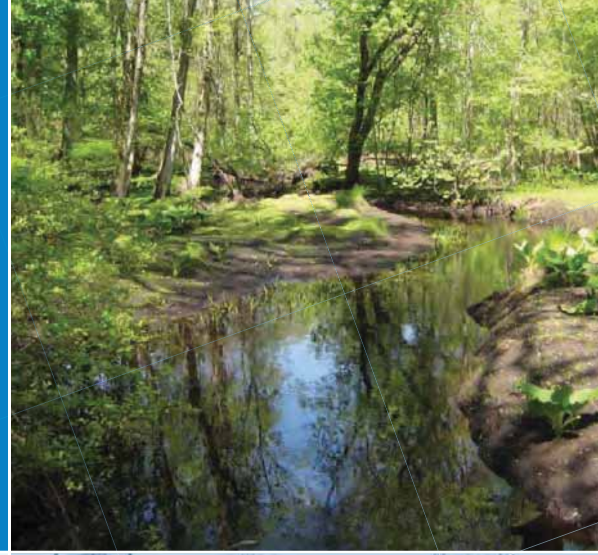
BRICK UTILITIES
THE BRICK TOWNSHIP MUNICIPAL UTILITIES AUTHORITY

Metedeconk River Watershed Protection and Restoration Plan



May 2013

CDM Smith

John S. Truhan Consulting Engineers, Inc.

Funded by the New Jersey Department of Environmental Protection Watershed Restoration Program

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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BOB MARTIN
Commissioner

May 23, 2013

Robert Karl
Brick Township Municipal Utilities Authority
1551 Highway 88 West
Brick, New Jersey 08724

RE: Approval for the Metedeconk River Watershed Protection and Restoration Plan (NJDEP Contract RP09-058)

Dear Mr. Karl:

The Department of Environmental Protection's Division of Policy Implementation and Watershed Restoration (Division) is in receipt of the Metedeconk River Watershed Protection and Restoration Plan dated April 2013 completed as part of the above-noted 319(h) grant, RP09-058 entitled, "Development of a Metedeconk River Watershed Protection and Restoration Plan," prepared by Brick Township Municipal Utilities Authority, CDM Smith and John S. Truhan Consulting Engineers in consultation with the Metedeconk Stakeholder Advisory Committee and Steering Committee. The plan compiles a comprehensive watershed characterization and a watershed plan with emphasis on nonpoint source control and stormwater management to address water quality focused on nutrient, pathogen and suspended solids reduction for the Metedeconk River, a tributary to the Barnegat Bay.

The Division has reviewed the above noted plan and found it addresses the US Environmental Protection Agency's nine minimum elements required for a Watershed-based Restoration Plan. Specifically, the plan presents a comprehensive characterization of the watershed, utilizing water quality monitoring and visual assessments conducted during plan development that determined the priority pollution sources and water quality problem areas throughout the watershed. Developed with a high degree of input from the Metedeconk Stakeholder Advisory Committee and Steering Committee, the plan also contains technical information for recommended structural and non-structural non-point source pollution control measures that upon implementation will improve water quality and remove impairments. These measures and practices identified in the plan may also be transferable to other areas of the state where watershed-based restoration plans are being prepared and implemented.

The Division has determined that this plan adequately identifies and prioritizes specific stormwater-related implementation projects to address water quality and quantity that are needed in order to improve water quality and address water quality impairments. Based upon the information contained in this plan, the Division hereby approves this plan as a Watershed-based Restoration Plan for the Metedeconk River Watershed.

Funding for implementation projects identified in this approved plan should be sought from all available federal and state sources, e.g. the 319(h) Nonpoint Source Grant Program. Please access the Department's website at www.state.nj.us/dep for more information on future 319(h) grant funding opportunities. Specific projects identified in this approved plan may also be undertaken by watershed partners in the implementation of their respective nonpoint source program responsibilities.

Thank you for your ongoing efforts to improve water quality in the State of New Jersey. I am confident that the various implementation projects identified in this approved plan will reduce nonpoint source pollution in this critical water supply watershed. If further information is required, please contact Kyra Hoffmann or myself at 609-633-2201.

Sincerely,

Robert B. Piel, Jr., Director
Division of Policy Implementation and Watershed Restoration

c: Kyra Hoffmann, NJDEP
Dave McPartland, NJDEP
Joseph Maggio, BTMUA

Acknowledgements

Funding for this project was provided by the New Jersey Department of Environmental Protection Watershed Restoration Program Grant No. RP09-058. The completion of this plan would not have been possible without the support and valuable contribution of a large number of individuals and organizations. The following individuals contributed to the completion of the Metedeconk River Watershed Protection and Restoration Plan:

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Metedeconk Watershed Stakeholder Advisory Committee
See Appendix B for a list of individuals.

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Ronald Baker - United States Geological Survey
Richard Borys - Commissioner, Jackson MUA; Jackson Environmental Commission
Linda Brennen, P.P., AICP – Monmouth County Planning Board
Michael DeLuca – Rutgers University IMCS JCNERR
Justin Flancbaum – Lakewood Township MUA
Stan Hales, Ph.D. – Barnegat Bay National Estuary Program
Helen Henderson – American Littoral Society
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List of Acronyms

ASR	Aquifer Storage and Recovery
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
BTMUA	Brick Township Municipal Utilities Authority
C1	Category One waterway
DCIA	Directly Connected Impervious Cover
DO	Dissolved Oxygen
ET	Evapotranspiration
HUC	Hydrologic Unit Code
LID	Low Impact Development
MCL	Maximum Contaminant Level
MS4	Municipal Separate Storm Sewer System
NJDEP	New Jersey Department of Environmental Protection
NJPDES	New Jersey Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
OSDS	On Site Disposal Systems (septic)
PCB	Polychlorinated byphenol
SBR	Statewide Basic Requirement
SVA	Stream Visual Assessment
SWMPT	Stormwater Management and Planning Tool
SWQS	Surface Water Quality Standards
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UGSI	Urban Green Stormwater Infrastructure
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOCs	Volatile Organic Compounds
WMA	Wildlife Management Area

Introduction

The Metedeconk River serves as an important regional source of drinking water supply and provides a significant amount of freshwater discharge to the Barnegat Bay estuary. It is the primary water supply source of the Brick Township Municipal Utilities Authority (BTMUA) which serves more than 100,000 residents within Brick Township, the Ramtown section of Howell Township, Point Pleasant Borough and Point Pleasant Beach Borough. From a drinking water perspective, the Metedeconk River has very good water quality to supply BTMUA's water treatment plant and raw water storage reservoir. However, the river has a number of water quality impairments that have been identified by the New Jersey Department of Environmental Protection. Increasing nitrogen loads, which are creating stress on the Barnegat Bay, and river flow changes are also major concerns. The Metedeconk River is classified as a Category One (C1) waterway due to its exceptional water supply significance.

The primary cause of these problems is stormwater runoff from developed areas. The amount of stormwater discharging to the Metedeconk River and its tributaries is increasing as development and directly connected impervious cover within the watershed increase. Because of the Metedeconk River's importance to the region, restoration efforts to address existing problems and mechanisms to ensure the long-term protection of this resource are needed.

The flow of the Metedeconk River is divided between the North and South Branches. Both branches are fed by dozens of tributaries within eleven sub-basins or HUC 14 watersheds, ranging in size from 5 to 11 square miles (**Figure ES-1**).

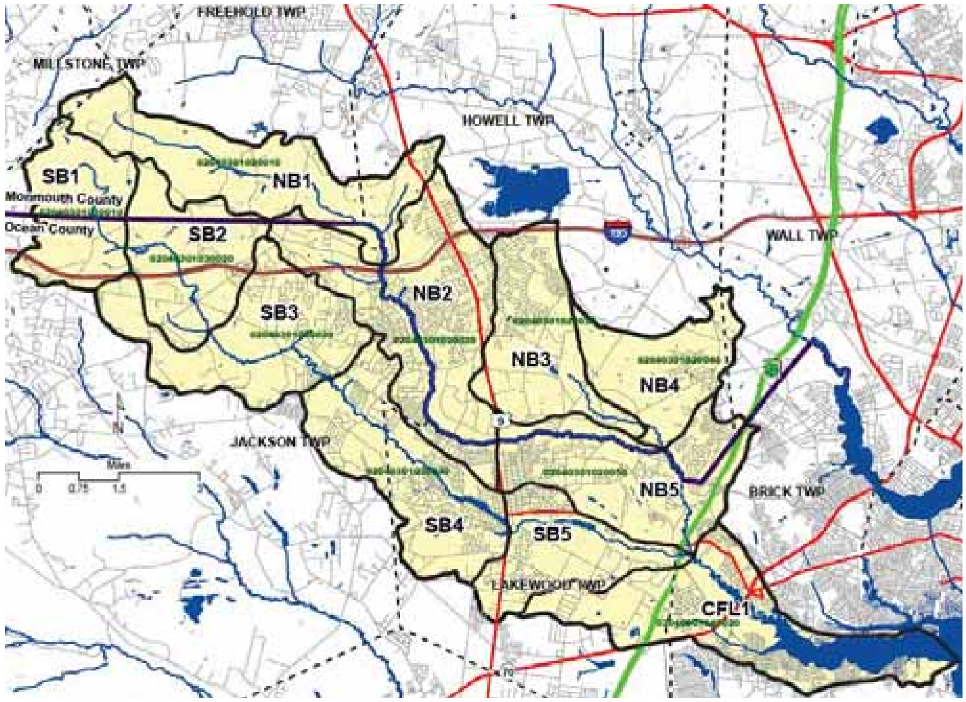


Figure ES-1 Metedeconk River watershed study area.

As the Metedeconk River is a vital resource for drinking water supply and the ecological health of Barnegat Bay Estuary, numerous studies of the Metedeconk River watershed have been carried out over the past 15 years with the last regional watershed analysis completed in 2000. These studies have characterized the water quality of the watershed as “good” and indicate that the watershed’s wetlands and coarse, sandy sediments as well as the largely intact riparian areas have helped offset the impacts of increased development, but note that continued development and increases in impervious cover could overwhelm this buffering capability.

Much progress has been made by the New Jersey Department of Environmental Protection (NJDEP) and the municipalities in managing stormwater within the watershed since the early watershed studies. In 2004, new stormwater regulations were adopted in New Jersey that specifically address water quality issues associated with stormwater. One set of regulations are the Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Regulation Program Rules (N.J.A.C. 7:14a), which established Statewide Basic Requirements (SBRs) that were to be implemented in an effort to reduce nonpoint source pollutant loads in stormwater. These apply to all municipalities that have municipal separate storm sewer systems (MS4s), as well as to public complexes (universities, etc.) and highway agencies. The municipalities are grouped by population into Tier A (larger and more densely populated) and Tier B municipalities. All of the Metedeconk River watershed municipalities fall into the Tier A category and must establish a stormwater pollution prevention plan as well as comply with the SBRs.

The Stormwater Management Rules (N.J.A.C. 7:8) were a second set of regulations adopted alongside the NJPDES stormwater rules. These rules require municipal stormwater management plans and ordinances and establish stormwater design standards for new development, including compliance with Category One riparian buffers. Procedures for implementing stormwater management plans under the Municipal Land Use Law are also included in the Stormwater Management Rules.

84-inch outfall discharging to the North Branch Metedeconk River at BTMUA sampling site NF14 in Lakewood

A important element of the Stormwater Management Rules is that all major development must meet a groundwater recharge requirement by either maintaining 100% of the average annual preconstruction groundwater recharge volume for the entire site, or infiltrating the increase in the stormwater runoff volume from pre-construction to post-construction of the two-year storm. In addition, the rules include a 300 foot riparian buffer for C1 waterways such as the Metedeconk River.

Although these regulations will help alleviate additional impacts from future development, much of the existing development within the Metedeconk River watershed is older and includes antiquated stormwater infrastructure. Direct discharge outfalls and detention basins are prevalent throughout the watershed. There is considerable opportunity for the installation of stormwater BMPs and other restoration projects to address existing problems.

Several focused task reports and memoranda were prepared to document the water resource issues facing the watershed and management strategies to address these issues.

This Plan was developed based on the culmination of a number of prior tasks as summarized on **Table ES-1**. The Plan is commissioned by the Brick Township Municipal Utilities Authority (BTMUA) with funding from the New Jersey Department of Environmental Protection (NJDEP). This Executive Summary provides an overview of the study findings and recommendations.

Water Resources Plan Goals

Working together with the Stakeholder Advisory Committee, which consisted of more than 100 individuals from all levels of government, academia, special interest groups, private sector and commercial establishments, and citizens within the watershed, the watershed management goals for this Plan were defined, along with more detailed and measurable objectives, as summarized on **Table ES-2**.

Table ES-1
Summary of Watershed Protection and Restoration Plan Task Reports and Memoranda

Task	Date Completed	Purpose/Contents
Task 1: Project Advisory Committee	January 2010	Develop a project Stakeholder Advisory and Steering Committee
Task 2: Stream Visual Assessments	July 2011	Stream Visual Assessment report which documents findings at 83 sites throughout the watershed.
Task 3: Technical Analysis	July 2011	Documents the technical evaluation of the watershed concerning land use, water use, water quality and major issues.
Task 4: Set Plan Objectives	September 2011	Sets the Plan goals and objectives based on input from the Stakeholder Advisory Committee
Task 5: Management Strategies	May 2012	Describes numerous management strategies/BMPs that can be applied throughout the watershed
Task 6: Education and Outreach	April 2012	Describes the education and outreach program for the Plan
Task 7: Develop and Implement Quality Assurance Project Plan (QAPP)	October 2012	QAPP for water quality sampling and pre- and post-BMP implementation monitoring
Task 8: Metedeconk River Watershed Protection and Restoration Plan	October 2012 (DRAFT)	Draft Plan
Task 8: Metedeconk River Watershed Protection and Restoration Plan	March 2013 (FINAL)	This document, incorporating stakeholder comments on the Draft Plan.

Table ES-2
Goals and Objectives for the Metedeconk River Watershed Protection and Restoration Plan

Goal 1: Provide a sustainable water supply to the human population while maintaining natural water regimes

Objective 1: Improve natural freshwater flows

Objective 2: Promote water conservation and implement water re-use demonstration projects on public properties

Goal 2: Maintain Category 1 designation and eliminate water quality impairments

Objective 1: Reduce stormwater flow via implementation of projects on public facilities and re-development projects

Objective 2: Reduce nitrogen, phosphorus, pathogens, tds and tss

Objective 3: Implement TMDLs

Objective 4: Prevent habitat loss and support habitat restoration within riparian buffers to preserve and improve regional biodiversity

Objective 5: Address data gaps for groundwater and tributary water quality

Objective 6: Protect and restore critical wildlife habitat and natural lands identified by NJDEP, TPL, Rutgers University, Ocean County Natural Lands Trust and others

Objective 7: Minimize health risks to recreational contact water users from pathogens

Objective 8: Improve soil health for biological, chemical and physical function; implement demonstration projects on public and/or priority properties

Objective 9: Identify multiple sources of funding for Plan implementation

Table ES-2
Goals and Objectives for the Metedeconk River Watershed Protection and Restoration Plan (cont'd)

Goal 3: Support the health of the Barnegat Bay

Objective 1: Reduce nitrogen, phosphorus, pathogens and tss
Objective 2: Reduce stormwater runoff to the bay
Objective 3: Provide passive recreational access
Objective 4: Protect natural shoreline buffers and open space; implement buffer setback

Goal 4: Improve the water quality of watershed lakes

Objective 1: Reduce pathogen and phosphorus inputs
Objective 2: Address invasive plant species and sediment accumulation

Goal 5: Promote education and outreach regarding watershed impacts from growth

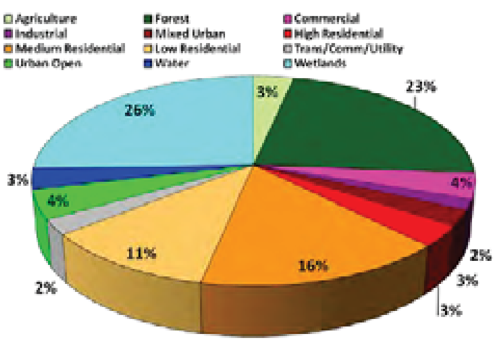
Objective 1: Enlist involvement and support of all levels of government, specifically municipal and/or county planning and zoning boards and environmental commissions, stormwater coordinators, DPWs, etc., for sustained effectiveness in managing watershed resources
Objective 2: Identify and encourage Low Impact Development standards appropriate for the Metedeconk basin
Objective 3: Promote cooperation among the development community, such as board of realtors, shore builders assoc., etc., involved in watershed development
Objective 4: Promote cooperation among various regulatory agencies involved in watershed resources and development
Objective 5: Support Smart Growth standards
Objective 6: Support open space planning and preservation
Objective 7: Work in concert with the Barnegat Bay Partnership and other organizations involved in education and outreach to: (1) expand the public's understanding of the watershed; (2) encourage public participation and support of improving watershed health; (3) promote public involvement in restoration activities
Objective 8: Increase public understanding of the Metedeconk watershed and the role the public plays in its health
Objective 9: Involve stakeholders in defining problems, objectives and solutions.

Watershed Characterization

Baseflow is critical to the Metedeconk River watershed as it provides nearly 70% of the total annual flow and 100% of the flow to the Metedeconk River during dry periods. As a percentage of total flow, baseflow has declined steadily since 1973. Although average annual discharge is generally stable (no trend in either direction), the baseflow component of average annual flow is declining. Since 1990, average annual baseflow as a percentage of total flow is just below 68%, as compared to 71% for the period evaluated for the North Branch in the Phase I Report (1973 to 1989). Since 2000, average annual baseflow as a percentage of total flow within the North Branch is just under 67%.

The decline in baseflow over the years is likely attributed to an increase in impervious cover, particularly since the annual total flow hasn't changed much (e.g., runoff component of flow is higher). An analysis of the land use change since 1995 has determined that overall impervious cover has increased from 12% in 1995/1997 to 15% in 2007.

As new development increases, the amount of impervious cover increases. This increase in impervious cover can result in stream flow changes, in that more discharge will be in the form of runoff as opposed to baseflow. Impervious cover has been correlated with changes in stream quality. In general, watershed percent impervious cover between 10-25% is considered "impacted"; 25-60% is considered "non supporting" and >60% is considered urban drainage (Schueler, 1995; CWP, 2003). Effects on the streams may include water quality issues as well as hydrologic impacts from increased impervious cover (channel stability, stream biodiversity).



Existing (2007) land use within the Metedeconk River watershed

The Metedeconk River watershed is already the most developed watershed within the Barnegat Bay watershed, and there are concerns that continued development and water quality degradation may negatively impact the Barnegat Bay. The land use pattern of the watershed is roughly half open space, and half developed area. Overall, the watershed is 23% forest, 26% wetlands, 3% water, 3% agriculture, and the remaining 45% urban land use based on 2007 NJDEP land use data. Much of the forest and wetlands are in the headwater areas which is a major benefit to water quality within the watershed.

In general, existing development increases downstream. The North Branch and South Branch Metedeconk River headwater sub-basins, NB1 and SB1 share a similar undeveloped makeup, containing extensive wetlands. Moving downstream, a marked jump in developed or urbanized area is seen in NB2 while the percentage of developed area increases more gradually progressing downstream on the South Branch through sub-basins SB2 through SB5.

However, sub-basins NB3 and NB4 do not follow the trend in development, as they drain tributary areas of the North Branch Metedeconk River which are not as densely developed.

Significant development within the watershed is planned over the coming years to accommodate a growing population. More than 18% of the watershed is developable, based on non-urban land use (2007) and existing zoning. With implementation of the NJDEP Stormwater Rules, new development will have to abide by much more stringent standards for managing stormwater runoff than was required in the past, when much of the watershed was developed. Nevertheless, with new high-density development there is an opportunity to explore innovative LID techniques and enhanced treatment methods for stormwater runoff.

Stream Visual Assessments

Stream visual assessments are commonly used by water resource managers to evaluate basic stream health. They are field evaluations of individual stream reaches, where observations of a stream's physical condition are documented and obvious problems are identified. Visual assessments can be incorporated into watershed planning projects to provide a better understanding of the issues affecting the watershed and more detailed information for restoration and protection activities.

A total of eighty-three (83) stream visual assessments were conducted throughout the Metedeconk River watershed during spring 2010 to support the development of a watershed protection and restoration plan (**Figure ES-2**). The visual assessments were performed in accordance with a Visual Assessment Project Plan and assessment protocol approved by the New Jersey Department of Environmental Protection.

A considerable amount of information was gathered during the visual assessments, including observations of the stream's physical condition, water quality appearance, riparian area, habitat, nearby land use types, stormwater infrastructure, utility facilities, and pollution sources. Each reach was scored on a 1-10 scale based upon a series of visual assessment indicators and categorized as Excellent, Good, Fair or Poor. The data from the visual assessments were entered into a custom database to facilitate accessibility, review and analysis.

Of the 83 visual assessments conducted, one (1) site ranked Excellent (1%), thirty-three (33) ranked Good (40%), thirty (30) ranked Fair (36%), and nineteen (19) ranked Poor (23%). The results show a relationship between degraded stream condition and more intense land development/alteration in the

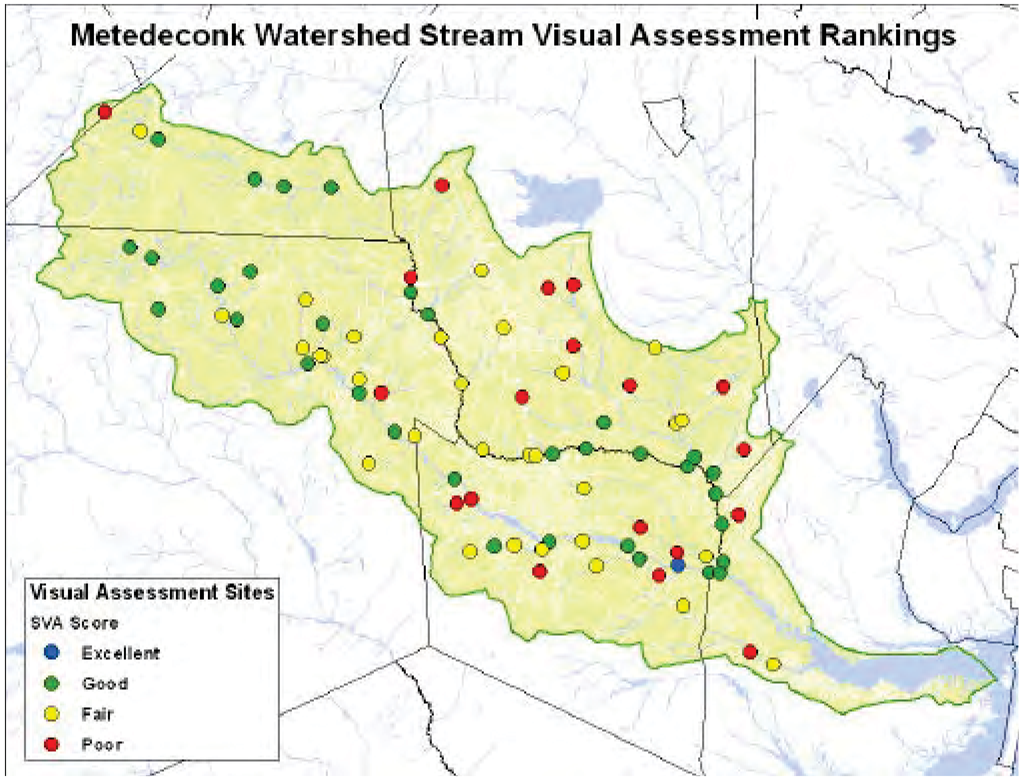


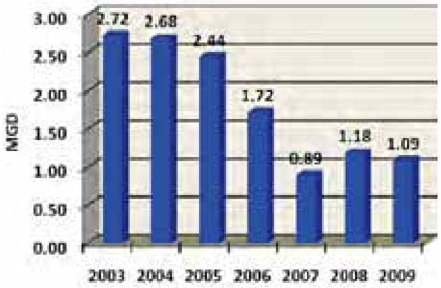
Figure ES-2 Stream Visual Assessment sites.

surrounding area. Smaller tributary streams were clearly more sensitive to local urbanization and stormwater inputs than the larger branches of the Metedeconk River. Some tributaries have undergone substantial streamflow changes, causing erosion and sedimentation problems and, in effect, making them part of the stormwater conveyance system. The assessment data suggests that natural riparian buffer and wetland areas have been beneficial in helping offset the impacts of urbanization on streams in many areas.

Very few clearly identifiable sources of pollution were documented at the assessment sites, which indicate that nonpoint source pollution is the primary cause of existing water quality impairments. Utility facilities located along the streams were found to be well maintained, though litter and dumping is a common problem. Antiquated stormwater infrastructure exists throughout the watershed involving direct discharge outfalls and detention basins providing little to no treatment of stormwater runoff.

Water Supply

There are currently four primary water purveyors within the Metedeconk River watershed: Brick Township Municipal Utilities Authority, Lakewood Township Municipal Utilities Authority, Jackson Township Municipal Utilities Authority,



Average annual pumpage from the Kirkwood-Cohansey aquifer system: 2003-2009.

and New Jersey American Water Company. All of these purveyors utilize groundwater for potable supply, although most of the BTMUA potable supply comes from the Metedeconk River.

Within the watershed, there are 23 community supply wells that are screened within the Kirkwood-Cohansey aquifer system that are either within or immediately adjacent to the watershed. Pumpage from the Kirkwood-Cohansey aquifer system shows declines over recent years, largely due to less groundwater withdrawals by BTMUA. However, the wells are used as needed and they remain an important source of water for the utility. BTMUA also owns and operates an 860-million gallon reservoir located on the border of Brick and Wall Townships as well as an aquifer storage and recovery (ASR) well.

Agricultural water use is not well documented. Only three farms within the watershed are registered with NJDEP and just one uses groundwater. There are more than 400 agricultural parcels within the watershed. As NJDEP requires registration for users which withdraw more than 100,000 gallons per day or 70 gpm, it appears that many of the users pump less than this amount. The cumulative withdrawal may be significant and should be further evaluated.

A reduction in shallow groundwater pumping over recent years should, in theory, result in higher baseflow to the Metedeconk and its tributaries. However, baseflow continues to decline despite the reduced groundwater pumpage, potentially due to increases in impervious cover.

One of the goals of this Plan is to provide a sustainable potable water source while maintaining natural flow regimes. More than 150,000 people live within the Metedeconk River watershed and receive drinking water from either groundwater or surface water. Water supply is a concern for the Metedeconk watershed. The New Jersey Statewide Water Supply Plan projects significant water supply deficits for the Metedeconk watershed based upon population growth and build-out projections. Options offered in the Water Supply Plan (1996) to help alleviate these concerns include managing the use of surface and groundwater water supplies to maximize availability (conjunctive use), aggressive water conservation programs, development of reservoir storage, and development of aquifer storage and recovery (ASR) well facilities to store water underground during low demand periods for later recovery during high demand periods. Since the 1996 Water Supply Plan was released, several water purveyors in the watershed have developed ASR facilities, and the Brick Township Municipal Utilities Authority completed construction of the 860 million gallon Brick Reservoir in 2004. The NJDEP is currently working on an updated statewide water supply plan.

Much of the water use in the watershed is depletive in nature, as wastewater is collected, treated and discharged to the Atlantic Ocean. During summer 2010, numerous water utilities in the region, including BTMUA, experienced record water demands, and a statewide drought watch was issued by NJDEP. Water conservation programs are recommended. Future water supply needs of Lakewood Township will be significant and a water supply plan for its build-out has not yet been developed.

Significant water quality issues are summarized below, as part of a description of how this Plan includes the USEPA's nine watershed plan components.

USEPA Watershed Plan Components

This plan has been developed using guidance published in the USEPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA, 2005) and can be utilized by municipalities and other stakeholders as a reference to identify impairments to the watershed, develop mitigation and protection measures, and help guide future policy. As such, this plan includes the USEPA's nine minimum components of watershed plans.

***Component A*: Identify causes and sources or groups of sources that need to be controlled to achieve load reductions and prioritized ranking of sources on subwatershed and site-specific perspective.**

The Metedeconk River Watershed is currently listed on the New Jersey 2010 303(d) list of water quality limited waters for one or more of the following parameters: dissolved oxygen, temperature, TSS, phosphorus, arsenic, and mercury. In addition, the pesticides DDD, DDE and DDT are listed as impairments within NB1 and polychlorinated byphenyls (PCBs) are listed as impairment in SB3. More imperatively, multiple Total Maximum Daily Loads (TMDLs) have been established by NJDEP to address pathogen and phosphorus impairments for which stormwater is the primary source of the impairments.

Nutrients and pathogens are the pollutants of greatest concern in the Metedeconk River Watershed. There are several anthropogenic sources of nutrients to the river, and the most prominent are stormwater runoff of fertilized residential and commercial landscapes, groundwater discharge which receives nitrogen and phosphorus loading from septic systems in unsewered areas, and fertilization and other activities from agricultural land uses. Nitrogen and phosphorus are understood to be the limiting nutrients for eutrophication of the Barnegat Bay estuary and the freshwater streams of the Metedeconk River watershed, respectively. The recently passed Statewide Fertilizer Law should reduce nitrogen and phosphorus loads within the watershed over time.

Elevated concentrations of pathogens threaten the recreational usage of the watershed streams and lakes and the consumption of shellfish from the estuary. Pathogen concentrations, as indicated by fecal coliform, enterococci and Escherichia coli (E. coli) counts are consistently elevated throughout the watershed, enough to warrant multiple TMDLs.

The only confirmed source of pathogens in the Metedeconk watershed is geese. Various livestock operations exist in the watershed such as horse farms and pasturelands, some with close proximity to streams. Cattle access to streams does not appear to be an issue in the watershed as no known occurrences have been reported. However runoff from these farms has high potential to contribute pathogen loading to the streams. Additionally, the application of manure to croplands should be identified and characterized to address this potential source.

Total suspended solids (TSS), although only causing a documented impairment in one sub-basin, is a surrogate for other pollutants since it carries nutrients, pathogens, metals and other pollutants with it. Other water quality parameters, such as pH, temperature, BOD, dissolved oxygen, and VOCs indicate generally normal conditions, although impairments for temperature and dissolved oxygen are included in the New Jersey Integrated Water Quality Monitoring and Assessment Report.

Dissolved oxygen has violated the NJ Surface Water Quality Standards (SWQS) on a number of occasions on both the North and South Branch in which several samples have shown levels below 4 mg/L. Interestingly, the most undeveloped sub-basin, NB1, has the most impairments identified on the 303(d) list and is the only sub-basin that the phosphorus TMDL is applicable (potentially due to wetlands and heavy fertilization from surrounding low density residential and agricultural land uses).

Arsenic is in violation of SWQS at most locations but not drinking water standards. The lowest SWQS for arsenic for FW2 waters is 0.017 ug/L (for human health); although the New Jersey drinking water standard for arsenic is 5 ug/L. Available data from the USGS in 2006 indicate that total arsenic concentrations are between 0.3 and 0.52 ug/L within the North Branch (01408100 North Branch Metedeconk River at Lakewood NJ) and 0.25 to 0.57 ug/L within the South Branch (01408152 SB Metedeconk River near Laurelton NJ) which is generally consistent with concentrations recorded by BTMUA. The cause of the arsenic in the Metedeconk could be from both natural and anthropogenic sources.

Lead and turbidity have been added to several of the subwatersheds based on the draft 2012 303(d) list of water quality limited waters. Note that dissolved oxygen has been de-listed from all subwatersheds on the draft 2012 303(d) list. Also, arsenic has been de-listed as an impairment from several watersheds as well.

Component A is more thoroughly addressed in Section 3.2. A more detailed list of pollutants of concern by subbasin and their sources can be found in **Table 3-13**.

<u>Component B</u>: Estimates of pollutant load reductions on a HUC14 basis. Management practices will be selected.

Land Cover	TP load (lbs/acre/yr)	TN load (lbs/acre/yr)	TSS load (lbs/acre/yr)
High, Medium Density Residential	1.6	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/Transitional Area	0.5	5	60

Unit area loads for total phosphorus (TP), total nitrogen (TN) and total suspended solids (TSS; from NJDEP BMP Manual).

Loading estimates were calculated for the Metedeconk River watershed for total nitrogen, total phosphorus and total suspended solids using NJDEP unit area loads. This approach was also used for the development of the total phosphorus TMDL in NB1.

Nitrogen loading from the Metedeconk River accounts for more than 21% of the total nitrogen load to the Barnegat Bay-Little Egg Harbor Estuary (Weiben and Baker, 2009).Watershed nitrogen loads were analyzed on a total annual load and an annual load per acre basis. The annual load of nitrogen to the Metedeconk is approximately 364,000 lbs (165,107 kg). The largest percent is from sub-basin NB2, which contributes an annual load of 59,300 lbs, which is 16 percent of the total load. NB2 is the largest sub-basin; however, it ranks fourth in the nitrogen load per acre at 8.54 lbs per acre. It is above the watershed wide average of 7.27 lbs per acre. Sub-basin NB5 contributes the most nitrogen per acre with an annual load per acre of 9.65 lbs. NB5 is a highly impervious sub-basin. The predominant land use in sub-basin NB5 is medium density residential.

The USGS estimates nitrogen load to Barnegat Bay from the Metedeconk River is 86,000 kg/yr based on flow and concentration data within the river (189,597 lb/yr; Weiben and Baker, 2009). This would indicate that approximately 48% of the surface nitrogen load as calculated by the Unit Area Load analysis is lost through denitrification and vegetative uptake.

Watershed phosphorus loads were analyzed on a total annual load and an annual load per acre basis. The annual load of phosphorus to the Metedeconk is approximately 31,000 lbs. The largest percent is from sub-basin NB2, which contributes an annual load of 5,400 lbs, which is 17 percent of the total load.

Total phosphorus load was calculated as 1,686 lb TP/year in NB1. The TMDL calculated total phosphorus load is approximately 1,572 lb TP/year. However,

Solids along Pine Street in Lakewood

HUC	Load Reduction (lb/yr)		
	Nitrogen	Phosphorus	TSS
NB1	5,358	1,067	158,844
NB2	25,199	4,339	446,157
NB3	12,093	2,083	217,045
NB4	5,858	1,091	144,841
NB5	21,258	3,567	341,680
SB1	1,979	398	62,894
SB2	4,730	861	103,529
SB3	11,072	1,981	222,902
SB4	17,953	3,040	299,261
SB5	12,220	2,025	187,754
CNFL1	21,116	3,496	318,951

1995/1997 land use/land cover was used for that analysis. The small increase in phosphorus load in that watershed can be attributed to the increase in development that has occurred since 1995/1997.

Due to the amount of development within CFL1, this sub-basin has the second highest nutrient (N, P) load within the Metedeconk River watershed. This sub-basin discharges directly to the Barnegat Bay, making nitrogen loading a significant concern.

Total suspended solids (TSS) loading was calculated throughout the watershed using the TSS unit area loads in the NJ BMP Manual. However, besides these land use based loads, another source of TSS is the stream banks. As higher flows move through the river and streams, easily erodible banks can contribute significant TSS to the water column. In addition, utilizing unit area loads does not account for soil erodibility.

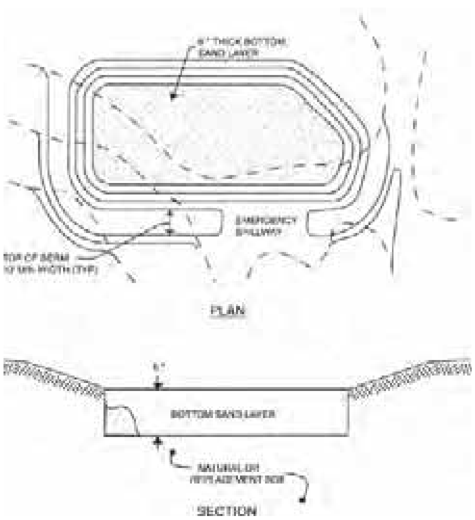
Fecal coliform loading was calculated for the Metedeconk River fecal coliform TMDL. All HUC14 subwatersheds besides SB1 and CFL1 were included in the TMDL.

In order to reduce pollutant loads, the volume of stormwater reaching stream system must be reduced, particularly for smaller, more frequent storms such as the stormwater quality design storm of 1.25-inches of rainfall over two hours.

