total watershed area**	**Projected Future TP Load (lbs /year)**	**Percent of total TP load**
1-Main Lake Basin	2,224.13	50.47%	488.52	**43.83%**
2-Harvey Brook	971.53	22.05%	175.86	**15.78%**
3-Lollypop Pond	204.14	4.63%	79.24	**7.11%**
4-Colonial Terrace	149.82	3.41%	71.18	**6.39%**
5-Tributary	464.88	10.55%	181.70	**16.30%**
6-Hollow Brook	391.66	8.89%	118.12	**10.60%**
TOTAL WATERSHED	**4,406.16**	**100%**	**1,114.62**	**100%**

Table 15 – Buildout TSS Load By Sub-Watershed				
Sub-watershed	**Total Acreage**	**Percent of total watershed area**	**Projected Future TSS Load (lbs /year)**	**Percent of total TSS load**
1-Main Lake Basin	2,224.13	50.47%	632,465.60	**41.79%**
2-Harvey Brook	971.53	22.05%	302,044.71	**19.96%**
3-Lollypop Pond	204.14	4.63%	68,544.85	**4.53%**
4-Colonial Terrace	149.82	3.41%	73,480.11	**4.85%**
5-Tributary	464.88	10.55%	203,246.53	**13.43%**
6-Hollow Brook	391.66	8.89%	233,761.49	**15.44%**
TOTAL WATERSHED	**4,406.16**	**100%**	**1,513,543.29**	**100%**

A comparison was made between computed current pollutant loading and pollutant loading computed under future development, "buildout" conditions, given the assumptions described above. The results of this comparison are provided in Tables 18 through 20, below. In most cases, pollutant loads are expected to increase under project future development conditions, although the highly urbanized nature of this watershed means that current pollutant loads are already close to buildout levels. However, there are a few important exceptions to this scenario. For example, TN, TP and TSS loading are actually anticipated to decrease in subwatershed #2 (Harvey Brook), although by very small percentages (-4% TN, -14% TP and -12% TSS), while TSS is also expected to decrease in subwatershed #1 (main lake basin) by less than 2%. The basis for these seemingly counterintuitive predictions is most likely the anticipated transition of a small portion of land in subwatershed #2 from agricultural production to residential and commercial development, consistent with current municipal zoning regulations. This means that intensive use of high-nitrogen fertilizers commonly associated with farm fields, as well as soil erosion due to agricultural activities, will decrease, resulting in lower or comparable TN and TSS concentrations under buildout conditions. In addition, subwatershed #2 has relatively large areas of wetlands (considered undevelopable), which act as a "sink" for TP and TSS and are not estimated to add to TN loads.

Overall, subwatershed 6 (Hollow Brook) is expected to experience the largest percentage increase in pollutant loading under buildout conditions: +24% TN, +64% TP and +122% TSS. This can be attributed in part to the relatively large amount of currently forested area located in the industrial, commercial and residential zones surrounding the Route 18 corridor in this subwatershed. Assuming these forested areas are converted to the development permitted in these areas, pollutant loads can be expected to increase accordingly.

It should be noted, however, that the UAL modeling methodology used here does not account for additional TSS loading associated with the severely eroded stream banks and scouring characteristic of many watershed streams. It must also be stressed that in-stream concentrations of TSS could increase in all subwatersheds, even if the land-based load is decreased (as in the conversion of agricultural lands to urban development). This could occur under a scenario where increased total flows or increased peak flows would contribute to the scour of the stream channel and exacerbate bed and bank erosion of the Deal Lake tributaries.

These scenarios underscore the importance of improved management and treatment of stormwater-based NPS pollution in the watershed (particularly in the specific subwatersheds likely to experience the greatest future water quality impacts) to mitigate these anticipated increased pollutant loads. Given the existing level of development in the watershed, stormwater BMP retrofits, mitigation of current stormwater management problems, and the potential construction of regional stormwater management basins to address road runoff in some of the major transportation corridors of the watershed will all play a major part in the WPP.

It should also be emphasized that floatables are a significant, and highly visible, component of the overall NPS pollutant load within the Deal Lake watershed. While not addressed by the NJ SWQS or a TMDL, floatables can greatly reduce the recreational and aesthetic values of the lake, clog stormwater inlets and outfalls and negatively impact wildlife habitat. Reducing the amount of floatables and debris entering the lake and its tributaries will be an important component of the Deal Lake WPP.

Table 18 - Change in TN Loading - Current to Future Development					
Sub-watershed	**Total Acreage**	**Current TN Load (lbs/year)**	**Projected Future TN Load (lbs/year)**	**Diff. Current Vs. Future TN load (lbs/year)**	**Percent Change**
1-Main Lake Basin	2,224.13	4,572.78	4,751.88	**179.10**	**3.92%**
2-Harvey Brook	971.53	2,033.55	1,958.79	**-74.76**	**-3.68%**
3-Lollypop Pond	204.14	479.76	572.34	**92.58**	**19.30%**
4-Colonial Terrace	149.82	398.54	467.85	**69.31**	**17.40%**
5-Tributary	464.88	1,080.12	1,267.38	**187.26**	**17.34%**
6-Hollow Brook	391.66	713.37	881.00	**167.63**	**23.50%**
TOTAL WATERSHED	**4,406.16**	**9,278.12**	**9,899.24**	**621.12**	**6.69%**

Table 19 - Change in TP Loading - Current to Future Development					
Sub-watershed	**Total Acreage**	**Current TP Load (lbs/year)**	**Projected Future TP Load (lbs/year)**	**Change Current Vs Future TP load (lbs/year)**	**Percent Change**
1-Main Lake Basin	2,224.13	472.36	488.52	**16.16**	**3.42%**
2-Harvey Brook	971.53	203.78	175.86	**-27.92**	**-13.70%**
3-Lollypop Pond	204.14	58.34	79.24	**20.90**	**35.82%**
4-Colonial Terrace	149.82	53.01	71.18	**18.17**	**34.28%**
5-Tributary	464.88	139.46	181.70	**42.24**	**30.29%**
6-Hollow Brook	391.66	72.03	118.12	**46.09**	**64.00%**
TOTAL WATERSHED	**4,406.16**	**998.98**	**1,114.62**	**115.64**	**11.56%**

Table 20 - Change TSS Loading - Current to Future Development					
Sub-watershed	**Total**	**Current TSS Load**	**Projected Future**	**Change**	**Percent Change**

	Acreage	(lbs/year)	TSS Load (lbs/year)	Current Vs Future TSS load (lbs/year)	
1-Main Lake Basin	2,224.13	642,547.92	632,465.60	**-10,082.32**	**-1.57%**
2-Harvey Brook	971.53	343,361.98	302,044.71	**-41,317.27**	**-12.03%**
3-Lollypop Pond	204.14	62,183.55	68,544.85	**6,361.30**	**10.23%**
4-Colonial Terrace	149.82	65,269.47	73,480.11	**8,210.64**	**12.58%**
5-Tributary	464.88	147,498.00	203,246.53	**55,748.53**	**37.80%**
6-Hollow Brook	391.66	105,133.84	233,761.49	**128,627.65**	**122.35%**
TOTAL WATERSHED	**4,406.16**	**1,365,994.76**	**1,513,543.29**	**147,548.53**	**10.80%**

The results of the watershed survey, field sampling and pollutant modeling efforts show that there are diverse factors affecting the water quality and ecological status of Deal Lake and its tributaries. There is an apparent, strong linkage between watershed development, water quality degradation, ecological impacts and overall use impairments. The types of impairments are wide-ranging, including the most obvious: sediment loading and the influx of large quantities of floatables and urban litter. However, numerous other impairments exist that, although not as obvious, have had significant consequences. These include elevated concentrations of fecal coliform bacteria, phosphorus and ammonia the lake's streams. These pollutants increase the rate of eutrophication and result in a number of associated problems that negatively affect the lake's overall aesthetics, recreational potential and ecology. These pollutants decrease the public recreational use of the lake for swimming, fishing and boating. In addition, widespread damage has occurred, and continues to occur, due to the inadequacies of the existing stormwater management system.

5.0 The Objectives of The Deal Lake Watershed Protection Plan

5.1 Water Quality, Quantity and Recharge Objectives of the WPP

The identification of "drainage area-specific water quality, groundwater recharge and water quantity objectives" are outlined in this section in accordance with the with the goals of stormwater management planning as defined in N.J.A.C. 7:8-2.2 and the stormwater regulations for WPP as identified in N.J.A.C. 7:8-3.5. The objectives address "the elimination, reduction, and minimization of stormwater related impacts associated with new and existing land uses". Factors concerning environmental, social, and economic factors of the Deal Lake watershed have been taken into consideration.

TMDLs have been identified for two waterbodies within the Deal Lake watershed: Deal Lake (phosphorus) and Hollow Brook (fecal coliform). Deal Lake also appears on the NJDEP 2006 303(d) List of Impaired Waterbodies related to pH and pathogen impairments. As such, the drainage area objectives address these pollutants (phosphorus, pH, and fecal coliform) that threaten and impair the water quality of the Deal Lake watershed. The impacts of these contaminants, along with excessive sedimentation and the influx of large quantities of floatables have been repeatedly documented. The measures prescribed herein are intended to aid in satisfaction of the phosphorus and coliform TMDLs, reduce sediment and floatable loading and decrease secondary sediment transport to the lake caused by excessive scour of the lake's tributaries.