Runoff volume is best treated through infiltration BMPs which reduce the volume reaching the stream and improve groundwater recharge. These are particularly effective in the sandy soils of the watershed and where depth to the water table is sufficient to allow for infiltration of the collected stormwater. When infiltration capacity has been maximized, extended detention type BMPs, including variations of dry ponds, wet ponds, and wetlands, provide runoff volume control. These BMPs attenuate not just peak flows, but also regulate the magnitude and timing of flows reaching the stream channel, and provide water quality treatment.

Target load reductions have been calculated for each sub-basin with regard to nitrogen, phosphorus and total suspended solids. For pathogens, load reductions from the fecal coliform TMDLs were utilized which call for between 90-99% reductions. The highest target load reduction for nutrients and TSS are within NB2.

To achieve the required load reductions, antiquated stormwater infrastructure should be retrofit with management strategies that provide treatment of the stormwater prior to discharge to the stream. One of the priority strategies is private property BMPs, such as rain gardens and rain barrels, which will reduce



Infiltration Basin (from NJ BMP Manual)

the amount of runoff that is generated from each parcel and can be retrofitted into any pre-existing development. Private property BMPs along with urban green stormwater infrastructure (infiltration tree trenches, etc.) are critical in areas that have direct discharge outfalls with little or no room to retrofit a larger BMP to treat all of the stormwater that discharges from that outfall. Controlling the stormwater at the source through private property BMPs and other stormwater infrastructure throughout a development will be critical in limiting the amount of stormwater that reaches the outfall.

Calculations of pollutant loads and required reductions are more thoroughly in Sections 3.4 and 4.2, respectively.

<u>Component C</u>: The plan should describe the management measures that need to be implemented to achieve the load reductions estimated under element b, as well as to achieve any additional pollution prevention goals called out in the watershed plan (e.g., habitat conservation and protection).

A number of management strategies have been identified in the Task 5 Memorandum, *Management Strategies*, but are also summarized in Section 4 as well as in Appendix C. General management strategies by subbasin are listed and prioritized in **Table 5-2** and a list of individual projects, as identified by the stakeholders within the watershed, are included in **Table 5-3**. Implementation of the various management strategies is described in Section 5.

The existing TMDLs need to be implemented. Management strategies that are recommended to achieve the pathogen and phosphorus TMDLs (as specified by the TMDLs) include agricultural BMPs, urban stormwater BMPs and retrofits, geese management plans, enforcement of existing pet waste ordinances, riparian buffer restoration, the identification and elimination of sewage conveyance facilities failures, and addressing inadequate on-site sewage disposal. Enforcement of the recently passed Statewide Fertilizer Law should significantly reduce phosphorus loading to the watershed.

To address the loadings of sediment, nutrients, and pathogens from impervious areas and restore watershed hydrology, six primary strategies are recommended. These strategies are aimed at working with and retrofitting existing failing structures to the fullest extent possible and meet the primary objectives of the stakeholders (namely water quality improvement and the promotion of infiltration to restore the baseflow component of the river). The application of each depends on various factors including density of development, available open space, ownership, presence of existing stormwater basins, and proximity to streams:

1. Retrofit existing stormwater detention basins;

2. Install structural BMP at existing direct outfalls;
3. Source control and flow path BMPs;
4. Resource conservation and protection;
5. Development of ordinances to require LID development techniques on all new and redevelopment within the watershed; and
6. Education and outreach.

A number of site specific projects have been identified by the project team and the stakeholders within the watershed. These projects, and each of the sub-basins, have been prioritized so that a list of projects is readily available for implementation as funds become available. The highest priority is given to the TMDLs, as they have yet to be implemented.

Conceptual-level designs have been developed for five high priority implementation projects. The projects include the retrofit of basins, direct outfalls, and impervious areas (e.g. roads and parking lots) with stormwater Best Management Practices (BMPs) to increase groundwater recharge, reduce runoff and nonpoint source pollution, and improve water quality. These demonstration projects address the most common watershed problems and are intended to serve as models that can be replicated in other areas throughout the Metedeconk basin.

Water supply within the Metedeconk River watershed is a concern. Significant development is planned within the watershed in the coming years, particularly in Lakewood Township. A water supply plan for the build-out of each municipality should be developed so that potential impacts can be quantified. In addition, water conservation programs should be identified and implemented to help offset peak demands. These conservation programs can be in the form of rate structures (which can also be used to fund watershed programs), odd/even irrigation days, promotion of low maintenance/drought tolerant landscaping and the development of an education and outreach program. Water re-use projects can also be evaluated.

The baseflow component of the total flow within the Metedeconk River has been declining over the past few decades. Total flow, however, has remained fairly constant, indicating that the runoff component of flow has increased, primarily due to an increase in impervious cover and a lack of infiltration-type BMPs. Antiquated stormwater infrastructure should be retrofitted where possible to allow for infiltration type BMPs. Uniform design standards should be developed for stormwater BMPs within the watershed.

In order to refine basin retrofit prioritization, a watershed-wide stormwater basin survey, expanding upon the existing Stormwater Management and Planning Tool (SWMPT), should be established. Priorities for retrofit should be given to basins on public land, those that have already been identified as restoration candidates in SWMPT and/or those which support TMDL implementation.

The long term maintenance responsibility of each basin should ultimately be clarified as should funding mechanisms to provide the necessary inspections and maintenance. In order to help ensure that basins and other stormwater infrastructure is maintained, a unified, legally defensible basin maintenance ordinance should be developed. A standard maintenance costing analysis should be undertaken to determine the actual costs and insure that there will be adequate funds to properly maintain the systems over the long term. Stormwater infrastructure information should be uploaded to a unified database where maintenance of the basins can be tracked.

Drainage areas to direct discharge outfalls should be determined and those having the largest drainage areas should be prioritized. The outfalls should be retrofitted with infiltration type BMPs to the fullest extent practical, but where space limitations occur, upstream pre-treatment strategies such as green stormwater infrastructure and private property BMPs should be utilized to the fullest extent practical. Many of the smaller infiltration type BMPs such as rain gardens and pervious pavement can be implemented in areas with larger amounts of impervious cover, such as commercial shopping centers and industrial complexes.

Although NJDEP's Stormwater Rules will help alleviate future impacts from additional development, Metedeconk watershed-specific low impact development (LID) standards should be developed to enhance protection of the watershed. The standards should be implemented through LID ordinances adopted at the local level and applied to new and re-development. Lakewood Township will be the focus of much development over the next 20 years, and green infrastructure/LID demonstration projects as well as urban watershed education projects will be beneficial. As per the date of this Plan, a Stormwater Management Plan and stormwater control ordinance has not been adopted in Jackson Township. This presents a good opportunity to include more progressive LID techniques into the management plan and ordinance.

In order for the flow characteristics of the Metedeconk River to be monitored for both the North and South Branches, both existing USGS stream gages should continue to be funded so they remain operational.

Although high density septic systems are not common throughout most of the watershed, there are a few areas where sanitary sewer should be extended. These areas include:

Route 88

- Areas of Lakewood Township in the southwest portion of the watershed (currently outside approved sewer service area, but additional development is being approved);

- Route 88 corridor in Lakewood Township;

- Residential areas around Lake Enno in Jackson Township; and

- Freewood Acres section of Howell Township.

Agricultural land uses have been identified as potential sources to pollutant loads to the Metedeconk River. BMPs should be implemented at stream-side agricultural operations where appropriate/feasible.

Resource conservation and protection was identified as the most effective management strategy for meeting the objectives of this Plan. A number of properties have been identified by the Trust for Public Land for protection and restoration. These parcels, as well as riparian areas identified by Rutgers University, should be targeted for acquisition and/or restoration.

As the Metedeconk River watershed provides the second largest contribution of freshwater to the Barnegat Bay estuary and is also the most developed sub-watershed within the Barnegat Bay watershed, problems in the Metedeconk watershed will carry into the Barnegat Bay estuary. Conversely, improvements made within the Metedeconk watershed will also carry over to help improve the Barnegat Bay estuary.

Several outfalls have been identified along the shoreline of the estuarine portion of the Metedeconk River within CFL1. The drainage areas to these outfalls should be determined and BMPs prioritized so that stormwater loading to the bay is minimized. Projects may involve the implementation of BMPs at or near the outfall, or more widespread implementation of decentralized private property BMPs to reduce runoff at the source. These management strategies should be targeted to reduce nitrogen loading to the fullest extent practical.

The existing surface water quality standard for floatables is violated at a number of sites throughout the watershed. There are many catch basin inlets which have not been retrofitted to reduce floatables and other trash from entering the inlet and ultimately the streams. All catch basins should be retrofit, with a priority placed on those located along major roads and highways or otherwise known to be problematic (e.g. Route 9, sites identified in the stream visual assessments).

Water quality of the watershed lakes should be improved through the implementation of lake TMDLs and BMPs to reduce sediment and other pollutant loads to the lakes. Lake management activities such as dredging and lake lowering for nuisance aquatic plant control should continue. In some cases, more comprehensive lake restoration efforts are needed. The presence of Hydrilla, a recently identified and particularly noxious invasive aquatic plant, should be further evaluated to determine its extent within the watershed.

Component D: Sources of technical and financial assistance with overview of programs available.

Without funds, this Plan will not be able to be effectively implemented. Funding sources should be fully evaluated. Grant funding should be sought, but feasibility studies should also be conducted to evaluate other potential funding strategies, such as source water protection fees from water purveyors or the establishment and implementation of a stormwater utility. Shared service opportunities should also be evaluated in order to offset maintenance costs.

A fiscal analysis containing a description of funding sources and various programs is contained within Section 5.4. General cost estimates for various management strategies are included in Appendix C.

Component E: The plan should include an information and education (I/E) component that identifies the education and outreach activities or actions that will be used to implement the plan. These I/E activities may support the adoption and long-term operation and maintenance of management practices and support stakeholder involvement efforts.

Education and outreach is critical to the success of this Plan and the restoration and protection of the Metedeconk River watershed. A comprehensive education and outreach program was created as a key component of the Metedeconk River Watershed Protection & Restoration Plan. The program identifies target audiences and outreach actions. For example, targeted outreach to municipal planning and zoning boards about the importance of stormwater management and BMPs was identified as a concern during the planning process. Such outreach would lead to better informed decision making about future developments.

A full education and outreach program is included as Appendix E.

Component F: You should include a schedule for implementing the management measures outlined in your watershed plan. The schedule should reflect the milestones you develop in Component G

A schedule for Plan implementation is included as **Figure ES-3**. This schedule depicts activities over a period of greater than 10 years. Short term measures are included, some of which can be implemented immediately. Many of the mid and long-term measures will be dependent on funding. Full implementation of the Plan may take much longer than 10 years, depending on the rate at which funds can be obtained.

A schedule of activities can be found in Section 5.5.

<u>Component G</u>: Develop interim, measurable milestones to measure progress in implementing the management measures for your watershed plan.

Although BTMUA has spear-headed this watershed protection and restoration plan, implementation of the Plan will require a commitment from all stakeholders within the watershed. The Stakeholder Advisory Committee and Steering Committee that guided the development of this Plan has been invaluable. In order for the implementation of this Plan to consistently move forward, it is recommended that a Metedeconk River Watershed Committee be established to oversee the implementation of the Plan and make recommendations on projects to be prioritized and funded in the coming years.

The existing committees serve as an excellent starting point for the implementation committee. It is anticipated that this committee would have quarterly to semi-annual meetings to discuss the implementation of the Plan, identify projects, and prioritize land parcels that should be acquired through discussions/collaboration with existing open space preservation programs. A second committee should be established to focus on education and outreach.

The effectiveness of plan implementation should be continually monitored to assess progress in the restoration and protection of the Metedeconk River watershed.

Implementation matrices have been developed for each Watershed Plan Goal which can be used by the Watershed Committee to monitor plan implementation and track milestones.

<u>Component H</u>: As projects are implemented in the watershed, you will need water quality benchmarks to track progress; and

<u>Component I</u>: Monitoring program

The overarching water quality objective of the plan is to achieve in-stream water quality improvements. New Jersey's Surface Water Quality Standards (N.J.A.C. 7:9b) and the impairment status of the waterways in the Metedeconk basin will be used as the water quality benchmarks to track progress towards meeting the plan's water quality objectives. A number of recommended monitoring metrics and a monitoring program are summarized in Section 5.3. These metrics include in-situ (temperature, dissolved oxygen, pH, specific conductance), discrete (total phosphorus, total nitrogen, TSS, fecal coliform and E.Coli), hydrology (water demand, stream flow) and biological metrics (macroinvertebrate surveys). Existing quarterly water quality monitoring along the main stems should continue.

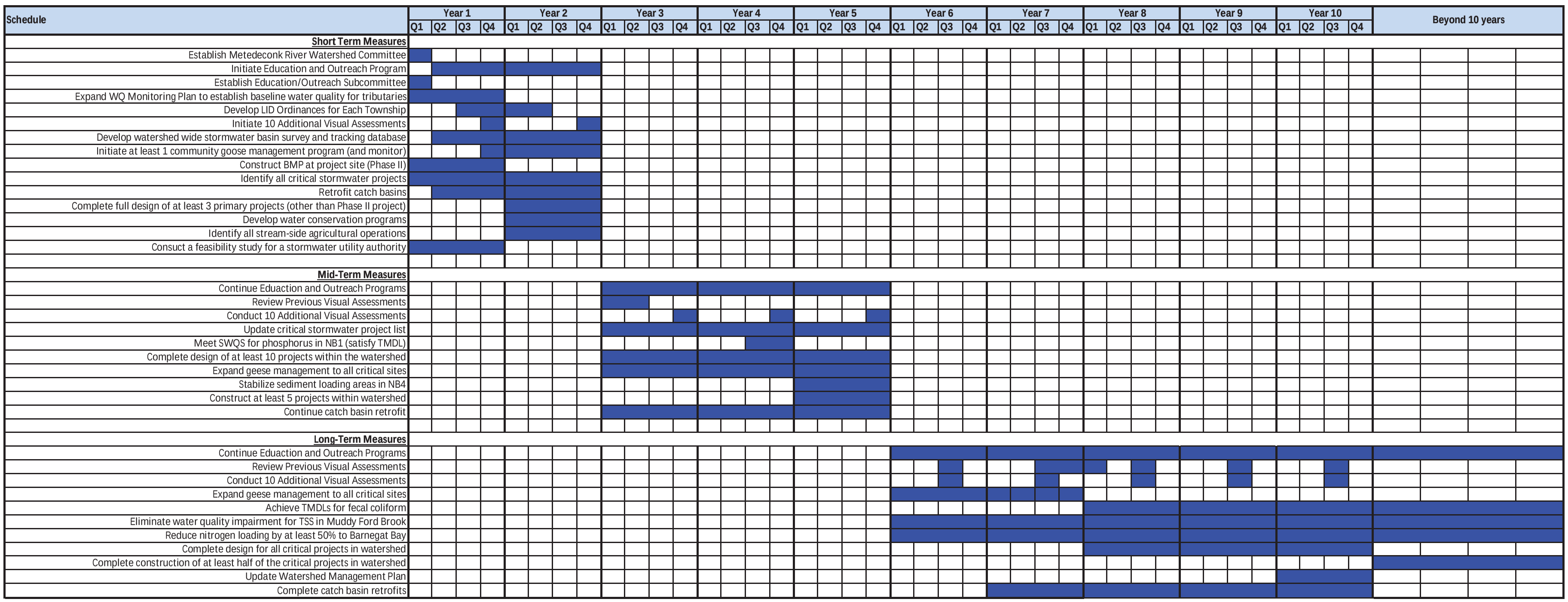
Water quality data along the tributaries is somewhat sparse and a baseline water quality database should be developed for representative tributaries in the watershed. Water quality samples should be collected along the tributaries upstream of the confluence between the tributary and the main stem. At a minimum, samples should be collected quarterly and evaluated for the following set of parameters:

- Field parameters (pH, temperature, specific conductance/tds);
- Dissolved oxygen;
- Nitrogen (nitrate/nitrite as nitrogen, ammonia, TKN);
- Phosphorus;
- Total suspended solids; and
- Pathogens (total coliform, fecal coliform, E. Coli).

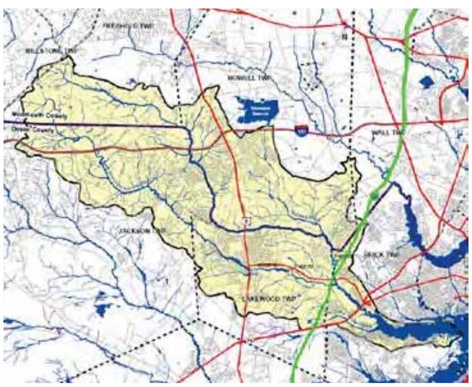
The stream visual assessments conducted as part of this Plan were very effective and extremely useful to help understand many of the problems throughout the watershed. Additional stream visual assessments should be conducted at the rate of 10 per year. In addition, all SVA sites should be re-inspected on a 5 year basis to compare conditions. Full SVAs may not be necessary, but at a minimum a photographic database should be maintained. Inspections should occur during the late autumn or early winter periods so that vegetative growth is minimized and visibility of stream conditions is adequate.

Monitoring data and stream visual assessment results should be readily accessible to the NJDEP and watershed stakeholders. The NJDEP's Water Quality Data Exchange would be the most appropriate means of sharing this information.

Figure ES-3
Proposed Implementation Schedule



Section 1
Introduction



County	Municipality	Area in Watershed (mi^2)	Percent of Municipality in Watershed	Percent of Watershed
Monmouth	Howell Twp.	20.51	33%	26%
	Freehold Twp.	10.45	27%	13%
	Millstone Twp.	0.17	0%	0.2%
	Wall Twp.	0.34	1%	0.4%
	Total in Monmouth	31.47		40%
Ocean	Jackson Twp.	21.48	21%	27%
	Lakewood Twp.	17.36	69%	22%
	Brick Twp.	8.01	25%	10%
	Total in Ocean	46.84		60%

Municipalities within the Metedeconk River watershed

The Metedeconk River watershed encompasses approximately ninety square miles in southern Monmouth and northern Ocean Counties. The freshwater area of the watershed consists of nearly seventy eight square miles and includes seven municipalities within its boundary. Almost the entire freshwater portion of the watershed is included within five municipalities, namely Brick, Freehold, Howell, Jackson and Lakewood Townships. Millstone and Wall Townships make up less than 1% of the watershed area.

The Metedeconk River is an important resource to potable water supply as well as to the Barnegat Bay Estuary. It is the primary water supply source of the Brick Township Municipal Utilities Authority (BTMUA) which serves more than 100,000 residents within Brick Township, the Ramtown section of Howell Township, Point Pleasant Borough and Point Pleasant Beach Borough. The Metedeconk River provides the second highest discharge of fresh water to the Barnegat Bay Estuary, second only to Toms River. It is considered by NJDEP as a waterway with "exceptional water supply significance" and as such was designated a Category One (C1) waterway in 2004. As a C1 waterway, it is protected from any measureable degradation in water quality (Surface Water Quality Standards rules at N.J.A.C. 7:9B).

As the Metedeconk River is a vital resource for drinking water supply and the ecological health of Barnegat Bay Estuary, numerous studies of the Metedeconk River watershed have been carried out over the past 15 years. These studies have characterized the water quality of the watershed as "good" and indicate that the watershed's wetlands and coarse, sandy sediments as well as the

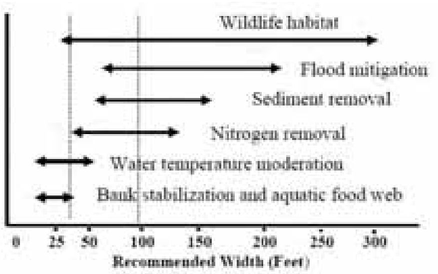
largely intact riparian areas have helped offset the impacts of increased development, but note that continued development and increases in impervious cover could overwhelm this buffering capability. In addition, these studies have identified that water quality issues within the river are primarily due to impacts from stormwater runoff.

Much progress has been made by the municipalities in managing stormwater within the watershed since the early watershed studies. In 2004, new stormwater regulations were adopted in New Jersey that specifically address water quality issues associated with stormwater. One set of regulations are the Phase II New Jersey Pollutant Discharge Elimination System (NJPDES) Stormwater Regulation Program Rules (N.J.A.C. 7:14a), which established Statewide Basic Requirements (SBRs) that were to be implemented in an effort to reduce nonpoint source pollutant loads in stormwater. These apply to all municipalities that have municipal separate storm sewer systems (MS4s), as well as to public complexes (universities, etc.) and highway agencies. The municipalities are grouped by population into Tier A (larger and more densely populated) and Tier B municipalities. All of the Metedeconk River watershed municipalities fall into the Tier A category and must establish a stormwater pollution prevention plan as well as comply with the SBRs.

The Stormwater Management Rules (N.J.A.C. 7:8) were a second set of regulations adopted alongside the NJPDES stormwater rules. These rules require municipal stormwater management plans and ordinances and establish stormwater design standards for new development, including compliance with Category One riparian buffers. Procedures for implementing stormwater management plans under the Municipal Land Use Law are also included in the Stormwater Management Rules.

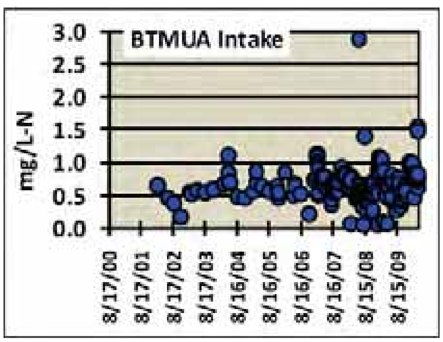
An important element of the Stormwater Management Rules is that all major development must meet a groundwater recharge requirement by either maintaining 100% of the average annual preconstruction groundwater recharge volume for the entire site, or infiltrating the increase in the stormwater runoff volume from pre-construction to post-construction of the two-year storm. As the runoff component of total flow in the Metedeconk River has been increasing over the years (attributed to increasing impervious cover), this rule will help stabilize this trend and prevent additional loss of baseflow from new residential development.

The Stormwater Management Rules also require a 300 foot riparian buffer area (special water resource area) around Category One (C1) waterways. This buffer was established in an effort to protect the water quality, aesthetic value, exceptional ecological significance, exceptional water supply significance, and exceptional fisheries significance of the Category One water. The 300 foot buffer rule was motivated in part to protect the wildlife habitat that is characteristic of the high quality and sensitivity of a Category One waterway. It also provides a factor of safety to ensure the future water quality of the water supply. Only in rare instances is any disturbance within the C1 buffer area permitted. Since the Metedeconk River has been designated a C1 waterway, it is afforded this greater level of protection.



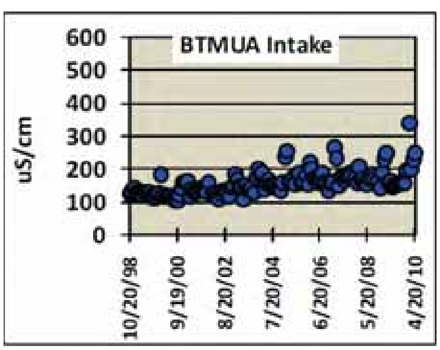
Minimum Required Width for a Riparian Buffer and the Associated Function (from: United States Department of Agriculture Forest Service 2003)

Despite the progress that has been made, stormwater remains a significant issue and continues to impact the Metedeconk River as well as the Barnegat Bay (approximately 71% of non-point source pollution in the bay is attributed to stormwater according to the Barnegat Bay 2020 Report). Much of the existing stormwater infrastructure and development within the Metedeconk River watershed pre-dates stormwater regulations and antiquated infrastructure with outfalls directly discharging stormwater to streams is common throughout. Maintenance of both existing and newly installed stormwater infrastructure remains a concern moving forward.



Nitrate (as nitrogen) concentrations measured at BTMUA intake over time.

The percent of impervious cover within the watershed continues to increase, from 12% in 1995 to 15% in 2007, using the project area HUC14s (freshwater portion of the watershed). Since 1995, most of the development has occurred in Jackson, Howell and Lakewood Townships. The highest intensity of development is found in Lakewood, accounting for the largest relative increase in high density residential, commercial and industrial land uses. Lakewood is also projected to be the largest growing municipality within the watershed by far, in which 26,000 new residential units are projected within the next twenty years (T&M Associates, 2009). Any potential impacts to the Metedeconk River will need to be properly managed if the goals and objectives of this plan are to be met.



Specific conductance data at BTMUA intake showing an increasing trend.

Impacts resulting from stormwater are beginning to be evident in water quality and stream flow characteristics. Increasing trends in stream conductance, total dissolved solids (TDS) and other water quality indicators are present as well as an increasing trend in the runoff component of total flow. Impacts are also being visually observed as nearly 60% of 83 sites visited as part of a Stream Visual Assessment (SVA) classified as either fair (36%) or poor (23%).

Though the overall surface water quality is good with respect to drinking water maximum contaminant levels (MCLs), nitrogen has been increasing over the years and concentrations exceeding 1.5 mg/L have been detected at the BTMUA intake. Increases in nitrogen are also observed moving downstream throughout the watershed as additional development contributes to the cumulative nitrogen load to the river. While nitrogen concentrations are well below drinking water standards (MCL is 10 mg/L for nitrate as N, which is also the

84-inch outfall discharging to the North Branch Metedeconk River at BTMUA sampling site NF14 in Lakewood

surface water quality standard for FW2 waters), concentrations are excessive with regard to the Barnegat Bay because nitrogen is the main limiting nutrient for primary production (e.g., algae growth). It has been noted in previous studies that eutrophication in the bay is worse near the Metedeconk River than in the southern, less developed portions of the Barnegat Bay watershed (TPL, 2008). The Toms River and Metedeconk River basins account for more than 60 percent of the nitrogen load to the estuary from surface water runoff (Wieben and Baker, 2009).

Total Maximum Daily Loads (TMDLs) have been developed for the watershed for fecal coliform, phosphorous, pathogens and total coliform. A TMDL for mercury in fish tissue also exists, although the cause of the impairment is air deposition and the source is likely outside of the watershed. Stormwater has been identified as the primary mechanism for pollutant loading within the TMDLs. In addition, there are several parameters listed on the New Jersey 2010 303(d) List of Water Quality Limited Waters (as well as the draft 2012 303(d) List) which need to be addressed.

Recently, the New Jersey Fertilizer Law (A2290) was passed which limits the duration and locations of fertilizer application, as well as the amount of nitrogen within the fertilizer. Also, fertilizers containing phosphorus can only be applied during very specific instances and may not be applied routinely. As approximately 29% of excess nutrient loading to Barnegat Bay is due to organic nitrogen in residential and commercial fertilizer (TPL, 2008), this bill will help reduce the nitrogen and phosphorus loading to the Metedeconk River and the Barnegat Bay.

The Metedeconk River watershed is already the most developed watershed within the Barnegat Bay watershed, and there are concerns that continued development and water quality degradation may negatively impact the Barnegat Bay. Significant development within the watershed is planned over the coming years to accommodate a growing population. More than 18% of the watershed is developable, based on non-urban land use (2007) and existing zoning. With the understanding that further growth will occur in the watershed, this plan can serve as a guide for protecting the water quality and quantity in the Metedeconk River. It is essential that both new development and redevelopment utilize low impact development (LID) standards to the fullest extent practical, and modification of existing municipal ordinances would be the most effective means of ensuring this occurs.

In addition to stormwater and water quality concerns, there are several water supply-related concerns for the Metedeconk River watershed. The most recent New Jersey Statewide Water Supply Plan (August 1996) projects significant water supply deficits for the area through 2040. Among the water supply challenges described in the plan are high peak water demands during the summer months, periodic droughts, stream baseflow depletion from shallow groundwater withdrawals, vulnerability of shallow aquifers to contamination due to the permeable soils, localized salt water intrusion in the Point Pleasant area, and the large-scale depletive water use from regional wastewater treatment discharges to the Atlantic Ocean. All of these concerns are relevant to the Metedeconk River watershed. Further, the watershed falls entirely within Water Supply Critical Area #1, where confined aquifers have been depleted and their availability for water supply is severely limited.

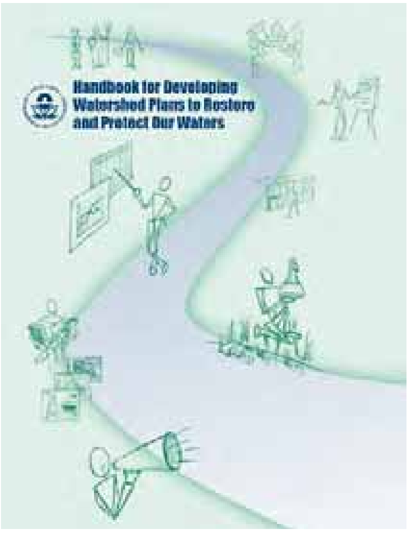
Options offered in the New Jersey Statewide Water Supply Plan to help alleviate these concerns include managing the use of surface and groundwater water supplies to maximize availability (conjunctive use), aggressive water conservation programs, development of reservoir storage, and development of aquifer storage and recovery (ASR) well facilities to store water underground during low demand periods for later recovery during high demand periods. Since the 1996 Water Supply Plan was released, several water purveyors in the watershed have developed ASR facilities. The BTMUA completed construction of the 860 million gallon Brick Reservoir in 2004 to provide storage capacity. The NJDEP is currently working on an updated statewide water supply plan.

Many of the shallow water supply wells that are located within the Metedeconk River watershed have been used less consistently in recent years, particularly those owned by the BTMUA. Although total flow of the Metedeconk River has remained stable over the years, the baseflow component of total flow is declining (runoff is increasing). Because shallow groundwater withdrawals have been reduced, this reduction in baseflow is likely attributed to an increase in impervious cover.

Although a number of studies on the watershed have been conducted over the last several years, a comprehensive regional analysis of the watershed has not been completed in more than 10 years. The Brick Township Municipal Utilities Authority has undertaken the development of this formal Metedeconk River Watershed Protection and Restoration Plan with support from NJDEP and close collaboration with the watershed stakeholders to update and build upon previous studies and planning work.

This plan has been developed using guidance published in the USEPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA, 2005) and can be utilized by municipalities and other stakeholders as a reference to identify impairments to the watershed, mitigation and protection measures, and to help guide future policy.

1 Section 1
Introduction



The Metedeconk River Watershed Protection and Restoration Plan includes a comprehensive evaluation of previous studies and more recent data to identify existing issues within the watershed and potential mitigation strategies. It serves as the culmination and summary document for a number of prior tasks that have been completed as part of the overall plan development project. Much of the technical details concerning the findings and recommendations within this plan can be found in those task reports. A listing and full reference of all task reports can be found in **Appendix A**.

This Plan has been developed with the input of more than 100 stakeholders comprising the Metedeconk Watershed Stakeholder Advisory Committee. This committee included representatives from Federal, State, County and Local government, private utilities, academia, not for profit organizations, businesses and local citizens. In addition to a Stakeholder Advisory Committee, a smaller 14-person Steering Committee was developed to help guide the technical analysis and conclusions reached by each of the tasks prior to distribution to the Stakeholder Advisory Committee. The participants of both committees are included in **Appendix B**.

The goals and objectives of the Metedeconk River Watershed Protection and Restoration Plan have been developed by the project team and the rest of the Stakeholder Advisory Committee. Goals represent consensus on a series of "wishes" for the watershed. For example: "improve stream water quality" might be a goal. Objectives translate the "wishes" into more specific and measurable quantities. These objectives must meet two minimum criteria: they must be measurable (to establish current conditions, and to set future milestones), and they must be concrete enough so that implementation strategies can be directly developed to achieve them. For example, the goal "improve water quality" can be made more concrete and measurable with one or more objectives such as "develop a phased approach to meeting fecal coliform TMDLs in dry weather and wet weather."

Goals and objectives were identified and revisited at three separate periods within the project: 1) initially at the Stakeholder Advisory Committee kick-off meeting, held in January 2010; 2) revisited and refined by the project Steering Committee in March 2011, following review of the draft reports for the stream visual assessments and technical analysis tasks; and 3) finalized at the third Stakeholder Advisory Committee meeting following finalization of the stream visual assessment and technical analysis reports and their review by the Stakeholder Advisory Committee.

Goals and objectives for the Metedeconk River Watershed Protection and Restoration Plan are shown on **Table 1-1**. In order to meet these goals and objectives, a number of management strategies have been identified, many of which will serve as retrofits to existing antiquated infrastructure that is found throughout the watershed.

This Plan has been organized into six sections as follows:

- Section 1 – Introduction
- Section 2 – Watershed Characterization. This section provides an overview of the Metedeconk River watershed and describes the existing conditions.
- Section 3 – Watershed Conditions. This section highlights the current water quality conditions within the watershed. Impairments to the watershed are identified as well as loading estimates. A subwatershed basin analysis is also included.
- Section 4 – Identification of Management Strategies. As watershed impairments were identified in Section 3, this section highlights the required load reductions and management strategies that can be utilized to help achieve those load reductions.
- Section 5 – Implementation Program. This section describes implementation of the various management strategies addressed in Section 4 and the overall Plan in general. A list of priority projects identified by the stakeholders is included in this section.
- Section 6 – References

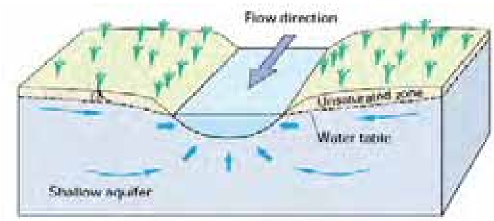
Section 2
Watershed Characterization

The purpose of this section is to characterize the watershed and document existing conditions with regard to land use, zoning and water use. Water quality analyses and the results of a stream visual assessment that was conducted are presented in Section 3. While build out analyses concerning water and land uses have not been conducted under the scope of this Plan, the intent of this section and Section 3 is to document the current state of the watershed and identify any concerns that may become a more serious issue in the future.

2.1 Physical and Natural Conditions

The flow of the Metedeconk River is divided between the North and South Branches. Both branches are fed by dozens of tributaries within eleven sub-basins or HUC14 watersheds (**Figure 2-1**), ranging in size from 5 to 11 square miles. For the purposes of this study, the subbasins will be referenced by alternate identifiers (IDs) as shown in **Figure 2-1** (e.g. NB1, SB1, etc). These alternate IDs are similar to those introduced in the Phase I Report (CDM, 2000); although it should be noted that NB2 includes the formerly identified NB2 and NB3. There are also several lakes along the reach of the river, primarily along the South Branch.

The watershed is typical of coastal regions of New Jersey with gentle slopes and sandy soils and sediments. The topography of the Metedeconk River watershed is characterized by a general low relief with a maximum elevation of 220 feet above mean sea level in Millstone (**Figure 2-2**). The watershed is located within the Coastal Plain geologic province and most of the flow within the river occurs as base flow discharging from the unconfined Kirkwood-Cohansey aquifer

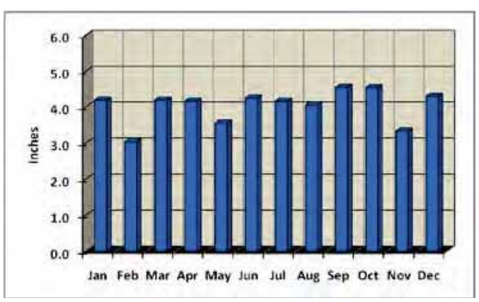


Baseflow (from USGS).

system. Because of the importance of baseflow to the Metedeconk River, changes in land use and rapid growth in Ocean and Monmouth counties are cause for concern because of the impact of increased groundwater withdrawal on baseflow, increased pollutants loads on groundwater quality, and changes to the pattern of groundwater recharge on the underlying aquifer system.

The Kirkwood-Cohansey aquifer system is characterized by a southeastward dipping wedge of unconsolidated deposits of sand and gravel with interbedded layers of silt and clay. The system is actually composed of two units, the Cohansey Sand and the upper part of the Kirkwood Formation, but as they are hydraulically well connected they act as a single aquifer system. The lower portion of the Kirkwood Formation is composed of primarily clay and acts as a thick confining bed which limits hydraulic connection to underlying aquifers and represents a regional confining unit. The Kirkwood-Cohansey has sediments that are generally transmissive having horizontal hydraulic conductivity ranges between 9 – 140 ft/day (CDM, 2000) making it a productive aquifer system. The water table ranges from over 150 feet above mean sea level in Millstone to sea level where it discharges to the Barnegat Bay (Watt et al, 1994).

Groundwater flow and water quality within the Kirkwood-Cohansey system is critical to the health of the Metedeconk River watershed as baseflow accounts for almost 70% of average annual total flow. During periods of low precipitation, baseflow makes up 100 percent of the flow, making maintenance of baseflow a high priority for watershed management. Groundwater protection was also noted as critical by the Metedeconk Watershed Source Water Stewardship Exchange Team in 2003 (TPL, 2003).