5.1.1 Water Quality Objectives

a. Objective: Address regulatory measures that affect water quality

i. Goal: Proper long-term management of the Deal Lake watershed.

ii. Measures:

a. Site development review by Deal Lake Commission (DLC)

i. For lands located within 300' of the lake proper or its tributaries, DLC will work in concert with the local planning boards in an advisory role providing technical review and comment on all applications for all major development or redevelopments of significant proportion, as well as for any projects that result in a significant amount of soil disturbance (> 1,000 ft^2).

ii. Plans supplied on cooperative manner by municipalities to DLC.

iii. Review fees to be borne by developer or applicant.

b. Mitigation Plans

i. DLC will provide municipalities within prioritized mitigation project site located within each municipality for projects that fail to comply in full with the N.J.A.C. 7:8-5, Design and Performance Standards for Stormwater Management Measures.

ii. Project must be stormwater-related and designed to decrease pollutant loading or correct an existing stream scour and/or erosion problem.

iii. Site: all sites that have applied for new development permits, site plan approvals or related municipal or county approvals.

b. Objective: Address bacterial impairments

i. Goal: Meet water quality standards for bacteria (TMDL)

ii. Measure:

a. Complete the mapping of sanitary sewer lines to help identify and target possible sources of illicit connections, pipe breaks or contamination.

b. Pet Management

i. Secure grant funding for interpretive signage enforcing the link between human activities and waterfowl to degraded water quality

ii. Design and execute education campaign.

c. Canada Geese management

i. Secure money for interpretive signage communicating the link between human activities and waterfowl to degraded water quality

ii. Design and execute education campaign.

iii. Continue support of local efforts to control goose population via education, egg addling and the use of trained and supervised boarder collies (e.g. Geese Peace).

iv. Continue the DLC's past efforts with lake-front owners and municipal properties to protect or re-establish native vegetation and promote shoreline aquascaping as means of controlling goose access to and from the lake.

iii. Sites: Sunset Lake, Deal Lake, Lollypop Pond, Colonial Terrace Golf Course, Fireman's Pond, Hollow Brook, Allenhurst train station, lower reaches of Harvey's Brook and other sites where geese congregate and nest and municipally-owned lands.

c. Objective: Address nutrient impairment and pollutant loading

i. Goal: Reduce nutrient and pollutant loading, reduce transport of floatables, litter and debris

ii. Measure:

a. Aid in preparation and support passage of local ordinances:

i. Riparian Zone Protection Ordinance.

ii. Fertilizer Application Ordinance.

iii. Improved anti-litter, pet waste and yard waste ordinances and the enforcement of said ordinances.

b. Storm basin retrofit and other stormwater management techniques

i. Green infrastructure/LEED certification.

ii. Nonstructural Techniques.

iii. MTD installation.

iii. Sites:

a. Retrofit catchbasins with NJCAT-certified devices along Routes 35, 66 and 18
b. Create regional stormwater basins at the following sites: the Mayer Dam at Harvey Brook, Hollow Brook, Lollypop Pond and at Seaview Square Mall.
c. Install MTDs at key outfall sources of sediment and floatables, focusing on locations adjacent to Asbury High School.
d. Where practical and supported by the availability of public owned land construct bioretention type BMPs. Demonstration site for such a BMP is the Colonial Terrace Golf Course, an Ocean Township owned facility.

d. Objective: Address sediment loading to watershed and stream bank erosion

i. Goal: Reduce stream bank erosion
ii. Measure:
    a. Hydrologic/hydraulic analyses of tributary streams to Deal Lake to correctly establish flow rates, volumes and related data fundamental to the design of corrective measures.
    b. Make use where applicable Rosgen type approaches to stream bank stabilization. These will focus on bio-engineered solutions that are sustainable and compliment or recreate existing riparian habitat.
    c. Target known high erosion stream segments, such as the lower portion of Harvey Brook between Roseld Avenue and Monmouth Road for biorestoration.
iii. Sites:
    a. Retrofit catch basins to better trap sediment generated as road grit from the surfaces of Routes 35, 66, and 18. Will require NJDOT participation.
    b. Identify appropriate areas in need of stabilization and restore eroded stream channels.
    c. Evaluate the potential for the conversion of the Route 66/35 Circle as a regional stormwater management structure.
    d. Evaluate the potential for the condemnation and acquisition of land along the banks of the lake's Colonial Terrace tributary, immediately east of Route 35 for the construction of a regional stormwater basin.

5.1.2 Water Quantity Objectives

a. Objective: Address flooding issues

i. Goal: Reduce flood levels
ii. Measure:
    a. Obtain funds needed to redesign and electrify flume gates so as to allow for the quick manipulation of lake level. This is key to addressing persistent flooding problems. The existing manual actuators are damaged, difficult to operate, dangerous to operate during periods of high flow and cannot be used effectively to

manipulate lake height. Electrification of the flume would correct this longstanding problem.

b. Conduct detailed hydrologic and hydraulic studies of Harvey and Hollow Brooks with emphasis placed on the backwater impacts caused by the various road crossings.
c. Target known flood damaged stream segments, such as the lower portion of Harvey Brook between Roseld Avenue and Monmouth Road for biorestoration.

iii. Sites:
a. Implement flow controls at Hollow Brook, Lollypop Pond and Terrace Pond. Essentially convert these independently dammed sections of the lake into designated regional stormwater management basins. This will not only address localized and regional flooding issues but facilitate periodic maintenance dredging under a General Permit-1 as opposed to a General Permit-13.
b. Create regional stormwater basins at Mayer Dam (at Harvey Brook), Hollow Brook, Lollypop Pond and Sea View Square. Make use of existing structures, via their renovation and/or redesign to better control peak flows and control overall flood volumes.
c. Electrify flume gates as noted above to allow for the quick and safe manipulation of the lake's pool level.

5.1.3 Groundwater Recharge Objectives

a. **Objective: Address recharge of stormwater**

i. Goal: Increase recharge
ii. Measure: Work with municipalities to implement as part of the local development ordinances a requirement that the redevelopment of any site within the Deal Lake watershed provides a site-specific recharge rate of 110% or implement a recharge mitigation project. Computation as per N.J.A.C. 7:8 and GSR-32 methodology. This will help decrease the impacts of historically, improperly mitigated stormwater runoff from older development sites by encouraging the routing of runoff into the underlying soils. Focus placed on roof top runoff, but would include parking areas, even in those cases where the redevelopment will not increase the site's total amount of impervious cover.
iii. Sites:
a. Create regional stormwater basins, initially targeting Mayer Dam (Harvey Brook), Hollow Brook and Sea View Square Mall.
b. Evaluate the potential for the conversion of the Route 66/35 Circle into a regional stormwater management structure.

c. Evaluate the potential for the condemnation and acquisition of land along the banks of the lake's Colonial Terrace tributary, immediately east of Route 35 for the construction of a regional stormwater basin.

6.0 Recommended Design and Performance Standards (Summary of Milestone 4A Report)

Through the objectives outlined above and detailed herein, with the NJDEP's acceptance of the WPP the DLC should be able, working in a cooperative manner with the local municipalities, expand it role in the protection of the lake and its watershed. Within Section 6 highly recommended changes to existing stormwater design performance standards are presented for the consideration by the Deal Lake municipalities. These recommended changes will alter the ways that developers are currently required to manage stormwater runoff from both new and redevelopment sites. However, it must be emphasized that within the context of the WPP, the DLC's role is not mandatory and the towns are not obliged to implement the recommended changes to the local MSWMP Design and Performance Standards for Stormwater Management Measures. Additionally, it is not mandatory and the towns are not obliged to require development projects that do not comply in full with Design and Performance Standards for Stormwater Management Measures to implement the mitigation projects outlined by the DLC. However, it is the intent of the DLC, through this WPP, that the Deal Lake municipalities adopt the recommended changes and amend their development ordinances accordingly.

6.1 Stormwater Design Performance Standards

90% TSS Removal Standard

- The transport of sediment from Hollow Brook, the Seaview Tributary and Harvey Brook to the western fingers of Deal Lake is a long standing concern. The DLC, with funds obtained through the NJDEP, USACOE and EPA and in-kind services provided by the municipalities, County and private stakeholders, has conducted large-scale dredging projects in segments of the lake that were impacted over time by the influx and settling of sediment. These dredging projects resulted in the removal of approximately 100,000 yds^3 of sediment from the lake. However, the lake continues to be impacted by sediment loading. Therefore, it is recommended that a performance standard of 90% f Total Suspended Solids (TSS) removal be required for <u>all</u> development projects.
- The 90% TSS removal standard would apply to both <u>future major</u> residential and commercial development projects, as well as the re-development of commercial properties, even in those cases where the total amount of disturbance or the amount of new impervious do not respectively exceed 1 acre or ¼ acre.

110% Recharge

- It is recommended as a means of reducing the stormwater flows that cause property flooding and stream bank erosion, a watershed-wide standard be adopted requiring a post development stormwater recharge standard of 110%, as opposed to the current recharge standard of 100% (as computed in accordance with N.J.A.C. 7:8 and GSR-32 methodology). In addition, where applicable, infiltration would be required for all development and redevelopment projects. With respect to commercial redevelopment, emphasis is given to the collection and subsequent infiltration of roof top runoff. Rain water harvesting and reuse is also being promoted as a means of decreasing off-site discharge of stormwater.

Nutrient Removal

- To address the phosphorus TMDL for Deal Lake and nutrient loading in the watershed, phosphorus and nitrogen it is recommended that the local municipalities adopt a performance standard requiring the removal of 60% of the phosphorus load and 30% of the nitrogen load in a site's stormwater runoff. These removal rates are in keeping with those identified in the NJDEP BMP Manual and can be achieved through the use of various bioretention stormwater management systems.

Pathogen Removal

- Pathogen reductions and impairments will be addressed by constantly inspecting the watershed's stormwater collection and conveyance system for potential illicit connections. This is an existing requirement of the MSWMPs adopted by each of the Deal Lake municipalities and approved by the County. As is currently required, any such connections must be repaired and eliminated.

6.2 Stormwater Management Ordinances and Related Municipal Ordinances

The following recommended changes to existing local ordinances are presented as a "source control" means of directly addressing some of the lake's major, but very ubiquitous, sources of nutrient and pathogen loading.

6.2.1 Fertilizer Application Ordinance[6]

Rationale

Elevated levels of nutrients, particularly phosphorus, in surface waterbodies can result in a eutrophic system. A system that is eutrophic tends to support an excessive and accelerated growth of algae and aquatic plants that degrades the aesthetic and recreational value of a waterbody. Enhanced plant and algae growth can also degrade conditions for aquatic life because dissolved oxygen levels in the water drop when dead plant material decomposes; low levels of dissolved oxygen can cause fish kills in many lakes and streams in New Jersey.

The results of the WPP water quality monitoring of Deal Lake clearly demonstrate that phosphorus concentrations in the lake are at elevated levels that are conducive of eutrophic conditions. Measured concentrations of total phosphorus (TP) exceeded the 2006 New Jersey State Surface Water Quality Standard (found at N.J.A.C. 7:9B) during every sampling event of the 2005 monitoring program with one exception. During the late summer sampling events in August and September, TP concentrations in Deal Lake were routinely measured in the 0.2 and 0.3 mg/L range—4 to 6 times greater than the State standard, 0.05 mg/L. These in-lake concentrations are much greater than that needed to stimulate and support a dense algae bloom.

[6] It is recognized with the recent passage of the State-wide fertilizer bill, the need for such an ordinance is now moot. However, this section of the report was retained in the updated WPP as it provides the rationale for the municipalities to both support and enforce the requirements of the newly passed bill.

Furthermore, there is a TMDL for Deal Lake for phosphorus. All water quality monitoring results for the WPP are included in the Characterization and Assessment Report, August 2006.

A solution to the excessive use of fertilizers is to regulate its use with an ordinance. A fertilizer application ordinance will help to protect water quality of Deal Lake and decrease the amount of phosphorus loading. Therefore, increased regulations on the use of phosphorus fertilizers on lakeshore lawns will be implemented and will be enforced. The NJDEP Model Ordinance on Fertilization Application is recommended by the DLC and WPP for adoption by each of the Deal Lake Communities. This Model Ordinance is enclosed as Appendix B

Implementation Strategy

After adoption of the WPP, watershed municipalities will adopt and will enforce a fertilizer application ordinance within 12 months. Municipalities may adapt the NJDEP model ordinance, found in Appendix B, to address their needs, or utilize the non-phosphorus fertilizer ordinances currently in place in Mountain Lakes (Morris County) and Sparta (Sussex County).

- The ordinance must state that a soil test is required prior to selection and application of fertilizer.
- If the soil test shows that phosphorus is needed, a fertilizer containing no more than 0.5% phosphorus will be applied.
- If the soil test shows that phosphorus amendment is not need, only fertilizers that do not contain phosphorus or other compounds containing phosphorus, such as phosphate, may be applied to all established lawns that border any section of Deal Lake, including coves, tributaries, main stem and headwaters streams.
- Fertilizers will not be permitted to be applied on impervious surfaces.
- Exceptions to this will relate to the seasonal fertilization of tress and shrubs and when a new lawn is being established, or as noted above when the soil data supports the need for phosphorus amendment.

In addition, the DLC will work with local businesses to promote low phosphorus products. Educational materials and guidance will be made available on the DLC web-site. Supplementing the information available through the website will be information and signage distributed by the DLC to local businesses communicating to customers the regulations set forth in this ordinance and the negative effects that phosphorus has on the water quality and conditions of Deal Lake.

6.2.2 Riparian Zone Protection Ordinance

Rationale

Natural riparian zones, or buffers, provide various ecological functions, and in addition provide a benefit to public health and safety by reducing flood damage risk. When riparian buffers are undisturbed, vegetated, and are in a natural state, ecological functioning is maximized. In contrast, a riparian buffer that is compromised by buildings, impervious surface, or lawn areas

limits the ecological and flooding benefits. Riparian buffers provide ecological functions such as:

- Create stream side shading that reduces water temperature;
- Filter sediments and other contaminants;
- Reduce nutrient loads of streams;
- Stabilize stream banks with vegetation;
- Reduce erosion caused by uncontrolled runoff;
- Provide riparian wildlife habitat;
- Protect fish habitat;
- Maintain aquatic food webs;
- Provide a visually appealing greenbelt;
- Provide recreational opportunities; and
- Reduce flooding by absorbing water.

Even the most western reaches of the Deal Lake watershed are becoming a developed landscape with large amounts of impervious surfaces. Large, in-tact forested buffers are few and those that remain are in poor health due to invasive species like Japanese knotweed and *Phragmites*. Buffer width is an important factor in maintaining the health of a waterway, maximizing ecological function, reducing non-point source pollution, and reducing the risk of flood damage.

Implementation Strategy

The DLC through the WPP recommends that each municipality adopt a Riparian Zone Protection Ordinance for the Deal Lake watershed with a minimum buffer of 100 feet that extends from top of bank or 100 year floodplain. A Riparian Zone Protection Ordinance will be adopted and will be enforced in order to prevent further degradation of riparian areas in the watershed. The ordinance will apply to new construction and redevelopment activities conducted within the Deal Lake watershed. Watershed municipalities will adopt and will enforce an ordinance to address riparian buffer conservation within 16 months of the adoption of the WPP. The NJDEP model ordinance in Appendix B provides a resource for municipalities. The municipalities may also choose to develop this ordinance following the guidance available through a similar ordinance developed and implemented in Readington Township (Hunterdon County). It is noted that the proposed buffer exceeds the riparian buffer provisions currently contained in the NJDEP Flood Hazard Area Rule (N.J.A.C. 7:13). The municipal riparian corridor ordinance can be designed to provide relief for given disturbances as per the stipulations provided within N.J.A.C. 7:13.

6.2.3 Waste Reduction Ordinances

Rationale

Watershed municipalities are encouraged to prepare and adopt the five (5) following ordinances. It should be noted that each of the five are already mandated by the New Jersey Municipal Stormwater Rules (N.J.A.C. 7:15) and the NJPDES permit requirements for Tier A

municipalities. As such, these measures should already be in place and being enforced. The rationale for their inclusion in the WPP is primarily to reinforce the importance of control of all forms of waste entering Deal Lake. If someone is found to be in violation of an ordinance, municipal code enforcement officers and/or the police should presently be enforcing these ordinances. NJDEP Model ordinances are available at the following NJDEP website: http://www.njstormwater.org/tier_A/ordinances.htm

6.2.3.1. Yard Waste

Regular yard waste collections help to ensure that the wastes do not end up in our storm sewers or water bodies. When leaves are carried away by stormwater, they can have several detrimental effects on the surrounding community and environment. Excess leaves and grass clippings can clog stormwater systems, causing flooding and requiring additional maintenance at municipal expense. If yard wastes enter local waterways, they remove oxygen from the water during the decomposition process and lead to increased nutrients, which cause excessive plant and algal growth. Each watershed municipality will adopt and will enforce an ordinance prohibiting placing yard waste in the street. This means that property owners may not pile leaves, grass, or any other clippings at the curb for collection. Property owners will be encouraged to compost these materials.

6.2.3.2. Pet Waste

Pet waste can be a significant source of organic pollutants and pathogens. When pet waste is left on yards, sidewalks and streets and is not properly disposed of, it can be carried into storm drains by rain during storm events. Most storm drains are not connected to sewage treatment plants, but drain directly to local water bodies. By controlling pet waste, pollutant loading entering these surface waters is reduced. Watershed municipalities will adopt and will enforce an ordinance that requires pet owners or their keepers to immediately and properly dispose of their pet's solid waste deposited on any property, public or private, not owned or possessed by that person. Information on the Pet Waste Ordinance and the benefits of proper disposal of pet solid waste will be distributed with pet licenses.

6.2.3.3. Litter

The accumulation of floatables in Deal Lake is a constant concern for users, residents and municipal officials. Several annual volunteer clean-ups are scheduled by the DLC and other community groups. These occur in the spring and fall of each year and result in the removal of tons of trash and floatables from the lake. At times emergency removal operations have been required to remove trash and debris impinged upon the grates protecting the lake's fume gate to prevent the backup of water and the subsequent flooding of properties. As such, litter control is important in the overall management of the lake.

6.2.3.4. Improper Waste Disposal

The improper disposal of pollutants can have a negative effect on surface and ground water quality in the Deal Lake watershed. Failure to properly dispose of materials like automotive fluids, motor oil, lawn and garden supplies, household cleaning supplies, and paints and solvents, can have a direct impact on receiving waterbody quality. Watershed municipalities will adopt and will enforce an ordinance prohibiting the improper spilling, dumping, or disposal of materials other than stormwater into catch basins and other stormwater conveyance structures bordering and discharging into the lake and its tributaries. This includes materials like automotive fluids, used motor oil, paints and solvents that can have a direct impact on receiving water bodies. The Phase II NJPDES permit does allow the following new and existing non-stormwater discharges, and the proposed ordinance will have no affect on controlling such discharges, many of which are required for proper and orderly operation of local services that benefit the health and welfare of the Deal Lake community:

- Water line flushing and discharges from potable water sources
- Uncontaminated ground water (e.g., infiltration, crawl spaces or basement sump pumps, foundation or footing drains caused by a seasonal and/or storm induced rise in ground water)
- Air conditioning condensate (excluding contact and non-contact cooling water)
- Irrigation water (including landscape and lawn watering runoff)
- Flows from springs, riparian habitats and wetlands, water reservoir discharges and diverted stream flows
- Residential car washing water and residential swimming pool discharges
- Sidewalk, driveway and street wash water
- Flows from fire fighting activities
- Flows from rinsing with clean water Equipment used in the application of salt and de-icing materials immediately following salt and de-icing material applications. Prior to rinsing with clean water, all residual salt and deicing materials must be removed from equipment and vehicles to the maximum extent practicable using dry cleaning methods (e.g., shoveling and sweeping). Recovered materials are to be returned to storage for reuse or properly discarded. Rinsing of equipment in the above situations is limited to exterior, undercarriage, and exposed parts and does not apply to engines or other enclosed machinery.

6.2.3.5. The Feeding of Canada Geese

In 2006, the DLC initiated a goose management program that included recommendations forwarded to the municipalities concerning the language and content to be used in the crafting of a Canada Geese Feeding Ordinance. It is the intent of the DLC to continue their efforts to reduce the impacts of geese on the lake. The following is intended to serve as a complement to the DLC's management efforts, as well as the efforts of other volunteers. The ordinance can serve as an effective means reducing the amount of goose waste that pollutes Deal Lake. At a minimum the Deal Lake municipalities are encouraged to adopt and enforce a goose feeding ordinance that prohibits the feeding of wildlife on all municipally owned properties, such as municipal parks. This will help prevent nutrients, organic pollutants, and pathogens associated

with the fecal matter of geese from entering the lake and its tributaries. The DLC will provide support in the form of education and out-reach materials to the municipalities.

Implementation Strategy

If they have not yet done so as part of their MSWMP, the Deal Lake municipalities are encouraged to adopt the five waste reducing ordinances detailed above. Given that many of these ordinances are State Basic Requirements (SBRs) for Tier A municipalities, such measures may already be in place in some of the Deal Lake communities. Municipal code enforcement officers will be the primary enforcement authority.

6.3 Zero Silt Runoff

Rationale

Deal Lake is presently inundated by excessive amounts of sediment. As noted above, several sections of the lake although dredged in the recent past and are once again in need of maintenance dredging. The influx of sediment to the lake represents one of the most obvious impacts to Deal Lake. It results not only in the filling of the lake but in perpetuating its consistently turbid appearance. Lakeshore residents and lake users attending the monthly DLC meetings frequently voice concerns about the sedimentation and the deterioration of the aesthetic and recreational value of the lake caused by the influx sediment and related turbidity and infilling impacts. Sediment loading impacts the aquatic life of the lake and its feeder streams by clogging gills, smothering eggs, and degrading aquatic habitat for fish and macroinvertebrates. As this sediment accumulates in the lake is creates deltas and shallows that in turn become colonized invasive aquatic plants and benthic mat algae. Sediment infilling has repeatedly been documented to impede the recreational use of the lake, very often causing the lake's more western areas to become too shallow for boating and fishing. The accumulated sediments also alter the lake's circulation and flushing characteristics creating back water areas that become stagnant, are prone to blue-green algae blooms, facilitate mosquitoes breeding and increase localized oxygen demands that further impact fish life. As the DLC can attest, the removal of these sediments is costly and difficult.

Harvey Brook and Hollow Brook are the two main conduits for sediment transport into the lake. Twenty to thirty years ago the major source of the problem was development occurring along the Route 35 corridor. Widespread land disturbance, improperly or inadequately implemented erosion controls and inadequate stormwater management facilitated the at times the documented rapid infilling of the lake. More recently, although erosion control standards have greatly improved, land development and redevelopment activities continue to generate sediment that washes into the lake. Again, most of this is associated with land disturbance activities along the Route 35 and Route 18 corridors and in the western-most portions of the watershed.