Average monthly precipitation data from BTMUA weather station, 1997-2009.

Average annual precipitation over the watershed varies between 43 and 48 inches, and rainfall is fairly evenly distributed over the 12 months of the year. Precipitation evaporates back to the atmosphere, infiltrates the groundwater system as recharge, or runs off directly to the river as stormwater runoff. Average annual evapotranspiration (ET) is approximately one-half the amount of precipitation.

During the winter months, most of the precipitation that falls eventually infiltrates and recharges the groundwater system. Some may be lost to pervious area runoff if the ground is frozen or may runoff in the form of snow melt. During the summer, ET is high, and little recharge occurs except during large storm events. Estimated annual average recharge to the Metedeconk River watershed is approximately 15 inches per year (Watt et al, 1994, Nicolson, 1997).

2.1.1 Soils

There are 53 different soil types within the Metedeconk River watershed (**Figure 2-3**), but over 95% of the soils (and 92% of the watershed area) are composed of 20 different soil types (**Table 2-1**). Soil types are listed by subbasin in **Table 2-2** for the soil types that comprise 95% of the soils within each subbasin (the Natural Resource Conservation Service (NRCS) "water" classification was excluded from the calculation).

As shown in **Table 2-2**, soil drainage improves downstream due to the extensive presence of wetlands within the headwaters. Erosion potential listed in **Table 2-2** is qualified by the soil erodibility factor (the "K factor") which is a measure of how easily soil particles become detached. Soils that are high in clay content generally have low K factors since the clay particles are difficult to detach. Well drained, coarse grained soils are also not easily eroded since the water will flow through the sediment without detaching. Medium textured soils such as silt loams have a higher potential to become detached and have a moderate K factor. Soils having a high silt content are the most easily eroded and have a K factor in excess of 0.4 (RUSLE, 2012). For the purposes of this evaluation the maximum erodibility factor given for each soil type was used to evaluate the susceptibility to erosion since the stream or river can cut through several horizons. Soil erodibility is shown on **Figure 2-4**. Areas having a moderate to high erosion potential are susceptible to having solids enter the surface water system.

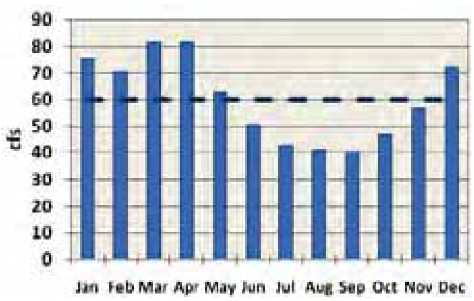
2.2 Demographics

Population within the seven municipalities and individual subbasins is shown on **Tables 2-3** and **2-4**. Population data for the Metedeconk watershed is derived from the 2010 decennial census (United States Census Bureau, 2012). The US Census Bureau blocks are used for the analysis. Blocks are the smallest geographic entity for which the Census Bureau collects and tabulates data. The decennial summary file 1 (STF1), which is the 100% count (not a sample), is linked to the block polygons. After the data are linked to the blocks, a field for population density is calculated by dividing the population by the area of the block. The Metedeconk sub-watersheds and the municipal boundaries are intersected with the blocks, the area of the intersected polygons is recalculated, and the population of each polygon is calculated by multiplying population density and the new area. This produces an area-weighted population that can be summed by watershed and/or municipality.

Brick Township accounts for approximately 12% of the total population within the study area and Freehold Township accounts for less than 1%. Howell and Jackson Townships have very similar populations within the watershed, each with approximately 20% of the total. Lakewood Township has more than double the population of Howell or Jackson, with 47% of the total. Lakewood is also projected to be the largest growing municipality within the watershed by far, in which 26,000 new residential units are projected within the next twenty years (T&M Associates, 2009).

Additional data published by the US Census Bureau is shown on **Table 2-5** for the five largest towns within the watershed.

2.3 Flow Characteristics



Average monthly flow from the North Branch Metedeconk River near Lakewood, NJ (1973-2009; data from USGS)


Gage 01408120 (from USGS)

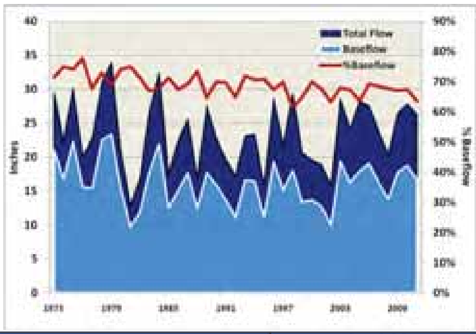
Baseflow is mostly derived from groundwater discharge to the stream, while runoff results from overland discharge. Development potentially impacts the Metedeconk River by increasing impervious cover, resulting in increased runoff and decreased baseflow. Average annual total flow, however, may not necessarily be directly affected. Other potential impacts may be observed through an increase in peak discharge rates and the fraction of the year that daily mean discharge in a stream exceeds annual average discharge, or an increase in stream flashiness (CWP, 2003; Konrad and Booth, 2002).

As new development increases, the amount of impervious cover increases. This increase in impervious cover can result in changes in stream flow in that more discharge will be in the form of runoff as opposed to baseflow. Impervious cover has been correlated with changes in potential stream quality. In general, watershed percent impervious cover between 10-25% is considered "impacted"; 25 – 60% is considered "non supporting" and > 60% is considered urban drainage (Schueler, 1995; CWP, 2003). Besides potential water quality issues, there are also potential hydrologic impacts from increased impervious cover (channel stability, stream biodiversity).

There are four USGS stream gages that have been used to collect flow data along the Metedeconk River. Two of these gages are currently active (**Figure 2-1; Table 2-6**). Since gage 01408120 has continuous streamflow over a long period, it was used for long-term flow analyses. This gage is also a "real-time" gage that can be accessed online (http://nj.usgs.gov).

As listed in **Table 2-6**, a gage has recently been installed on the South Branch in Lakewood. Recent flow data from the two active gages are shown graphically on **Figure 2-5**. Although the drainage area to the South Branch gage is 15% smaller than the drainage area to the North Branch gage, low flows in the South Branch are somewhat higher than the North Branch. Flows within the North Branch are also higher for high flows. This is likely due to the relatively large lakes on the South Branch dampening the higher flows (namely Lake Carasaljo and Lake Shenandoah). In addition, groundwater gradients could be higher along the

South Branch resulting in an increased relative baseflow. Lastly, there are more impervious acres within the North Branch subbasins which may also be contributing to a lower groundwater recharge and higher storm flows. These flow characteristics are consistent with flows analyzed in the Task 3 Technical Analysis Report completed as part of this project.



Statistic	Flow (cfs)	
	1973 – 2009	1990-2009
Average	60.10	58.56
Standard Deviation	55.01	55.15
Coefficient of Variation	0.92	0.94
Maximum	1300	1300
Minimum	7.40	7.4
7Q10	11.57	11.00

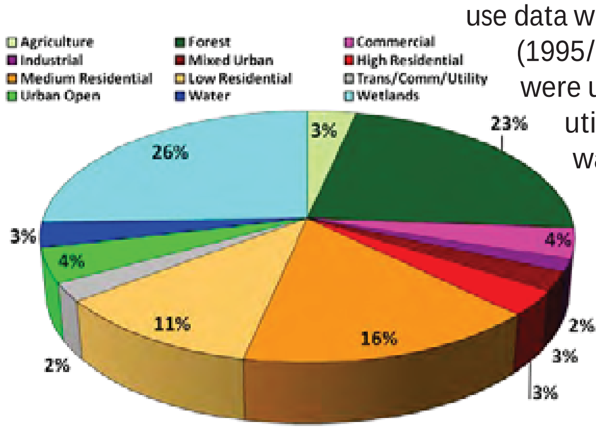
Summary of total flow for the North Branch of the Metedeconk River (at USGS gage)

As a percentage of total flow, baseflow has declined steadily since 1973. Although average annual discharge is generally stable (no trend in either direction), the baseflow component of average annual flow is declining. Since 1990, average annual baseflow as a percentage of total flow is just below 68%, as compared to 71% for the period evaluated for the North Branch in the Phase I Report (1973 to 1989). Since 2000, average annual baseflow as a percentage of total flow within the North Branch is just under 67%.

In addition to a decline in baseflow (and subsequent increase in runoff) over time, stream flashiness has also increased in the North Branch (and potentially the South Branch, but only limited data are available), likely in response to an increase in development and impervious cover. Additional detail regarding the increase in stream flashiness can be found in the Task 3 Technical Analysis Report.

2.4 Land Use/Land Cover

Land use within the Metedeconk River watershed was provided by the New Jersey Department of Environmental Protection (NJDEP) Bureau of Geographic Information Systems. All data were analyzed using GIS and existing (2007) land use data were documented and compared with previous land use data (1995/1997) to evaluate changes over time. Land use data from 1995 were used for comparison since that was the data set that was previously utilized for the last regional evaluation of the Metedeconk River watershed (CDM, 2000). Existing (2007) land use is shown and summarized by municipality on **Figure 2-6**. **Table 2-7** documents the change in land use by municipality. Existing (2007) land use is summarized by subbasin in **Table 2-8** and shown on **Figures 2-6a-k**. The change in land use throughout the watershed from 1995 to 2007 by subbasin is shown in **Table 2-9** and on **Figure 2-7**.



Existing (2007) land use within the Metedeconk River watershed (NJDEP)

The land use pattern of the watershed is roughly half open space, and half developed area. Overall, the watershed is 23% forest, 26% wetlands, 3% water, 3% agriculture, and the remaining 45% urban land use based on 2007 land use data. The total urban land area was approximately 22,560 acres which includes the following land use categories as designated by NJDEP: commercial; industrial; mixed urban; high,

Metedeconk River Greenway (from http://www.monmouthcountyparks.com/page.aspx?ID=3973)

medium, and low density residential; transportation/communications/utilities and other urban or built-up land. The greatest portion of the urban area is residential land use. There are 15,195 acres of residential area in the watershed, which is nearly 30% of the total watershed area. Of the residential area land use, the greatest proportion is medium density residential at 7,965 acres, followed by low density residential at 5,610 acres, and lastly high density residential at 1,618 acres. This breakdown of the residential land use accounts for 16%, 11%, and 3% of the total watershed area, respectively.

There are more than 2,000 acres of County and municipal parks within the watershed. Some of the larger parks include those within the Monmouth County Park System (Turkey Swamp Park, Metedeconk River Greenway in NB1) and the Ocean County Parks Department (Lake Shenandoah County Park, Ocean County Park and the Metedeconk River Conservation Area).

Land use classifications are based on a modified system by Anderson et al (1976). For residential development, NJDEP utilizes the following categories (from NJDEP 2007 Land Use/Land Cover metadata):

> **Residential (high density or multiple dwelling)**: either high density single units or multiple dwelling units on lots that are 1/8 to 1/5 acre in size. Impervious surface coverage is approximately 65%.
>
> **Residential (medium density)**: single unit residential units on lots between 1/8 to ½ acres. Medium density residential developments generally have impervious cover between 30-35%.
>
> **Residential (low density):** Single unit residential neighborhoods situated on lots that are between ½ acre and 1 acre in size. Low density residential neighborhoods typically contain areas of impervious cover on the order of 20-25%. Areas of lower density (single lots > 1 acres and impervious cover < 15-20%) are classified as rural residential.
>
> **Residential (mixed):** mixed residential is assigned when more than 1/3 of land use within an area consists of various residential uses which cannot be separated on a scale less than 1 acre.

In general, development increases downstream. The North Branch and South Branch Metedeconk River headwater subbasins, NB1 and SB1 share a similar undeveloped makeup, containing extensive wetlands. Moving downstream, a marked jump in developed or urbanized area is seen in NB2 while the percentage of developed area increases more gradually progressing downstream on the South Branch through subbasins SB2 through SB5. However, subbasins NB3 and NB4 do not follow the trend in development, as they drain tributary areas of the North Branch Metedeconk River which are not as densely developed (**Figures 2-6a-k**).

Medium density residential is the dominant urban land use in Brick, Howell, and Lakewood, while low density residential land use accounts for most of the urban land use in Jackson. There are large areas of fairly intact wetlands and forest in Freehold, Jackson, and Howell. While Lakewood does have some remaining wetlands, there is a greater amount of existing forested areas.

Photo of forest clearing for new development in Howell Township: Northbound Rt. 9 between East 1st St. and Conover St. (photo taken spring 2012)

On a watershed scale, the largest changes are the loss of forest to residential, commercial and industrial development. The increase in the water land use category is likely a function of wet or clogged retention basins being depicted as surface water from an aerial photograph and therefore being designated "water" in NJDEP's classification process. The loss of almost 650 acres of wetlands is also likely a function of how the wetlands were delineated from aerial photographs by the NJDEP. Wetlands are identified by the aerials, but when field surveys are conducted, it is possible that the land use isn't actually a wetland or that the field designated area is different from the aerial analysis.

From a municipality and acreage basis, Jackson Township has realized the most residential development since 1995. However, more than 50% of the development that has occurred was low density residential, which in general, will pose a relatively low risk to the health of the watershed (as opposed to medium and high density residential or industrial land uses). Howell and Lakewood Townships have the next highest residential growth rates (from a land use acreage basis) with Lakewood showing the highest number of acres of high density residential development since 1995/1997. Freehold and Brick Townships have shown relatively little additional development since 1995. Almost all of Freehold Township's residential development has been in low density residential whereas most of Brick's has been medium density residential.

Lakewood Township shows the highest development with regard to commercial and industrial land use followed by Howell and Jackson Townships.

From a subbasin basis, the change in acreage by land use between the South Branch and North Branch is similar, although the South Branch has undergone more than five times the development of high density residential land uses.

Figure 2-7 shows generalized changes in land use in which the 13 land use categories were simplified into Open or Developed (agriculture and water uses remained the same classification). In evaluating the changes in land use over time, the 2002 data were also evaluated. The purpose of **Figure 2-7** is only to highlight where development occurred. Due to the many potential combinations of land uses from the 13 categories (originally more than 70), specific land use changes per parcel would not be easily identifiable. The important categories are those that have changed to developed. The agriculture/developed and open/developed designations show where development has occurred between 1995 and 2007. Most development has occurred in Jackson and Lakewood within the subwatersheds of the South Branch. There was some land use change in Howell in the North Branch watershed.

An analysis of the land use change since 1995 has determined that overall impervious cover has increased from 12% in 1995/1997 to 15% in 2007 (**Figure 2-7a**). On a municipal basis, the highest amount of impervious cover is in Lakewood Township with 2,460 impervious acres within the Metedeconk River watershed. The largest increase in impervious surface since 1995/1997 was in Jackson and Lakewood Townships, having increases of 487 and 438 acres, respectively.

Extensive impervious cover is often found at commercial centers

On a HUC 14 basis, the most impervious surface is found within CFL1, NB2 and NB5, followed by SB4 and SB5. The three subbasins that are furthest downstream (NB5, SB5 and CFL1) average to 23% impervious cover. The lowest amount of impervious surface is found at the headwaters within NB1 and SB1 due to the wetlands and preserved land within these areas.

The largest increase in impervious surface by subbasin was in the South Branch watershed within SB3 and SB5, increasing by 261 and 190 impervious surface acres, respectively.

Discharge from septic systems to groundwater from medium-high density systems can have an adverse impact on water quality, particularly for nitrate as nitrogen. Within the past 10 years, a lot of focus has been given to nitrate in groundwater as it poses not only a threat to drinking water supplies (the NJDEP drinking water standard for nitrate as nitrogen is 10 mg/L-N), but can lead to excessive nitrogen loading into rivers which in turn provides an excessive load to coastal embayments, which are often nitrogen limiting. Therefore, excessive nitrogen loading may lead to eutrophic surface water conditions. This has been well documented in similar coastal plain areas in the northeast, such as the Forge River in Suffolk County, New York, where septic discharges were identified as the primary source of nitrogen to the river (Cameron Engineering, 2012). The NJDEP has developed a nitrogen dilution model which determines housing density required to meet particular nitrogen targets.

The existing NJDEP-approved sanitary sewer service area (as of October 2011) is shown along with areas that are currently being served by septic systems within the watershed on **Figure 2-8**. While other areas of Jackson and Howell are served by septic than what is shown on the map, those areas are on lot sizes greater than 1 acre. Many older developments pre-date the installations of sanitary sewer but are within the service areas. High density residential and commercial areas that are currently on septic, but within the sanitary sewer service area should ultimately be connected to sanitary sewer, especially if the septic system is failing. There are many areas within Jackson Township, for example, where land development has occurred on small ½ to ¼ acre lots that should be connected to the sewer system. From discussions with Township Engineer, the neighborhood constructed around Lake Enno has been identified as in need of public sewer service. Areas such as these are found not only in Jackson, but also within Howell and Lakewood (**Figure 2-8**).

Areas within the townships with medium-high density residential areas currently served by septic systems, but where sanitary sewers exist, should be notified of the option to connect to the sanitary sewer when their septic system fails. In some instances (e.g. Jackson Township) this connection is mandatory.

Although almost all of Lakewood Township is within the approved sewer service area, the area within SB4 that is outside the currently existing sewer service area (as per the date of this report) is currently being developed on septic with lot sizes of approximately 12,000 to 15,000 square feet (personal communication, Lakewood MUA). Where public sewer service is not available, the Township Ordinance (18-811) will permit septic systems with the Board of Health approval. There are no requirements for minimum lot size as it relates to nitrate dilution or evaluating subsurface soil conditions. At a minimum, if these residential developments are being approved for septic sewer disposal, additional treatment should be included, such as Chromaglass™ systems, Nitrex™ systems or similar. Alternatively, the NJDEP approved sewer service area should be expanded to include those areas targeted for higher density development.

It should be noted that as per the date of this version of the Plan, a revised sewer service area has been prepared for Lakewood Township which includes the septic system area shown on **Figure 2-8**. As per the date of this Plan, the draft has not yet been approved by NJDEP. The final draft for Lakewood as well as other municipalities served within Ocean County can be viewed online at the Ocean County Planning Department's website: http://www.planning.co.ocean.nj.us/watershed/wwmgt.htm.

Commercial areas such as the Route 88 Corridor in Lakewood should also have sanitary sewer connections.

2.5 Zoning Patterns

Existing zoning patterns for each of the five largest townships were evaluated. Zoning data were acquired from the individual townships for Brick, Freehold and Howell. Zoning data for Jackson and Lakewood Townships were acquired through the Ocean County Planning Department.

Zoning maps for each subbasin are shown on **Figures 2-9a-k**. As shown on the maps, Freehold Township and Howell Township generally have low to very low residential density zoning along the main stem of the river, with the exception of the Route 9 corridor in Howell. Note that since most subbasins span municipal boundaries, there are multiple zoning identifiers within each subbasin (corresponding to each municipality).

The majority of the southern portion of Freehold Township is zoned Rural Environmental (RE), which requires a minimum of 10 acres per each building lot. There are a few smaller areas of existing homes with a Rural Residential (RR) Zone – 5 acre lot size and 2 acre (R-80) lot size – scattered within the watershed. The RE zone is not served by public sewer and contains lands with a prevailing high water table, high recharge capability for the regional aquifer, and other environmentally sensitive areas such as wetlands and floodplains. The RE zone also allows for parks, golf courses and cluster subdivisions from 3 acre to 10 acre lot sizes in order to preserve and not disturb the remaining tract area.

Although a build-out analysis was not conducted for each municipality as part of this Plan, "open" land use designations from the NJDEP 2007 land use/land cover database (urban open, vacant, forest, etc.) were coupled with the zoning GIS layers to determine what could be developed within each town and subbasin. This would be land that is currently classified as an open land use (open space, recreation, vacant, etc) that is currently zoned for development (residential, commercial, or industrial). A summary of "developable land" within each subbasin is presented on **Figures 2-10a-k** and summarized on **Table 2-10**. Regardless of zoning, parcels that have been acquired for preservation or are owned by the County Parks Departments have been removed from what could be "developed". These lands included those properties identified within the Ocean County Farmland Preserved and Ocean County Natural Lands layers as well as those identified in the NJDEP state and county open space layers. A separate GIS layer was also obtained from Monmouth County Park System (March 2012) and those parcels owned or acquired by Monmouth County were removed. Lastly, potential "developable land" within the 300 foot buffer to the Metedeconk River or its tributaries was removed.

It's important to note that since this developable land analysis was land use based, developable land as quantified here includes land that is already being utilized. For example, a 10 acre parcel may only have a portion of that area utilized by a residential or "urban" land use. The remaining area is classified as forest or open space in the land use layer. However, since the actual parcel is zoned as residential, there may be additional development on that particular lot (such as a home addition). Similarly, there may be a large commercial lot that is currently being underutilized and additional development may occur in the future.

Looking south along Route 9 in Howell.

Most of the potential development is to residential land uses. On a municipal basis, Howell and Jackson Townships have the most potential for development based upon acreage. Most of the developable land in Howell, however, is zoned low density residential (2 – 6 acre zoning). In Jackson Township, much of the developable land is zoned for residential use, although a good deal of it is currently zoned commercial, or light manufacturing. A fair amount of acreage of developable land is also available in Lakewood Township. Much of the "developable" land is currently zoned medium-high density residential or industrial. The current industrial area in CFL1 is presently somewhat broken up by patches of forest. These forested areas are also zoned industrial and may allow for the impervious cover in this area to be more connected. Should this development move forward, best management practices should be utilized in an effort to maintain a connected network of open space corridors and preserve the ecological function of the existing area.

On a subbasin basis, the most developable land is within NB2 and SB3, although there isn't much difference between these and the other subbasins. Although there are almost 900 acres of "developable land" within NB1, nearly all of the land is very low density residential with zoning of 2 acres or more. In Freehold and Jackson, 5 or 10 acre zoning is specified. In addition, development is limited due to the amount of wetlands and preserved land throughout the subbasin. Despite the presence of wetlands in this subbasin and only low density residential development, water quality is compromised and a TMDL for phosphorus has been developed for this subbasin (see Section 3).

It's important to note that due to the NJDEP Stormwater Rules, new development will have to abide by much more stringent standards regarding stormwater runoff than in the past, when much of the watershed was developed and impacts from future development are anticipated to be relatively minor. Nevertheless, with new high-density development there is an opportunity to explore innovative LID techniques and enhanced treatment methods for stormwater runoff.

A summary of the subbasins within the watershed (moving downstream) is presented below. Additional information is also presented in Section 3.

NB1: Development within NB1 is somewhat restricted as more than 40% of the land within NB1 is preserved and/or consists of wetlands. As mentioned above, most of the available zoning for development is low density residential. There are approximately 100 acres of forest within Howell currently zoned for business and/or office use. These areas should employ extensive LID practices should they be developed, particularly since they are within the headwaters of the North Branch.

SB1: As shown on **Figure 2-9b**, there is a lot of area that is zoned for light manufacturing in Jackson within the vicinity of the I-195 corridor. However, there is an abundance of wetlands within that area (**Figure 2-6b**) which limit the amount of development that could occur. Nevertheless, forested areas could be converted to light manufacturing which may lead to a significant increase in impervious cover in that area and, depending on the type of manufacturing, could also lead to some contaminants being introduced to the watershed. As these areas represent the headwaters of the South Branch, any development of that area should be carefully managed.

NB2: This subbasin is currently fairly developed with medium density residential land use and has an impervious cover of 19%. Developable land within NB2 is predominantly zoned low density residential (1-2 acre zoning) with a forested area within the southern portion of the HUC that is zoned medium density residential. There are also some scattered portions of medium density residential land use within Howell, some of which is already on existing developed lots (large wooded yards). As discussed further in Section 3, NB2 marks where the land use transitions from low density residential and wetlands in NB1 to medium density residential (impervious cover increases from 4% in NB1 to 19% in NB2). As a result, water quality data indicate a significant increase in nitrogen and fecal coliform.

SB2: Most of the existing use within SB2 is forest and wetlands with low density residential and an area of medium density residential in Jackson. Based on this analysis, there is not any developable land in Freehold Township within SB2, but almost 900 acres of developable land within Jackson Township, much of which is classified as Planned Mixed Use Development (represented as “residential” within the table on **Figure 2-10d**). In addition, more than 150 acres of developable land are zoned for commercial development. Impervious cover within SB2 is currently 7% and below the threshold of when impacts are observed (10%). Additional development of forested or open areas to commercial areas will increase impervious cover within the watershed and must be managed appropriately through low impact development and stormwater best management practices (e.g. allow infiltration into parking lot islands, bioretention areas, etc.; See Section 4).

NB3: NB3 is entirely within Howell Township and consists of the drainage area to Haystack Brook which drains to Muddy Ford Brook to the east and ultimately to the North Branch. Besides some wetlands within the riparian corridor of the streams, much of the headwaters of Haystack Brook are currently medium density residential. Impervious cover is at 14% and 4 of the 6 visual assessments that were conducted within this subbasin were classified as “poor”. Developable land is generally low density residential with some pockets of medium density residential.

SB3: SB3 is entirely within Jackson Township. Much of the headwaters portion of this sub-watershed consists of wetlands, but a transition to medium density residential and commercial development is evident downstream. Developable land is primarily zoned low density residential with some commercial potential along County Road 526, though it also includes the Mitch Leigh property zoned for Planned Mixed Unit Residential Development (PMURD).

NB4: NB4 is entirely within Howell Township and consists of the drainage area to Muddy Ford Brook which discharges to the North Branch. Much of this subbasin is comprised of wetlands and forest. Developable land is primarily zoned low density zoning (2-6 acres). In addition, there is some area which is zoned ARE-C and ARE-NRW, which are protection zones so development will be limited.

SB4: SB4 is within Jackson and Lakewood Townships and currently has a lot of development, particularly to the southeast. Impervious cover within this subbasin is approaching 20% and water quality data collected from this subbasin indicate an increase in total nitrogen and coliform loading from upstream. There are almost 1,000 acres of developable land, including some industrial areas in Lakewood. Much of the developable land within Jackson is fairly low density residential with 2 acre zoning, but there are scattered areas of potential development of ¼ acre zoning or less in both Jackson and Lakewood Townships. A portion of the developable land within Lakewood (near Watering Place Brook) is being approved for development of medium density residential on lots of approximately ¼ acre in size (personal communication, Lakewood MUA). This area presents a concern not just for impervious cover, but is problematic from a nitrogen loading perspective because it is outside the sewer service area (as per the date of this version of the Plan) and will require septic systems. As the impervious cover is already approaching 20% in this subbasin, careful management of this and further development is critical and low impact development techniques should be implemented to the fullest extent practical.

NB5: NB5 is currently highly developed and has an impervious cover which exceeds 20%. However, more than 700 acres remain developable, most of which are in Lakewood and zoned medium density residential. Developable land within Howell is primarily 2 acre zoning although some portions of the northeast section of this subbasin have 1/3 acre zoning. Due to the already high impervious cover within this subbasin, careful management of further development is critical, and low impact development techniques should be implemented to the fullest extent practical.

SB5: SB5 currently has the highest percentage of impervious cover within the watershed at 26%. Although impervious cover is already above 25%, there remain approximately 550 acres of developable land in Lakewood Township (less than 1 acre of developable land in Brick Township). Due to the already high impervious cover within this subbasin, careful management of further development is critical and low impact development techniques should be implemented to the fullest extent practical.

CFL1: Impervious cover within CFL1 already exceeds 20%, but there are almost 900 acres of developable land within Brick and Lakewood Townships. Developable land in Lakewood is primarily zoned industrial and residential with 1 acre lots. Developable land within Brick is primarily zoned as business along the Cedar Bridge Branch and various densities of residential development. Some of the developable land is located along the saltwater portion of the estuary, downstream of the Brick MUA drinking water intake. Those parcels are located on the water and, although do not pose a threat to the freshwater portion of the Metedeconk River, acquisition/protection of these parcels will benefit the health of the Barnegat Bay. Due to the already high impervious cover within this subbasin, careful management of further development is critical and low impact development techniques should be implemented to the fullest extent practical.

It's important to note that the developable land presented in **Table 2-10** and **Figures 2-10a-k** is a good first approximation based on all available data, but its purpose is only to estimate a relative developable area for each of the townships. The developable acreage does not account for the number of units, setbacks, etc. Since it is land use based, developable land could actually be forested areas of a back yard. While there may be forested areas in a residential zone, it does not imply that those forested areas will be cleared and developed or modified.

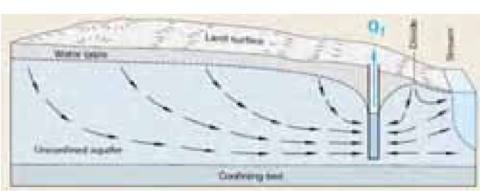
By no means do these data replace any more detailed evaluations that may have been conducted prior to or following this study nor should the acreage presented in **Table 2-10** be used for any detailed planning analyses without first consulting the planning departments of the individual municipalities. In addition, since properties are continuously being acquired as part of open space preservation efforts by the State, counties and municipalities, the data presented in this Plan are current as of spring 2013.

2.6 Water Quantity

The 7Q10 (also referred to as the MA7CD10 by NJDEP, or the minimum average seven consecutive day flow with a statistical recurrence interval of 10 years) for the Metedeconk River has been calculated by the USGS (Watt, 1994) by using low-flow correlation methods to stream flow data measured at the Toms River near Toms River, NJ stream flow gaging station (USGS gage 01408500). This correlation technique was utilized due to the relatively short time period for which stream flow data were available for the North Branch (at the time 1972-1989 for gage 01408120) and South Branch (1972-1976 for 01408140). Correlation equations were derived and stream flows recorded at the Toms River station (data available since 1929) were used to calculate corresponding flows in the Metedeconk River. The calculated 7Q10 was 14.7 and 13 cfs for the North and South Branches, respectively.

Since more than 20 years of data have been made available from the USGS gage for the North Branch of the Metedeconk River near Lakewood (01408120), the 7Q10 was calculated in a different fashion, by simply calculating the running 7-day average, using the minimum 7-day average for each year and determining the flow rate that has a probability of occurring once every 10 years. Using this simplified approach, the 7Q10 was calculated to be approximately 11.5 cfs or 7.4 million gallons per day (mgd) for the North Branch. Although flow data are very limited for the South Branch, from available data, the 7Q10 is approximately 13 cfs, or 8.4 mgd. Total flow downstream of the confluence would be approximately 24.5 cfs or 15.8 mgd downstream of the confluence.

2.6.1 Water Use



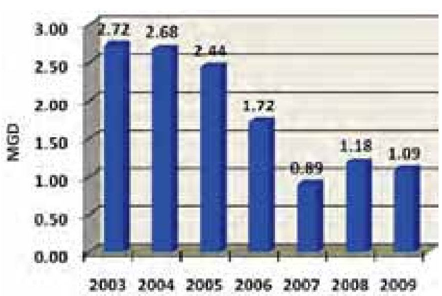
Water supply well intercepting groundwater prior to discharging to stream as baseflow (from USGS, 1989)

Water users that withdraw or have the potential to withdraw more than 100,000 gallons per day are regulated by the NJDEP. Non-agricultural users are regulated with Water Allocation permits or Temporary Dewatering permits. Agricultural users are regulated with Agricultural Water Use Certifications (if the user diverts more than 100,000 gallons per day) or Agricultural Water Use Registrations (if the user diverts less than 100,000 gallons per day, but has the potential to divert more water). Similarly, Water Use Registrations are issued to non-agricultural users who also do not typically withdraw or divert more than

100,000 gallons per day but have the potential to (combined installed pump capacity of 70 gpm).

There are currently four primary water purveyors within the Metedeconk River watershed: Brick Township Municipal Utilities Authority (BTMUA; which has purchased Parkway Water Company), Lakewood Township Municipal Utilities Authority, Jackson Township Municipal Utilities Authority, and New Jersey American Water Company. All of these purveyors utilize groundwater for potable supply although most of the BTMUA potable supply is from an intake upstream of the mouth of the Metedeconk River. Although there are a total of 51 community supply wells within the watershed, there are only 18 that are screened into the Kirkwood-Cohansey aquifer system (**Figure 2-11**). Since the baseflow to the Metedeconk is derived from the Kirkwood-Cohansey aquifer, and hydraulic connection between the upper Kirkwood-Cohansey and lower aquifers is limited due to the confining unit present in the lower Kirkwood, withdrawals from that aquifer will have a direct impact on baseflow to the Metedeconk. However, it should be noted that increased withdrawals from deeper aquifers may indirectly impact the Metedeconk as the higher pumping rates will result in larger recharge areas and may result in less recharge to baseflow to the Metedeconk. A more detailed evaluation into the recharge areas of the deeper supply wells is required to make an accurate assessment of their impact on the Metedeconk.

Within the watershed, there are 23 community supply wells that are screened within the Kirkwood-Cohansey aquifer system that are either within or immediately adjacent to the watershed (**Figure 2-11; Table 2-11**). The five wells that are outside the boundary of the watershed have their wellhead protection areas (or recharge areas) overlap within the watershed. Therefore a portion of the source water to the wells originates within the Metedeconk River watershed. In addition to community public supply use, there are four golf courses within the Metedeconk River watershed: Metedeconk National, Lakewood Country Club, Woodlake Country Club and Forge Pond Country Club. All four golf courses utilize surface water (irrigation ponds and intakes along the Metedeconk River) for irrigation, although Forge Pond Country Club also has three wells for domestic supply.



Average annual pumpage from the Kirkwood-Cohansey aquifer system: 2003-2009.

Monthly groundwater withdrawals from the community supply wells screened in the Kirkwood-Cohansey aquifer system have declined since 2003, primarily due to the shut-down of the Parkway system wells and less withdrawal of shallow groundwater by BTMUA between 2006-2010. Note, however, that shallow groundwater use by BTMUA increased during the summer drought of 2010 and remains an important water supply source for the utility (see **Figure 2-12**).

BTMUA reservoir

BTMUA directly withdraws surface water for potable use from its Metedeconk River intake which is treated and sent to its distribution system. BTMUA also owns and operates an 860-million gallon reservoir located outside of the watershed on Herbertsville Road in the northwest portion of Brick and southeast portion of Wall Township (see **Figure 2-11**). This pumped raw water storage reservoir is also supplied with water drawn from the Metedeconk River intake. BTMUA's diversion is governed by a water allocation permit issued by NJDEP and includes minimum passing flow requirements and flood-skimming provisions to ensure withdrawals do not negatively impact downstream areas or nearby freshwater habitat. In addition, BTMUA owns and operates an aquifer storage and recovery (ASR) well system where treated water is stored underground during low demand periods for later use during high demand periods. The ASR system hasn't been in operation since October 2009 due to problems with the well. As of the date of this report, BTMUA is undertaking an ASR well replacement project with a new ASR Well 15A expected to be completed during 2012.

Surface water withdrawals are summarized on **Figure 2-13** for the Metedeconk River. From 2003-2009, the average monthly surface water withdrawal was approximately 6.8 mgd.

There are only three farms within the watershed registered with NJDEP, two of which use surface water for irrigation. The other farm uses groundwater, but the well is screened within the upper Potomac-Raritan-Magothy (PRM) aquifer and groundwater withdrawals are not likely to impact the flow within the Metedeconk River. Note that total agricultural withdrawal is only a small fraction of the total (**Figure 2-13**). However, there are more than 400 agricultural parcels within the watershed comprising almost 1,700 acres. It is likely that there are a number of agricultural users that withdraw water at rates less than 100,000 gallons per day or 70 gpm, beneath regulatory thresholds. The cumulative impact of agricultural irrigation pumping from these sites could be significant, as could non-agricultural irrigation pumping (i.e. residential and commercial irrigation wells).

Section 3
Watershed Conditions

The Metedeconk River Watershed maintains relatively good water quality and ecological health, despite significant impervious cover associated with regional development that has accelerated over the last twenty years. As a vital resource for drinking water, recreation, and ecological health of Barnegat Bay, water quality in the watershed is well documented and subject to regulatory action and stakeholder concern. Of particular concern is that the water quality buffering capacity of the watershed's wetlands and coarse, sandy sediments is nearing a threshold, soon to be overwhelmed by continued development and associated increases in stormwater runoff. As discussed in Section 2 of this Plan, the overall watershed impervious cover has increased from 12% in 1995/1997 to 15% in 2007 and continues to increase, with the largest increase in impervious surfaces occurring in Jackson and Lakewood Townships on the South Branch. Five of the eleven sub-watersheds exceed 19% impervious cover, up to 26% impervious within SB4.