Past soil erosion problems has led to the accretion of sediment in the streams. These "legacy sediments" are another source of sediment loading. These sediments become mobilized and

transported into the lake during storm events independent of any sediment that may wash in with runoff. The presence of these accreted legacy sediments in the lake's streams impacts their flood storage. These sediments also add to the scour and continuing "down cutting" of the stream channels and the destabilization of riparian vegetation.

Equally important is the sediment attributable to stream bed and bank disturbance. This source of sediment is caused by the erosive force of stormwater and is the direct result of poor, past stormwater management controls. Thus even in fully developed subwatersheds, with relatively stable ground cover and little soil erosion, the stormwater loads generated by even the smaller, more frequently occurring rainfall events results in enough erosive force to scour the stream channel. Exposed soils are then washed into the lake. Past development activity with the streams' floodplains and riparian zones impede the ability to assimilate and naturally manage storm surges further abetting the erosion of the stream. Exacerbating these conditions are the acid producing soils that are so prevalent in the Deal Lake watershed. Once denuded or disturbed, it is difficult for vegetation to once again become established, thus perpetuating unstable soil conditions along the banks of the lake's feeder streams.

It is the intent of the WPP that each and every construction site, whether involving new development or re-development, would adopt a Zero Silt Runoff strategy as a means of proactively reducing direct and indirect (legacy sediment and bed/bank erosion sources) to the lake.

Implementation Strategy

The implementation strategy for the application of the Zero Silt Runoff strategy involves both a regulatory element and a management element. In terms of the regulatory element, current New Jersey Soil Erosion and Sediment Control Standards apply only to all new construction that disturbs an area in excess of 5,000 ft^2. Through the Deal Lake WPP, in support of the Zero Silt Runoff strategy, it is recommended that the existing erosion and sediment control standards be required of both new construction and redevelopment project that disturb area in excess of 1,000 ft^2. Obviously, compliance with this standard will require the cooperation of the Freehold Soil Conservation District, municipal engineers, and local and county planning boards, and unless formally adopted is non-mandatory.

In terms of the management element of the Zero Silt Runoff strategy, the DLC, in concert with the Freehold Soil Conservation District, municipal engineers, and local and county planning boards promote the implementation of such runoff management techniques at all development sites:

1. Minimization of site disturbance through the application of Low Impact Development (LID). With less site disturbance and the maintenance of existing natural drainage there will be a reduction in both the potential for soil erosion or an increase in runoff.
2. Weekly site basis and inspections following every rain event of active construction sites to ensure that proper soil erosion control measures are in place and are being correctly maintained.

3. Protect inlets and storm drains by using measures other than only hay bales and silt fencing (See Table 21).
4. Require and enforce the regular maintain and/or replacement of sediment trapping devices.
5. Utilize various alternative types of silt control measures including:
    a. Polymers
        i. Soiltac® Soil Stabilizer
        ii. PAM-12
    b. Erosion Control Blankets or Fiber Matrices
    c. Hydroseeding
    d. Other innovative techniques, e.g., Terra Tubes

Table 21 - Examples Of Inlet And Storm Drain Protection Devices	
Ultra-Inlet Guard®	http://www.spillcontainment.com/products/stormwater/catch_basin/inletguard.htm
Ultra-Grate Guard®	http://www.spillcontainment.com/products/stormwater/catch_basin/grateguard.htm
Ultra-Drain Guard®	http://www.spillcontainment.com/products/stormwater/catch_basin/drainguard.htm
Inlet Filter	http://www.blocksom.com/sedimenterosioncontrol_moreinfo.htm
IPP Inlet Filter	http://www.inletfilters.com/index.php

6.4 Mandatory Illicit Connection Detection and Elimination

Rationale

Illicit connections are a common problem in the Deal Lake watershed owing to its urban setting, and the age of the stormwater collection system. As has been the case in the Deal Lake watershed, often times these connections are not intentional or are unknown to the home owner or business owner. Some of the illicit discharges/connections that have been documented in the Deal Lake watershed were the result of the connection of waste drains and discharges from cooking establishments and laundries. Some of these connections were found to be purposeful and intended to by-pass the wastewater collection system apparently in order to avoid or reduce utility fees.

Bacterial impairments are a concern in the Deal Lake watershed. Deal Lake appears on Sublist 5 for fecal coliform (FC) and Hollow Brook has a TMDL for the contaminant. The results of the water quality monitoring for the WPP included FC measurements for five dates between July and September 2005 at two in-lake stations and two tributary stations. At one in-lake station and at the Hollow Brook tributary station, FC concentrations were routinely elevated and contravened the 2006 State Surface Water Quality Standards (N.J.A.C. 7:9B). On two sampling dates at this in-lake station, FC concentrations were elevated enough to exceed the laboratory's limit of detection (>1600 CFU/100 ml). The second in-lake station was the only station where FC concentrations did not exceed 200 CFU/100 ml, the State standard (in fact, the highest concentration recorded at this station was 120 CFU/100 ml in July). All water quality monitoring results for the WPP are included in the Characterization and Assessment Report, August 2006.

Illicit discharge detection and elimination programs are designed to prevent contamination of ground and surface water supplies by monitoring, inspection and removal of these illegal non-stormwater discharges. The first step of the detection initiative is to complete thorough mapping of the sanitary sewer system within the watershed. An essential element of this initiative is the authority to inspect properties suspected of releasing contaminated discharges into storm drain systems. Another important factor is the establishment of enforcement actions for those properties found to be in noncompliance or that refuse to allow access to their facilities.

Implementation Strategy

The correction of illicit connections is a mandatory requirement of the MSWMP, including the need for the aggressive detection and correction of such problems is one of the most significant ways by which the lake's fecal coliform problems can be addressed. The Deal Lake WPP supports the work of the watershed municipalities to address illicit connections. Additionally, as a follow-up to the WPP, the DLC will seek funds to expand and update the mapping of outfalls thus far conducted by the municipalities under their MSWMP requirements. An element of future mapping and data management initiatives conducted as part of the WPP includes the creation of a uniform means by which suspected problem outfalls can be further investigated. Specifically, the DLC would seek funding to conduct more intensive investigations and implement projects that correct these problems or mitigate their impacts. A modified NJDEP Checklist for Illicit discharges is included in Appendix C. This form can be used to ensure that data collection is conducted in a uniform manner. Other useful resources pertaining to the mapping, detection and control of illicit connections and discharges are available through such sources as the Center for Watershed Protection (http://www.cwp.org/) and the USEPA Clean Flows Clearing House (http://www.nesc.wvu.edu/wastewater.cfm). It should be stressed that this element of the WPP is limited to the development of the methodology to conduct more detailed and uniform illicit connection surveys/inspections, not the actual site investigations or the correction of verified illicit connections and discharges. The actual remediation will need to be dealt with on a case-by-case basis given the complexity of such problems.

6.5 Coastal Lakes Stormwater Committee

Rationale

In order to better disseminate watershed information, learn about new technologies, educate municipal employees, and create opportunities for roundtable discussions about stormwater issues, a Coastal Lakes Stormwater Committee will be formed composed of members of the DLC, Deal Lake municipal representatives, Monmouth County Planning and Engineering, Monmouth County Mosquito Commission, Rutgers Cooperative Extension and other interested groups that manage stormwater in Coastal Region of New Jersey.

Implementation Strategy

A Coastal Lakes Stormwater Committee should be formed within six months of NJDEP's approval of the Deal Lake WPP. Members should meet approximately 2 to 4 times per year. The

Committee will organize yearly stormwater conferences or training workshops for municipal officials and employees. The Committee will charge registration fees to offset the cost for the annual meetings.

6.6 Deal Lake Commission Municipal Site Development Review Assistance

Rationale

As previously noted, as part of the long term management of the Deal Lake watershed, all new development applications for properties located within 300' of the lake or its tributaries should be forwarded by the local planning board to the DLC for a non-binding, courtesy review. This would apply to both new construction and redevelopment projects. The benefit of this review lies in the fact that the DLC, in an advisory manner similar to local environmental commissions, can provide the planning board with insight, guidance and recommendations based on the site's unique features (soils, cover, slope, history of disturbance, etc.) that are directly relevant to the long-term management or protection of the lake. The DLC, due to their development of various pollutant loading databases, water quality data and first-hand knowledge of the lake often has information not available to the planning board or not requested of the developer by the planning board. This information could justify the need for additional environmental precautions or the need for certain design or impact mitigation measures that would not be normally required. The Lake Hopatcong Commission has provided such development reviews for the towns surrounding Lake Hopatcong, so a review of this nature conducted by the DLC is not unprecedented.

Additionally, by having site development reviews conducted by the DLC there will be greater likelihood that application of the regulatory and structural measures that affect water quality occurs uniformly throughout the Deal Lake watershed. Additionally, because improper stormwater management and inadequate environmental impact mitigation are responsible for the majority problems, having the DLC weigh in on the review of proposed development projects will also help ensure that the goals and objectives of the WPP are being addressed and met.

As the state-appointed stewards of Deal Lake, the DLC is an appropriate group to review development and redevelopment activities that could potentially disturb soil, stress existing infrastructure, increase impervious surface and impact water quality, quantity and recharge. The DLC represents an active and knowledgeable contingency of volunteers and environmental professionals that are able to perform technical and regulatory review and provide comment that is both practical and representative of progressive stormwater practices. These qualifications enable the DLC to function as an advisory board to the planning boards in a capacity similar to the local environmental commission.

As such it is recommended through the WPP that the DLC will be recognized by all the municipalities of the Deal Lake watershed as a bona fide review board for site development. For projects occurring within 300' of the lake or the banks of its tributaries the DLC should be given the opportunity to provide comment on all major development or redevelopments applications, as well as for any project that results in a significant amount of soil disturbance (>1000 ft^2). The reviews would focus on stormwater-related issues, environmental impact mitigation and seek to

ensure that the proper provisions and measures are in place to protect water quality, decrease the amount of runoff, control sediment loading and promote groundwater recharge. Any fees associated with these reviews would be paid by the developer/applicant. If projects fail to fully comply with N.J.A.C. 7:8-5, Design and Performance Standards for Stormwater Management Measures, the DLC, through these reviews would also be afforded the opportunity to specify an appropriate mitigation site.

Implementation Strategy

Immediately following NJDEP's acceptance of the Deal Lake WPP, the DLC will petition the local planning boards to receive as part of the review process copies of the plans, reports and related supporting information submitting as part of a development or redevelopment application. As noted above, this would apply only to development and re-development projects occurring within 300' of the lake or the banks of its tributaries. Given the frequency of "infill development" that occurs within the Deal Lake watershed, the DLC will also reach out the local zoning boards, as well as the local building inspectors, and asked them to consider the assistance of the DLC in the review of smaller projects that exceed the 1,000 ft^2 site disturbance threshold, but would not be subject to planning board review.

Each municipality may need to sign a resolution that provides their use of the DLC in this project review capacity. The DLC will be required to complete the review of each application in a timely manner (typically within ten (10) days) of receipt of the applicant's supporting environmental and engineering data, reports, plans and details. This review timeframe will thus have no deleterious impact on the 90 day municipal review time clock, as it will be conducted simultaneously with the review conducted by the municipal planning or zoning boards. As previously stated, the DLC's review will focus on environmental and stormwater management issues directly relevant to the health and ecological function of the lake and its tributaries. It will thus result in minimal duplicative review as it will emphasize the assessment of impacts and proposed mitigative strategies typically outside of that conducted by the engineers and/or planners representing the planning board or board of adjustment.

The DLC will forward their completed review to the municipal board having jurisdiction on the proposed development activity. In some cases the review letter may conclude with "no comment" or "application fully complies with the WPP". In other cases the review letter will detail the short comings of the application and provide recommendations to facilitate the application's compliance. When needed, DLC will provide a technical expert to testify on the findings and recommendations contained in the DLC's report. As with the review itself, the costs incurred for any testimony will be the responsibility of the applicant and covered through the development review escrow account in place with the municipal land use board.

7.0 Recommended Watershed and Stormwater Management Projects (Summary of Milestone 4B Report)

One of the primary goals of the Deal Lake WPP is the reduction of phosphorus, sediment, pathogen, floatable and gross particulate pollutant loading to the lake using replicable, easy to maintain BMPs that are consistent with the NJDEP's overall stormwater management approach as so detailed in the NJDEP Stormwater Best Management Manual. In doing so the DLC will:

- Demonstrate that effective and measureable reductions of phosphorus, sediment, pathogen, floatables and gross particulate pollutants can be achieved in an ultra-urbanized environment using cost-efficient, easy to install and maintain stormwater outfall MTD retrofits, attractive and sustainable, small-footprint bioretention systems, and regional stormwater management basins.
- Use the recommendations and guidance developed through the WPP to control existing and future NPS loading and aid the lake and Hollow Brook meet their respective phosphorus and pathogen TMDLs.
- Through the combined public outreach capabilities of the DLC and the Friends of Deal Lake, promote the WPP and demonstrate to municipal government and DPWs that MTD retrofits, created wetland systems and bioretention basins are cost-effective, easily maintained solutions that can significantly reduce NPS loading to Deal Lake.

The following section of the WPP outlines voluntary stormwater management measures and strategies that can be implemented by the DLC and the Deal Lake municipalities as funding becomes available. This section of the WPP also outlines the types of projects that are deemed necessary to remedy stormwater-related problems in the watershed. This includes projects targeted to specific sites identified by the DLC and the WPP stakeholders. Most of the identified project sites are long-standing problem areas. Others were identified through the field investigations conducted as part of this project. Most of these are linked to recent development projects located in the western reaches of the watershed, especially along the Route 18, 35 and 66 corridors. Improper, inadequate and poorly constructed or maintained stormwater management provisions are a direct, root-cause of the problems impacting the lake and its feeder streams. Of particular concern to the DLC and local stake holders is the on-going transport of sediment into Deal Lake. As noted in the earlier sections of this report, much of this sediment loading is the result of legacy sediments and the continued erosion of the bed and bank of the lake's tributaries. Due to unmitigated sediment deposition portions of the lake can no longer be navigated by even small row boats. Given the historical and current use of Deal Lake as a popular boating and fishing destination, this sediment loading diminishes the lake's overall recreational opportunities.

In addition to the continued influx of sediment, high nutrient and fecal coliform loading continues to negatively affect the ecological, hydrodynamic, physical and biological properties of the lake. This exacerbates the problems that impact recreational use. These problems also depress the property values of the homes abutting the lake. The measures outlined in this section

have been crafted to address the water quality, quantity and recharge objectives of the WPP through three types of initiatives:

1. Watershed Restoration
2. Stormwater Management
3. Education

7.1 Watershed Restoration

Rationale

Watershed restoration in part addresses the water quality objectives identified within the WPP as well as concerns pertaining to stream bank erosion, sediment transport, and the loss or degradation of aquatic and riparian habitats. As water quality becomes degraded and increased pollutants concentrate in Deal Lake, the resulting impacts become increasingly visible (e.g., intense algae blooms, sediment deltas, etc.). These impacts negatively affect the lake's aesthetic and recreational values. Water quality, quantity, and recharge objectives can be addressed by protecting riparian buffers and maintaining/restoring a native, vegetated lake shoreline.

As identified in the Deal Lake Watershed Characterization and Assessment Report, approximately 30% of the watershed area is comprised of forest, wetland, recreational land, water, agriculture and beach. These types of land use and land covers are found mostly in the remaining undeveloped areas of the watershed. They are all characterized by a low percentage of impervious area. The remaining 70% of the watershed is characterized as developed. This is land defined as urban land-areas having a high impervious cover. Given the nature of the Deal Lake watershed, it is recommended through this WPP that restoration techniques that are suited for urban areas be prioritized for implementation. Such measures take into account the "flashy" nature of lands having a large amount of impervious cover, as well as areas with an extensive stormwater collection system but little open land for the construction of new BMPs. Each site should be evaluated independently and site-specific considerations should be taken into account when developing design plans. Where funding allows, hydrologic and hydraulic studies of the system should be completed in advance of, are as part of, the implementation of the recommended BMP project. Background information about urban stream restoration is provided in Appendix D.

Specific Elements:

The watershed-based restoration plan should include the following elements:

- Baseline water quality monitoring and creation of a long-term monitoring database
- Completed inventory and survey of stormwater conveyance system including a map of sanitary sewer lines (to address fecal contamination) in the subwatershed area
- Urban restoration techniques
    - Streambank stabilization
    - Buffer improvements

  - Urban forestry
  - Other appropriate techniques
- Example restoration sites as identified by the DLC and the WPP stakeholders:
  - Harvey Brook
  - Hollow Brook
  - Seaview Brook

7.2 Structural Stormwater BMPs to Address Pollutants in the Watershed

Standard catch basins are intended to simply collect, concentrate and transport storm water to a receiving waterbody as quickly as possible to avoid localized flooding. As a result, they offer little positive benefit in terms of the management of storm water from either a quantity or quality perspective. In contrast, water quality inlets, including certain manufactured treatment devices (MTDs) can convey stormwater in a manner similar to a standard catch basin, yet provide some degree of pollutant reduction. MTDs and water quality inlets should be considered for the Deal Lake watershed as a means of decreasing pollutant loading to the Deal Lake and its tributaries.

MTDS are specially designed structures that are typically used to retrofit an existing stormwater collection system. Some rely on filters while others on enhanced settling or sediment segregation to improve water quality (Table 22). The pollutant removal capabilities of these structures are limited largely to the removal of total suspended solids and floatables, and to some extent, particulate pollutants, including particulate phosphorus and the heavy metals and petroleum hydrocarbons that adhere to sediments. There is a variety of manufactured stormwater treatment devices recognized and approved by the NJDEP. As per NJDEP, the typical TSS removal efficiency achieved with a properly sized MTD is 50%. The biggest disadvantage of MTDs is their cost. Additionally they must be routinely (1-4 times annually) cleaned out. Those that make use of a filtering system can be very costly to maintain owing to the price of the filters or replacement media.

Water quality inlets are more basic catch basin retrofits. They have lower performance benefits than MTDs. An example of a water quality inlet is a sumped catch basin. This is a standard catch basin that has an outlet invert pipe elevation approximately 0.6 m (2 ft) from the bottom of the basin. By raising the outlet pipe, a retention volume (sump) is created within the basin. This sump helps to trap sediments by slowing storm surges and reducing the velocity of the inflowing runoff. In addition to trapping sediments, water quality inlets may remove any heavy metals, petroleum hydrocarbons and, to a lesser extent, nutrients bound to the settled and trapped sediment. The installation of an elbow hood or baffle in a sumped basin further aids its ability to trap oil and grease and collect floatables (paper, leaves and trash). This modification also minimizes the re-suspension of the sediment trapped within the sump. Water quality inlets are unobtrusive and are compatible with standard storm drain networks. They can be easily accessed for maintenance and are capable of reducing pollutant loading from vehicular traffic, especially petroleum hydrocarbons. The biggest disadvantages of water quality inlets include their limited stormwater and pollutant removal capabilities, and the need for the frequent clean-out of accumulated sediments.

Both the MTD and water quality inlet type BMPs will at a minimum need to be cleaned out twice per year; once in late autumn after leaf fall is completed, and following the spring thaw once all deicing/snow clearing activities have ceased. The proper maintenance of these structures is critical to their pollutant removal performance.

Rationale

Proper stormwater management will help alleviate pollutant loading to the lakes tributaries as well as to Deal Lake proper. The MTDs certified by NJ Corporation for Advanced Technology (NJCAT) represent devices recognized by NJDEP to adequately remove total suspended solids (TSS). Table 22 provides a few examples of NJCAT certified BMPs. Each is listed by product name and confirmed pollutant removal efficiency.

Table 22 - NJCAT-verified Manufactured Treatment Devices (MTDs)

Company	MTD Name	TSS Removal (NJCAT Verification)
CONTECH Stormwater Solutions, Inc.	Stormwater Management StormFilter®	79% (2007)
	Vortechs® Stormwater Treatment System	64% (2004)
	CDS- High Efficiency Unit	68.5-88% (2003)
	VortSentry® System	69% (2005)
	CDS- Filtration System	82.7% (2006)
Stormceptor® Group of Companies	Stormceptor® System	75% (2004)
Hydro International	Downstream Defender®	70% (2005)
AquaShield, Inc.	Aqua-Swirl™ Concentrator	60% (2005)
	AquaFilter™ Filtration Chamber	80.5% (2005)
Terre Hill Concrete Products	Terre Kleen Stormwater Device	78% (2007)

There are other structural devices that have been used to remove phosphorus, bacteria and other stormwater pollutants, but these have not been certified by NJCAT. Although NJDEP may have some reservation with installing non-NJCAT certified MTDs, many of these other devices have been demonstrated to have the ability to reduce bacteria and phosphorus loading from runoff. Such devices may be useful in meeting the TMDL reductions established for fecal coliform loading to Hollow Brook and for phosphorus loading to Deal Lake. Table 23 highlights three patented, structural devices that reportedly remove bacteria, phosphorus and other pollutants.