In addition to the Barnegat Bay nutrient loading concerns, water quality monitoring indicating degraded water quality has led to several identified impairments on the New Jersey Statewide 303(d) list and the development of Total Maximum Daily Loads (TMDLs). TMDLs have been developed for the watershed addressing fecal coliform, phosphorus, pathogens and total coliform. The pollutant of concern for the fecal and coliform TMDLs is pathogens. The TMDLs use fecal and total coliform as indicators for pathogens.

Pollutant source evaluation, utilizing visual assessment and land use loading analysis, were conducted on the watershed to identify the causes and sources or groups of similar sources that will need to be controlled to achieve load reductions estimated in this Plan. A prioritized ranking of these sources on a subwatershed (HUC14) and site-specific basis is provided.

Visual assessments conducted in 2010 indicated fair to good conditions at representative sites within the watershed. Habitat, erosion, riparian buffer, and other parameters relating to water quality were scored and mostly corresponded, as expected, to the level of development in the surrounding and contributing drainage area which increases progressing in the downstream direction for both the north and south branches. Lesser order tributaries demonstrated a greater sensitivity to contributing land uses than did the larger river channels skewing some of the scoring.

Estimated pollutant loadings based on land use were developed for three of the major watershed pollutants, nitrogen, phosphorus, and total suspended solids (TSS). These loading rates are generally proportional to loading rates of other, less predictable parameters, such as fecal coliform and total dissolved solids (TDS), where the loading rate corresponds to impervious area percentage. Source land use types with the highest annual loading rates per unit land area covering considerable areas are targeted for their load contributors in each HUC14 subbasin. Urban land uses, consisting of residential, commercial, and industrial land uses are the greatest contributors with some significant agricultural contributors.

The extent of development and related stormwater impacts generally increase in the downstream direction through the parallel tracks of the North and South Branch Metedeconk River, culminating at the Metedeconk River and Estuary within the subbasins with the greatest percentage of land covered by urban impervious area, SB5, NB5 and CFL1.

The purpose of this section is to summarize some of the significant watershed conditions. Much of the analyses conducted and results documented here originated from the Task 3 Technical Analysis Report and the Stream Visual Assessments, which were completed as part of Task 2. Both documents should be referenced for additional detail.

3.1 Water Quality Conditions

Previous studies have concluded that the surface water quality of the Metedeconk River was generally good, but identified some parameters of concern. Phosphorus and pathogens are most significant with total maximum daily loads (TMDLs) for fecal coliform, total coliform, and total phosphorus in place for the Metedeconk River. Another prevalent pollutant causing impairment as listed on the 303(d) list for the watershed is arsenic.

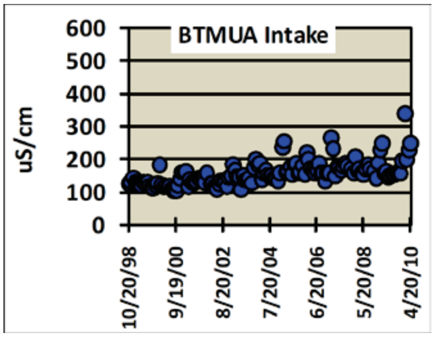
The Source Water Assessment Report developed for BTMUA by the NJDEP indicates that the intake is highly susceptible to pathogens and inorganic constituents (NJDEP, 2004). The susceptibility to nutrients and volatile organic compounds (VOCs) was classified as medium and the intake has a low susceptibility to pesticides, radionuclides and radon.

Impairments for other constituents listed on the 303d list are described further below. Nitrogen concentrations, conductance, TDS and temperature increase progressing downstream and show a correlation with surrounding increases in impervious cover and the associated increase in urban runoff. These and other parameters, along with the volume of urban runoff reaching the stream system, are directly and cumulatively degrading the water quality and ecological health of the stream system as observed in the visual assessments.

The Metedeconk River is classified as a class FW2 waterway, most of which is classified as a "non-trout" status (FW2-NT; except a few stretches of the North Branch which are classified as "trout maintenance", or FW2-TM; see **Figure 3-1**). In addition, the Metedeconk River is classified as a Category One (C1) waterway due to its exceptional water supply significance. The C1 designation covers the entire watershed eastward to Forge Pond at State Hwy 70 and includes both the North and South Branches and all freshwater tributaries. According to State regulations, C1 waters are to be protected from any measurable degradation (including calculable or predicted changes) to the existing water quality.

Results of the water quality analysis determined that a measurable decline in water quality has been observed and identified potential problem areas for restoration. Average annual (2008) concentrations for the various water quality parameters were evaluated in the Technical Analysis Report. In addition to average annual water quality data, trend plots were developed and mapped to evaluate any increasing trends over time. Water quality data indicate that there is a slow increasing trend in total dissolved solids and specific conductance concentrations which are likely indicative of increased urban development within the watershed over time. While water quality remains generally good, the increasing trends in these parameters and to some extent total nitrogen may indicate that impacts are being realized. Continued development and impervious cover without proper management practices could result in a continuance of the water quality degradation, in direct conflict with the C1 designation.

Nutrients and pathogens are the pollutants of greatest concern in the Metedeconk River Watershed. Excessive loadings of nitrogen and phosphorus are causing eutrophication of parts of the river and lakes as well as adverse impacts to the Metedeconk River Estuary and Barnegat Bay. Elevated concentrations of pathogens threaten the recreational usage of the watershed streams and lakes and the consumption of shellfish from the estuary. Total suspended solids (TSS), although only causing a documented impairment in one subbasin, is a surrogate for other pollutants since it carries nutrients, pathogens, metals and other pollutants with it. Other water quality parameters, such as pH, temperature, BOD, dissolved oxygen, and VOCs indicate generally normal conditions, although impairments for temperature and dissolved oxygen are included in the New Jersey Integrated Water Quality Monitoring and Assessment Report. Dissolved oxygen has violated the surface water quality standard (SWQS) on a number of occasions on both the North and South Branch in which several samples have shown levels below 4 mg/L. Interestingly, the most undeveloped subbasin, NB1, has the most impairments identified on the 303(d) list and is the only subbasin that the phosphorus TMDL is applicable (potentially due to wetlands and heavy fertilization from surrounding low density residential and agricultural land uses).



Specific conductance measured over time at the BTMUA intake.

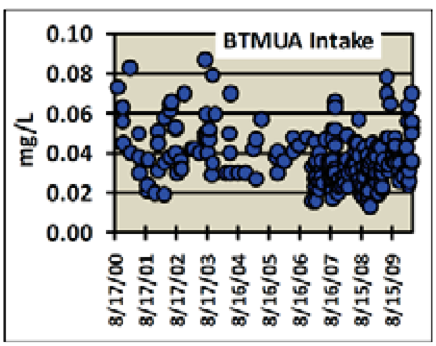
Another notable constituent with generally low average concentrations is specific conductance. Observed conductivity levels are indicative of relatively unpolluted surface water, however, there is an increasing trend as the sampling locations move further downstream on both branches in addition to an increasing trend over time. This increase is most likely due to the higher level of urbanization downstream and the increase of pollutants in both stormwater runoff and groundwater in more urbanized areas. The Metedeconk River temporarily exhibits very high conductance levels following road de-icing operations during the winter. The increasing trend in conductivity may also represent long-term increases in groundwater conductivity resulting from percolation of road salts into the shallow aquifer, although groundwater data are not available to evaluate that hypothesis.

Surface water quality was primarily evaluated using BTMUA's water quality database, supplemented with data collected from the USGS, NJDEP and USEPA (STORET) at various stations along the north and south branches (although most STORET data post 2000 is from BTMUA). BTMUA implements a very rigorous water quality monitoring program as their intake is at the mouth of the river at CFL1. They are very progressive and analyze for a variety of constituents. However, as their primary concern is the water quality of the main stems (and rightfully so), most of their water quality sampling occurs within the North and South Branches as opposed to the tributaries. Water quality issues may be greater in localized areas off of small tributaries that drain large developments. Because BTMUA is able to conduct routine sampling of the Metedeconk River, the water quality analyses discussed below are possible.

3.1.1 Nutrients

Excessive nutrient loading to the Metedeconk River is in the form of nitrogen (ammonia, nitrate and nitrite) and total phosphorus. There are several anthropogenic sources of nutrients to the river, but the most prominent are stormwater runoff of fertilized residential and commercial landscapes, groundwater discharge which receives nitrogen and phosphorus loading from septic systems in unsewered areas, and fertilization and other activities from agricultural land uses. Nitrogen and phosphorus are important as the limiting nutrients for eutrophication of the salt water Barnegat Bay and the freshwater streams of the Metedeconk River Watershed, respectively.

Nitrogen is not a problem for the entire Metedeconk River, as nitrogen is typically not the limiting nutrient for eutrophication in fresh water and the drinking water standard for nitrate as nitrogen is 10 mg/L (also the surface water quality standard for FW2 waters), far above the maximum nitrate as nitrogen detected at the BTMUA intake. However, ammonia was cited as a concern from the analysis conducted for the Technical Analysis Report. The calculated standard for ammonia is not exceeded at all times, but is exceeded somewhat frequently.



Total phosphorus concentration over time measured at the BTMUA intake.

Total Phosphorus (TP) is an important indicator of the presence of agricultural and lawn fertilizers in runoff and of increased nutrient loads to a river. Phosphorus will tend to sorb onto soils and, unlike nitrogen, generally does not easily migrate through groundwater and is not collected in runoff from atmospheric deposition over impervious surfaces. Phosphorous issues are generally associated with stormwater runoff from fertilized areas, but may also come from septic systems in unsewered areas. Phosphorus concentrations are lower at sampling sites further downstream, but tend to remain relatively constant. Phosphorus concentrations have exceeded 0.4 mg/L in BTMUA's most upstream sampling site within NB1 and have exceeded 0.15 mg/L near the discharge point of the HUC14.

While concentrations generally remain below the SWQS of 0.1 mg/L within the Metedeconk River at most of the downstream sampling sites (downstream of NB1), concentrations have frequently exceeded the SWQS standard for lakes of 0.05 mg/L. Lakes within the watershed have periodically experienced eutrophic conditions (Birdsall Engineering Inc., 2005). Phosphorus is identified as an impairment in Muddy Ford Brook (within NB4) and a TMDL for phosphorus has been established for NB1.

There is no evident trend in the phosphorus data, although in general, concentrations are slightly higher within the North Branch than the South Branch. Note that the North Branch has more than twice the amount of agricultural acreage within its watershed, which may explain the increased phosphorus concentrations. Also, the lakes along the South Branch may also serve as phosphorus sinks.

3.1.2 Pathogens

Pathogen concentrations, as indicated by fecal coliform, enterococci and Escherichia coli (E. coli) counts are consistently elevated throughout the watershed, enough to warrant multiple TMDLs. The data for coliform is highly variable due to the fact that coliform is primarily transported in wet weather runoff. Counts tend to spike after rainfall events as runoff impacts the river and drop to zero during longer dry periods. Groundwater generally does not contribute any fecal coliform to the river. From a groundwater perspective, only those sites that are unsewered and close enough to the river (or tributaries) to allow groundwater to discharge within a very short travel time would have the potential to contribute fecal coliform and E. coli. Although E. coli and enterococci have been determined to be an improved indicator of pathogens over fecal coliform, a TMDL for fecal coliform and total coliform was developed prior to widespread utilization of E. coli and enterococci as indicators. To be consistent with the TMDLs, loading and reduction of loading for pathogens are represented as fecal coliform.

3.1.3 Total Suspended Solids

Total suspended solids (TSS) are used as one of the primary indicators of poor watershed management of soils. TSS is often associated with agricultural runoff, runoff from construction sites, highways, and highly urbanized areas. Average TSS data in 2008 were available for only the intake, NA and SA. Average TSS concentrations were about 2.7 mg/L at NA and approximately 1 mg/L at the intake and at SA. While these are very low TSS concentrations, TSS is extremely variable, and can rise by several orders of magnitude during storm events. For example, maximum TSS has been measured at 118 mg/L at station NH over the period of record. On the South Branch, a maximum TSS of 68 mg/L was measured at SG. Both of these maximum values occurred on 12/8/1999.

Generally, soils that contain a higher percentage of silt are more likely to erode during storm events and create TSS issues within the streams (**Figure 2-4**). The Technical Analysis Report (Task 3) noted that stream flashiness is increasing within the Metedeconk which will result in an increase in erosion of the stream banks.

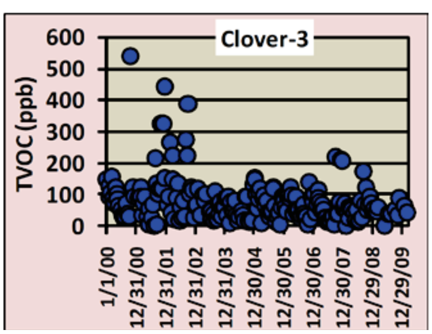
The surface water quality standard for TSS is 25 mg/L for the FW2-TM reach and 40 mg/L everywhere else. TSS is listed as an impairment to Muddy Ford Brook (see **Table 3-1** below).

3.1.4 Toxic Chemicals/VOCs

The use of VOCs as solvents and degreasers became widespread beginning in the mid-1940s. VOCs are also present in products such as paint, cleaning agents, deodorants, adhesives, and polishing products that were commonly used by industries, commercial establishments, and homeowners without disposal restrictions until the mid-1970s, when VOCs began to be detected in groundwater. VOCs can be both mobile and persistent in the natural environment and many are known carcinogens.

As almost 70% of the total flow in the Metedeconk River is composed of baseflow, it is not surprising that VOCs within the groundwater system would be detected in baseflow samples. However, as VOCs volatilize, they are not stable in a surface water environment and concentrations are expected to be below those typically found in groundwater. Therefore, since VOCs are volatile, other than direct spills, the likely source of the VOC contamination is through groundwater. NJDEP drinking water standards are as low as 1 ug/L for many commonly detected VOCs (benzene, trichloroethene (TCE), tetrachloroethene (PCE), etc); although the SWQS is lower in some cases (0.15 ug/L for benzene, for example).

Within the coastal plain, it is not uncommon to detect low concentrations (below the drinking water MCL) of VOCs within streams (Nicholson et al, 2003). Nicholson et al (2003) discuss that in general, the most frequently detected VOCs in surface waters in this region are MTBE, chloroform, TCE, PCE, and 1,1,1-trichloroethane (TCA), which have also been detected in streams on Long Island (CDM, 2006). Volatile organic compounds have been monitored by BTMUA for several years. As shown in the Technical Analysis Report, VOCs are somewhat ubiquitous within the watershed and at least some detections are present throughout the watershed (see Figure 4-12 in Technical Analysis Report). There are 76 known contaminated sites (or point sources) within the watershed, as documented by NJDEP (**Figure 3-2**).



Total volatile organic compounds measured at BTMUA sampling station Clover-3

The "Clover-3" and "POND-6" BTMUA monitoring stations (**Figure 3-2**) are routinely monitored for VOCs by BTMUA as they are known sites of VOC contamination. Clover-3 is located adjacent a former coal gas plant in Lakewood Township and POND-6 is located adjacent an asphalt plant in Brick Township (both were sites for stream visual assessments). Additional monitoring stations that have historically shown very high concentrations of VOCs are NO (within NB1), STM-1 (within NB2), NF14 (within NB5), TR13-2 (within SB3) and SE1 (no longer monitored; within SB4).

3.2 Identified Impairments

Although water quality is generally considered good in the Metedeconk watershed, nearly every subbasin in the Metedeconk River Watershed is currently listed on the New Jersey 2010 303(d) list of water quality limited waters for one or more of the following parameters: dissolved oxygen, temperature, TSS, phosphorus, arsenic, and mercury. In addition, the pesticides DDD, DDE and DDT are listed as impairments within NB1 and polychlorinated byphenyls (PCBs) are listed as an impairment in SB3. More imperatively, multiple TMDLs have been established by NJDEP to address pathogen and phosphorus impairments. A full listing of water quality impairments by subbasin, listed on the 2010 303(d) list are shown in **Table 3-1** and are discussed below.

Also shown on **Table 3-1** are the additions of lead and turbidity to several of the subbasins based on the 2012 Draft 303(d) list of water quality limited waters. Note that dissolved oxygen has been de-listed from all subbasins on the draft 303(d) list. Also, arsenic has been de-listed as an impairment from several watersheds as well.

3.2.1 Total Maximum Daily Loads (TMDLs)

Total Maximum Daily Loads (TMDLs) are developed to address impaired water bodies listed by NJDEP on Sublist 5 of the *Integrated List of Waterbodies.* TMDLs exist for fecal coliform, total coliform and phosphorus in the Metedeconk River Watershed. As mentioned above, the fecal and total coliform is being used as indicators for pathogens. Currently, E. coli and enterococci have been shown to be improved indicators of pathogens. In addition, a TMDL for mercury in fish tissue also exists for the Metedeconk River, although the source of the mercury is from air deposition and it is likely that the source of mercury is outside of the watershed.

3.2.1.1 In-Stream Fecal Coliform TMDL

A fecal coliform TMDL was established for the Metedeconk River because both the North Branch and the South Branch are listed on Sublist 5 of the *2002 Integrated List of Waterbodies* as impaired for pathogens, as indicated by fecal coliform. The fecal coliform SWQS are defined in N.J.A.C 7:9B-1.14(c), which states that fecal coliform levels should not exceed a geometric average of 200 cfu/100 ml nor should more than 10 percent of the total sample taken during a 30 day period exceed 400 cfu/100 ml in FW2 waters.

3.2.1.2 Lakes Fecal Coliform TMDL

Fecal coliform TMDLs were also established for two lakes within the Metedeconk River Watershed. Lake Carasaljo and Ocean County Park Lake are listed as High Priority on the *2004 Integrated List of Waterbodies* and Sublist 5 of the *2006 Integrated List of Waterbodies* for fecal coliform impairment.

3.2.1.3 Total Coliform TMDL

The Metedeconk River discharges into Barnegat Bay, which is also impaired for total coliform. The SWQS in New Jersey specify that shellfish waters shall meet National Shellfish Sanitation Program (NSSP) guidelines. Waterbodies are listed as impaired if they do not fully support shellfish harvest in accordance with National Shellfish Sanitation Program (NSSP) criteria. TMDLs were developed to meet the NSSP.

Source assessments were conducted to identify and characterize potential pathogens sources that may be impacting water quality and shellfish growing areas in the listed waters. Shoreline surveys, an analysis of land use, point source information, literature sources, and other available data were used in the source assessment. The Metedeconk River estuary was included in the Local Area Report (LAR) completed for the BB-1 shoreline survey area. The BB-1 shoreline survey area is defined as Barnegat Bay North, areas from Bayhead to Bay Shore. LARs provide information on local shellfish growing areas with a characterization of the growing area, surrounding land use, and potential pollution sources in the watershed. These reports helped to develop the TMDL for the Metedeconk River by identifying potential pathogen sources that may be impacting shellfish harvest areas.

3.2.1.4 Phosphorus TMDL

The Phosphorus TMDL has been established for the North Branch Metedeconk River's westernmost HUC14 subwatershed (NB1) and is based upon impairment listed on Sublist 5 of the *2004 Integrated List of Waterbodies*. The in-stream New Jersey SWQS for phosphorus states that total phosphorus shall not exceed 0.1 mg/l in any stream, unless it can be demonstrated that total P is not a limiting nutrient and will not otherwise render the water unsuitable for the designated uses in FW2 streams.

3.2.1.5 Mercury TMDL

A mercury TMDL exists in SB4 to address mercury in fish tissue caused primarily by air deposition. Mercury emissions sources listed within the TMDL are outside the watershed and therefore, the source of the mercury in fish tissue caused by air deposition is likely outside of the watershed

The 303(d) List includes mercury in the water column within NB4. The SWQS for mercury is 0.05 ug/L in fresh water systems. Mercury is also identified as an impairment in fish tissue in NB1 and SB3. STORET data indicate the presence of mercury in the surface water within the watershed. It has also been in violation of SWQS at times at CTB-1 and NA, but average concentrations are below the SWQS.

3.2.2 Water Quality Impairments

In addition to the approved TMDLs, the Metedeconk River Watershed has waters in each HUC14 not meeting their intended uses according to the 2010 New Jersey Integrated Water Quality Monitoring and Assessment Report [303(d) list]. **Table 3-1** lists these latest impairments by HUC14 subbasin.

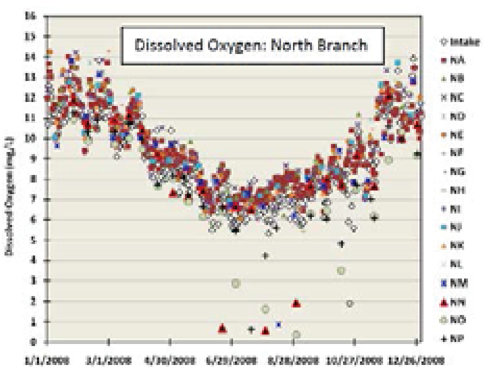
These listings, which are subject to change for each listing year, include all water quality parameters not meeting a limit designated for a particular water body use. Each of these may be assigned a TMDL beyond 2012, but are subject to changing requirements for TMDL establishment including the methods report for monitoring and assessment protocol for 2012 (2012 Integrated Water Quality Monitoring and Assessment Methods, NJDEP: http://www.state.nj.us/dep/wms/bwqsa/2012_integrated_report.htm). As of the date of this document, the 2012 Draft 303(d) list has been issued and changes from the 2010 list are included in **Table 3-1**.

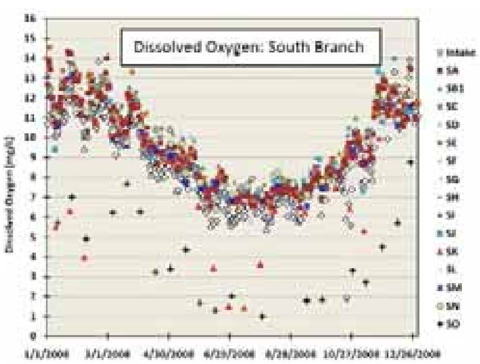
A listing of surface water quality standards pertinent to the Metedeconk River classifications is in **Table 3-2** for non-toxic parameters.

3.2.2.1 Dissolved Oxygen

Dissolved oxygen is often used as an indicator of the biological health of surface waters, and can be indicative of the degree of nutrient loading to surface waters. Since shallow moving river water tends to re-oxygenate, DO is less of an indicator for fast flowing rivers than it would be for quiescent water bodies such as lakes and ponds. Also, colder water is capable of holding more dissolved oxygen than warmer water, which results in seasonal variations in DO. Average DO for both branches is about 8 to 10 mg/l, which is relatively high and close to the saturation concentration at temperatures of around 50 to 60 degrees Fahrenheit.

The Surface Water Quality Criteria for dissolved oxygen for FW2-TM waters is 'not less than 5.0 mg/L at any time' and 'not less than 4.0 at any time for FW2-NT waters'. As described in the Technical Analysis Report, as dissolved oxygen does not drop below 5.0 at one time (in 2008) along the FW2-TM stretch, the SWQS is being maintained for that reach. However, dissolved oxygen drops below 4.0 at upstream stations along the North Branch (NM through NP) and along the South Branch at SK and SO. These stations correspond to HUC14s NB1, SB1 and SB2. This is potentially due to the amount of wetlands present in the headwaters area which can be a reducing environment (and can also provide a means for denitrification). Another potential is that excessive phosphorus loading in this area is causing some eutrophication. NB1 has a TMDL for phosphorus and VAPP scores are low for nutrient enrichment and water appearance.

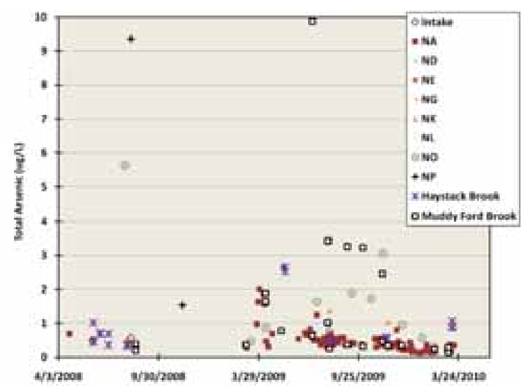




Dissolved oxygen data collected by BTMUA in 2008

It should be noted that the 2012 Draft 303(d) list does not list dissolved oxygen as a water quality impairment. However, since 2008 water quality data show that dissolved oxygen has dropped below 5 mg/L in the past, it has the potential to be re-listed on the 303(d) list in the future.

3.2.2.2 Arsenic



Total arsenic measured at BTMUA sample stations between 2008-2010.

Arsenic is in violation of SWQS at most locations but not drinking water standards. The lowest SWQS for arsenic for FW2 waters is 0.017 ug/L (for human health); although the New Jersey drinking water standard for arsenic is 5 ug/L. Available data from the USGS in 2006 indicate that total arsenic concentrations are between 0.3 and 0.52 ug/L within the North Branch (01408100 North Branch Metedeconk River at Lakewood NJ) and 0.25 to 0.57 ug/L within the South Branch (01408152 SB Metedeconk River near Laurelton NJ) which is generally consistent with concentrations recorded by BTMUA. The average arsenic concentration detected in the BTMUA database between 2008-Spring 2010 is 0.72 ug/L and a geometric mean of 0.48 ug/L (after removing an outlier sample collected on 1/19/2010 from SA). Data are somewhat skewed, however, as there are many more samples collected at NA and SA than other stations over time. For those two stations, the geometric means are 0.42 and 0.41 ug/L, respectively for dates when both sites were sampled between 2008 and spring 2010 (72 sampling events). Arsenic is also found at similar concentrations within the STORET database (0.2 to 0.72 ug/L).

In most instances arsenic is well below the drinking water standard of 5 ug/L throughout the watershed and has always been below the drinking water standard at the BTMUA Metedeconk River intake.

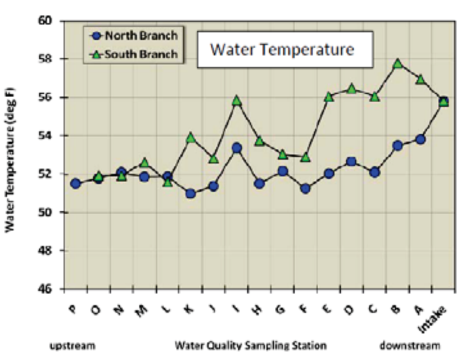
Arsenic is naturally occurring and can be released from geochemical reactions in fractured bedrock and the erosion of arsenic-bearing sulfide minerals in an oxidizing environment (Cartwright, 2004). Other sources of arsenic are industrial products such as paints, dyes and metals and also runoff from glass and electronics production facilities (EPA, 2012). The USGS reports that other sources are agricultural products in the form of fertilizers and pesticides such as sodium arsenite (herbicide) and lead arsenate (insecticide; Cartwright, 2004). These pesticides were often applied in the past at orchards, so arsenic is often associated with runoff from orchards in which pesticide residues remain in the soil. Agricultural uses of these arsenic compounds were banned by the EPA in 1988.

A USGS investigation of sources of arsenic in Raccoon Creek, located in Gloucester County, NJ noted that likely sources are from both the Kirkwood Formation as well as anthropogenic inputs from a previous land use (orchard; Barringer et al, 2011). Atmospheric deposition of arsenic within New Jersey is another source that is contributing arsenic to the Metedeconk River as reported volume-weighted arsenic concentrations in precipitation range from 0.066 to 0.16 ug/L (Reinfelder et al, 2004).

The cause of the arsenic in the Metedeconk could be from both natural and anthropogenic sources. Low concentrations of arsenic, consistent with lower concentrations found in the Metedeconk River (although higher than the SWQS) have been detected in shallow water supply wells (BTMUA unpublished data, 2010). However, concentrations throughout the watershed are detected at much higher concentrations as well. Runoff from industrial sources may be contributing to the elevated arsenic concentrations.

3.2.2.3 Temperature

The temperature criteria has been changed for the 2010 303(d) list from the previous 303(d) list (2008) and is listed as an impairment to NB2 and NB5 on the North Branch. The new temperature criteria replaces the previous criteria and calls for evaluating continuous monitoring data (collected every 15 minutes to 1 hour for weeks at a time) to evaluate the maximum temperature recorded over a 1 hour period to the SWQS criteria. Should the temperature exceed the maximum SWQS temperature on two separate days over the review period (up to 5 years), then the temperature criterion has been exceeded.



Average temperature at BTMUA water quality stations: 2008

Available data from those HUC14s has been evaluated from the BTMUA database. Both HUC14s have reaches that are classified as "Trout Management" classification for which the SWQS are that daily maximum temperature does not exceed 25 degrees C and the 7 day rolling average does not exceed 23 degrees C (**Figure 3-1; Table 3-2**).

Temperature data are collected daily by BTMUA at the intake and water quality stations NA and SA, which are both located immediately upstream of the confluence and located in NB5 and SB5, respectively. Moving upstream and still within NB5, temperature at stations NB, NC and ND, NE and NF is recorded once every 1-2 weeks. Data are also recorded on a weekly or bi-weekly basis at stations NG through NK within NB2, although data beyond 2008 are lacking for stations NH and NJ.

Maximum daily temperature within the BTMUA database for sampling stations within NB2 and NB5 was recorded at station NF and was 23.04 degrees C on 7/23/08. Hourly or continuous data were not made available to conduct a more detailed evaluation. Based on BTMUA water quality data, the criteria are met in recent data, but are not always met in previous years.

One cause for elevated temperatures is a lack of tree or canopy cover over the river which would otherwise provide shade. Average temperature within the watershed increases downstream, due to the increase in development and reduced vegetative cover.

3.2.2.4 Total Suspended Solids (TSS)

As shown in Table 3-1, TSS is listed as an impairment for NB4. As shown on **Figure 2-4**, some soils within NB4 have a moderate erosion potential. It is possible that those soils are causing the impairment. Although not listed as an impairment in SB5, field investigations have noted excessive sediment within roadways which is also consistent with **Figure 2-4**.

3.2.2.5 Pesticides

DDT and its breakdown products DDE and DDD are listed as impairments within NB1. DDT was a widely used pesticide, but hasn't been used for domestic uses in the United States since 1972. However, it is still used in other parts of the world and is atmospherically deposited in very low concentrations (pg/m3). SWQS for human health are 0.00022 ug/L for 4,4-DDT and 4,4'-DDE and 0.00031 ug/L for 4,4'-DDD.

Chlordane in fish tissue is listed as an impairment within NB1 and SB3. Chlordane was a widely applied pesticide between 1948 and 1988 when it was banned for use in the United States by the EPA (http://www.epa.gov/ttn/atw/hlthef/chlordan.html).

3.2.2.6 Polychlorinated byphenyls (PCBs)

PCBs are listed as an impairment within SB3. The SWQS for PCBs is 0.000064 ug/L for human health and 0.014 ug/L for aquatic-chronic health. PCBs have been used in a variety of commercial and industrial products since the late 1920s, but have been banned since 1979 (http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/about.htm). Sources of PCBs to the environment in modern periods can be through the improper disposal of products containing PCBs, leaks from electrical transformers which may contain PCBs, and through the burning of wastes which contain PCBs. They can persist for a long time in the environment and are mobile in air.

3.2.2.7 Other

Lead has infrequently exceeded SWQS but average concentrations are below SWQS throughout the watershed, based on the 2008 data set used for much of the analysis. However, lead is listed as an impairment on the 2012 Draft 303(d) List within NB1, SB1, NB5 and SB5. Sources are listed as urban runoff and also industrial in NB1.

Benzene has been detected at concentrations in violation of SWQS at Clover 3, NF14, SE2, SE3, SE4, SE5, and the Stanley Boulevard station. Other specific VOCs that have been detected at concentrations exceeding the SWQS are:

- Bis(2-ethylhexyl) phthalate (DEHP) – NF14
- 1,2-Dichloropropane - NA, SA, SE
- Hexachlorobutadiene - Clover 3
- Tetrachloroethene (PCE) - NB, NF14, POND2, POND6 (also sites A-D), TR13-1, TR13-2
- Trichloroethene (TCE) – POND6A-C, TR13-1, TR13-2
- Vinyl Chloride – NF14, POND6(A-C), TR13-2

Floatables and excessive siltation at culvert running beneath Pine Street in Lakewood Township

Routine sampling is conducted at sites with elevated VOC concentrations to monitor VOC concentrations within the river (see trend plots on Figure 4-12 of the Technical Analysis Report).

Although not listed as an impairment, trash and floatables are prevalent throughout the watershed and are in violation of the SWQS.

3.3 Visual Assessments

Eighty-three stream visual assessments were conducted throughout the Metedeconk watershed in the winter and spring of 2010. Stream visual assessments are field evaluations of stream reaches where observations of the stream's physical condition are documented and obvious problems are identified. The incorporation of visual assessment observations into the watershed analysis provides a better understanding of issues affecting the watershed, additional information on features such as storm outfalls and drainage ditches, and clearly identified problem areas and restoration targets. Because they provide a smaller scale snapshot of the condition of the watershed, the visual assessments can also be used as a benchmark for future restoration activities.

The Stream Visual Assessments Report has been completed as Task 2 of the Metedeconk River Project. Details on the assessments as well as the Visual Assessment Project Plan (VAPP) and Assessment Protocol can be found in that report.

The stream reaches were selected to be representative of the watershed and encompass a broad range of conditions, from forested headwater areas to heavily urbanized commercial centers closer to the coastline. Results from the visual assessments indicate that most sites are classified as “Fair” (36%) or “Good” (40%). Only one site was rated “Excellent” and 19 sites were rated “Poor” (23%).

An analysis of the assessment data by HUC14 subwatershed provides further insight into the relationship between land use and stream health. It is evident in **Figure 3-3** that there is a general progression of higher to lower assessment scores from the relatively undeveloped headwaters in the western areas of the watershed to the more densely developed areas in the east. SB5 is interesting in that although it is located within a heavily urbanized area and along the Route 9 corridor, it is characterized by a riparian corridor that has been left intact and large contiguous areas of open space, including two Ocean County parks. Lakes Carasaljo and Manetta immediately upstream may also have a role in moderating South Branch flows entering SB-5. CFL-1 is heavily urbanized and ranked in the lowest class, though it should be noted that stream assessments in this HUC14 were limited to the Cedar Bridge Branch due to the tidal influences on the Metedeconk River. A summary of visual assessment site rankings is shown in **Table 3-3**.

As can be seen on **Figure 3-3**, sites with poor or fair scores are characterized by reaches with steep channel banks (TR13-1) and sediment deposits (SE-P) or absent buffers (CP-3), while the good and excellent sites have adequate buffers (SL), less visible impairments to water quality (POND6), and the stream has access to the floodplain (NM). An interesting observation in the eastern area is that while many of the reaches along the tributaries have an overall score in the poor to fair range, the main stems of the North and South Branch into which they discharge have higher scores, in the fair to good range. This may be due to the fact that there is a more intact riparian area along the main stem of the North and South Branch which tends to be absent in the upstream tributaries.

Sites SA-DEN, NM, and POND6 are examples of sites with the highest scores and have excellent or good rankings. SA-DEN near Denby Avenue and Ocean Ave in Lakewood is the only site that scored an excellent ranking at 9.5. This site is along the main stem of the South Branch approximately one mile upstream from the confluence of the North and South Branches. There is an abundant riparian buffer (mostly 300 ft or greater) along this reach and no stormwater outfalls, which may be a factor in the excellent condition of the reach. This site could be considered a reference site for other sites throughout the watershed.

Infrastructure that would be considered antiquated by today's standards is prevalent throughout the watershed. Older stormwater systems were designed to simply remove stormwater from a site, with the runoff either discharged directly to the nearest waterway or temporarily held in a detention basin prior to discharge. Direct stormwater discharges to the river were found at 68 sites, and a total of 117 storm outfalls and 24 drainage ditches were cataloged. Many of the upstream tributaries in the eastern portion of the watershed are fed by stormwater.

While many of the sites scored low in habitat categories, such as pools or canopy cover, the channels were generally of good condition. While most channels showed signs of past channelization and some showed evidence of high stormwater flows, few were severely eroded. Sediment was observed in channels that receive stormwater runoff. Stormwater was conveyed to most reaches by outfalls at road crossings with no treatment. A number of the reaches were in areas that were cleared for power lines. Since the native riparian vegetation was not intact, these areas had lower scores in the habitat categories.

Other than stormwater, there were very few sources of near-stream pollutant loading identified by the visual assessments. Nearly the entire watershed is listed as impaired for fecal coliform, total coliform or pathogens and subject to adopted Total Maximum Daily Loads (TMDLs). Waterfowl were the only clear source of fecal coliform loading documented in the assessments. The results include observations of other potential sources of pathogen loading (e.g. agricultural livestock operations and septic systems) in the vicinity of the assessment sites, but no cases where these other factors were actually causing discernible problems along the reach. Phosphorus impairments are also documented in the watershed. The assessments identified only one site with a near-stream nutrient loading source, specifically site SHB1, which is located within subwatershed NB4. In this instance, nutrient-rich runoff from an adjacent nursery operation was discovered draining toward the stream and causing unusually lush vegetative growth along the stream bank.

SVA Site SHB-1

Similar to the case with fecal coliform, the assessment results include observations of other potential sources of nutrient loading (e.g. agriculture, lawn/turf maintenance, etc.) that exist in the vicinity of the assessment sites, but no other clearly identifiable problem areas.

Few stormwater BMPs were observed in the SVA survey. Numerous detention and retention basins were observed and identified as possible sites for restoration. Sites that were identified in the Stream Visual Assessment as possible candidates for restoration are summarized in **Table 3-4**.

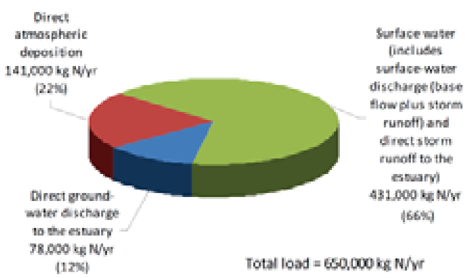
3.4 Pollutant Sources and Loading Estimates

Land Cover	TP load (lbs/acre/yr)	TN load (lbs/acre/yr)	TSS load (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/Transitional Area	0.5	5	60

Unit area loads for total phosphorus (TP), total nitrogen (TN) and total suspended solids (TSS; from NJDEP BMP Manual).

Total annual loading of nitrogen, phosphorus, and total suspended solids (TSS) was calculated for the eleven subbasins within the Metedeconk River Watershed. The analysis was performed using the 2007 NJDEP Land Use/ Land Cover dataset and land cover pollutant loading coefficients found in Table 3-1 of the NJ BMP Manual (see margin). The watershed subbasins were intersected with the land use layer, and for each land use polygon, the total acreage was multiplied by the assigned load factor. Load factors are presented as pounds per acre per year (lbs/acre/yr). The total pollutant load for each subbasin is the sum of the loads per land use within the basin area. For land use types not specifically listed in the NJ BMP Manual, some assumptions were made. For example, although not specified in the unit area load table, medium density residential was assigned a loading rate of 15 lb-N/ac/yr. A summary of loading rates assigned for each of the land use types is listed in **Table 3-5**. This approach is consistent with the methodology utilized for the phosphorus TMDL within the watershed.

It is important to note that the loads presented here are surface loads only and are not based on concentration or flow data. They are not loads within the river and do not account for losses such as denitrification through the aquifer and the hyporheic zone in the river and various streams. Nor were these loads calibrated to actual water quality and flow data. They are simply assigned as unit area loads as published in the NJ BMP Manual and are intended to highlight areas of relative significance. For example, total nitrogen load is calculated at 364,000 pounds per year, which is nearly twice the annual load discharging to the Barnegat Bay published by the USGS (Weiben and Baker, 2009). However, the USGS loads are surface water loads into the Barnegat Bay from the Metedeconk River and are based on actual water quality and flow data within the river.

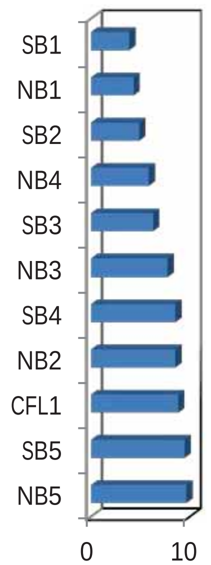


Nitrogen loading contribution to the Barnegat Bay-Little Egg Harbor Estuary from Atmospheric, groundwater and surface water sources (from Weiben and Baker, 2009).

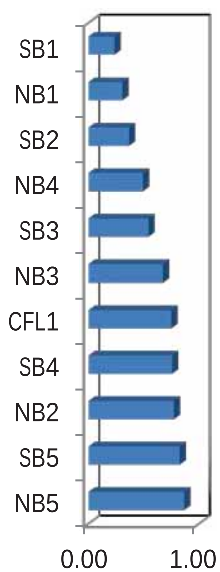
Pathogen loading was approximated by fecal coliform loading as specified within the existing fecal coliform TMDL.

3.4.1 Watershed Nitrogen Loading

Nitrogen loadings reaching the Barnegat Bay have steadily increased from the early 19th century to 1990 (Velinsky, 2011). Nitrogen loading from the Metedeconk River accounts for more than 21% of the total nitrogen load to the Barnegat Bay-Little Egg Harbor Estuary (Weiben and Baker, 2009). Valiela (2005) estimated that fertilizer applications contribute 43% of the total nitrogen load to the Metedeconk River with atmospheric deposition contributing the remaining 57%. This atmospheric contribution is significant as it represents nearly twice the atmospheric contribution to the Barnegat Bay-Little Egg Harbor



Nitrogen Loading (lbs TN/acre/yr)



Phosphorus Loading (lbs TP/acre/yr)

Estuary (22%; Weiben and Baker, 2009). Septic systems are also expected to contribute significantly to the nitrogen loading, but little information to quantify their impacts is available with regards to their distribution remaining in the larger sewered area of the Metedeconk watershed or the smaller unsewered area.

Potential sources of nitrogen contributing to concentrations found in the Metedeconk River are shown in the graphic chart on **Figure 3-4**.

Watershed nitrogen loads were analyzed on a total annual load and an annual load per acre basis. The annual load of nitrogen to the Metedeconk is approximately 364,000 lbs (165,107 kg). The largest percent is from subbasin NB2, which contributes an annual load of 59,300 lbs, which is 16 percent of the total load. NB2 is the largest subbasin; however, it ranks fourth in the nitrogen load per acre at 8.54 lbs per acre. It is above the watershed wide average of 7.27 lbs per acre. Subbasin NB5 contributes the most nitrogen per acre with an annual load per acre of 9.65 lbs. NB5 is a highly impervious subbasin. The predominant land use in subbasin NB5 is medium density residential, which accounts for 26 percent of the total land area. The headwater subbasins NB1, SB1, and SB2 contribute the least amount of nitrogen with 4.30, 3.86, and 4.88 lbs per acre per year, respectively. These subbasins are the least developed with contiguous area of forest and wetlands and, likewise, have the least amount of impervious surface area of all the subbasins.

Calculated watershed nitrogen load is shown on **Figure 3-5** and listed in **Table 3-6**.

The USGS estimates nitrogen load to Barnegat Bay from the Metedeconk River is 86,000 kg/yr (189,597 lb/yr; Weiben and Baker, 2009). This would indicate that approximately 48% of the surface nitrogen load is lost through denitrification and vegetative uptake. The area weighted load for total nitrogen and nitrate were 434.8 kg/km2/yr and 232.5 kg/ km2/yr for the North Branch and 535.5 kg/ km/m^2/yr and 348.1 kg/ m^2/yr for the South Branch (1987-2008).

3.4.2 Watershed Phosphorus Loading

Phosphorus, as a nutrient found in animal waste products and fertilizer, comes from the same sources as nitrogen, except that nitrogen is also accumulated in the watershed through atmospheric deposition. Since groundwater generally does not contribute significant phosphorus to Barnegat Bay watersheds (USGS, 2003), surface runoff is the main delivery pathway. Surface runoff comes from developed areas as well as forest and wetlands. The difference between natural loadings and excessive loadings reaching the river is in the volume of runoff reaching the stream system from the various ecosystems within the watershed.

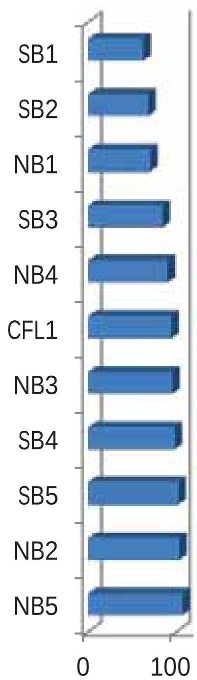
Watershed phosphorus loads were analyzed on a total annual load and an annual load per acre basis. The annual load of phosphorus to the Metedeconk is approximately 31,000 lbs. The largest percent is from subbasin NB2, which contributes an annual load of 5,400 lbs, which is 17 percent of the total load. NB2 is the largest subbasin; however, it ranks third in the phosphorus load per acre at 0.77 lbs per acre. It is above the watershed wide average of 0.62 lbs per acre. Subbasin NB5 contributes the most phosphorus per acre with an annual load per acre of 0.87 lbs. NB5 is a highly impervious subbasin. The predominant land use in subbasin NB5 is medium density residential, which accounts for 26 percent of the total land area. The headwater subbasins SB1, NB1, and SB2 contribute the least amount of phosphorus with 0.23, 0.31, and 0.37 lbs per acre per year, respectively. These subbasins are the least developed with contiguous area of forest and wetlands and, likewise, have the least amount of impervious surface area of all the subbasins.

Total phosphorus load by HUC is shown on **Figure 3-6** and listed in **Table 3-7**. As shown in **Table 3-7**, total phosphorus load is calculated as 1686 lb TP/year in NB1. The TMDL calculated total phosphorus load is approximately 1572 lb TP/year. However, 1995/1997 land use/land cover was used for that analysis. The small increase in phosphorus load in that watershed can be attributed to the increase in development that has occurred since 1995/1997 (see **Table 2-8)**.

3.4.3 Total Suspended Solids Loading

Total suspended solids (TSS) loading was calculated throughout the watershed using the TSS unit area loads in the NJ BMP Manual. However, besides these land use based loads, another source of TSS is the stream banks. As higher flows move through the river and streams, easily erodible banks can contribute significant TSS to the water column. In addition, soil type and erosion potential (see **Figure 2-4**) is not accounted for using this approach.

The more urbanized downstream basins tend to contribute the greatest total and areal weighted TSS loads. The annual TSS load to the Metedeconk is approximately 4,500,000 lbs, or 2,250 tons. The largest percent is from subbasin NB2, which contributes an annual load of 716,600 lbs, which is 16 percent of the total load. NB2 is the largest subbasin; however, it ranks second in the TSS load per acre at 103 lbs per acre. It is above the watershed wide average of 90 lbs per acre. Subbasin NB5 contributes the most TSS per acre with an annual load per acre of 107 lbs. Similar to the nitrogen loading results, the headwater subbasins NB1, SB1, and SB2 contribute the least amount of TSS with 70, 62, and 68 lbs per acre per year, respectively.



Total Suspended Solids Loading (lbs /acre/yr)

Agriculture does not seem to have a large impact on the TSS loads throughout the watershed. While agricultural land uses are assigned the highest pollutant load per land cover (300 lbs per acre per year), there is not enough land area of agricultural use to impact the subbasin wide totals. However, there may be TSS impacts in isolated areas that are not identified in this broad analysis. Subbasins NB1 and NB4 have the greatest amount of agricultural land use by subbasin with 375 acres and 310 acres, respectively. As mentioned earlier in this section, TSS is listed as an impairment to NB4 on the 2010 303(d) list. NB1 has the third lowest TSS load per acre at 70 lbs per acre, and NB4 has the fifth lowest TSS load per acre at 90 lbs per acre, which is also the watershed wide average. NB1 ranks fifth lowest and NB4 ranks third lowest in total annual TSS load. The agricultural impacts to TSS may be offset by the large amount of wetlands and generally low levels of urbanization in these subbasins.

Calculated TSS load is shown on **Figure 3-7** and listed in **Table 3-8**. Also shown on **Figure 3-7** are the soils with a medium and high erodibility potential and agricultural land use.

A summary of calculated loads by subbasin using the unit area load approach is shown in **Table 3-9**. Also shown on the table is the relative rank of each HUC for each parameter. It is further divided into aggregated land use type in **Table 3-10a-c**.

3.4.4 Pathogen Loading

Pathogens, usually measured as fecal coliform or Escherichia coli (E. coli) originate in human or animal wastes and enter the stream system through various pathways. Due to characteristically variable growth and wash off rates, the loading of pathogens to a water body can vary more widely and be less predictable than nutrients or TSS. However, since pathogen sources and delivery pathways generally correspond to those of nutrients, the spatial distribution of the estimated loading rates for nitrogen and phosphorus are used to indicate loading densities for fecal coliform in stormwater. Other source delivery methods include contributions by septic systems, sanitary sewer conveyance leaks and overflows, and wildlife which are highly variable and may or may not exist in a given subbasin. Potential sources of pathogens are shown on **Figure 3-8**. The only confirmed source of pathogens in the Metedeconk watershed is geese.

SVA Site GH-1

Various livestock operations exist in the watershed such as horse farms and pasturelands, some with close proximity to streams. Cattle access to streams does not appear to be issues in the watershed as no known occurrences have been reported. However runoff from these farms has high potential to contribute pathogen loading to the streams. Additionally, the application of manure to croplands should be identified and characterized to address this potential source.

Fecal coliform loading was calculated for the Metedeconk River fecal coliform TMDL and those loading values are used by reference here. All HUC14 subbasins besides SB1 and CFL1 were included in the TMDL. Additional detail on the methodology used to calculate loads can be found within the individual TMDLs. For the North Branch, the load allocation geometric mean concentrations were calculated as follows:

- 4,641 CFU/100 mL was calculated as the load allocation for the 400 FC/100 mL standard.

For the South Branch, load allocation geometric means were:

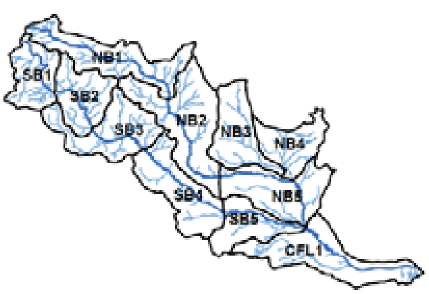
- 471 CFU/100 mL was calculated as the load allocation for the 400 FC/100 mL standard.

Load allocations calculated for Lake Carasaljo and Ocean County Park Lake are as follows:

- Ocean County Park Lake: 1.53×10^{10} colonies/year
- Lake Carasaljo: 1.54×10^{12} colonies/yr

Within the Metedeconk River estuary, existing load was calculated at 1.47×10^{16} colonies per year.

3.5 Subbasin Analysis (HUC14)



A prioritized ranking of potential pollutant sources was conducted based on the identified impairments, pollutant loading estimates, and the visual assessment results for each HUC14 subbasin. An individual analysis of each subbasin was performed to isolate and identify the most significant potential contributing areas as sources of the various pollutants to the Metedeconk River. A description of the potential pollutant sources by land use, visual assessment observations, and riparian conditions is provided for each of the 11 subbasins in the Metedeconk River watershed as they relate to water quality, water quantity, and habitat conditions. A figure depicting each subbasin is provided with the major water features (streams, wetlands, and lakes) overlain onto 2010 aerials to illustrate the land use distribution, development proximity and encroachment with respect to the riparian corridor. The following target loading sources are identified as prevalent in each subbasin and connected to the pollutants they are estimated to be contributing:

- Medium density residential runoff
- High density residential runoff
- Commercial runoff
- Industrial runoff
- Cropland and pastureland
- Livestock farms / Other agriculture
- Golf courses

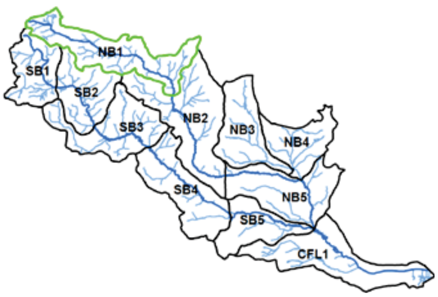
In addition to the above, while not land use types, riparian encroachment and medium to high density residential areas served by septic systems are additional issues of concern to the watershed.

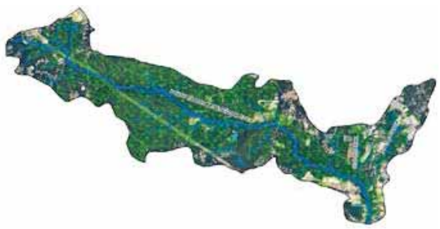
As mentioned above in Section 3.4.3, calculated loads for each general land use category are presented by subbasin in **Tables 3-9** and **3-10a-c**. For the parameters calculated in those tables (TN, TP, TSS), more specific land uses comprising the top 50% of total loading are presented in separate tables within the text below, based on the primary constituent of concern (TN, TP or TSS).

All HUC14s with the exception of SB1 and CFL1 are impaired for pathogens of which the major source is stormwater.

A summary of water quality and visual assessment data for all HUC14s is presented in **Tables 3-11 and 3-12** for the North and South Branches respectively. Although the main stems have predominantly 'Good' SVA scores, water quality degradation is apparent downstream. A shift to more intense land use (medium-density residential) is associated with lower tributary SVA scores and water quality degradation. SVA data indicate the condition of the watershed at the tributary level although water quality data are lacking in many instances.

A summary of all identified water quality impairments are listed in **Table 3-13**. As shown in the table, "runoff volume" is identified as an impairment to the watershed. Based on the SVA data, there is a correlation between impervious cover and the associated increased runoff volume leading to degraded stream channels. Since degraded conditions were reported in the visual assessments for the more developed basins, this is a pollutant of concern for these basins.

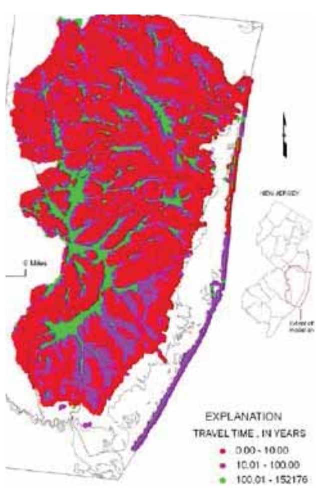




NB1

More than 75 percent of the HUC14 subbasin NB1 land use is forest and wetlands. Minimal scattered residential and agricultural land uses, mostly located on the fringes of the drainage basin, generally correspond with high water quality in this mostly undeveloped headwater subbasin. However, the establishment of one of only two TMDLs for phosphorus in the entire Barnegat Bay Watershed, established in 2005, for the North Branch Metedeconk River indicates that this subbasin is contributing excessive phosphorus to the stream system. According to the loading analysis, the largest non-point sources of phosphorus reaching the stream in subbasin NB1 are runoff from agriculture and residential uses. The 2010 303(d) List documents the source of the phosphorus impairment as fertilizer and manure.

The most upstream headwaters of the North Branch include some localized areas of large lot residential land use and a pond indicated in the Stream Visual Assessments as a possible source of nutrients. Approximately 1,029 acres of the Turkey Swamp natural lands comprised of forest and wetlands in this subbasin are protected from development as state owned Wildlife Management Areas (WMA).The amount of urban residential and agricultural land use intensifies towards the outlet of the subbasin.



Simulated groundwater travel time (after Nicholson, 2010)

On Site Disposal Systems (OSDSs) are not anticipated to be a significant source of nutrient or pollutant loading since the development is very low density (> 5 acre lots). Nor are OSDSs anticipated to be a significant source of pathogens to the river. Although OSDSs could very well be a source of pathogens, they have to be within a fairly short groundwater travel time to the river (as baseflow; pathogens not persistent along long (years) groundwater flow paths) and generally in higher density development.

The source of the pathogen impairment is listed as manure and wildlife, which is most likely attributed to geese. This subbasin includes several open water and open spaces which may be attracting geese.

The source of the non-attainment of the SWQS for dissolved oxygen could be the wetlands themselves, which can produce a reducing environment (and a means for denitrification). As the SVA indicated low scores for nutrient enrichment and water appearance, phosphorus loading could be causing some eutrophication, which would also contribute to the low dissolved oxygen levels.

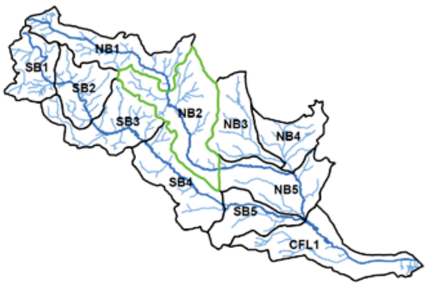
As mentioned above, the source of the arsenic is likely a combination of natural sources consisting of atmospheric deposition through precipitation and the aquifer matrix in which arsenic is being discharged with baseflow. In addition, there are some land uses listed as "ORCHARDS/VINEYARDS/NURSERIES/ HORTICULTURAL AREAS" which may be supplying arsenic through runoff from fields that were once treated with arsenic based pesticides. Although there aren't many of these uses within NB1 (only just over 26 acres), there are some upstream of BTMUA water quality sampling station "NO" which has shown elevated arsenic (numerous samples > 1 ug/L, but still below drinking water standards).

The source of the DDT and its related breakdown products is unclear. It could be the result of atmospheric deposition or potentially remnants of baseflow from the far recharge areas to the watershed. As DDT was banned 40 years ago in the United States, it is unlikely that it is an active source.

The impairment for lead listed on the 2012 Draft 303(d) List includes urban runoff and industrial land uses as sources. As there are only approximately 13 acres of industrial land use within NB1, more refined source tracking should be conducted.

Figure 3-9 illustrates the extent and distribution of wetlands and development in the NB1 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Phosphorus Loading	Percent Subbasin Area
Residential, rural, single unit	16%	8%
Cropland and pastureland	16%	4%
Other Agriculture	10%	2%
Commercial/Services	7%	1%



NB2

The largest HUC14 subbasin in the Metedeconk encompasses the mid-section of the north branch from north of I-195 to Route 9 and is split north/south by the North Branch with the majority of the area to the north in Howell Township, and the rest within Jackson Township. This subbasin is heavily developed with mostly medium density residential type land use served by a municipal sanitary sewer system. Significant development in this subbasin over the last 15 years seems to have occurred to the eastern and western portions of the subbasin. Several stormwater basins (mostly dry ponds) exist at the headwaters and along the Route 9 corridor which detain stormwater, but provide minimal treatment. Development has encroached on the riparian corridor for much of its length. A utility easement intersects the river rendering a large area of the riparian buffer cleared of forested vegetation. Over 3 miles of Route 9 transects the subbasin from north to south with a corresponding high density commercial corridor and a 3.5 mile stretch of Interstate 195 also transects the subbasin.

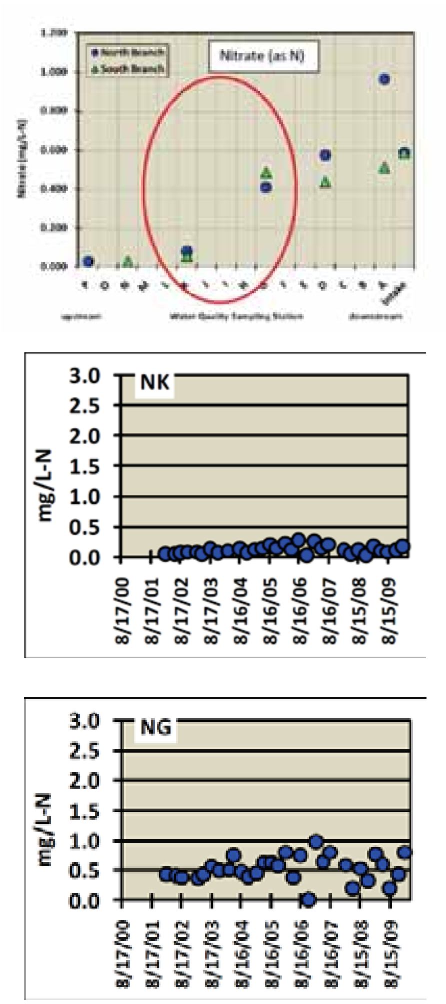
Subbasin NB2 contributes more N, P, and TSS to the Metedeconk River than any other subbasin, not only due to its size, but due to the extensive medium and low density, single family residential development (46 %) blanketing the subbasin. Nitrogen concentrations increase significantly within NB2 from low nitrogen within NB1 (from an average concentration of 0.08 mg/L to 0.41 mg/L (based on 2008 data collected by BTMUA). Increases in specific conductance/TDS are also observed as are decreases in SVA score (**Table 3-11**).

There are at least 42 stormwater basins (mostly dry ponds) predominantly located along the Route 9 commercial corridor and the more recently developed northwest area. The main stem North Branch Metedeconk River and 4 tributaries are listed as impaired for fecal coliform. Significant growth has continued throughout this subbasin in both Howell and Jackson Townships since 1995.

The source of the pathogen impairment is stormwater runoff, which transports pathogens in animal waste from pets and wildlife, primarily geese.

The cause of the low dissolved oxygen may be also attributed to the wetlands producing a reducing environment. Although not as extensive as NB1, wetlands do cover 20% of this HUC14, particularly to the northern portions. Also, it is possible that the water leaving NB1 has not yet oxygenated by the time it reaches the sampling points within NB2, as indicated by the source listed in the 2010 303(d) List (upstream wetlands).

Similar to NB1 (and for the rest of the HUC14s throughout the watershed where arsenic is identified as an impairment), the source of the arsenic is likely a



Nitrate as nitrogen at BTMUA water quality stations. Top: average annual (2008) at water quality stations along the North and South Braches; Middle: concentration of nitrate as nitrogen at Station NK, near discharge of NB1; Bottom: nitrate as nitrogen at Station NG, within HUC-14 NB2

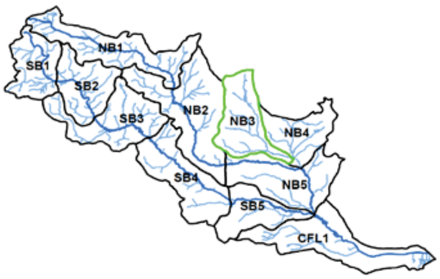
combination of natural sources consisting of atmospheric deposition through precipitation and the aquifer matrix in which arsenic is being discharged with baseflow. In addition, there are some land uses (18 acres) listed as "ORCHARDS/VINEYARDS/NURSERIES/ HORTICULTURAL AREAS" which may be supplying arsenic through runoff from fields that were once treated with arsenic based pesticides. It is also likely that some of the elevated arsenic is a result of potential excessive loading to NB1 as NK, which shows elevated arsenic, is immediately downstream of NB1.

The source of the elevated temperature which violates the SWQS in this subwatershed is not evident from readily available water quality data, although the SVA scores indicate that the canopy cover scores are low at several stations within NB2 (**Figure 3-10**). As listed in Table 3-13, the source of the turbidity impairment listed on the 2012 Draft 303(d) List is urban runoff.

Figure 3-11 illustrates the extent and distribution of wetlands and development in the NB2 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Residential, single unit, medium density	50%	29%
Commercial/services	12%	5%

NB3



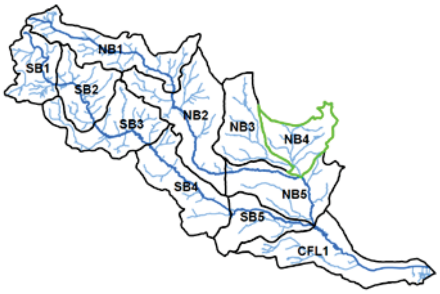
The drainage area of Haystack Brook before it confluences with Muddy Ford Brook and the North Branch Metedeconk River is entirely within HUC14 subbasin NB3 in Howell Township. Urban land uses account for about 85% of the pollutant loading in this subbasin while only covering 50% of the land. Medium density residential land use towards the north end of the subbasin and the high density commercial corridor along Route 9 comprise the majority of the urban land uses. The riparian corridor is mostly intact except at the very headwaters of the Haystack Brook tributaries and near the confluence with Dicks Brook. Visual assessment observations in this subbasin indicate poor riparian conditions throughout the subbasin. There are at least 14 stormwater basin facilities (mostly dry ponds) identified in addition to 3 lakes.

The northern portion of Haystack Brook is on the 303d list for pathogens. Although there is a large portion of this HUC14 not served by sanitary sewers, septic systems are likely not a significant source of nutrients and pathogens since the current land use and zoning is low density residential with 1-6 acre zoning (see **Figure 2-9e**). As per the 303(d) List and the TMDL, the source of the pathogens impairment is urban runoff, pet waste, waterfowl and other wildlife.

Specific conductance is also elevated within NB3, likely due to an increase in impervious cover from upstream HUC14s. Increased impervious cover is also associated with increased stormwater runoff of which urban loading and more specifically through road salt can lead to increased specific conductance. In addition to direct runoff, road salt may also be infiltrating into pervious areas and ultimately discharging as baseflow. Additional groundwater data are required to determine the likelihood of that possibility.

Figure 3-12 illustrates the extent and distribution of wetlands and development in the NB3 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Residential, medium density	47%	24%
Commercial	10%	4%



NB4

Agriculture appears to be impacting water quality in NB4 more than any other subbasin within the watershed. The 2010 New Jersey Integrated Water Quality Monitoring and Assessment Report lists phosphorus and TSS as impairments for Muddy Fork Brook. In addition, pathogens are listed as an impairment as per the fecal coliform TMDL for Tarklin Brook and Muddy Fork Brook. Nitrate levels at MF1, which is near the mouth of Muddy Ford Brook, are approximately the same level as those along the main stem of the North Branch. This is interesting because the total area draining to Muddy Ford Brook is small in comparison to the entire area draining to the North Branch. In addition, TSS loading is somewhat elevated and soils in the eastern portion of the sub-watershed have a medium-high soil erodibility rating (silty) which could be contributing to the TSS issues in the brook (see **Figure 3-7**).

The drainage area upstream of MF1 is a mixture of agriculture and residential development. Residential areas are predominantly at the headwaters of the tributaries to Muddy Ford Brook, and the streams are fed by stormwater. The SVA scores in the drainage area to Muddy Ford Brook are relatively low (**Table 3-11**). Thirteen of the 19 stormwater basins (mostly dry ponds) identified in NB4 are associated with the two new large residential subdivisions in the eastern half of NB4 (near the Ramtown section of Howell Township). Urban land use, mostly medium density residential, covers approximately 27% of the land and adds an estimated 48% of the pollutants while cropland, pastureland, and other agricultural land uses contribute about 23% of the phosphorus from 9% of the land.

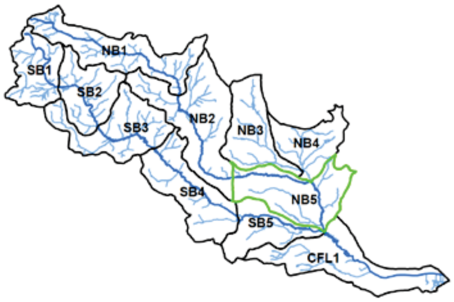
As mentioned above, the assessments identified only one site with a near-stream nutrient loading source, specifically site SHB1, which is located within subwatershed NB4. The more than 30 acres of orchard land use types may also be contributing to some arsenic loading within the subbasin. Mercury in the water column is also listed as an impairment although the cause is unknown and could perhaps be related to atmospheric deposition related to the TMDL for mercury in fish tissue. The source of the arsenic is natural sources consisting of atmospheric deposition through precipitation and the aquifer matrix in which arsenic is being discharged with baseflow.

Figure 3-13 illustrates the extent and distribution of wetlands and development in the NB4 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Phosphorus Loading	Percent Subbasin Area
Residential, medium density	24%	8%
Other Agriculture	15%	6%
Residential, rural	9%	8%
Cropland and Pastureland	8%	3%

Land Use	Percent Subbasin TSS Loading	Percent Subbasin Area
Other Agriculture	19%	6%
Residential, medium density	13%	8%
Cropland and Pastureland	11%	3%
Residential, rural	9%	8%

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Residential, medium density	21%	8%
Other Agriculture	10%	6%
Deciduous Forest	7%	13%
Residential, rural	7%	8%
Cropland and Pastureland	5%	3%



NB5

HUC14 subbasin NB5 receives flows from the North Branch Metedeconk River to the west and Haystack Brook and Muddy Ford Brook to the north, and discharges at the confluence with the South Branch Metedeconk River. The subbasin is split between Howell Township, Lakewood Township and Brick Township by the North Branch. Residential high and medium density land uses as well as commercial impervious areas dominate this subbasin with 22% impervious area, an increase of 3% since 1995. The Garden State Parkway parallels the eastern border of the drainage basin. There are about 21 identified stormwater basins controlling runoff from a small portion of the developed land area, and many older developed areas with no basins. The Woodlake Country Club interrupts the riparian corridor (wetlands) along Cabinfield Branch.

Pine Creek and Gravelly run are largely fed by stormwater inputs from large residential developments upstream. Excessive siltation was observed at the outfall at SVA site GR2 (see **Figure 3-1**). BTMUA water quality data also indicate increased nitrogen within this subbasin. Nitrogen loading is primarily due to medium and high density residential land use.

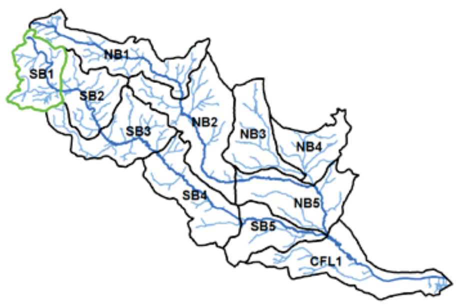
This subbasin has impairments for arsenic and temperature. The arsenic is likely naturally occurring with loading through baseflow and precipitation. There are very few orchards in this subbasin (less than 7 acres), so orchard runoff is not likely to be a significant source. Most of the water quality data collected by BTMUA at the discharge point of this subbasin (water quality station NA – refer to **Figure 3-2**) indicate arsenic concentrations well below 1 ug/L. Canopy cover scores from the SVA are low along Schoolhouse Branch and along the Route 9 corridor near NF-14, which could help explain the reason for the temperature impairment, although canopy cover scores are fairly high along most of the main stem.

Although the water quality dataset used for the technical analysis (2008) did not indicate lead as an impairment, lead is listed on the 2012 Draft 303(d) List. The source of the lead impairment has been identified as urban runoff. More than 60% of the area of this subbasin is classified as urban as per the 2007 NJDEP land use/land cover database.

NB5 is also impaired by pathogens, as per the fecal coliform TMDL.

Figure 3-14 illustrates the extent and distribution of wetlands and development in the NB5 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Residential, medium density	41%	26%
Residential, high density or multiple dwelling	15%	10%
Commercial	11%	5%



SB1

The South Branch Metedeconk headwater subbasin, similar to NB1, has extensive wetlands covering just over 50% of the land area, much of which are county owned lands. Approximately 210 agricultural acres in the northern, Monmouth County and Freehold Township portion of the subbasin account for the single largest estimated potential pollutant loading source within SB1, which has the lowest estimated pollutant loadings of all the Metedeconk River HUC14 subbasins. Interstate 195 traverses the subbasin along the southern end. SB1 is the only subbasin not listed for fecal coliform impairment in the Metedeconk River Watershed, but it does contain a reach of the South Branch Metedeconk River listed as impaired for arsenic and dissolved oxygen. Septic systems are another potential source of nutrients and in this subbasin, particularly from the industrial land uses which are not served by sanitary sewers (**Figure 3-15**).

Nearly 2,000 acres of the Turkey Swamp lands within this subbasin are protected from development as state-owned wildlife management areas (WMA). Another 569 acres are protected as Ocean County Natural Lands Trust Fund (NLTF) acquired parcels. The Turkey Swamp WMA covers most of the northern half of the subbasin, in Freehold Township and Monmouth County. The NLTF parcels cover the majority of the southern half of the subbasin in Jackson Township, Ocean County.

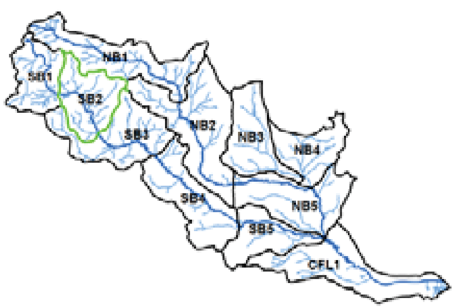
The source of the pathogen impairment is listed as manure and wildlife, which is most likely attributed to geese. This subbasin includes several open water and open spaces which may be attracting geese. Although septics are a potential source, they are not anticipated to be a significant loading source since the development is very low density.

The source of the arsenic impairment is likely natural, although the 2012 Draft 303(d) list indicates that the source of the arsenic is from agricultural activities; however, only approximately 0.2% of the subbasin is comprised of orchards, although previous land uses may have had a higher percentage. The dissolved oxygen impairment could be due to the wetlands creating a reducing environment (as per 303(d) list), but also could be due to some eutrophication resulting from phosphorus loading from the agricultural land uses and other activities which utilize fertilizer. As per the date of this draft, dissolved oxygen is not included on the 2012 Draft 303(d) list.