Table 23 - Structural BMPs that Address Bacteria and Phosphorus		
Company	**Name**	**Pollutant Targets**
AbTech Industries	Smart Sponge® Technology	**Bacteria**, Hydrocarbons, and Floatables
	Case Study: Installed at a public bathing beach in RI to capture bacteria in catchbasins before entering waterbody. Catch basin inserts installed in Norwalk, CT helped abate an oil spill of 1200 gallons in an effort to protect the Long Island Sound.	
EcoSense™ International	EcoSense™ Stormwater Filtration System	**Bacteria**, Hydrocarbons, Floatables, Heavy Metals, **Sediment, Phosphorus**, Nitrogen
Fabco Industries	Fabco StormX Products	**Bacteria**, Hydrocarbons, Floatables, Heavy Metals, **Sediment, Phosphorus**, Nitrogen
Source: http://www.epa.gov/ne/assistance/ceitts/stormwater/techs.html		

Implementation

The installation of MTDs on a retrofit basis must begin with targeting the removal and replacement of the catch basins along the Route 35 and Route 66 corridors. The same holds true for certain catch basins located adjacent to the lake. To date the DLC has investigated and identified a number of key catch basins requiring replacement. These include 4-6 basins located on Route 35 near the Route 35/66 Circle. These catch basins discharge into the Seaview Tributary of the lake and are documented sources of sediment, particulate phosphorus and floatable loading to the lake. The DLC has discussed the replacement of these key basins with the NJDOT, given that the existing structures and their proposed replacements are located within the NJDOT right-of-way. The discussions to date have been favorable, and resulted in the DLC applying for 319(h) funding. Though funding not awarded, the project remains a priority effort for the DLC.

Another key catch basin is located on the west side of Asbury Park High School, at the terminus of Comstock Avenue. This outfall is another significant documented source of sediment, particulate phosphorus and floatable loading to the lake. The replacement of this basin occurs within the roadway right of way administered by the City of Asbury Park.

Other key catch basins are located along the perimeter road that encircles the lower-most portion of Deal Lake proper bordering Loch Arbour and Asbury Park. The replacement of these basins was the subject of multiple ISTEA grant applications submitted to the NJDOT by the DLC in the mid-1990s. That funding was not awarded and the project still remains a priority of the DLC. As is the case with the Asbury High School catch basin, these basins discharge directly into the

lake and are documented sources of sediment, particulate phosphorus and floatable loading. These basins are under the jurisdiction of Loch Arbour Village and the City of Asbury Park.

7.3 Non-Structural and Low Impact Development Requirements for Development and Redevelopment Projects

The 2004 New Jersey Stormwater Rules require the implementation of Low Impact Development (LID) and Non-Structural Stormwater Management techniques for new major developments; however, this requirement does not apply to re-development projects. It is the intention of the Deal Lake WPP that all new development projects incorporate to the fullest extent practical both the NJDEP promoted nonstructural stormwater management and LID site development techniques for new construction and redevelopment projects. These design provisions have the ability to proactively reduce stormwater runoff and pollutant loading. It is recognized that each development and re-development project is affected by unique zoning, site conditions and resource attributes that create constraints to the full application of an LID design. These same site-specific conditions may dictate the extent to which non-structural stormwater BMPs can be used. The LID and non-structural BMP strategies which the WPP promotes for consideration in the design of all new development and redevelopment projects are outlined below. Additional information for LID and non-structural stormwater BMPs measures is provided in Subchapter 5 of the NJDEP Stormwater Management Rules.

- Protect areas that provide water quality benefits or areas particularly susceptible to erosion and sediment loss.
- Minimize impervious surfaces and break up or disconnect the flow of runoff over impervious surfaces.
- Maximize the protection of natural drainage features and vegetation.
- Minimize the decrease in the pre-construction "time of concentration."
- Minimize land disturbance including clearing and grading.
- Minimize soil compaction.
- Provide low maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides.
- Provide vegetated open-channel conveyance systems that discharge into and through stable vegetated areas.
- Provide preventative source controls.
- Encourage the disconnection of downspouts and disconnection of impervious cover.

It should be noted that by combining structural and nonstructural measures, key catch basin retrofits and ordinances that provide source control reductions in pollutant loading have the cumulative potential to alleviate many of the water quality, quantity and recharge problems of the Deal Lake watershed. Therefore, these techniques should be used in a complementary fashion to control the amount of runoff generated from the lake's watershed, manage stormwater before it enters the lake or its tributaries and lessen the runoff effects of development and impervious surfaces in the Deal Lake watershed.

7.4 Specific Sites for Stormwater Management—as prioritized by the DLC

The following is a prioritized list of specific stormwater management projects identified by the DLC and WPP stakeholders that are in need of stormwater management. These projects reflect long-standing and well supported efforts to ameliorate the stormwater related damage to the lake and its tributaries created by the lack of, or inadequacy of, stormwater management measures for existing watershed development. The need for the Lollypop Pond project dates back to the mid-1980s, being one of the projects prioritized in the lake's original 314 Diagnostic Feasibility Study. Each project is first and foremost aimed at decreasing the lake's phosphorus and sediment loads. Some, for example the Mayer Dam, Lollypop Pond, Sea View Square and Flume gate projects will also mitigate flooding and flood related impacts to the lake, adjacent riparian areas and adjoining private and public properties.

1. Creation of a regional stormwater basin at Mayer Dam (Harvey Brook);
2. Creation of a bioretention, created wetland system at Lollypop Pond;
3. Creation of a bioretention swale system within Colonial Terrace Golf Course;
4. Redesign of the existing stormwater basins to create a regional stormwater basin at Sea View Square Mall;
5. Creation of a regional stormwater basin at the upper reach of the Hollow Brook arm of the lake (east of Route 66 and west of Wickapecko Drive);
6. Electrification of the Deal Lake Flume gates;
7. Catch basin retrofits along State highways Routes 35, 66 and 18 (see 7.2 above);
8. Retrofit of the catch basin at the terminus of Comstock Avenue, near Asbury Park High School (see 7.2 above).

As previously noted, many of the observed problems with the lake's feeder streams are associated with existing land uses and development, and the limited stormwater control systems and controls. Correction or mitigation of these impacts may involve the redesign, retrofit or upgrade of existing stormwater systems and controls to decrease sediment, nutrient and pollutant loadings (see 7.2 above). The projected implementation schedule and cost of these projects are presented in Table 25 in Section 8 of this report, and the locations for the priority projects are depicted on maps in Appendix E.

Potential structural stormwater strategies are highlighted in the Table 24, which were extracted from the 2005 USEPA Handbook for Watershed Restoration. This USEPA matrix rates bioretention basins, infiltration trenches, stormwater wetlands or wet ponds with a good or a high capability to reduce fecal bacteria and nutrients, which are a concern in this watershed. These methods would also help to infiltrate, recharge and/or retain stormwater in the subwatershed areas, which are also priority objectives identified for this watershed. Conventional dry detention or extended dry detention would not satisfy the current NJDEP requirements for 80% TSS reduction or satisfy the NJDEP recharge requirements. Bioretention, infiltration trenches, and wet ponds should be evaluated as appropriate structural strategies that can be selected for site specific areas within the Deal Lake Watershed. Land availability and costs are critical considerations for these BMP strategies.

Table 24: Best Management Practice Screening Matrix (EPA 2005).

Structural Management Practice	Hydrologic Factor				Pollutant Factor				
	Interception	Infiltration	Evaporation	Reduced Peak Flow	Total Suspended Solids	Nutrients	Fecal Coliform Bacteria	Metals	Temperature
Bioretention	●	ɵ	ɵ	ɵ	●	●	●	●	●
Conventional dry detention	○	○	ɵ	●	○	○	●	ɵ	ɵ
Extended dry detention	○	○	ɵ	●	ɵ	ɵ	●	ɵ	○
Grass swale	ɵ	ɵ	○	○	ɵ	○	○	●	ɵ
Green roof	●	○	●	ɵ	○	○	○	○	●
Infiltration trench	○	●	○	ɵ	●	●	●	●	●
Parking lot underground storage	ɵ	ɵ	○	●	●	●	ɵ	●	●
Permeable pavement	ɵ	ɵ	ɵ	ɵ	ɵ	○	ɵ	○	ɵ
Sand filter	○	○	○	○	●	●	ɵ	●	●
Stormwater wetland	●	○	ɵ	●	●	●	●	●	ɵ
Vegetated filter strip with level spreader	ɵ	ɵ	○	○	ɵ	ɵ	○	ɵ	ɵ
Water quality swale	ɵ	ɵ	ɵ	ɵ	●	●	○	●	●
Wet pond	○	○	●	●	●	●	●	●	○

Table key: ○ Poor, Low or No Influence, ɵ Moderate Influence, ● Good, High Influence[7]

7.5 Stormwater Education and Outreach

Rationale

Public Education is required under the New Jersey Stormwater Rule, it is a requirement for watershed planning, and for Regional Stormwater Management Plans. The continued protection and preservation of the Deal Lake Watershed is contingent upon an educated audience of county

[7] The recommendations in Table x were based primarily on the following references: USEPA National Management Measures to Control Nonpoint Source Pollution from Urban Areas, NJDEP Stormwater BMP Manual, NYDEC Stormwater Manual on Structural BMPs, and the Connecticut Stormwater Manual.

and municipal leaders, residents, land owners, and the business community regarding various matters affecting the health of the watershed and its critical habitat areas, including:

- Improve communication, training and coordination among local, county, state governments, local committees, and environmental organizations for watershed related activities.
- Improve public education and raise awareness to promote stewardship of watershed resources, improve water quality, and reduce non-point source pollutants.
- Improve environmental and land conservation efforts by preserving open space, sensitive environmental areas and habitats by promoting such concepts as riparian buffer stream bank preservation and restoration, reforestation, floodplain preservation,
- Enhance the existing volunteer stream monitoring and restoration programs in this watershed offered by DLC and the Friends of Deal Lake and the municipal committees.
- Celebrate successes to recognize noteworthy efforts, encourage participation, and continue the implementation of the Deal Lake WPP at the annual meetings.
- Prepare and disseminate the Watershed information via:
  - Educational Displays and Brochures for community events
  - Demonstration projects
  - Watershed tours or hikes
  - Workshops and staff training seminars
  - Volunteer opportunities for cleanups, plantings, monitoring or stenciling storm drains
  - Local planning or ordinances efforts

The implementation of these actions and success of this plan is greatly dependent upon the continue commitment and coordination among the municipal partners and stakeholders that were involved along with the DLC in the preparation of the WPP. These groups may be able to collectively obtain grants that will enable them to share the costs of outreach efforts and work to ensure that a specific audience is reached with a targeted message.

The New Jersey Stormwater rules for the municipal stormwater permit for Tier A communities require that township employees must be educated in aspects related to BMP maintenance and management, and stormwater permitting. As discussed in section 5.6 the WPP the DLC recommends the implementation of an extensive education program that targets for township engineers. Te WPP also calls for the creation of a Coastal Lakes Stormwater Committee that would initiate round table discussions of stormwater issues and serve as a forum for brainstorming options for stormwater management techniques. The committee could also be involved in drafting stormwater management ordinances, identifying sites requiring stormwater management or stream bank improvements and providing outreach to township officials. Obviously this same committee could work with the municipalities to obtain grant monies for project implementation. It is envisioned that the committee would perhaps conduct 2-4 workshops each year. The municipalities of the Deal Lake watershed could rotate the responsibilities for hosting the meetings and use registration fees to offset their costs.