As with other subbasins for which lead is listed as an impairment on the 2012 Draft 303(d) list, lead was not evident as an impairment from the 2008 dataset used for the water quality analysis. Nevertheless, it is now listed as an impairment and should be addressed. Urban runoff is listed as the source of the impairment. Only 8% of the area of the subbasin is listed as urban and of that only approximately 13-14 acres is industrial.

Figure 3-15 illustrates the extent and distribution of wetlands and development in the SB1 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5). Cropland and pasture land account for 15% and 27% of the nitrogen and phosphorus load, respectively.

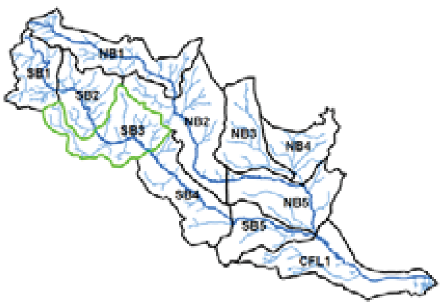
SB2



The second subbasin along the South Branch Metedeconk River contributes the second least estimated amount of pollutants to the Metedeconk River system due to its limited development. The South Branch Metedeconk River travels through the Metedeconk National Golf Club, beneath Interstate 195, and through Jacksons Mills Lake, all in Jackson Township. The riparian corridor maintains a continuous wide buffer except around the I-195 and Jackson Mills Road crossings, contributing to high overall water quality ratings. Although medium density residential contributes the greatest estimated load of N, P, and TSS, recreational lands (i.e. golf course) contribute an estimated 8% of the total load for those pollutants for the 4% of land area covered in SB2. Of the 15 or more existing stormwater basins identified in this watershed, 12 are attached to the recently constructed large subdivision on the eastern half of the subbasin and are mostly wet detention type facilities.

SB2 is also impaired by pathogens, as per the fecal coliform TMDL. The source of the pathogens is primarily stormwater, as documented by the TMDL. In addition, turbidity is listed as an impairment on the 2012 Draft 303(d) list of which stormwater is the source.

Figure 3-16 illustrates the extent and distribution of wetlands and development in the SB2 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).



SB3

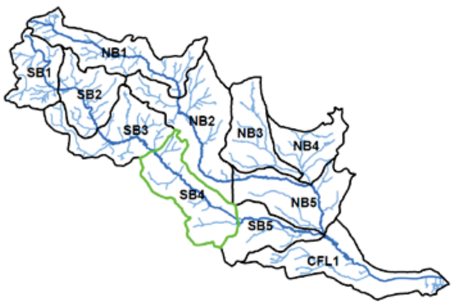
More development exists in this subbasin than upstream, leading to reduced water quality and visual assessment scores. Stormwater runoff, mostly occurring from areas north of the South Branch Metedeconk River, is the largest contributor of pollutants in SB3. Medium density residential land use comprises 12% of the area and contributes 20-31% of the N, P, and TSS loadings. Low density residential comprises 15% of the area and contributes about 17% of the loadings. Agricultural land uses (cropland and pastureland) comprise 2% of area and add 3-8% of P, N, and TSS loadings. Much of this recent urban development was constructed with stormwater detention facilities (almost all dry ponds) which provide some peak flow attenuation but minimal water quality treatment. SB3 is entirely within Jackson Township and is within the sanitary sewer service area except for portions to the very north and the southwest.

Identified impairments within this subbasin (**Table 3-13**) are consistent with an increase in impervious cover. Visual assessments have identified eroded stream banks within this subbasin. The fecal coliform TMDL identifies stormwater as the source of impairment for pathogens. Increased conductance and total dissolved solids (TDS), particularly during the winter, is likely the result of road salting which is also attributed to impervious cover. Excessive application of road salt may also be discharging into the South Branch and its tributaries as baseflow as the salt dissolves and infiltrates into the aquifer.

The transition to medium-density residential land use correlates with increased concentrations of nitrogen downstream of BTMUA sample site SI. In addition, SVA scores are primarily “Fair” and “Poor” along the tributaries downstream of station SI (**Table 3-12**). The impervious cover increases in SB3 to 13%, up from 7% in SB2.

Figure 3-17 illustrates the extent and distribution of wetlands and development in the SB3 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Residential, single unit, medium density	29%	12%
Commercial/Services	9%	3%



SB4

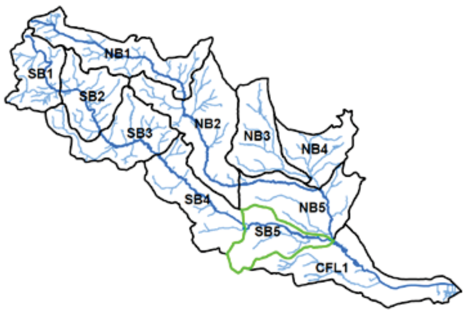
The SB4 HUC14 subbasin begins in Jackson Township and ends near the center of Lakewood Township at Lake Carasaljo and Lake Manetta. The riparian buffer along the South Branch Metedeconk River is mostly continuous and wide until about halfway through, where it passes through the Lakewood Country Club and a residential subdivision to the south encroaches on the river. Lakes Carasaljo and Manetta have very little, if any, naturally vegetated riparian buffer, and there are numerous stormwater inputs directly into the lakes from the surrounding residential development. Impervious cover of the subbasin is almost 20%. Existing stormwater detention basins (mostly dry ponds) are dispersed throughout SB4, associated with more recent development. Urban land uses (residential, commercial, etc) occupy 60% of the subbasin and are responsible for approximately 86% of the total pollutant loadings. There are at least 5 large high density residential subdivisions, two of which do not appear to have any stormwater management facilities intercepting flow prior reaching the waterway.

As shown in **Table 3-13**, this subbasin is also impaired by arsenic. Although not listed in the 303(d) List, the source of the elevated arsenic is likely due to natural conditions within the Kirkwood-Cohansey aquifer releasing elevated concentrations of arsenic to the Metedeconk River watershed as baseflow. Visual assessments have also revealed eroded stream banks, associated with flashy flows caused by increased impervious cover.

As indicated earlier in this Section, in addition for being included in the stream TMDL for fecal coliform, a TMDL for fecal coliform exists for Lake Carasaljo. An evaluation of Lake Carasaljo in 2005 (Birdsall Engineering, 2005) concluded the following:

- Primary pollutants to the lake were phosphorus and fecal coliform;
- Stormwater runoff is the primary source of pollutants to the lake;
- Waterfowl contribute a significant source of fecal coliform, but still less than stormwater;
- Turbidity is a problem and is likely due to stormwater runoff and excessive phytoplankton;
- The lake can be characterized as eutrophic due to its high nutrient concentration and excessive coverage of macrophytes, primarily fanwort.

Figure 3-18 illustrates the extent and distribution of wetlands and development in the SB4 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).



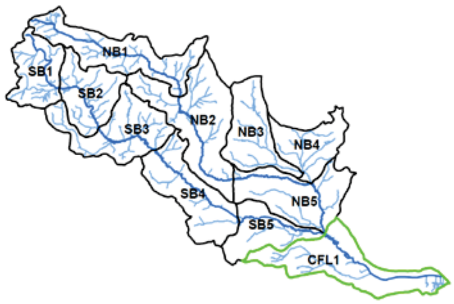
SB5

The Lakewood downtown area and Lakewood Industrial Park cover this subbasin with the highest impervious area of all the Metedeconk River Watershed subbasins, at 26% impervious. At least 32 stormwater basins are detaining urban runoff from the Lakewood Industrial Park, First Energy Park, and some of Lakewood's commercial and residential development, with direct stormwater discharges from older developed areas. Most of the remaining undeveloped area in this subbasin is zoned for medium density residential and the Cedarbridge Redevelopment Area (**Figure 2-10j**). Single unit, medium density residential land use contributes the largest percentage (26 percent) of the estimated nitrogen loadings across 15 percent of the land while commercial areas contribute the largest loadings per acre at about 25 percent of the nitrogen over 10 percent of the land. Intact riparian buffers along considerable lengths of the South Branch Metedeconk River and tributaries have been beneficial in protecting water quality and stream function in this heavily developed subwatershed.

As shown in **Table 3-13**, this subbasin is also impaired by arsenic and pathogens. The arsenic is likely naturally occurring with loading through baseflow and precipitation. The source of the pathogens is primarily stormwater, as documented by the TMDL. Mercury and lead are also listed as impairments, likely due to excessive stormwater runoff from elevated impervious cover from industrial and other urban land uses. Stream visual assessments conducted within this subbasin noted an excessive amount of floatables.

Figure 3-19 illustrates the extent and distribution of wetlands and development in the SB5 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Medium Density Residential	24%	15%
Commercial	23%	10%
Industrial	11%	7%



SVA Site CBB-3

CFL1

This subbasin is downstream of the confluence of the North and South Branches. It is heavily urbanized and includes a portion of the Lakewood Industrial Park in Lakewood Township and Brick Plaza and surrounding commercial centers in Brick Township. Residential, commercial, and industrial land uses account for the 23% impervious cover and contribute the second highest pollutant loadings to the Metedeconk River of all the watershed subbasins. Cedar Bridge Branch is heavily channelized and piped through intensive industrial and commercial areas and, as a result, received the lowest visual assessment rankings for riparian conditions. Only 9 existing stormwater basins were identified in this subbasin to control urban runoff. The Forge Pond County golf course is located just upstream of Forge Pond on the Metedeconk River. However, loading estimates from the golf course are small compared to the loadings contributed by the extensive urbanized areas.

As shown in **Table 3-13**, this subbasin is also impaired by arsenic and pathogens (Enterococcus). The arsenic is likely naturally occurring with loading through baseflow and precipitation. The source of the pathogens is primarily stormwater, as documented by the TMDL.

Figure 3-20 illustrates the extent and distribution of wetlands and development in the CFL1 subbasin (also see Land Use and Zoning in Sections 2.4 and 2.5).

Land Use	Percent Subbasin Nitrogen Loading	Percent Subbasin Area
Medium Density Residential	31%	18%
Commercial	22%	9%

Section 4 Identification of Management Strategies

Protection and restoration of the Metedeconk River Watershed entails halting impacts of further development and reversing impacts of existing development. Further development is inevitable in the watershed and if not properly managed has the potential to cause significant water quality degradation. Therefore, measures must be taken to minimize any additional impacts and mitigate the impacts that have already been realized from existing development.

Under the Phase II NJPDES stormwater rules for the Municipal Stormwater Regulation Program, municipalities with separate storm sewer systems are required to implement various control measures that should reduce bacteria and nutrient loadings. These requirements also include measures to eliminate "illicit connections" of domestic sewage and other waste to the stormwater conveyance system, adopt and enforce pet waste ordinances, prohibit feeding of unconfined wildlife on public property, clean catch basins, perform good housekeeping at maintenance yards, and provide related public education and employee training. These strategies will help to achieve the percent reductions to meet the TMDL targets.

In addition, the Stormwater Management Rules include updated performance standards for new development which include runoff controls and groundwater recharge. For example, for new major development, 100% of preconstruction groundwater recharge must be maintained or the increase in stormwater runoff following construction from a two-year storm must be infiltrated. The Stormwater Management Rules define "major development" as any development which disturbs one or more acres of land or increases impervious area by ¼ acre or more.

As time progresses and the Stormwater Management Rules are implemented, impacts to the watershed from new development will be significantly reduced relative to periods before the Stormwater Rules were developed. So, in essence, implementation of the Stormwater Rules is in fact a regional management measure. The management measures identified within this Plan are therefore targeted at previously developed or redevelopment areas. However, future stormwater management practices can be more protective of watershed function through the incorporation of progressive Low Impact Development (LID) concepts to the fullest extent practical.

Stormwater management is among the most pressing concerns for the watershed. In order to reduce pollutant loads, the volume of stormwater reaching stream system must be reduced, particularly for smaller, more frequent storms such as the stormwater quality design storm of 1.25-inches of rainfall over two hours. Antiquated stormwater infrastructure, including direct discharge outfalls and detention basins, are prevalent throughout the watershed. There is considerable opportunity for the installation of stormwater BMPs and other restoration projects to address existing problems.

Increased runoff is directly related to the loadings of each pollutant, erosion, reduced groundwater recharge and base flow, and an altered hydrologic regime entering the estuary. Runoff volume is best treated through infiltration BMPs which reduce the volume reaching the stream and improve groundwater recharge. These are particularly effective in the sandy soils of the watershed and where depth to the water table is sufficient to allow for infiltration of the collected stormwater. When infiltration capacity has been maximized, extended detention type BMPs, including variations of dry ponds, wet ponds, and wetlands, provide runoff volume control. These BMPs attenuate not just peak flows, but also regulate the magnitude and timing of flows reaching the stream channel, and provide water quality treatment.

The objectives for protection and restoration of the Metedeconk River watershed have been set by the stakeholders (see **Table 1-1**). Watershed conditions and problem areas are identified based on monitoring and loading studies. Potential causes and sources of pollutant loadings have been identified and prioritized on a HUC-14 basis in the previous section. A “toolbox” of prioritized best management practices (BMPs) has been prepared with estimated reduction efficiencies and costs. Application of these BMPs to areas and specific sites throughout the watershed is intended to optimize local and regional water quality benefit, improve in-stream conditions, eliminate use impairments, and improve aesthetic and recreational value in accordance with the watershed objectives.

In order to protect and restore the Metedeconk River watershed, management strategies commensurate with the source types, scales, distributions, and delivery mechanisms of pollutant loadings associated with impairments are identified for implementation. Also presented in this Section are management strategies for the several lakes within the watershed. Although a TMDL for fecal coliform (pathogens) is in place for two of the lakes within the watershed, other lakes have also had impacts through sedimentation, nuisance vegetation and phosphorus loading from stormwater.

The Task 5 Memorandum, *Management Strategies*, provided a comprehensive "toolbox" of available structural and non-structural management strategies. This section applies these tools to the watershed conditions described in Section 3.

The identified strategies are intended to address NJDEP's priorities of eliminating water quality impairments and maintaining the Category One non-degradation standard in the watershed, as well as the priorities of the stakeholders within the watershed, including the Barnegat Bay Partnership (estuary restoration) and Brick Utilities (water supply protection).

Load reductions required to eliminate impairments are estimated to set quantified, measureable goals for non-point and point source pollution abatement. The TMDL documents for phosphorus (sub-basin NB1 only) and fecal coliform for the watershed provide load reductions for these pollutants. A load reduction goal for nitrogen is presented herein consistent with the goal of supporting the health of the Barnegat Bay. Load reductions for other regulated impairments are generally associated with stormwater management measures.

Load reductions for arsenic are not specified as the natural background arsenic concentrations within the aquifer likely exceed the SWQS. Arsenic loading within streams is primarily in particulate form during higher flows and arsenic that is supplied through groundwater baseflow is often bound to streambed sediments. The geologic contribution to groundwater is considered to be significant (Barringer et al, 2011). Additional groundwater data within the Metedeconk River watershed would be required to make a better determination. A potential anthropogenic source is runoff from orchards, so further investigation of those land uses is recommended to address the arsenic impairment. However, it is likely that arsenic is naturally occurring and natural background concentrations may in fact exceed the New Jersey Surface Water Quality Standard (SWQS) of 0.017 ug/L.

Clearstream Court/ Ridgeway Road (2006)


Clearstream Court/ Ridgeway Road (Cty. Rte. 571) (2008)

From Ocean County Planning

Pollutants and parameters indicative of reduced water quality such as low DO and high temperatures will be addressed through more quantifiable reductions in N, P, and TSS since these pollutants are proxy metrics for these parameters.

Previous management strategies have been shown to be effective and others are currently on-going. The Ocean County Department of Planning has completed a project that was funded under the Atlantic Coastal Watershed Program Grant. The project focused on stormwater basin retrofits to improve infiltration at a number of locations. Although none of these projects were within the Metedeconk River watershed, the project was very successful and improved not only the treatment and infiltration performance of the basins, but the aesthetic value as well. Ocean County continues to be proactive with regard to basin retrofits and other stormwater pollution prevention measures including promotion of rain gardens, pet waste prevention, street sweeping and floatables control, among others (see http://www.planning.co.ocean.nj.us/watershed/stormwatermgt.htm for additional information).

Stormwater basin mitigation projects are also underway as part of New Jersey's Barnegat Bay 10-Point Comprehensive Action Plan, which was unveiled by Governor Chris Christie in December 2010. The projects are being funded primarily through principal forgiveness loans (PFLs) of which $17 Million was initially made available. One project will be completed within the Metedeconk River watershed through the first funding cycle, involving the retrofit of a large stormwater basin in Howell Township to a constructed gravel wetland. It is anticipated that a total of $100 million in funding will be made available through the New Jersey Environmental Infrastructure Trust (NJEIT) between 2011 and 2021 for similar projects. Three bills were also signed into law as part of the Action Plan. The first requires the New Jersey Department of Transportation to inventory and assess State-owned stormwater basins in the Barnegat Bay watershed and to include needed repairs or replacements in its capital project plans. The second, a new Fertilizer Law, establishes the strictest-in-the-nation standards to control the amount and content of fertilizer applied to lawns. This will significantly reduce phosphorus and nitrogen loading throughout the estuary. The third bill will improve statewide soil erosion and sediment control standards by requiring post-construction soil restoration to limit soil compaction.

Rutgers University and the Jacques Cousteau National Estuarine Research Reserve (NERR) have developed a Stormwater Management & Planning Tool for the Barnegat Bay Watershed (SWMPT) for Ocean County. This tool includes an inventory of stormwater infrastructure as well as potential mitigation sites within the Barnegat Bay watershed.

In addition to Rutgers University, Georgian Court University has been proactive in implementing stormwater management demonstration projects on its campus. It has installed a model nitrogen-reducing rain garden based on the UNH gravel stormwater basin design and is monitoring its performance and pollutant removal capability. It has also made improvements in landscape maintenance (e.g. no mow zones) and soil restoration (i.e. soil de-compaction using a Verti-Quake machine). Additional stormwater management demonstration projects for the GCU campus are in the developmental stages. GCU has some key objectives in undertaking these projects, besides decreasing the university's impact on the Metedeconk watershed. It intends to evaluate the performance of the various strategies and BMP designs so that informed decisions can be made about which will be most effective for broader application in the region. It also wishes to showcase these strategies to a wide audience and communicate and educate the public about stormwater management. Funding for this work is being actively sought by the University.

Water supply is a concern for the Metedeconk watershed. The New Jersey Statewide Water Supply Plan projects significant water supply deficits for the Metedeconk watershed based upon population growth and build-out projections. Options offered in the Water Supply Plan (1996) to help alleviate these concerns include managing the use of surface and groundwater water supplies to maximize availability (conjunctive use), aggressive water conservation programs, development of reservoir storage, and development of aquifer storage and recovery (ASR) well facilities to store water underground during low demand periods for later recovery during high demand periods. Since the 1996 Water Supply Plan was released, several water purveyors in the watershed have developed ASR facilities, and the Brick Township Municipal Utilities Authority completed construction of the 860 million gallon Brick Reservoir in 2004. The NJDEP is currently working on an updated statewide water supply plan.

Much of the water use in the watershed is depletive in nature, as wastewater is collected, treated and discharged to the Atlantic Ocean. During summer 2010, numerous water utilities in the region, including BTMUA, experienced record water demands, and a statewide drought watch was issued by NJDEP. Water conservation programs are recommended. Future water supply needs of Lakewood Township will be significant and a water supply plan for the build-out has not yet been developed.

4.1 Water Conservation

Water efficiency occurs on both the supply-side, or reductions in water losses within the utility system itself, and the demand side, primarily through direct water conservation measures from the customer, such as reduced irrigation and improved plumbing fixtures.

Water use efficiency on the supply-side is primarily conducted through the installation and proper maintenance of leak detection systems and maintenance and/or replacement of critical infrastructure components such as water mains and storage tanks. Water losses within the system, otherwise known as unaccounted for water (UAW) or non-revenue water (NRW, as preferred by the American Water Works Association), can occur through a number of circumstances. Apparent losses are due to unauthorized consumption or meter inaccuracies. Real losses are physical leaks in the distribution system. NRW is calculated simply by subtracting the volume of water usage that was billed to customers from the water that was produced at the source. Estimates of UAW can vary considerably between different water purveyors as it is a function of the age of the system and how well it is maintained. In order to better quantify and understand water losses, a water audit can be conducted on the system. Depending on the condition of the system, the percent of water that can be saved due to leak repair can be significant.

Water conservation on the demand side typically involves reducing water use in daily activities, finding and fixing leaks, replacing older fixtures and appliances with more efficient models, and reducing landscape irrigation. Efficiency improvements in landscape irrigation are particularly important and can result in significant reductions in water use during the summer, when water demands may be as much as double those in the winter.

Ideally, landscaping within the Metedeconk River watershed should be comprised of native, drought-tolerant plantings that are suitable to the soil and climate and do not require much irrigation. Rethinking traditional grass lawns, planting rain gardens and using rain barrels are particularly beneficial for outdoor water conservation. Planning ahead with consideration of things like shaded areas, taking advantage of natural runoff, using mulch, and proper soil preparation through turning, aerating and enriching with compost are also helpful.

Utilization of drought tolerant plants including trees, shrubbery and flowers coupled with native plant species that are acclimated to New Jersey weather patterns will help reduce watering duration and frequency of outdoor landscaping. Landscaping with such plants is also referred to as Xeriscaping.

Homeowners can reduce consumptive and depletive water use by choosing native New Jersey and/or drought tolerant plant species to shade and landscape their home and property with.

The installation of drought tolerant and native species plants will allow homeowners to use less water, if any, to irrigate and properly hydrate their landscaping. This landscaping will stay lush and provide a favorable appeal, while reducing the amount of water required for residential outdoor uses. Water savings will be most noticeable during the summer months when irrigation needs are at their peak. A water savings of up to 15% can be achieved.

In general, landscaping requires 1 to 1.5 inches of water each week to thrive. During lower than average precipitation months during the growing season or when precipitation is not distributed consistently throughout the month, supplemental water may be required. However, automatic irrigation systems that water lawns each day, including rainy days, can often exceed the targeted one inch of precipitation per week. Although the amount of water delivered to a lawn by a sprinkler system varies depending upon the distribution system pressure, the sprinkler setting and the duration of sprinkling, it is estimated that about an inch of water is provided by an hour of sprinkling (United Water Suez). Therefore, watering a lawn for just 15 minutes each day would provide almost twice as much water as the lawn requires, even if there were no precipitation events during that week.

While the public has become increasingly aware that both water and money can be saved by turning off inground sprinkler systems during precipitation events, casual observation indicates that sprinkler systems on a number of properties continue to operate even during rain events. An ordinance should be established to require that all new in-ground sprinkler systems incorporate a sensor that would turn the system off when a pre-specified amount of precipitation is detected. The use of soil moisture and rain sensors, whether voluntary or mandatory, would reduce summer time pumpage, although not necessarily peak demand.

Empirical studies have shown that outdoor water use is more responsive to price than indoor use, especially during the summer months when outdoor use is greatest. Because outdoor use tends to be more discretionary than indoor water use, people are more willing to reduce outdoor water use as prices increase. Because outdoor water use occurs mainly in the peak summer months, the costs of providing outdoor peak demand can be increased; outdoor use should be priced at a higher rates during peak periods of the year, both to help to recover the incremental cost of providing water during peak periods and as an inducement to conserve water because of seasonally limited supplies. AWWA reports that “conservation rates have proven to be an effective tool for reducing peak season demand” (AWWA, 1997). A recent Water Environment Federation (WEF, 2010) study reported that saving money was the most frequently identified factor motivating conservation.

Conservation based rate structures have been used successfully to reduce water demands in arid regions (Albuquerque, NM and Phoenix, AZ), in rapidly developing areas (Cary, NC), and in nearby suburban areas with similar household characteristics (Rockland County, NY). Conservation based rate structures can include inclining rate blocks, seasonal rates, and excess use charges. Developing the appropriate rates and definition of 'excessive water use' is one challenge that water suppliers face when establishing rate structures to motivate conservation. However, rate structures have been shown to be effective in a number of different settings.

Some additional measures commonly used to promote water conservation include the development and/or continuation of customer education programs, and odd-even lawn watering days, enforced through a municipal ordinance.

4.2 Anticipated Load Reductions Required

Pollutant loadings were estimated from existing land use data for the entire watershed to quantify the impacts that various source areas are having on the stream system and leading to impairments. Loading reductions are required to protect and restore the natural conditions of the watershed as measured by concentrations of pollutants in the stream system water and sediments. Loading reductions have been quantified for phosphorus, total suspended solids, and lake fecal coliform in the HUC-14 sub-basins with impairments for these constituents, and for nitrogen and stream fecal/total coliform across the entire watershed.

Load reductions required to meet intended uses depend on the use definition and other complex variables. Required load reductions for specific impairments in the form of TMDLs have been evaluated and established for phosphorus and coliform in streams, lakes, and the Metedeconk River Estuary. TMDLs and corresponding load reductions for other documented impairments (i.e. arsenic, temperature, dissolved oxygen and mercury) may be forthcoming from NJDEP in the future, pending further evaluation.

In addition to the state mandated reductions to meet TMDLs and the potential load reductions associated with current 303d listed water bodies, reduction of nitrogen loading to the Barnegat Bay is necessary to restore ecosystem health of the bay.

4.2.1 Total Maximum Daily Loads (TMDLs)

As discussed in Section 3, TMDLs exist for fecal coliform, total coliform and phosphorous and significant load reductions are required as listed in **Table 4-1**. The TMDL for both the North Branch and South Branch Metedeconk River is a 90% load reduction of fecal coliform.

The TMDL for Lake Carasaljo is an overall watershed load reduction of 99% to 15,300 million fecal coliform colonies per year, and the TMDL for Ocean County

Park Lake is an overall watershed load reduction of 96% to 691 million fecal coliform colonies per year.

The TMDL for the Metedeconk River Estuary is an 87% reduction in total coliform load. The loads contributed by forest lands and barren lands were not reduced in the TMDL allocation, therefore the load reduction is to be applied to urban areas, agricultural lands, and marinas. Since the Metedeconk River empties into Subarea D of the Barnegat Bay, the TMDL for this area of the Barnegat Bay was calculated using a nested approach to account for proposed reductions in upstream tributaries. By using this approach it was determined that by meeting the TMDL of an 87% total coliform reduction in the Metedeconk River and a 41% reduction in the neighboring Beaverdam Creek Estuary, Subarea D of the Barnegat Bay would require no further action to support designated uses.

The TMDL for the North Branch Metedeconk River's westernmost HUC14 (NB1) is an overall reduction of 49.8% of the phosphorus load, which can be achieved through an 84.9% reduction in total phosphorus load from residential, commercial, industrial, mixed/other urban and agricultural land uses.

4.2.2 Nitrogen, Phosphorus and TSS Load Reduction

The difference between estimated pre-development loadings and current development loadings could be the theoretical load reduction required to fully restore the water quality entering the Metedeconk River Estuary and the Barnegat Bay. The bay ecosystem evolved to its pre-disturbance state based on the natural hydrologic regime and water quality conditions tendered by the watersheds. Restoration of native seagrass beds and shellfish, which are parts of the ecosystem functionality, are dependent on the content and character of inflows from the Metedeconk River.

The Metedeconk River and Toms River are the leading contributors to eutrophication of the bay attributed to urban runoff. Nitrogen is considered to be the primary limiting nutrient in the salt-water of the estuary and bay. Based on uniform pre-development conditions across the watershed, the nitrogen loadings for the watershed would be reduced to 150,357 pounds per year with a 3 lbs/acre/yr areal loading representative of forest and wetlands. With the current N loading estimated at 364,424 lbs/yr, the reduction goal would be 214,067 N lbs/yr, or 59%.

A more appropriate reduction goal for nitrogen in the watershed is based on the average loading rate of 4.5 lbs/acre/yr utilized for the Chesapeake Bay nitrogen reduction goals. This reduction goal would seek to cut N loading by 138,888 lbs/yr or 38% across the watershed. To achieve this goal, a 49% loading reduction would be required for all urban land use areas (from 266,384 lbs N/yr) and all agricultural lands (from 16,956 lbs N/yr).

A reduction goal for phosphorus loading was calculated also based on the Metedeconk River watershed TMDL reduction goals (for NB1). The TMDL for phosphorus calls for an 85% reduction across urban and agricultural land uses.

Target loads for total suspended solids used the NJ BMP Manual load for forest, water and wetlands to represent pre-development conditions. The load per acre as calculated in the Chesapeake Bay reduction targets results in TSS loads that exceed existing conditions. Therefore, the NJ BMP Manual approach which yields a 73% reduction was utilized.

Estimated Pollutant Load	Nitrogen (lbs/yr)	TSS (lbs/yr)	Phosphorus (lbs/yr)
Total Current Load	364,424	4,506,406	31,105
Target Load	225,535	2,004,760	7,159
Load Reduction	138,889	2,501,646	23,946
% Reduction from Urban/Ag	49%	73%	85%

A summary of load reductions by HUC-14 is shown on **Table 4-2**. The highest estimated load reductions are within NB2. These estimates of load reductions are meant to serve as the target for this Plan. Although they should be updated with additional releases of NJDEP land use/land cover databases and/or unit area load estimates, they can serve as the ultimate target for each HUC-14. As each project is implemented within each HUC-14 within the watershed, load reductions based on mass removed from the specific BMP and land uses within the drainage area of the project can be quantified so that progress within each HUC-14 can be tracked (see Section 5).

Estimating the load reductions expected for a new BMP project can be simplified depending on the level of accuracy required. Utilizing a model such as the EPA STEPL model or performing simple calculations using the unit area loadings cited in the NJ Stormwater BMP manual can provide estimates appropriate for most needs. The following general procedure outlines the steps to determine the loading expected from a given drainage area and the expected reduction in loading for a given pollutant and BMP type:

1. Determine the area of each land use type in the drainage area;

2. Multiply the area of each land cover type by the estimated loading rate from the NJ BMP Manual Table 3-1 Pollutant Loads By Land Cover (also provided in Table 3-4 of this report);

3. Sum the loadings for the drainage area; and

4. Multiply the influent loading by the reduction efficiency percentage (i.e. 0.75 for 75% reduction) for the applicable BMP and pollutant to obtain the estimated load reduction.

4.3 Selection of Management Strategies

To achieve the target load reductions as shown in **Table 4-2** and overarching watershed management objectives, management strategies from the prioritized BMPs listed in **Table 4-3**, from the Task 5 Management Strategies Memorandum, are selected to address the priority pollutants under the existing watershed conditions. Scale, reduction efficiency, cost effectiveness and stakeholder priorities were considered in ranking the prioritized BMPs. A description of each of the BMPs listed in **Table 4-3** can be found in **Appendix C**.

Management strategies were selected based on their ability to meet the goals and objectives of the study. Eight BMP functions were identified that meet one or more of the objectives. A description of the eight BMP functions is provided below.

- Reduce Stormwater Peak Flow and Total Volume: The ability to retain stormwater runoff, resulting in a reduction in the peak flow being discharged from the contributing drainage area as well as total volume.

- Improve Infiltration: The ability to infiltrate stormwater into the ground, providing a much needed increase in base flows within the watershed and a reduction of stormwater runoff.

- Promote Water Conservation and Reuse: The ability to conserve potable water through the retention and reuse of stormwater, and through simple reductions in household water consumption.

- Reduce Nutrient Loads: The ability to remove nitrogen and phosphorus from stormwater runoff.

- Reduce Sediment Loads: The ability to remove suspended solids from stormwater runoff.

- Reduce Pathogen Loads: The ability to remove pathogens from stormwater runoff.

- Improve Habitat: The creation of habitat to support wildlife abundance and biodiversity. This would also have a positive impact on water quality through reforestation of riparian buffers.

- Potential for Public Involvement: The ability of the BMP to be used as a demonstration project for the public to promote watershed education and awareness.

BMP Function	Average Relative %	Min	Max
Improve Water Quality	**24**	10	50
Improve Baseflow	**16**	0	35
Improve Habitat	**13**	3	40
Cost	**13**	0	40
Reduce Stormwater Peak Flow	**12**	5	40
Promote Water Conservation & Re	**12**	5	35
Potential for Public Involvement	**9**	0	20

Scoring values were assigned by the technical team which included members of the Project Steering Committee. Each BMP type was assigned a score from 1 (lowest) to 3 (highest) for each of the eight BMP functions based on their ability to meet the intent of the function. Stakeholder involvement was obtained with regard to the relative weight each member of the Stakeholder Advisory Committee would place on each BMP function (or how important the stakeholder felt it should be relative to the others in making decisions about which projects to implement in the future).

Management strategies that are recommended to achieve the pathogen and phosphorus TMDLs (as specified by the TMDLs) include agricultural BMPs, urban stormwater BMPs and retrofits, geese management plans, enforcement of existing pet waste ordinances, riparian buffer restoration, the identification and elimination of sewage conveyance facilities failures, and addressing inadequate on-site sewage disposal.

In addition to targeting priority pollutants, general protection and restoration through education and outreach is a priority strategy and is critical to the long term health of the watershed. The proposed education and outreach program for the Metedeconk River watershed can be found in Section 5.

4.3.1 Management Strategies

The most pervasive land use in the Metedeconk River Watershed, medium density residential, along with other urban uses, contributes excessive quantities of polluted stormwater runoff to the natural stream system. Elevated pollutant concentrations, erosion, reduced groundwater recharge and base flow, and an altered hydrologic regime entering the estuary are the results of urban runoff.

To address the loadings of sediment, nutrients, and pathogens from impervious areas and restore watershed hydrology, six primary strategies are recommended. These strategies are aimed at working with and retrofitting existing failing structures to the fullest extent possible and meet the primary objectives of the stakeholders (namely water quality improvement and the promotion of infiltration to restore the baseflow component of the river). The application of each depends on various factors including density of development, available open space, ownership, presence of existing stormwater basins, and proximity to stream:

- Retrofit existing stormwater detention basins
- Install structural BMP at existing direct outfalls
- Source control and flow path BMPs
- Resource conservation and protection
- Development of ordinances to require LID development techniques on all new and redevelopment within the watershed.
- Education and outreach

Stormwater detention basin in Howell Township (SVA Site GR4)

Retrofit Existing Stormwater Detention Basins

Detention basins in varying condition were identified in close proximity to 20 assessment sites. These basins were designed to moderate runoff flows and prevent downstream flooding, but do little to improve water quality or infiltrate stormwater. There is considerable opportunity in the watershed to retrofit existing infrastructure with stormwater best management practices (BMPs), which would reduce nonpoint source pollutant loading, enhance groundwater recharge, and help restore a more natural hydrologic function to existing developed areas. The stream visual assessments documented 49 sites (59 % of the sites evaluated) where installation of stormwater BMPs or the retrofit of basins appears feasible and beneficial. Targeted BMP retrofit projects would effectively complement the activities required under New Jersey's stormwater management regulations to reduce nonpoint source pollution.

The more recently developed areas of the watershed contain more than 200 existing stormwater basins, which presents a substantial opportunity to increase the level of treatment to the land area served by the basins. Conversion of existing dry detention ponds to more effective treatment facilities such as extended detention wet ponds, stormwater wetlands (and gravel wetlands), infiltration basins, or bioretention would require relatively minimal construction cost since the basin form is already in place.

A GIS database of all identifiable stormwater basins within the Metedeconk River watershed has been developed from the following data sources:

- Freehold Soil Conservation District
- Rutgers University Center for Remote Sensing & Spatial Analysis (CRSSA) and the Jacques Cousteau Natural Estuarine Research Reserve (NERR) Stormwater Management & Planning Tool (SWMPT) for the Barnegat Bay Watershed
    - Ocean County Soil Conservation District
    - Ocean County Municipal Mosquito Commissions
- NJDEP 2007 Land Use/Land Cover Database ("Stormwater Basins")

The GIS database is shown on **Figure 4-1**. As shown on the figure, more than 50% of the basins within the Metedeconk River watershed are detention basins. NB2 has the most detention basins and since that sub-basin also contributes the most nutrient loading within the watershed, it represents a great opportunity for retrofit.

With the exception of the stream visual assessments undertaken as part of this planning effort, field examinations of the stormwater basins in the watershed have not been conducted. Although the GIS database that was developed is a great start, individual basin evaluations are recommended to determine which should be prioritized for BMP retrofits as well as to assign a basin type to the 149 basins that are either specified as “unknown” or “not-specified”. For basins in Ocean County, the SWMPT provides a good start, highlighting potential mitigation sites.

Evaluation of existing stormwater basin performance can be conducted visually, through analysis of basin characteristics, or by sampling influent and effluent water quality. The following features inhibit stormwater basins from achieving higher levels of pollutant removal and can be assessed visually:

1. Concrete low flow channel;
2. Turf/lawn vegetative cover;
3. Short circuited flow path;
4. Significant erosion; and
5. Soil performance issues (ponding).

Recently, a Basin Ranking Matrix Field Evaluation for Ocean County has been developed (Princeton Hydro, 2012). This protocol considers many factors towards prioritizing basins including, but not limited to, site conditions, drainage area land use conditions, proximity to water resources, costs, and ease of maintenance. This ranking matrix is a useful tool which can be applied to evaluate basins that have not already been assessed (by CRSSA through the Stormwater Management and Planning Tool (SWMPT) or others).

Desktop analysis of detention time and other characteristics for a given basin can be utilized to determine if a basin and outlet structure are sized appropriately to provide maximum treatment benefit in line with the latest standards. Alternatively, results of influent and effluent water quality sampling in comparison with similar data for other facilities or numeric nutrient criteria can help identify basins performing below expectations.

Detention basin adjacent to SVA site TR13-1

The vast majority of the basins appear to be regularly mowed dry detention basins, with low flow concrete conveyance channels, and without extended detention capabilities. Modification of the outlet structure, vegetation, low flow channel, and soil de-compaction are all that is required to upgrade these existing basins. At a minimum, these basins should be encouraged to grow native vegetation which is only mowed 1-2 times per year, and to retrofit with a water quality orifice on the outlet structure. Less maintained vegetation filters pollutants, provides pollutant uptake, and promotes infiltration. The water quality orifice would extend the detention time to allow TSS and the attached pollutants to settle, providing an increased level of treatment from almost no treatment now to up to 60 percent removal for TSS, 60 percent for TN, and 50 percent for TP (general removal efficiencies for an extended detention basin). Restoring the soil permeability may also be required at these basins (it is often the case that during construction of the original detention basin, the shallow soil layers become very compacted due to the weight of the equipment, which significantly reduces infiltration potential).

Area Treated (acres)	900
Existing Load (lbs)	Medium Density Residential
TN	13,500
TP	1,260
TSS	126,000
Percent Reduction (Extended Detention Basin)	
TN	60%
TP	50%
TSS	60%
Load Reduction (lbs/year)	
TN	8,100
TP	630
TSS	75,600

Based on the total estimated area of existing stormwater basins (180 acres, based on 2007 NJDEP land use/land cover data), and by estimating a conservatively low average 5:1 ratio of drainage area to basin surface area, an estimated 900 acres of urban land use (mostly medium density residential neighborhoods) could be treated by converting these basins to extended detention (assuming all existing basins are standard detention basins). Since these existing basins provide little, if any, pollutant reduction, upgrading to extended detention capability would provide removal efficiency increases of up to 60% for TSS, 60% for nitrogen, and 50% for phosphorus. By simply retrofitting these standard detention basins as extended detention basins, an estimated loading reduction of 630 lbs per year could be realized for phosphorus, 8,100 lbs for nitrogen, and 75,600 lbs for TSS. These reductions represent around 3 to 6% of the target watershed load reductions for these three constituents (see **Table 4-2**).

Estimating the load reductions expected for a new BMP project can be simplified depending on the level of accuracy required. Utilizing a model such as the EPA STEPL model or performing simple calculations using the unit area loadings cited in the NJ Stormwater BMP manual can provide estimates appropriate for most needs. The following general procedure outlines the steps to determine the loading expected from a given drainage area and the expected reduction in loading for a given pollutant and BMP type:

1. Determine the area of each land use type in the drainage area;

2. Multiply the area of each land cover type by the estimated loading rate from the NJ BMP Manual Table 3-1 Pollutant Loads By Land Cover (also provided in **Table 3-4** of this report);

3. Sum the loadings for the drainage area; and

4. Multiply the influent loading by the reduction efficiency percentage (i.e. 0.75 for 75% reduction) for the applicable BMP and pollutant to obtain the estimated load reduction.

These basins may also have the potential to be converted into infiltration basins, stormwater wetlands, or bioretention areas, depending on the water table and soil conditions. These potential upgrades would facilitate even better reduction efficiencies for TSS, N, P as well as provide up to 90% capture for fecal coliform (NJIT, 2011).

Outfall in Howell Township discharging to the headwaters of Turtle Creek

HUC14	# Outfalls
NB1	118
SB1	39
NB2	237
SB2	93
NB3	88
SB3	276
NB4	124
SB4	318
NB5	239
SB5	240
CNFL1	255

Direct Outfall BMPs

Much of the older development, especially residential subdivisions, was not designed with stormwater basins. Instead, the stormwater drainage systems collect runoff from dwelling roofs, yards, driveways and streets and discharge it at one or more locations directly into the nearest stream with no treatment. Direct stormwater discharges to the river were found at 68 of the stream visual assessment sites, and a total of 117 storm outfalls and 24 drainage ditches were cataloged. Direct stormwater inputs typically present problems for Metedeconk River water quality and flow characteristics.

Any one of the structural BMPs providing extended detention and/or infiltration are recommended: wet ponds, stormwater wetlands or infiltration, e.g. bioretention and/or green stormwater infrastructure (infiltration tree trenches, stormwater bumpouts, pervious pavement). Collection of outfall location information and drainage areas is required to further evaluate this strategy. This process is already underway and the most recent database as per the date of this report identified more than 2,000 outfalls within the watershed (**Figure 4-2**). Drainage areas and upstream treatment (if any) should be determined to guide which specific outfalls are most critical.

Source Control and Flow Path BMPs (Private Property Scale)

There may not be ample land available to install a structural BMP to retrofit a direct discharge outfall in which case, stormwater should be treated at the source, prior to discharging to the outfall. This can be done with implementation of private property BMPs and green stormwater infrastructure throughout the neighborhood, upstream of the outfall (and associated catch basins which discharge to the outfall).

Downspout redirection, bioretention, rain harvesting (e.g. rain barrels), and impervious area reduction are all potential source control measures on private property.

Once concentrated, runoff can also be treated along the flow path before it enters the stream. Vegetated filters, swales, and infiltration can often be installed along the flow path.

Resource Conservation and Protection

In the Metedeconk Watershed, the presence of extensive headwater and riparian wetlands and forests, and the remaining high quality of water given the significant watershed development, is a testament to the ability of the natural system to attenuate and assimilate pollutant loads. In order to maintain the current level of natural treatment and ecological productivity, in accordance with the C1 designation, management of development must be the first priority, especially in the riparian corridor. The Special Resource Protection Area associated with the Category C-1 waters will protect the riparian area up to 300 feet from the stream for the river and tributaries throughout the entire watershed. In order for any encroachment to be granted, a Stream Corridor Protection Plan (SCPP) must be developed and approved by NJDEP.

Strict adherence to buffer rules restricting development within 300 feet of any stream is recommended (N.J.A.C. 7:8-5.5(h)), absent any NJDEP-approved Stream Corridor Protection Plans. Maintaining a 300 foot buffer offers protection to ecological habitats and the water quality of the Metedeconk River. There are water quality benefits to protecting habitat because of the interactions between aquatic and terrestrial ecosystems, although it is difficult to quantify. Additionally, protection from disturbance and a 100 foot buffer for wetlands above and beyond the net-zero-loss regulatory program is recommended for all wetlands in the watershed. The cost of preserving these critical resources now is much smaller than the cost of replacing their ecological and water quality services value later. These measures rely primarily on local ordinance, land use and zoning regulations.

Riparian corridor management includes not only protection, but restoration of vegetated buffers, wetlands, and streams. Buffer enhancement at several locations throughout the watershed could improve water quality and habitat conditions. Areas with cleared buffers include lakes, tributary headwaters (e.g. in sub-basin NB3), and golf courses among other scattered locations where maintained turf proceeds to the edge of the stream. The report by Barten et al (2003) identifies areas where buffer restoration may be feasible and most beneficial based on land use and other riparian characteristics.

Stream channel restoration is appropriate for significantly altered streams and streams with severely eroding beds and banks. Only a few locations observed during the visual assessment were recommended for bank stabilization and the majority of the riparian corridor appears to continue on a natural meandering pathway. For example, Cabinfield Branch, within sub-basin NB5, has been significantly altered and may exhibit unstable conditions causing erosion and sedimentation as a result. Before stream restoration is implemented, restoration of pre-development hydrologic regime should be implemented to achieve stability and ensure ecological success of the stream restoration.

The aesthetics of lakes and small ponds make them an amenity, but the absence of tall vegetation along their banks makes them attractive to Canada geese and more susceptible to direct runoff, which in turn makes them a source of pollutants. Several lakes and many small ponds exist throughout the watershed. Golf course ponds and even stormwater wet ponds intended to improve water quality may be accommodating geese, making direct contributions to elevated pathogen and nutrient concentrations in the waters. Open shorelines provide convenient access and line-of-sight safety from predators. They should be allowed to grow native vegetation which is mowed only seasonally, if at all. This native vegetation will also provide filtration of runoff otherwise carried directly to the water body. If trees are allowed to grow, they will provide shade for temperature moderation and habitat.

from Puget Sound Partnership

Ordinance Development for Integration of Low Impact Development

Regional implementation of watershed management strategies will ultimately be required to maximize the protection of the watershed. Regional implementation of BMPs can be achieved through municipal ordinances that require Low Impact Development (LID) techniques be applied to any new development or redevelopment project. These ordinances should be tailored so that infiltration of stormwater is achieved beyond what is required by the Phase II Stormwater Rules for new development and retrofit, wherever possible (zero runoff). This is particularly critical for areas that are anticipating significant growth in the coming years.

LID techniques can be applied to both new and existing development. For example, parking lots could encompass green parking designs which utilize pavers in overflow parking areas and have runoff directed to vegetated bioretention islands, as opposed to having the islands completely curbed and guttered. Curbs along streets could be eliminated by installing infiltration trenches, and the streets could be designed to be more narrow, thus generating less runoff. The purpose of LID is to manage the stormwater at the source in an attempt to mimic a natural system as much as possible (i.e. recharge).

As mentioned throughout this Plan, additional development and re-development is inevitable as the population within the watershed continues to grow. Incorporating low impact development will help minimize impacts to the Metedeconk River.


Bioretention retrofit at a parking facility (from Puget Sound Partnership, 2011).

Much information is available to help local municipalities include more rigorous LID development techniques into an ordinance. Particularly useful documentation is published by the USEPA and the Low Impact Development Center and is available online (http://www.epa.gov/owow/NPS/lid/). In fact, employing low density development techniques have actually been shown to be cheaper for developers compared to conventional design. LID will greatly minimize runoff and, therefore, large basins for managing stormwater are not needed and additional lots can be utilized. A LID ordinance was recently adopted by Los Angeles, California.

Education and Outreach

The development of an education and outreach program is critical for the health of the Metedeconk River watershed. Although implementing BMPs and retrofitting existing antiquated infrastructure with infrastructure that will treat the stormwater prior to discharge to the stream will go a long way in restoring the health of the watershed, source control of nutrient and pathogen loading is critical. In addition, education and outreach regarding water conservation and low impact development standards (new and retrofit) will also help achieve the goal of maintaining sustainable water supply while preserving natural flow regimes.

An education and outreach program has been developed for the Metedeconk River watershed and is described in more detail in Section 5 and **Appendix D**.

4.3.2 Fecal Coliform Reduction Strategies

One of the primary pollutants of concern throughout the watershed is pathogens. Stream, Lake and Total Fecal Coliform TMDLs exist for numerous segments and lakes. These TMDLs require upwards of 90% to 95% reduction of fecal coliform bacteria which is used within the TMDLs as an indicator of pathogens. Animal waste has been identified as the primary source of pathogens within the watershed, mainly from geese. The approved TMDLs recommend the following strategies for reduction in associated land use areas (as applicable to the Metedeconk River watershed):

- Urbanized areas
  - Conduct a fecal survey to narrow the scope of the major source of pathogens.
  - Organize community-based goose management programs
  - Continued and diligent implementation of the NPDES Phase II regulations, particularly those related to illicit discharges

- Implementation of cross-connection control programs
- Septic surveys to identify potential failures or close proximity to streams
- Incentive programs or requirements to connect to centralized treatment systems
- Enforcement of pet waste ordinances to reduce contribution from domestic animals
- Microbial source tracking to identify the contribution of various sources
- Requirements for targeted stormwater BMPs or urban retrofits
- Broad public education efforts

- Open space areas:
  - Within areas not utilized for recreational purposes, allow grass to grow, particularly around water areas, to discourage geese from congregating.
  - Plant additional vegetation where necessary.

- Agricultural areas
  - Support for implementation of conservation management plans
  - Fencing and/or stream buffers to limit livestock access to streams
  - Manure management for feeding operations
  - Public education and outreach

The Task 5 Memorandum, Management Strategies, highlights the following strategies as most effective at reducing pathogen loads:

- Source control

- Resource conservation and protection – Although land acquisition and preservation have been shown to be the best way to minimize impacts to a watershed, depending on what that parcel is, it may not do much to reduce pathogens from geese. Parcels of land that are purchased in the future through municipal and county open space preservation programs should couple those acquisitions with geese management. For example, if a large parcel of land near a stream or lake is acquired, part of the funding for that acquisition should be allocated to planting a natural buffer around the water body and meadow establishment within open areas near water bodies.

- Upland reforestation – re-vegetation of large tracts of barren land should be targeted.

- Agricultural BMPs – focus on livestock areas and horse farms located near streams (as per TMDL).

- Improve/repair failing septic systems – areas that remain on septic systems that are located immediately adjacent to a stream or lake should be evaluated / surveyed to determine the condition of the septic systems.

- Infiltration type BMPs – these BMPs manage stormwater through infiltration which will prolong the hydraulic travel time to the stream.
  - Infiltration basins
  - Bio-retention basins
  - Urban pre-treatment (or urban green stormwater infrastructure (UGSI): infiltration tree trenches, stormwater bumpouts, etc.

The fecal coliform TMDL implementation plan also identifies microbial source tracking (MST), which can be used to determine sources of fecal contamination. The presence of coliphages in defined contaminant areas can help to determine the sources of fecal contamination, whether they be point human, non-point human, point animal (livestock), or non-point animal such as pet waste, or wildlife. A TMDL source tracking project was completed as a result of the stream fecal coliform TMDL and Lake Carasaljo was one of the sampling sites included in the study. The results of this study, and future MST studies, can help to identify the management strategies needed to reach the target fecal coliform/pathogen TMDLs for the Metedeconk River.

4.3.3 Nutrient (specifically, P & N) Reduction Strategies

A reduction goal of up to 85% for P is targeted for the TMDL within NB1 since the in-stream water quality standard of 0.1 mg/L has not been met (as per TMDL for total phosphorus). Phosphorus load reductions are required in other portions of the watershed as well, since the phosphorus standard for lakes (0.05 mg/L) has been regularly exceeded and many water quality stations along both the North and South Branch have consistently shown phosphorus concentrations at or just above 0.04 mg/L (see Task 3 Report). Although implementation of management strategies and the resulting phosphorus reduction in NB1 will reduce the downstream phosphorus concentrations in the North Branch, the reductions may not be enough to consistently maintain concentrations below 0.05 mg/L.

In a similar fashion to how the Phase II Stormwater Rules will significantly reduce future impacts of stormwater from new development, the recently implemented statewide Fertilizer Law should drastically reduce the phosphorus load. So, assuming the new fertilizer legislation is carried out as planned, phosphorus impairments throughout the watershed should diminish over time.

Additional management strategies will still be required at agricultural and horticultural land uses as well as golf courses.

Nitrate as nitrogen is far below the drinking water standard and the FW2 SWQS of 10 mg-N/L, although ammonia has exceeded the calculated SWQS somewhat frequently (see Task 3 Report). Although concentrations of nitrate as nitrogen are not causing impairment within the Metedeconk River, concentrations of nitrate as nitrogen (and total nitrogen for that matter) are impacting the Barnegat Bay. As one of the goals of this Plan is to support the health of the Barnegat Bay, nitrogen reduction strategies are important.

Nitrogen load reductions will also be achieved through the implementation of the Fertilizer Law. Application restrictions will reduce the amount of fertilizer applied. Fertilizer cannot be applied by consumers or professionals before March 1st or after December 1st in any calendar year (consumer application is restricted to November 15th). Buffers prohibit fertilizer application within 10-25 of a water body, depending on how it is applied. Fertilizer application onto frozen ground or impervious surfaces is also prohibited which will reduce the runoff load within the watershed. Also, the requirement for slow release nitrogen (20% of total) will allow for more of the nitrogen to be retained within the root zone and utilized by the plants as opposed to leaching to groundwater. Rutgers University, through the Clifford E. & Melda C. Snyder Research and Extension Farm, has developed a Fertilizer Application Calculator which can be utilized by homeowners to determine how much fertilizer to apply to their lawns in conformance with the Fertilizer Law. The calculator is available online at: http://snyderfarm.rutgers.edu/njfertilizerlawguide.html.

The following measures have been identified as effective for reducing nutrients and should be a part of the overall watershed improvement strategy:

- Urbanized areas
  - Establish region-specific performance standards for post construction stormwater runoff controls for new development, particularly encouraging the use of runoff reduction strategies such as green infrastructure and low impact development.
  - Establish requirements for maintaining existing vegetation and minimizing directly connected impervious areas
  - Evaluate and implement retrofit projects for existing BMPs that currently provide minimal water quality treatment
  - Develop riparian buffer protection and restoration programs for existing developed areas
  - Enforce the low phosphorus Fertilizer Law
  - Establish broad public education efforts

- Agricultural areas
  - Support implementation of conservation management plans
  - Encourage fencing and/or stream buffers to limit livestock access to streams
  - Encourage manure management for feeding operations
  - Public education and outreach

The Task 5 Memorandum, Management Strategies, highlights the following strategies as most effective at reducing nutrient loads:

- Resource conservation and protection.

Constructed gravel wetland being installed in Toms River. Photo from Asbury Park Press, April 9, 2012.

- Constructed stormwater wetlands (constructed stormwater gravel wetlands are preferable) – constructed stormwater wetlands, particularly stormwater gravel wetlands, have been shown to be ideal for the removal of nutrients, especially nitrogen (UNHSC, 2009). Constructed stormwater gravel wetlands are being installed as part of the New Jersey Barnegat Bay Initiative, and various sites are being retrofitted with constructed gravel wetlands. One of the sites is a large detention basin within the Metedeconk watershed in Howell Township.

- Infiltration type BMPs – these BMPs manage stormwater through infiltration, which will prolong the hydraulic travel time to the stream.
  - Infiltration basins
  - Bio-retention basins/rain gardens
  - Urban pre-treatment (or urban green stormwater infrastructure (UGSI): infiltration tree trenches, stormwater bumpouts, etc.
  - Pervious paving

- Vegetated filter strips

- Wet ponds

4.3.4 TSS

Another key pollutant of concern in the Metedeconk Watershed is total suspended solids (TSS). Per State regulations, all new development projects must include BMPs to reduce total suspended solids by 80%. This requirement is even more restrictive in the rare cases where stormwater infrastructure must be placed within the C1 riparian buffer area.

The following measures should be considered for TSS reduction:

- Urbanized areas
  - Limits on site disturbance during construction

  - More frequent inspections and strict enforcement of existing erosion and sediment control programs
  - Proactive maintenance and operation of the drainage system, including a focus on catch basin cleaning and street sweeping (a requirement of the Phase II stormwater management rules)
  - Work with Soil Conservation Districts to help stabilize areas containing highly erodible soils
  - Evaluation and implementation of retrofit projects for existing BMPs that currently provide minimal water quality treatment
  - Riparian buffer protection and restoration programs for existing developed areas
  - Targeted stream restoration to reduce in-stream sediment loading
  - Evaluate sand spreaders and spreading procedures for highway applications
- Agricultural areas
  - Support for implementation of conservation management plans
  - Fencing and/or stream buffers to limit livestock access to streams
  - Public education and outreach

The Task 5 Memorandum, Management Strategies, highlights the following strategies as most effective at reducing TSS loads:

- Resource conservation and protection.

- Buffer and stream restoration

- Constructed stormwater wetlands (constructed stormwater gravel wetlands are preferable)

- Infiltration type BMPs – these BMPs manage stormwater through infiltration which will prolong the hydraulic travel time to the stream.

  - Infiltration basins
  - Bio-retention basins/rain gardens
  - Urban pre-treatment (or urban green stormwater infrastructure (UGSI)): infiltration tree trenches, stormwater bumpouts, etc.
  - Sand filter

- Vegetated filter strips

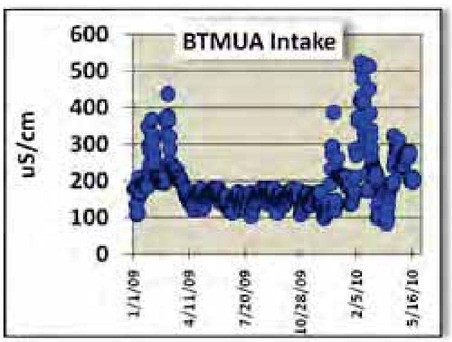
- Wet ponds

- Manufactured devices

- Off-line regional treatment.
- Agricultural BMPs

4.3.5 Specific Conductance

The technical analysis task (Task 3) indicated that the conductance values of the river water are clearly increasing throughout the watershed, in part due to road salting during winter conditions. Daily conductance values are very high following winter storm events and the monthly average has been increasing over the past 12 years, potentially due to elevated groundwater concentrations.



Specific conductance measured at the BTMUA intake between January 2009 and May 2010.

There are numerous townships and agencies responsible for road salting within the Metedeconk River watershed, including individual municipal public works departments (DPWs), the New Jersey Department of Transportation (NJDOT) and the New Jersey Turnpike Authority (NJTA). There is considerable variability in approaches to salting.

There are several BMPs for road salting that can be applied such as:

- Utilizing alternative products such as acetate deicers (calcium-magnesium-acetate, or CMA; potassium acetate (KA), sodium acetate) or organic process derivatives (Geomelt®, Ice Ban® and many others). However, the costs of some of these alternatives far exceed those of traditional road salt.
- Good housekeeping practices for storage and handling (store salt on flat impermeable pads in covered loading areas and away from water bodies; already included as a requirement in the Phase 2 Stormwater Rules). Also, expand buffers around storage facilities where possible, and use secondary containment for liquid storage.
- Applicator training to apply "just enough" and avoid over-application, including spreader calibration and procedures for automating the applicator shut down when truck is not moving (at intersections or in traffic)
- Pre-wetting – this process involves wetting the salt pile(s) with a pre-wetting solution which accelerates the process of brine formation and reduces bounce and scatter when applied to the road. Pre-wetting may reduce the application of road salt by 15-20% (UNHTTC, 2010).
- Anti-icing – application of liquid brine or other de-icing agent in advance of the storm

- Education and outreach for homeowners and private property deicing (shopping malls, industrial parks, etc).

While a combination of the above would provide the overall recommended management strategy, in order to evaluate how it would be best implemented, it is recommended that a workshop with representatives from all relevant departments and agencies be held to discuss the road salting methods currently applied by each.

4.3.6 Lake Management Strategies

Many of the lakes within the watershed have various impairments including pathogens (TMDL for Ocean County Park Lake, Lake Carasaljo), sediments and eutrophication from excessive phosphorus loading. Lake management strategies should focus on minimizing runoff which will significantly reduce nutrient and sediment load.

Community based goose management plans can be effective at reducing pathogen loading to the lakes. In addition, restoration of a thick vegetative buffer around the lake perimeter (at least 25 feet wide, as recommended by the **Phase I Diagnostic – Feasibility Study of Lake Carasaljo** (Birdsall Engineering, Inc., 2005)) can help prevent geese from gathering at or within close proximity to the lake. Community based goose management programs could include frequent visits to frighten geese away without harm (e.g. geese police).

Although the sewer service area is extensive and generally covers most medium and high density residential areas within the watershed, higher densities of on-site sewage disposal systems can contribute to the nitrogen and phosphorus problems in various lakes. Lake Enno in Jackson Township is impacted from medium-high density residential developments around the lake, which are also utilizing septic systems for waste disposal. Also, as shown on **Figure 2-8**, there are various areas in Lakewood that are medium-high density residential areas and remain on septic systems.

Hydrilla (photo from Cornell University 2011)

Nuisance vegetation is prevalent within Lake Enno, Jackson Mills Lake, Aldrich Lake, Lake Carasaljo, Lake Manetta and Lake Shenandoah. Nuisance vegetation is probably worst in Jackson Mills Lake and Lake Enno. Lake Shenandoah utilizes a harvester to remove vegetation while Jackson Mills Lake, Lake Enno, Lake Carasaljo and Lake Manetta utilize winter lake level drawdown practices to freeze the vegetation to control it.

The invasive species, *Hydrilla verticillata*, commonly known as hydrilla has recently been found in Lake Shenandoah and just downstream within the Metedeconk River. This plant species is very aggressive and has also been detected in the Cayuga Inlet in New York (Cornell University, 2011). Hydrilla can

Suspended sediment in Aldrich Lake (photo from Bing.com, 2013)

grow at a rate of 1 inch per day and strands can reach up to 25 feet in length. When it reaches the surface, it forms a thick mat which prevents sunlight from reaching other native aquatic plants along the river bottom. Early detection and management is critical to controlling hydrilla. Additional information on hydrilla can be found on Cornell University Cooperative Extension's website: http://www.nyis.info/index.php?action=invasive_detail&id=16.

As the lakes are within the flow path of the Metedeconk River and its tributaries, they act as good settling basins for TSS as it is generated during storms and other high flow events. They are therefore subject to excessive TSS loading. Lake Echo, Lake Louise and Lake Aldrich have been dredged to remove these excessive sediments. Sediment loading into Aldrich Lake may be occurring from a clearing to the northeast of the lake (south of I-195), potentially from Plover Brook, although additional investigation is necessary.

Section 5
Implementation Program

With an understanding of the watershed conditions, stressors, and potential improvement strategies, an implementation program has been developed to be consistent with the recommendations of the Stakeholder Advisory Committee, local and regional water quality improvement goals and the EPA "*Handbook for Developing Watershed Plans to Restore and Protect Our Waters*." The following sections summarize the elements of the Implementation Program.

Section 4 of this document, along with the project Task 5 Memorandum, identified potential management strategies proven to be effective in addressing the water quality improvement needs of the Metedeconk River Watershed. These strategies are listed in **Table 4-3** and are described in more detail within the Task 5 document, Management Strategies, as well as in **Appendix C**. These strategies represent the "tool-box" from which the stakeholders can select to implement within the watershed.

The ultimate plan for the Metedeconk River watershed should follow the BMP Treatment Train approach, which is defined as "a technique for progressively selecting various stormwater management practices to address water quality, by which groups of practices may be used to achieve a treatment goal while optimizing effectiveness, maintenance needs and space." The goal of the treatment train is to cost-effectively achieve pollutant reductions through source control BMPs prior to implementing more costly structural and retrofit strategies. An example BMP Treatment Train concept is presented in **Figure 5-1**.

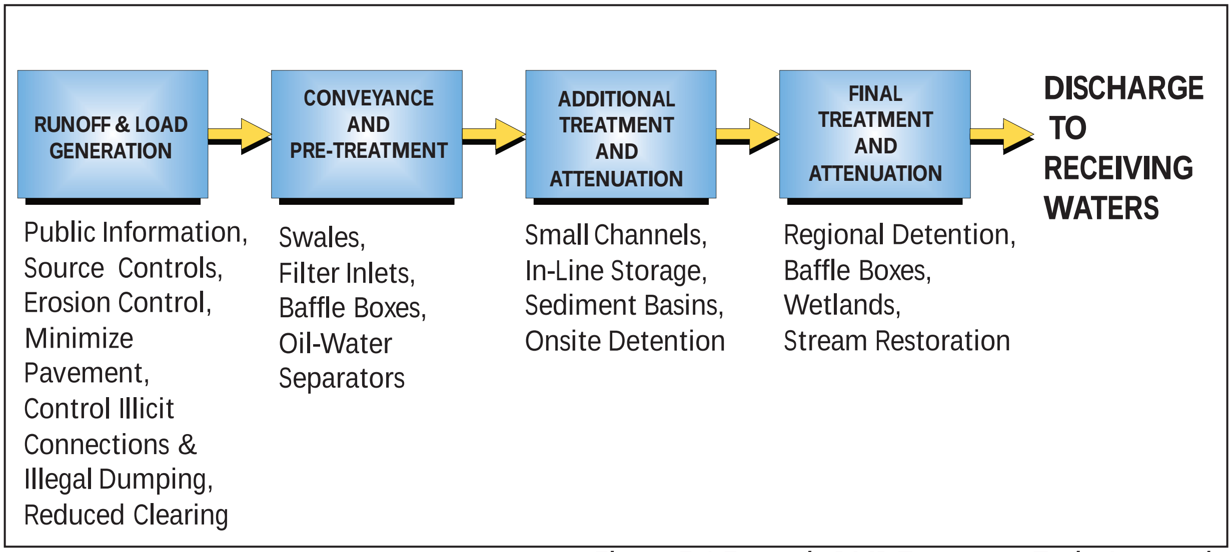


Figure 5-1 Example BMP Treatment Train Approach

As much of the Metedeconk River watershed is already developed, most of the strategies will involve retrofits into the existing community. In many cases, there is little available space at the outfall to construct a BMP. In addition, it is often the case that the outfall will be in an area where the water table is shallow and construction of an infiltration or bio-retention type BMP will not be feasible. Furthermore, in many cases, the outfall is within undisturbed portions of the C-1 buffer in which additional construction will not be permitted. Situations such as these emphasize the importance of source control through regional implementation of green stormwater infrastructure (infiltration tree trenches, etc.) and private property BMPs (rain gardens, rain barrels, etc.).

A good example of how the Treatment Train approach can be implemented in the Metedeconk River watershed is at Stream Visual Assessment (SVA) site GR2, which is located within an established residential neighborhood in Howell (see **Appendix D**). Runoff generated from this neighborhood is discharged directly to Pine Creek through a double barrel outfall. There is little land available at the discharge point to implement a BMP and treating the total stormwater at this site would be very expensive. A more cost effective approach would be implementation of private property BMPs and installation of decentralized pre-treatment facilities throughout the neighborhood to treat stormwater at the source prior to discharge to Pine Creek.

An important component of the Treatment Train approach is education and outreach. While retrofitting existing stormwater infrastructure with more advanced BMPs will provide enhanced treatment to stormwater, reducing runoff and pollutant loading at the source is critical. Providing the public with information and establishing an education and outreach program will help achieve stormwater and nutrient/contaminant load reductions.

Although implementation of the Treatment Train approach and retrofitting existing stormwater infrastructure should occur throughout the entire watershed over time, the subbasins have been prioritized based on existing water quality impairments and the amount of urban land use within each subbasin. A preliminary list of projects has also been established for each subbasin which can be further evaluated for construction as funds become available. The prioritization methodology as well as the list of individual projects is presented in the following section.

5.1 Priority Watershed Restoration Projects

On the watershed scale, management strategies involve protection of extensive wetlands and agricultural BMPs in the headwaters, restoration of encroached upon riparian buffers and moderate stormwater management in the middle subbasins, and moderate to intensive stormwater management as development density increases towards the downstream areas. As the watershed is more than 78 square miles, identifying site specific projects is a process that must be continued throughout the implementation of this Plan. The purpose of this section is to highlight priority management strategies within each subbasin and provide a list of individual projects that have been identified to date. These projects are primarily based on Stream Visual Assessments and those identified by the municipalities and other stakeholders within the watershed (as per the date of this Plan).

Property acquisition for preservation or restoration is an avenue to pursue for the watershed. The headwater subbasins NB1, SB1, NB3, and NB4, which are largely undeveloped with extensive wetland areas, present opportunities for protection from further development impacts. The Ocean County Natural Lands Trust Fund has been very successful in acquiring lands in the headwaters of the South Branch. The Monmouth County Park System has also been successful at land protection through the administration of the County and Municipal Open Space Programs, as well as preserving land within Turkey Swamp Park, along the Metedeconk River Greenway and other parcels within the North Branch watershed.

Barten et al (2003) identify areas for protection based on soil characteristics, hydrologic sensitivity, and other pertinent features. The Barnegat Bay 2020 report by the Trust for Public Land recommends specific parcels identified for critical resource value for protection and restoration. These parcels, and those identified by Barten et al (2003), should also be considered during implementation and coordinated with open space preservation programs and other land acquisition programs.

Areas of agriculture and onsite sewage disposal systems (OSDS) generally co-exist in subbasins NB1, NB3, NB4, SB1, and SB2 and require site specific application of agricultural BMPs, or dedicated study to determine the prevailing conditions of OSDS and any medium to high density residential and commercial/industrial areas which may be impacting groundwater and surface water.

Management of future development should be focused in areas that have experienced recent development and are expected to have additional development in the coming years. These areas are concentrated in the middle of the watershed where undeveloped space remains in close proximity to desirable amenities. Subbasins NB2, NB5, SB2, SB3 and SB4, mostly in Jackson and Lakewood Townships, present the most available land with the greatest anticipated growth rate.

The areas that are furthest downstream are also among the most developed. Subbasins NB5, SB5, and CFL1, contain the Lakewood Industrial Park, Brick Plaza, Downtown Lakewood Township, and the commercial corridor and marinas along Route 70. These highly urbanized areas require more intensive structural BMPs. Large extended detention and/or infiltration BMPs to address building and parking lot runoff from commercial and industrial complexes are needed. Numerous smaller BMPs should be installed in areas where a structural BMP cannot be constructed (due to a lack of available land or other constraints). The Lakewood Industrial Park is within the headwaters of Cedar Bridge Branch and should be prioritized due to the degrading impacts on the first and second order stream channels.

Portions of subbasin CNFL1 discharge directly to the estuarine portion of the Metedeconk River watershed and pollutant loading, especially nitrogen and pathogens, is a critical concern due to the impacts to the Barnegat Bay. Numerous outfalls have been catalogued along the shoreline (see **Figure 4-2**). These outfalls should be assessed and their drainage areas evaluated to determine the most appropriate management strategies to address direct stormwater runoff to the estuary. As mentioned earlier in this section, limited available space at the outfall is likely to be encountered and source control strategies should be utilized.

As decided by the stakeholders (see Task 5 Memorandum), improving water quality and baseflow are the two highest priority restoration functions within the watershed. Therefore, watershed priorities, or relative priority rankings, have been assigned based on identified water quality impairments specified on the draft 2012 303(d) List as well as the amount of impervious cover and urban land within each subbasin.

Subbasin	Number of Impairments*	Priority Ranking Based on 303(d)
NB2	6	1
NB1	5	2
NB4	4	3
NB5	4	3
SB5	4	3
CNFL1	3	6
NB3	2	7
SB1	2	7
SB2	2	7
SB3	1	10
SB4	1	10

**not including fish tissue impairments*

Subbasin priority ranking based on draft 2012 303(d) List

Subbasin	% Impervious Cover	Rank Based on Impervious Cover
SB5	26%	1
CFL1	23%	2
NB5	22%	3
SB4	19%	4
NB2	19%	5
NB3	14%	6
SB3	13%	7
NB4	7%	8
SB2	7%	9
NB1	4%	10
SB1	3%	11

Subbasin priority ranking based on % impervious cover

Subbasin	% Urban Land Use	Rank Based on Urban Land Use	Rank Based on Impervious Cover	Average
NB5	62%	1	3	2.00
SB5	55%	4	1	2.50
SB4	60%	2	4	3.00
CFL1	50%	5	2	3.50
NB2	59%	3	5	4.00
NB3	47%	6	6	6.00
SB3	45%	7	7	7.00
NB4	27%	8	8	8.00
SB2	27%	9	9	9.00
NB1	17%	10	10	10.00
SB1	8%	11	11	11.00

Subbasin priority ranking based on urban land use and impervious cover

Mercury in fish tissue is identified as an impairment in NB1 and SB3. However, the existing TMDL for mercury in fish tissue indicates that the source of the mercury is air deposition. The TMDL was based on the 2008 303(d) List which included SB4 as impaired for mercury in fish tissue and NB1 and SB3 were not listed at the time. Although the source has not yet been defined, it is quite possible that the source of the mercury in fish tissue within NB1 and SB3 is also due to air deposition which is outside the scope of this watershed plan.