Educational efforts will also be focused on the general public: disseminating information to landowners, schools and residents of the watershed about ways in which they can make a

difference in the water quality of Deal Lake. Together the DLC, the Friends of Deal Lake, municipal officials and staff, and the Coastal Lakes Stormwater Committee will work to provide recommendations for ongoing cleanups, plantings, and target watershed areas and deliver educational material and create opportunities to raise awareness about stormwater issues.

Specific Educational Topics

1. Education on Canada goose biology and the importance of not feeding waterfowl will be communicated to the public using interpretative signs on public land where waterfowl are known to nest and congregate.

2. Information about low phosphorus fertilizers and proper lawn care will be disseminated to the public.

    a. A 'lawn care expo day' for residents will be organized to demonstrate proper lawn care without the use of phosphorus fertilizers. Hand out information and demonstrations to be included.
    b. Outreach to retail businesses to advertise and promote lake friendly, low phosphorus products.

3. Education of local DPW employees on the management and maintenance of BMPs

    a. Training of DPW employees in the maintenance of bioretention, sand-filter, MTD and other "non-conventional" BMPs, sponsored by the DLC and conducted once in the spring and once in the fall.

4. Education of Planning Board and Land Use Board members

    a. Information and technical transfer presentation to land use board members (as well as elected municipal council members) of the WPP and its goals and objectives.
    b. Presentations keying on watershed and stormwater management activities of the DLC.

8.0 Summary of the Findings and Recommendations of the Deal Lake Watershed Protection Plan

As documented in the Milestone 3, Characterization and Assessment Report, widespread damage has occurred—and continues to occur to Deal Lake largely due to inadequacies in the way stormwater is controlled, managed and treated. The existing stormwater infrastructure system is focused on using the lake as the center for treatment, both for flood attenuation and for pollutant removal. If this situation is not corrected, the lake's water quality will never improve. The data and information compiled in the characterization and assessment report clearly show that no improvement in the condition of the lake and its tributaries will be possible unless a series of measures are put in place to correct the existing problems. Due to the magnitude and widespread nature of these problems, the corrections must encompass the following:

1. Regional stormwater management solutions that correct, replace and/or retrofit the existing stormwater management infrastructure;
2. Stabilization of the lake's stream channels;
3. Control of the influx of pollutants, including floatables;
4. Better stormwater management planning and design, with the focus placed on stormwater recharge to help moderate base flows, decrease storm surges and flooding, and lessen the opportunity for streambed and bank scouring;
5. Upgrade and retrofit of the existing stormwater management infrastructure and use of these opportunities to address and correct localized stormwater and pollutant loading problems;
6. Reclamation of sediment-infilled areas of the lake and development of a long-term management plan to ensure that the factors responsible for the infilling are corrected and that the reclaimed areas are easily and effectively maintained over time;
7. Decrease in the occurrence of invasive species within the lake and within the riparian areas of the lake and its tributaries;
8. Decrease in the frequency and magnitude of algae blooms;
9. Improvement in the lake's fishery as a major means of improving the lake's overall use attainment; and
10. Decrease in fecal coliform loading.

8.1 Prioritizing & Scheduling of BMP Implementations

The lists of management options described in the previous section were developed to meet each of the goals and objectives established for the Deal Lake WPP. The implementation of these measures, especially the structural stormwater BMPs, the stormwater retrofits, the installation of MTDs, and the implementation of the regional bioretention facilities described in sections 6.0 and 7.0 are dependent on many factors including but not limited to access to the lands, agreements with the NJDOT, and the acquisition of funding. Prioritizing the implementation of

these measures will be conducted based on the following criteria adopted from the *Pennsylvania Growing Greener Watershed Assessments program:*

- Measurable Stream Improvement/Restoration (TMDL Strategies)
- Ecological Benefit
- Community Support
- Land Owner Access and Cooperation
- Upstream to Downstream Prioritization
- Permitting Requirements
- Site Constraints (topography, groundwater, wetland/stream encroachments, etc.)
- Anticipated Costs, Funding Means and Expected Time Frame
- Identification of Project Partners for Implementation, Monitoring and Updating Progress

8.2 Funding and Financial Resources

Projected cost estimates have been developed and potential funding sources have been investigated for the stormwater management prioritized in the Milestone 4B report. The identified projects have been selected on the basis of the field and monitoring data compiled through the Characterization and Assessment study, as well as input from the community and stakeholders. For some of these projects (e.g. Lollypop Pond Created Wetland, Comstock Avenue MTD, Mayer Dam, Colonial Golf Course Bioretention System) concepts have been developed; however, none of these projects to date have been fully engineered or designed.

The projected costs provided in Table 25 are preliminary and are subject to further refinement. The exact mix of BMP installations/construction and other types of restoration measures implemented by the DLC over time will likely be determined by the availability of funding. For each project, the potential funding sources that will be investigated or solicited to implement the desired project are identified in Table 25.

Table 25 – Projected Cost Summary for Milestone 4B Prioritized Projects

BMP Project	Description	Responsible Party	Time frame	Projected Cost	Funding Source(s)
Lollypop Pond Created Wetland	Create a wetland bioretention system	DLC, Ocean Township	2009 - 2010	$165,000	319(h) funding submitted to NJDEP Sept 2008
Colonial Terrace Bioretention	Construct a bioretention swale within the Colonial Terrace Golf Course	DLC, Ocean Township	2009 - 2010	$80,000	319(h) funding submitted to NJDEP Sept 2008
Comstock Ave MTD	Remove existing catch basin at base of Comstock Ave. Replace with MTD	DLC, City of Asbury Park	2009 - 2010	$80,000	319(h) funding submitted to NJDEP Sept 2008

Mayer Dam	Rehabilitate existing Mayer Dam on Harvey Brook arm of lake to recreate regional stormwater management basin	DLC and Ocean Township	2012 - 2014	$1.1 million	Dam safety, 319(h)
Route 35/66 MTD Installations	Remove existing catch basins on Route 35 and Route 66 in the vicinity of the Route 35/66 circle. Replace with MTDs.	DLC, NJDOT, Ocean Township, Neptune Township	2010 - 2012	$450,000	NJDOT, 319(h)
Hollow Brook Bioretention System	Convert this independently dammed section of the lake into a designated regional stormwater management basin. Will address localized and regional flooding issues and facilitate periodic maintenance dredging under a General Permit-1 as opposed to a General Permit-13.	DLC, Neptune Township, and local stakeholder organizations	2011 - 2012	$600,000	319(h), Center for Watershed Protection (CWP), EPA
Sea View Square Bioretention Basin	Convert existing stormwater detention basins at Sea View Square Mall into bioretention basins.	DLC, Ocean Township, Sea View Square property owners	2012 - 2014	$250,000	319(h), CWP, EPA
Stream Bank Restorations	Identify appropriate areas in need of stabilization and restore eroded stream channels.	DLC and local stakeholder organizations	Begin in 2009, 2-5 years	$300,000 to $1million	NRCS, 319(h), USEPA, Depending on funding availability.
Electrification of the Deal Lake Flume Actuators	Electrify flume gates to allow for the quick and safe manipulation of the lake's pool level.	DLC, Asbury Park and Loch Arbor Village	2009	$100,000	319(h), FEMA funding
Continued education and outreach, voluntary signage	Develop Deal Lake Watershed displays for local events, WPP public outreach meetings	DLC/ each municipality local stakeholder organizations	2009 depends on funding .	$3,000 - $5,000 annually	319(h), EPA Env Justice, Dodge Foundation
Monitoring (see 8.3)	Annual monitoring program to track changes in lake and tributary conditions Resulting from WPP implementation	DLC/ local stakeholder organizations	2009 depends on funding .	$12,000 - $15,000 annually	319(h)

As illustrated in the above table, the DLC will investigate a variety of probable funding sources that include, but are not limited to:

- The NJDEP CWA 319(h) grant funds are available for implementation projects on public lands or lands under a Conservation Easement restriction. This funding limitation may

help prioritize demonstration projects on municipal, county or state owned lands such as town hall, school sites, and parklands. This funding is available to assist municipalities in meeting the Phase II Stormwater requirements.

- The New Jersey Environmental Infrastructure Financing Program, which includes New Jersey's State Revolving Fund, provides low interest loans to assist in correction of water quality problems related to stormwater and wastewater management. Grant funding is also available from the NRCS for restoration projects for public and private landowners.
- In other watersheds throughout New Jersey NRCS funding for landowners has been utilized to implement best management practices on private lands through programs sponsored by the NRCS, in partnership with the Natural Resources Conservation Service, Rutgers Cooperative Extension, the County Soil Conservation Districts, and the NJ Department of Agriculture. Some of these programs are highlighted below. Given the urban nature of the Deal Lake watershed and relevancy of development as opposed to agricultural related impacts, the applicability of these funding programs may be limited, but none the less represent potential funding opportunities for the DLC that will be investigated:
    - Conservation Reserve Enhancement Program (CREP)
    - Conservation Reserve Program (CRP)
    - Environmental Quality Incentives Program (EQIP)
    - Farm and Ranch Land Protection Program (FRPP)
    - Grassland Reserve Program (GRP)
    - Wetlands Reserve Program (WRP)
    - Wildlife Habitat Incentives Program (WHIP)

8.3 Long Term Monitoring Plans

The New Jersey Stormwater Regulations (N.J.A.C. 7:8-3.1) require a long term monitoring program be drafted and implemented in order to provide a technical database used to assess the success of the measures of the WPP. Long term monitoring can be used to assess not only water quality improvements realized through the implementation of the voluntary structural BMP mitigation measures, but also compliance and performance with the regulatory design standards measures. The focus of the monitoring plan presented below pertains to the former; evaluating the improvement in the lake and its feeder streams resulting from the installation or implementation of the various BMPs discussed in Section 7 and in the Milestone 4B report. Tracking these improvements in water quality will be an ongoing responsibility of the DLC, but will be conducted as noted in the Milestone 4B report dependent on the availability of funding and typically as part of a BMP implementation/installation project. A conceptual, cost-effective monitoring program is detailed below. This program is similar in context to the stream and lake quality data collection effort conducted as part of the WPP Characterization and Assessment Study (Milestone 3).

The monitoring program will involve the periodic sampling of the same four in-lake sampling stations and five stream sampling stations (Table 26) sampled as part of the Characterization and Assessment Study (Milestone 3 Report). All sampling will continue to be conducted in accordance with the NJDEP-approved Quality Assurance Project Plan (QAPP) developed as part

of the overall WPP study. Sampling events will be limited to the "growing season", May through September, as this is when water quality impacts and impairments peak in the lake and its tributaries. Sampling will be conducted under both baseflow conditions (defined as a condition of 72 continuous hours where less than 0.5 inches of rain has fallen) and storm event conditions as detailed below.

Baseflow Sampling

Baseflow sampling will be conducted on a monthly scale at the in-lake and stream stations (or as noted below) between May and September.

- Temperature (in situ)
- Conductivity (in situ)
- Dissolved Oxygen (DO) (in situ)
- pH (in situ)
- Flow (in situ, at stream stations only)
- Water Quality Chemistry (by lab analysis)
  - Total Phosphorus (TP)
  - Soluble Reactive Phosphorus (SRP)
  - Total Suspended Solids (TSS)
  - Nitrate-Nitrogen (NO^3-N)
- Bacteriological (at each stream stations, but mid-lake station only)
- E coli
  - Benthic macroinvertebrates (at stream stations only, only in June)

Table 26 - Deal Lake Long-Term Water Quality Sampling Program

Station #	Sampled parameters	Waterbody	Subwatershed	Municipality
ST-1	chemical, bacterial, biological	Deal Lake	1-Main Lake Basin	Asbury Park/ Loch Arbour
ST-2	chemical, biological	Deal Lake	1-Main Lake Basin	Asbury Park/ Interlaken
ST-3	chemical, bacterial, biological	Deal Lake	1-Main Lake Basin	Asbury Park/ Ocean Twp
ST-4	chemical, biological	Deal Lake	1-Main Lake Basin	Allenhurst / Ocean Twp
ST-5	chemical, bacterial, biological	Harvey Brook	2-Harvey Brook	Ocean Twp
ST-6	chemical, biological	Tributary to Lollypop Pond	3-Lollypop Pond	Ocean Twp
ST-7	chemical, biological	Tributary	4-Colonial Terrace	Ocean Twp

ST-8	chemical, biological	Tributary	5-Tributary	Ocean Twp
ST-9	chemical, bacterial, biological	Hollow Brook	6-Hollow Brook	Neptune Twp

Storm Event Sampling

Annually three (3) storm events will be sampled; one in May, one in July and one in September. Sampling will be limited to the five stream stations (ST-5, 6, 7, 8 and 9). The sampled parameters will be as follows:

- Temperature (in situ)
- Conductivity (in situ)
- Dissolved Oxygen (DO) (in situ)
- pH (in situ)
- Flow (in situ)
- Water Quality Chemistry (by lab analysis)
  - Total Phosphorus (TP)
  - Total Suspended Solids (TSS)
- Bacteriological (at each stream stations, but mid-lake station only)
- E coli

Annually the results of the baseflow and storm event sampling efforts will be synthesized in a summary report. The DLC, as it now does, will make use of its website and monthly public meeting to periodically (at least annually) present the results and findings of any water quality monitoring effort conducted by the DLC or stakeholders. The findings will also be summarized with regard to ongoing progress towards the performance and implementation of the measures stated in the WPP, whether they be voluntary or required. In addition, local community events will be targeted to disseminate general educational information, update the community on the implementation of specific projects, and to recognize or honor volunteers or stakeholders working on completed project tasks.

8.4 WPP Implementation and Effectiveness Milestones

8.4.1 Annual Reporting

To measure the success of this Regional Watershed Management Plan a variety of milestones and measurable criteria are suggested related to five basic strategies: Planning and Agency Coordination, Ordinance Adoption, Mitigation Projects, Monitoring, and Education. It is recommended that the watershed communities track their progress on implementing the various aspects of this WPP by summarizing their activities in the Annual Reports to NJDEP for Municipal Stormwater Plans. In addition to the requirements of the NJDEP Stormwater Annual

Progress Report, the DLC shall track progress in an Annual Report that includes the following items:

8.4.1.1 Planning and Policy/Agency Coordination

- Assess participation in both regional and local planning initiatives to implement measure to preserve and protect natural resources, such as: updates to Master Plan reports, ERIs, zoning initiations, environmental protective ordinances, etc.
- Ensure that Master Plans and other municipal documents are updated every six years to incorporate all the recommendations provided in the Deal Lake Watershed WPP. In addition, ensure partner coordination and community input.
- Assess the adoption of local land use and stormwater ordinances related to stormwater infiltration, impervious cover limits, redevelopment projects, riparian zone protection ordinances, as recommended in the Deal Lake Watershed WPP.
- Assess acres of preserved open space compared with the acres already preserved in the watershed, and ongoing acquisitions, and the implementation of greenways to protect the Deal Lake Watershed.
- Assess the creation of Tree Commissions, Community Forest Plans, Woodland Protection Ordinance and the development of stewardship plans for public lands.

8.4.1.2 Mitigation, Restoration, Projects and Maintenance

- Assess the obligation of funding and implementation of large and small-scale stormwater demonstration projects; recharge projects, pollutant loading reductions, repair of illicit connections, activities that restore the stream corridors, streambanks, and the surrounding landscape to improve the health of the watershed.
- Assess the obligation of funding and timely implementation of stormwater maintenance projects.
- Assess the implementation of the stormwater BMPS, retrofits, MTD installation and the installation of the regional bioretention facilities outlined in Section 6.0.

8.4.1.3 Monitoring and Research

- Routinely assess and compare the baseline data for water quality parameters for pathogens, nutrients, and TSS described in the Characterization Report with ongoing monitoring results. (See section 8.3 above and in 8.5 below)
- Assess populations and diversity of macroinvertebrates and fish species

8.4.1.4 Education, Outreach and Stewardship

- Assess the training provided to local officials and staff related to stormwater and other watershed concerns.
- Assess the number and public participation in community sponsored workshops, events, and volunteer stewardship opportunities
- Assess the dissemination of the educational materials to municipalities, environmental organizations and landowners regarding litter, yard waste and pet waste controls, water fowl feeding, water conservation, stormwater management, riparian zone protection, and open space preservation.

8.4.2 Criteria to Determine Water Quality Improvements

The measurable results of this project will be definitive. As documented in the WPP and the Characterization and Assessment report, the proposed regulatory and voluntary mitigation projects will address currently unmanaged or inadequately treated major sources of phosphorus, sediment, pathogen, floatables and gross particulate loading to the lake. These projects will help reduce known sources of non-point source pollutant loading to the lake, thereby aiding in the lake's overall water quality enhancement. This is in keeping with the need to improve the lake's quality and to reduce the lake's phosphorus load as so mandated by the NJDEP phosphorus TMDL and identified for other contaminants in the WPP. In doing so, the lake will be able to meet, on a more consistent basis, the State's water quality standards for TP, pathogens and TSS. Removal of particulate pollutants will also decrease the discharge of these materials into the ocean, thereby decreasing the frequency of beach closures. Note that some project objectives and associated tasks run concurrent with each other.

For all BMP sites, a water quality monitoring project will be set up prior to installation of the stormwater management device or facility (refer to Section 8.2 for general monitoring of lake and stream conditions). Baseline data will be collected and assessed prior to the installation of any stormwater management BMP. Post installation monitoring will also occur and the removal rates of the targeted pollutant or the overall improvement in water quality or other metric (e.g., linear feet of restored stream bank) will be calculated to ensure that the BMP is functioning effectively or the restoration project has been successful. Removal rates will be calculated using the EPA Region 5 model, StepL (Spreadsheet Tool for Estimating Pollutant Load). This model is easy to use and is available as a download from the EPA website in Microsoft Excel format. The actual sampling program conducted for each of the BMP installation/implementation projects will be designed specifically so as to generate the data needed to document the effectively of the project. As noted above, in some cases this may involve the measurement of pollutant load reduction while in other cases may involve the improvement in riparian habitat or the restoration of eroded stream channels. As such, the actual monitoring program will differ somewhat depending on the nature of the project.

8.4.3 Consistency with Other Plans and Regulations

This Deal Lake WPP is consistent with the NJDEP regulations for stormwater management (N.J.A.C. 7:8), Regional Stormwater Plans, Residential Site Improvement Standards (RSIS) N.J.A.C. 5:21, NJDEP established TMDLs, State Plan, NJ Wildlife Action Plan (Feb 2007), Municipal Land Use Laws (MLUL), Municipal Stormwater Management Plans and Ordinances, local Master Plans, and the Monmouth County Water Quality Management Plan. In addition, the WPP includes provisions from the Flood Hazard Mitigation Rules, (N.J.A.C. 7:13) and the Water Quality Management Plan Rules (WQMP) N.J.A.C. 7:15. The WPP will also be consistent with the past and current conservation and preservation efforts of the regional stakeholders to protect the surface and groundwater resources, preserve habitat for threatened and endangered species, better manage development within the watershed, prevent loss of baseflow and reduce stormwater pollutant loading, and preserve the rural and agricultural nature of the watershed.

8.5 Watershed Plan Adoption Process

A number of municipal and county government offices and a number of stakeholder organizations were invited to participate in the creation of the Deal Lake Regional Stormwater Management Plan, which has now evolved into the WPP. Each of the seven municipalities, the Monmouth County Mosquito Commission and two of the major stakeholders (Friends of Deal Lake and Monmouth University) routinely participated in the meetings and review process. Based on the findings and recommendations in the WPP each municipality will be asked to review and potentially modify their stormwater plans or ordinances in order to achieve goals and objectives set forth in the WPP. The Deal Lake Commission, as the designated project's Lead Planning Agency (LPA), will continue to work in concert with the NJDEP and the seven municipalities to implement the WPP and see its goals are achieved.

8.6 Summary of Compliance with Nine Required Elements of a WPP

The following summarizes the consistency of the Deal Lake WPP in terms of satisfying the nine required elements. Details are contained in the referenced Milestone Reports or the specified sections of the WPP. The WPP meets the USEPA's nine required plan elements as follows:

1. Identification of causes and sources of water quality and use impairments– Detailed in the Characterization and Assessment Report submitted and approved by the NJDEP (Milestone 2 Report)
2. Estimation of existing and future pollutant loads and required load reductions – Detailed in the Milestone 2 and 3 Reports submitted and approved by the NJDEP.
3. Description of the NPS management and BMPs needed to realize load reduction goals – Detailed in Milestone 3 Report submitted and approved by the NJDEP.
4. Estimation of the financial and technical assistance and authorities needed to implement the WPP – As discussed in herein in this report (Table 24) and in the Milestone 4A and Milestone 4B reports submitted to NJDEP.
5. Description of the educational, outreach and information dissemination measures/techniques that will be put into action to enhance public awareness of the WPP – As discussed herein in 8.4.1 and in the Milestone 4A and 4B Reports.

6. Schedule and Authorities for implementation - As detailed in the Milestone 4A and 4B Reports, and discussed herein in Sections 7 and 8.
7. Measurable milestones to determine attainment of WPP management measures – As discussed herein within Sections 7 and 8.
8. Description of criteria to determine progress – As discussed herein in Section 8.
9. Implementation of a monitoring element of the WPP – As discussed in Milestone 4B Report and herein in Section 8.

9.0 References

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