Similarly, impairments of chlordane and PCB in fish tissue may also be attributed to air deposition, although the source has not been specifically identified. Impairments within NB1 for DDT and its daughter products, DDE and DDD, are also beyond the scope of this Plan as DDT has been banned for some time. Atmospheric deposition may also be a source of DDT (USEPA, http://www.epa.gov/pbt/pubs/ddt.htm). Since atmospheric deposition may be the source of the fish tissue impairments, they are not included in the analysis since they are beyond the scope of this watershed plan.

Remaining impairments were totaled for each subbasin and a relative priority ranking was established in which subbasins with the most impairments were given the highest priority. In general, the North Branch subbasins indicate a higher priority based solely on water quality impairments. Note that nitrogen is not listed as an impairment to the Metedeconk River on the draft 2012 303(d) List, but is considered an impairment to the Barnegat Bay. Subbasin ranking based on nitrogen loading is quite different than the ranking using the draft 2012 303(d) List (see **Table 3-9**).

In order to establish a subbasin priority for improving baseflow, each subbasin was ranked based on the percent of impervious cover and percent of urban land use (residential, commercial, industrial, etc., as defined by NJDEP). Priority ranking was not based solely on urban land use since low density residential developments may have large areas of "urban land use", but relatively small percentages of impervious cover. Similarly, impervious cover was not used as the sole indicator of baseflow improvement since developments may have a relatively low impervious cover, but have antiquated stormwater infrastructure which could be improved through retrofits.

A priority ranking was assigned to each subbasin based on impervious cover and a second ranking was assigned based on urban land use. A higher priority was assigned for increased percentages of impervious cover and increased acreage of urban land use. The average of the two was assigned to each subbasin. This value was averaged with the relative ranking based on water quality impairments and an overall priority ranking was assigned for the subbasins. A summary table is shown on **Table 5-1**. If average priority ranks were tied, such as the case with NB2/NB5 and NB3/SB4, then the water quality (303(d) List) priority ranking takes precedence.

As shown on **Table 5-1**, the North Branch subbasins are generally a higher priority than those of the South Branch. The highest priority subbasin is NB2, which is consistent with identified water quality impairments as well as noticeable increases in nitrogen concentration compared to NB1.

Although NB1 is relatively undeveloped with low impervious cover (relative ranking of 10 out of 11), it has an overall priority of 6 due to the number of impairments that have been identified, even without including fish tissue impairments.

The priority watershed implementation projects are listed in **Tables 5-2 and 5-3** and on **Figures 5-2 through 5-19**.

Table 5-2 lists the general types of projects within each subbasin, which are shown on **Figures 5-2 through 5-12**. **Table 5-3** lists site specific projects for the subbasins, consistent with **Table 5-2**. For example, there are numerous site specific projects for the general project type “stormwater basins retrofit”.

General project types have been prioritized by subbasin. The highest priority projects should target the existing TMDLs within the watershed through management of runoff and geese management practices. Implementing the TMDLs is the highest priority. Although it was determined that NB2 is the highest priority watershed based on identified water quality impairments and urban land use, highest priority projects focus on the phosphorus TMDL in NB1 and the pathogens TMDL in Ocean County Park Lake and Lake Carasaljo. Implementation of the in-stream fecal coliform TMDL is also a priority, though it is applied to the entire watershed, so implementing projects that reduce runoff and control geese populations will help implement this TMDL.

Buffer restoration based on sites identified by Barten et al (2003; UMASS) is temporarily assigned a lower priority in **Table 5-2**, unless it is directly associated with the implementation of a TMDL (such as Lake Carasaljo). However, it’s important to stress that buffer restoration is a critical component to the health of the watershed. Implementation of buffer restoration efforts may be complicated by privately owned property. Therefore, for the buffer restoration parcels, it is recommended that the owner of the parcel be catalogued and those parcels on publicly owned or utility owned land be prioritized within each subbasin and the priority of buffer restoration be revisited and re-assigned accordingly.

Lake management strategies are also currently being implemented, so the priority for those strategies in most lakes is relatively low but should continue.

Priorities are higher for Lake Enno and Jackson Mills Lake as Jackson Township has indicated that a more comprehensive lake management strategy is a priority.

It should be noted that a site collecting urban runoff adjacent to Route 9 in Lakewood has been prioritized as it is the largest outfall found within the watershed and represents a significant point source load to the North Branch.

It's important to note that only a small sampling of the potential projects throughout the watershed is included in **Table 5-3**. As mentioned in the opening paragraph of this section, due to the vast area of the watershed, covering more than 78 square miles, only a portion of the number potential project sites have been visited and/or more thoroughly evaluated. Although **Table 5-3** includes a relative ranking, by no means must this ranking be final. It should be continually updated as additional site specific projects become identified during Plan implementation. Nevertheless, as a number of project sites have been identified, a general ranking of them has been assigned.

The project prioritization process began with an evaluation of all 83 Stream Visual Assessment (SVA) sites to identify those project sites that not only presented one or more impairments to the watershed, but also provided opportunities for demonstration projects and public education. The SVA sites were originally selected to reflect a sampling of the major issues within the watershed and were generally evenly distributed throughout all 11 subbasins. An initial list of potential projects was identified during the Technical Analysis (Table 3-1 of the Technical Analysis Report). This list was refined through further evaluation and site visits to focus on those sites that represented the best opportunities for demonstration projects that would also help resolve watershed impairments.

Following the identification of the most pertinent Stream Visual Assessment sites, project sites that were identified by municipalities and other stakeholders were included. Although most of these sites have not been assessed by the project team either through Stream Visual Assessments or site visits, they represent known issues to each of the municipalities and other stakeholders throughout the watershed. These projects were further sub-divided based on the project team's understanding of the urgency associated with each, but they will require further evaluation through Stream Visual Assessments and engineering site visits. Basin restoration sites as identified in the Stormwater Management Planning Tool (SWMPT) developed for the Barnegat Bay have also been added to the list of projects.

Finally, the remaining project sites that were identified from Stream Visual Assessments during the Technical Analysis were prioritized. These were ranked relative to each other based solely on the SVA scores.

In summary, the individual project sites are prioritized based on the following:

- Ranking of 1 given to those sites which were deemed the highest priority based on the Stream Visual Assessments and site visits by the project team.
- Ranking of 2-5 given to those sites that were identified by the municipalities and other stakeholders.
- Ranking of 6+ given to the SWMPT projects as well as the remaining Stream Visual Assessment sites that were identified during the Technical Analysis, with priority based on the SVA score

Stormwater basin located off of Sherrybrook Drive, Howell Township (photo courtesy of J. Herrman, Birdsall Services Group, 2012).

Figures 5-2 through 5-12, coupled with **Table 5-2** serve as a general project guide, highlighting areas and general project types for each subbasin while **Table 5-3** serves as a detailed listing of individual projects which have been identified to date through stakeholder input and/or individual site visits. For each general project priority (urban runoff, TMDL, etc.), there could be more than a dozen separate projects within any particular subbasin (retrofitting existing detention basins, for example). As additional projects are identified through the stakeholders or additional investigation based on site visits to areas listed on **Figures 5-2 through 5-12**, **Table 5-3** should be updated and re-prioritized.

5.1.1 Additional Control Strategies for Implementation

In addition to the various projects and priority sites identified above, specific recommendations have been identified during the planning process. They are as follows:

1. Continued identification of regional stormwater basin projects or smaller, source-control BMP projects throughout the watershed
    a. This process has begun with a documentation of various sites during the Stream Visual Assessments and can continue using **Table 5-1** as well as **Figures 5-2 through 5-12** as discussed in the previous section.

2. Develop a Green Infrastructure/LID Demonstration program

3. Identify and eliminate direct discharges meeting specific size/drainage criteria

   a. For example, large outfalls (and owners) should be identified and the feasibility of retrofitting with a suitable BMP should be assessed based on available area and permit requirements.

4. Perform routine, stream visual assessments to identify and/or track impairments. An initial list may include parcels identified by Barten et al (2003) and the Trust for Public Land (Barnegat Bay 2020).

5. Collaborate with municipal, county and state property acquisition programs on priority property acquisitions

6. As part of its source water protection program, BTMUA routinely tracks and evaluates spill incidents, contamination problems and other environmental concerns in the watershed, and coordinates with NJDEP and other local regulatory agencies to see that these issues are addressed. Mitigating such environmental problems in a timely manner is particularly important for a water supply. This program should continue with the necessary support from NJDEP.

7. Develop a wastewater reuse pilot project and promote water conservation.
   a. Evaluate the feasibility for a water re-use project at Forge Pond Golf Course

8. Collaborate with municipal, county and state infrastructure improvement projects so that stormwater management strategies can be incorporated. Incorporating stormwater projects into an existing construction project is much more cost effective than retrofitting a project into an area. A good example of this is the Garden State Parkway interchange project at Exit 91.

5.1.2 Metedeconk River Watershed Committee

A committee of Metedeconk River watershed stakeholders should oversee the implementation of the Plan and make recommendations on projects to be prioritized and funded in the coming years. As the development of this plan was achieved through stakeholder involvement and input, so should its implementation. The existing Stakeholder Advisory Committee should be approached to serve in this role, as the continued participation of the municipal, county, State and other organizations already involved in the project will be vital to successful plan implementation.

It is anticipated that this committee would have quarterly to semi-annual meetings to discuss the implementation of the Plan, identify projects, and prioritize land parcels that should be acquired through discussions/collaboration with existing open space preservation programs.

5.2 Education and Outreach

The Metedeconk River watershed community has a key role in ensuring the successful implementation of the Watershed Protection & Restoration Plan and the long-term health of the Metedeconk River. As described throughout this Plan, nonpoint source pollution and stormwater runoff are the main causes of the problems facing the watershed. Site-specific restoration projects will only go so far to address these issues. What remains must be dealt with through the actions of people living, working or otherwise spending time in the watershed. An education and outreach program will provide the community with a sound understanding of its watershed and the changes it can make to improve the quality of its water resources.

The education and outreach program has three primary objectives, which are consistent with the plan goals and objectives as determined by the Metedeconk Stakeholder Advisory Committee:

1. Work in concert with the Barnegat Bay Partnership and other organizations involved in education and outreach to:
    a. Expand the public's understanding of the watershed and Metedeconk River Watershed Protection & Restoration Plan;
    b. Encourage public participation and support for improving watershed health;
    c. Promote public involvement in the implementation of the plan and its watershed management and restoration strategies;
2. Focus outreach efforts on specific water quality impairment issues, such as stormwater management; and
3. Develop targeted public outreach materials and approaches that will not only inform and educate, but also initiate actions and changes in behavior to create positive results.

5.2.1 Initiatives and Target Audiences

The Metedeconk River watershed encompasses a diverse community which is an important consideration for the education and outreach program. The program is most effective if its messages are crafted and targeted towards smaller segments of the community which are broken down based upon location, watershed role, etc. This "targeted outreach" approach results in messages that are clear, specific and better understood and, ultimately, more likely to result in individual actions or changes in behavior.

Education and outreach initiatives for the general watershed community and numerous target audiences have been identified (**Appendix E**). These initiatives were developed in consultation with a group of education and outreach professionals from various stakeholder organizations with highly regarded programs. The Metedeconk project team drew extensively from the group's collective experience and expertise to identify target audiences, the important messages that need to be communicated, and the best approaches to getting those messages across. In some cases, other watershed stakeholders were consulted for their input on specific aspects. It is important to note that while efforts have been made to be as comprehensive as possible in identifying the various groups and initiatives, additions or modifications may be necessary in the future as the effectiveness of the program is evaluated.

The target audience groups are included in the Metedeconk watershed education and outreach program:

- **Municipal and county officials; planning and zoning boards of adjustment; environmental commissions** - Watershed health is determined, in large part, by policies and decisions made at the local level, particularly those pertaining to land use. Ideally, the protection of water resources is a priority and serves as an important consideration of officials as they as they carry out the challenging task of balancing fiscal, economic, social, environmental and other issues on a day-to-day basis. Outreach to local elected and appointed officials is an effective means of raising awareness about watershed issues to bring about positive changes that lead to water resources protection. Outreach specifically to municipal planning and zoning boards that is tailored to their unique role in making land use decisions should be included.

- **Public works departments and highway agencies** - By the nature of their work, public works department and highway agency operations can contribute to nonpoint source pollution. The State's MS4 stormwater permitting program includes various provisions to reduce nonpoint source pollution from DPW and highway operations, such as stormwater pollution prevention plans, standard operating procedures, maintenance requirements and annual employee training. Outreach about the Metedeconk watershed should build upon the existing programs.

- **Developers, engineers and planners** - Development alters the landscape of the watershed to meet the needs of a growing human population. Developers and their engineering and planning professionals play a key role in shaping the future condition of water resources, for better or worse, through their projects. Raising awareness about the Metedeconk watershed plan with this group will help ensure better protection of the watershed as growth occurs.

- **Residents (homeowners/renters/visitors)** - Approximately thirty percent of the land in the Metedeconk watershed falls into a "residential" land use/land cover category, more than any other type. As such, the watershed residents can make a big difference in helping to improve the health of the Metedeconk River through their everyday activities around their homes and elsewhere. Outreach to the residents and visitors of the watershed will go a long way towards making this happen.

- **Businesses; commercial and industrial property owners and managers** - Commercial and industrial complexes are commonly associated with higher stormwater and nonpoint source pollutant loads than other land use categories due to greater impervious surface coverage, vehicular traffic, housekeeping challenges, landscaping demands, etc. Efforts to address stormwater runoff problems and eliminate NPS pollution on commercial and industrial properties have a direct benefit for the watershed. They also may serve an educational role by exposing a large number of customers and employees to watershed-friendly property management practices. Outreach to this group will help facilitate the implementation of BMP's and other activities to better protect and restore the watershed.

- **Parks and recreation managers, golf courses, and residential complex managers** - There are large tracts of cultivated lawns in the Metedeconk watershed within parks, golf courses and residential complexes. For the most part, these sites are owned, managed and maintained by a relatively small number of individuals. Outreach to this subset of the watershed community about applying or improving sustainable landscaping practices would have numerous benefits (e.g. reduced water consumption, reduced fertilizer and pesticide use, reduced maintenance costs, improved infiltration, etc.). Because many of these sites have stormwater basins or other BMPs, outreach about stormwater management is also important.

- **Agricultural community** - Agricultural operations account for a relatively small percentage of the watershed area, but if not managed properly they can have significant impacts on local waterways. Nonpoint source pollutants commonly associated with farms and nurseries may include sediment, pathogens, nutrients and pesticides. Agricultural Best Management Practices can reduce nonpoint source pollution in runoff and result in better protection for sensitive areas such as wetlands and stream corridors.

Outreach to this group will help ensure agricultural BMPs are employed throughout the watershed where necessary.

5.2.2 Potential Education and Outreach Program Partnerships and Resources

There are many opportunities to build partnerships to effectively accomplish the education and outreach objectives of the Metedeconk River Watershed Protection & Restoration Plan. Outreach about water resources, watersheds and the environment is being conducted by numerous organizations at the State, regional and local levels, particularly for Barnegat Bay. Efforts should be made to coordinate with these groups and align common messages to the greatest extent possible. Similarly, there are opportunities to forge new partnerships with organizations that may not be involved in outreach per se but have the ability to reach a substantial number of people through their memberships, affiliations or patrons. Coordinating with these groups may be particularly effective for reaching new audiences. There is also a wealth of professionally produced and field tested outreach materials available in the public domain that can be utilized in the Metedeconk watershed. By forging partnerships, leveraging existing programs and resources, and drawing from the variety of available educational materials, the resources available for education and outreach will provide the greatest possible benefit.

Partnerships will be required to ensure that existing and future stormwater infrastructure is maintained. Retrofitting stormwater infrastructure will require maintenance to some degree. For example, installing bio-retention systems will require periodic trimming and weeding. In general, the responsibility for maintenance of stormwater BMPs will be shared by everyone in the watershed. The education and outreach program should seek to enlist partners from all target audiences to participate in maintenance. A successful education and outreach program will hopefully encourage local business owners, or any other group, to not only install bio-retention systems or other BMPs within their parking lots and around their businesses, but to also maintain them.

5.2.3 Education and Outreach Program Evaluation

Evaluation is an important component of the Metedeconk watershed education and outreach program. Gauging the effectiveness of a program provides a better understanding about whether its messages are reaching the intended audiences and resulting in the desired actions or changes in behavior. Where necessary, adaptations can then be made to improve or eliminate ineffective components and ensure that those that are working are supported or enhanced.

The education and outreach initiatives above are described in more detail in **Appendix E**.

5.3 Recommended Monitoring and Metrics

A wealth of information was collected and organized as part of the watershed characterization included in this plan. Because BTMUA has such a robust monitoring program, water quality data collected from that program were able to be quickly and efficiently utilized for this project. In addition, for the first time within the watershed, a Stream Visual Assessment Program was established and implemented by BTMUA along with Georgian Court University students.

The information presented within this Plan and the associated Task Reports represent a relevant starting point for the evaluation of watershed and water quality changes over time as the Plan is implemented. The *EPA Handbook for the Development of Watershed Plans* recommends the establishment of a set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward meeting water quality standards. In order to monitor the effectiveness of the Plan, trends in water quality and quantity need to be established and/or extended.

BTMUA collects water quality data primarily along the main stems of the North and South Branches, as well as at several sites of known VOC contamination. However, data have not typically been collected on a consistent basis at many of the tributaries, which represents a data gap. Water quality monitoring should be continued, if possible by BTMUA, as they have the experience and the facilities for effective implementation. A map of proposed tributary sampling stations is shown on **Figure 5-13**, although these sampling stations can be modified as necessary. Some of these stations have been or continue to be monitored by BTMUA.

Utilizing the metrics identified during the watershed characterization will be important for the long-term evaluation of the implementation program. The following sections represent a list of monitoring criteria that should be considered.

5.3.1 In-Situ Metrics

In-situ parameters are of primary importance for evaluating the long-term health of the Metedeconk River Watershed. Parameters such as temperature, pH, dissolved oxygen and special conductance should be routinely collected to represent a comparative baseline in future years. At a minimum, quarterly sampling is recommended. As BTMUA has routinely (daily at some stations) sampled for these parameters for more than a decade, most stations along the main stem will have more frequent data collected.

5.3.2 Discrete Metrics

As a complement to the in-situ metrics, monitoring of discrete metrics (i.e. chemical monitoring) should be performed/continued to assess changes over time for nutrients, particularly total phosphorus and total nitrogen, and TSS, as these are critical parameters causing impairment within the Metedeconk River watershed. In addition, fecal coliform/E. coli monitoring should be performed to track progress towards load reduction goals identified in the various TMDLs. Monitoring discrete metrics at BTMUA's current sampling stations and along the tributaries identified in **Figure 5-13** on a quarterly basis, at a minimum, is recommended, with more frequent monitoring for pathogens to ascertain compliance with the surface water quality standards (see QAPP; Appendix G). However, for fecal coliform and E. coli, the sampling schedules should also correspond to wet weather events whenever possible.

Total phosphorus data collected within NB1 should be continually evaluated to monitor for the TP TMDL. TP, TSS and mercury data should also be collected along the Muddy Ford Brook to evaluate the existing impairments identified within the 2010 303(d) list.

One of the stormwater improvement projects moving forward as part of the Barnegat Bay initiative is the construction of a stormwater gravel wetland within the existing stormwater detention basin off of West Shenandoah Road in Howell Township. This basin is located immediately adjacent to Sandy Hill Brook. In order to evaluate the effectiveness of the gravel wetland to determine its suitability for installation at other sites throughout the watershed, water quality should be collected upstream and downstream of the gravel wetland. BTMUA sampling stations along Sandy Hill Brook, SHB-1 and SHB-2, would serve this purpose (although a more appropriate sampling location may be somewhat upstream of SHB1 due to potential nitrogen loading associated with agricultural land use). Sampling the influent and effluent discharge to the gravel wetland should also be conducted to monitor effectiveness.

BTMUA surface water quality sampling stations SHB1 and SHB2 along Sandy Hill Brook

As described in Section 3 of this Plan, arsenic is listed as an impairment on the 2010 303(d) List, although the source of the arsenic is not known at this time. It is suspected that arsenic is naturally occurring and being discharged to the Metedeconk River as baseflow, but groundwater data are lacking within the watershed. Available data from shallow water supply wells indicates that arsenic is present in the groundwater at concentrations similar to those in the Metedeconk, but additional information is necessary. Collaboration with the USGS or other agencies to investigate the source of arsenic would be beneficial.

5.3.3 Hydrology Metrics

Since runoff reduction and infiltration measures are important components of the overall strategy, the collection of hydrology data should also be included in the overall monitoring plan. For existing stream gages in particular, base flow in the stream should be tracked to identify potential baseflow increases related to improved infiltration and better management of surface hydrology to mimic the natural environment. Currently, the USGS collects flow data at two gages within the watershed, one on the North Branch and another on the South Branch. Funding to keep these gages maintained and operational should continue.

Monitoring for the effectiveness of a water conservation plan is straightforward and can easily be tracked by evaluating water demand and the number of customers from the water purveyor records.

5.3.4 Biological Metrics

Macro invertebrate surveys can also be a key metric for tracking the on-going health of the aquatic ecosystem. Recommended measures in the plan should improve in-stream habitat through lowering the water temperature, and reducing erosion, sedimentation, and nutrient enrichment. Therefore, tracking the response of these organisms to in-stream conditions should be considered as part of the overall monitoring strategy. This program is essentially equivalent to the NJDEP Ambient Biological Monitoring Network (AMNET) in which several stations are periodically sampled within the Metedeconk River watershed. A similar study was previously conducted by the Monmouth County Health Department's Rapid Bioassessment (RBA) program.

It is recommended that this sampling be performed approximately once every five years.

AMNET sampling stations (from NJDEP, 2010)

5.3.5 Qualitative Assessments

Stream Visual Assessments (SVAs) were a key component of the initial assessment of watershed conditions. The implementation of this watershed plan will result in improved stream conditions over time. On-going, routine SVAs should be performed throughout the plan implementation to identify additional problem areas causing impairments, as well as to document potential improvements in watershed conditions. In particular, assessments should be performed along improved reaches to monitor site stability and erosion. Aside from the value of the actual data collected, SVA work also has the additional benefit of putting “feet on the ground” in the watershed in areas that may not be regularly visited to identify other pollutant threats such as illicit discharges, spills and other hazardous activities.

Although more than 80 SVAs were conducted throughout the watershed, additional sites should be incorporated at a rate of 5 additional sites per year. In addition, SVAs should be repeated once every five years (reasonable time frame to assess long-term changes in condition for impaired sites) for all impaired stream segments, particularly those with development potential (Fair and Poor ratings from previous assessment – 49 sites total). The SVAs should be conducted during periods of minimal vegetation (late autumn through late winter).

5.3.6 Analysis and Reporting

Monitoring data should be compiled into a report on a periodic basis for presentation to the public and elected officials. In addition, consideration may be given to development of a public-access web portal to review on-going monitoring/water quality data as a part of the public education program. The report and/or website should be geared towards the identification of trends and progress towards achieving water quality goals. Updates to the Management Plan should be considered at five and ten year intervals based on the monitoring results.

5.3.7 BMP Maintenance Database

One of the problems that have been identified by the stakeholders and the stream visual assessments is lack of maintenance of existing stormwater infrastructure. As identified in the Task 3 Report, in many townships the cost of BMP maintenance (in most cases, these have been stormwater detention basins) is paid by the developer for a number of years. After that time, the maintenance of the facility becomes the responsibility of the township. Observations in the field indicate that BMP maintenance is not being conducted at many sites throughout the watershed.

A database of current and future BMPs should be developed so that maintenance needs can be tracked and logged. The database will help identify problem areas and prioritize retrofits. The Stormwater Management and Planning Tool (SWMPT) has identified a number of potential basins for restoration in Ocean County. A database of this type could be expanded to include basins in Monmouth County and used to track maintenance of stormwater BMPs.

In addition to a maintenance database, the development of a model ordinance that addresses maintenance of privately held stormwater facilities would help municipalities enforce BMP maintenance for facilities that are privately owned.

5.3.8 Land Use Changes

Changes in land use/land cover should be closely monitored and land use statistics within the watershed should be updated with each re-issuance of the NJDEP land use/land cover database. A metric for directly connected impervious cover (DCIA) would be useful as a more appropriate way to evaluate impervious cover. This would entail cataloguing parcels to determine where runoff is directed. For example, a residential parcel may have roof leaders that discharge to the lawn or those that discharge to a driveway. Although a parcel may have a percentage of impervious cover, if only half of the impervious cover directs runoff to the street, then the DCIA would be 50%. As much of the development within the watershed involves direct discharge to the surface water much without any treatment, the DCIA is likely to be high. For example, one of the sites that was targeted for initial treatment is Brick Plaza in Brick Township (see **Appendix D**). This represents a very large area of impervious cover, much of which discharges directly to the Metedeconk River (DCIA is high). However, should runoff be directed to an infiltration basin or other BMP, the DCIA would be lower since the stormwater is being infiltrated/treated.

As development increases, impervious cover will naturally increase. However, LID ordinances should be established which will minimize directly connected impervious cover. Although DCIA has not been calculated for this Plan, it is assumed to be relatively high since there are many stormwater outfalls which discharge directly to the streams and many of the stormwater controls established in recent years are detention basins, which do not create much benefit during low volume storm events.

Preparation of a stream corridor protection plan and approval of that plan by the NJDEP may allow for encroachment of the 300 ft buffer to 150 feet in particular instances, but guidance on the preparation of that plan currently does not exist. Preparation of a guidance document would be useful for municipalities seeking NJDEP approval for stream corridor protection plans.

5.3.9 Monitoring Implementation of the Plan

As identified in the EPA *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*, developing an implementation plan matrix is a useful method to monitor plan implementation and identify any data gaps or budget issues. Implementation plan matrices can help identify where progress in a particular area to meet a specific goal and objective may be lacking and require additional funding or technical assistance. Proposed implementation plan matrices for the Plan goals, based on the USEPA framework worksheets are shown on **Figures 5-14** through **5-18**.

5.4 Fiscal Analysis

The recommendations in this plan represent a broad range of improvements to meet regulatory requirements, stimulate stakeholder initiatives and achieve water quality improvement. While prioritization will be key to the implementation phase, ultimately, funding will dictate how successful this plan will be. The following sections summarize funding options for consideration.

5.4.1 Sources of Funding

A critical factor in turning this plan into action is the ability to fund implementation. Funding will be needed for multiple activities, such as management practice installation, design and construction of BMPs, education activities, monitoring, and administrative support. EPAs "Paying for Sustainable Environmental Systems: Guidebook to Financial Tools" represents a great resource for municipal governments to identify a wealth of available funding opportunities. Another useful reference is also published by the USEPA, "Managing Wet Weather with Green Infrastructure Municipal Handbook: Funding Options". The following subsections describe the available sources for consideration in this plan.

5.4.1.1 Sources for Raising Revenue

General taxes, selective sales taxes and fees are the primary methods for raising revenue. Many of these tools for raising revenue are used primarily by local governments and typically go into the general fund. The process of gaining voter approval for dedication or earmarking of taxes for environmental protection initiatives is often difficult, considering that government-funded programs vigorously compete for monies and the popularity of environmental issues rises and falls over time. However, a well-documented plan for the program is a critical step in pursuing additional revenue for the program. Once a plan is formulated for the future cost of the program, elected officials may be approached if additional funding is required for implementation.

While taxes represent the most common source of revenue for environmental programs, increasingly municipal governments are moving towards fee-based systems to fund stormwater management programs. A fee is defined as the price one pays as remuneration for services, such as government administrative services and utility services. Fees are also defined as financial charges for activities undertaken, including polluting activities such as stormwater discharges.

Revenues from fees are often deposited into special funds related to the product or service upon which the fees are levied. These funds are then dedicated to only the cause for which they were collected. The primary advantage of a dedicated source of funding is that fees can be set annually to meet the anticipated costs of this plan and long-term financial stability is attainable.

Stormwater utilities have been established throughout the United States for the purpose of funding stormwater-related improvement projects and maintenance of those projects. According to the University of Western Kentucky Stormwater Utility Survey, there are between 1,200 and 1,500 stormwater utilities in 38 states. A stormwater utility would charge a fee based on impervious cover and runoff for each parcel. The fee could be significantly reduced if the owner of the property installs BMPs so that runoff is not generated. This would serve as an incentive to generate widespread implementation of private property BMPs such as rain gardens, rain barrels, pervious pavers, etc.

Other examples of incentives can be found in USEPA's "Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanisms". Much more information on stormwater fees can be found in USEPA's "Managing Wet Weather with Green Infrastructure Municipal Handbook: Funding Options". New Jersey does not currently provide legislative authority for the implementation of stormwater utility fee programs.

In many cases, water utilities allocate funding for monitoring programs, public education and related water resource protection activities in their annual operating and capital budgets. Alternatively, revenue could be generated by water purveyors through the implementation of a source water protection fee. This fee could be nominal percentage of a water bill. As an example, suppose a water purveyor has 25,000 customers. If a nominal fee of even $2 per quarter was implemented, that could generate $200,000 a year in revenue.

Conservation based rate structures (discussed in Section 4) could provide a source of revenue to the water purveyors to offset the lack of revenue associated with water conservation. Increased revenues from rate structures could also be used to fund monitoring, education and outreach programs, or other implementation initiatives.

Another source of funding could be an "adopt a stream reach" program or something similar. The "Adopt a Highway" program has been in place for years in which a corporation sponsors the maintenance of particular stretches along major highways, primarily through litter clean-up in exchange for a sponsor sign which includes the company name and color logo. "Adopt a stream reach" would be something similar, in which a company would pay a cost for the litter and floatables removal in exchange for a sign with their name and logo. Various "Adopt a Stream" organizations exist throughout the United States, many of which are volunteer efforts to monitor watershed conditions. Costs paid by companies for the potential "adopt a stream reach" for the Metedeconk River could provide funding for a sign of the stream name along the roadway, trash and floatable collection, and a stream visual assessment.

5.4.1.2 Tools for Acquiring Capital

Bonds, loans, and grants are the primary methods that local governments use to generate capital for improvement projects. A bond is a written promise to repay borrowed money on a definite schedule, and usually at a fixed rate of interest, for the life of the bond. While they represent a large source of capital, they can be more complex and expensive than typical loans. Loans typically involve fewer and lower transaction costs than bonds. Interest rates on government loans may be subsidized, particularly for small communities. Grants are generally regarded as more desirable than loans and bonds. However, since grants are designed by the awarding agency or organization to meet certain, often specific, goals, they may carry additional mandates as compared to loans and bonds.

The following is a list of loan opportunities for consideration:

- **The New Jersey Environmental Infrastructure Trust –** provides low-cost financing for projects that protect water quality, including open space acquisition
- **The Barnegat Bay Funding Initiative** - provides up to 100% principal forgiveness for a wide variety of stormwater improvement projects and programs
- **Environmental Infrastructure Financing Program** - provides low-interest loans for the construction of a variety of water quality protection measures
- **Clean Water State Revolving Fund** – USEPA program that provides low interest loans to fund stormwater management, nonpoint source controls, estuary protection and wastewater treatment projects.

The following is a list of grant opportunities for consideration:

- **319(h) Grants** – competitive funds provided to state and local agencies to fund nonpoint source management programs
- **NRCS Conservation Innovation Grants –** a voluntary program administered by NRCS to stimulate the development and adoption of innovative conservation approaches and technologies (requires 50-50 match)
- **Private Grants** – monies available from local watershed groups or land trusts for conservation

Other potential grants available, particularly for agricultural land owners and also for general land acquisition by local governments, include the following:

- NJ Department of Agriculture Farmland Preservation Program
- NJDEP Green Acres Program
- Green Communities Challenge Grant 2000 (Urban and Community Forestry Program)
- NJDEP Water Quality Management Planning Pass-Through Grant (604 Grants)
- Natural Resources Conservation Service (NRCS)
- 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)

Incorporating BMPs into infrastructure improvement projects that have been approved and will be constructed is a very cost effective way to fund various types of BMPs. Many of these projects involve some type of roadway or traffic improvement. Installation of pervious paving and/or upgrading road runoff BMPs can be incorporated into the project and since that project will be constructed regardless, retrofits would not be required. Infrastructure improvement projects should be tracked and reviewed prior to final design so that additional stormwater BMPs can be incorporated into the final design.

5.5 Schedule of Activities

This section outlines the implementation schedule for the recommended management measures. Implementation of the recommended measures is dependent on a number of factors, many of which have been discussed in previous sections of this document, including effectiveness of the strategy in meeting overall water quality goals, priorities as determined by the Stakeholder Advisory Committee, costs, available funding, and implementation "hurdles" such as permitting. A number of site specific projects have been identified through Stream Visual Assessments (SVAs), additional site visits and by the municipal engineers (see **Table 5-3**).

Available funding is critical to the overall strategy and may be scarce, particularly in these trying economic times. It is not reasonable to implement all of the above management measures within a short timeframe. Therefore, the plan has been designed to be implemented over a number of years in order to distribute costs over time. A phased implementation schedule also allows project sponsors to more effectively manage a smaller number of projects at any particular juncture and to take advantage of continued education efforts to win support for project adoption. The following sections will outline the short term, medium term, and long term project implementation schedule.

5.5.1 Short-Term Measures

The EPA *Handbook for the Development of Watershed Plans* defines short term as a period of implementation lasting approximately 1 to 2 years. As such, short term implementation measures should focus on the planning, technical assistance and funding required to execute the mid-term and long-term elements of the plan.

Most of the various planning and management measures should be initiated during this phase. Internal planning will likely be required to further refine the list of priority projects as well as the development of local ordinances for future land use management (such as performance standards, implementing more proactive LID techniques, conservation plans, etc.). However, known, high-priority projects should be accelerated as much as possible to create early program “successes” that can be used in future phases to continue generating political and public support for the plan. Similarly, implementation of the education and outreach portions of the plan should be initiated in this phase to foster public support.

In addition, technical and funding support should also be implemented during this phase. Many projects identified in previous sections may require collaboration with local planning groups, academic institutions or outside consulting firms to further refine program strategies. Also, funding will be critical for implementing mid-term and long-term elements of the program. Therefore, consideration should be given to upcoming grant and loan opportunities, or the development of alternative funding streams (such as a stormwater utility).

Parcels of property have been identified by previous studies (e.g. Barten et al, 2003; TPL, 2008) for protection and restoration. These parcels need to be coordinated with County and municipal open space preservation programs so that resource conservation is effectively implemented and those sites that would provide the most benefit to the health of the watershed (and Barnegat Bay) are prioritized for acquisition.

Lastly, all monitoring activities should be planned and implemented during this phase. Monitoring will be essential for tracking the long-term improvements of the program as well as to assess the effectiveness of future implementation measures.

5.5.2 Mid-Term Measures

The EPA *Handbook for the Development of Watershed Plans* defines Mid-Term as the period lasting from 2 to 5 years from the adoption of the Plan. It should be anticipated that the Mid-Term period of the plan will require the most activity, building upon the planning measures identified during the Short-Term period. Activities for this phase include the implementation of the remaining high-priority projects, development of design plans, construction of completed design projects, and maintaining public education and outreach efforts.

For efficient use of funds, projects on public lands should typically be prioritized over projects on private lands, unless there is a willing private partner for a priority project. From a water quality perspective, TMDLs should be addressed first, followed by the identified water quality impairments (303(d) List). Retrofits of existing stormwater infrastructure should also be prioritized (see Section 4). Consideration should be given to the permitting challenges associated with the various projects. Inspection and maintenance programs should be fully staffed and implemented during this phase, if not possible for the entire watershed then at least for newly installed BMPs undertaken through this plan to ensure their long-term effectiveness. Finally, implemented monitoring programs should be reviewed to evaluate water quality conditions or to identify any potential enhancement opportunities for the program.

5.5.3 Long-Term Measures

The EPA *Handbook for the Development of Watershed Plans* defines Long-Term as the period lasting from 5 to 10 years from the adoption of the Plan, although this period may be longer depending on available funding, particularly in times of economic recession. By this Phase, it should be assumed that the highest priority projects have been implemented while the remainder of medium and low priority projects will likely have been designed. The focus during this phase should be on the implementation of these lower priority projects.

In addition, it will also be important during the Long-Term phase to evaluate the effectiveness of measures implemented in earlier phases of the plan using on-going monitoring results. By this time, it may be evident that some strategies should be modified or replaced in the plan with either alternative measures or newer technologies. Information and education also should continue to play an important role in the overall strategy, as the public should continue to be informed of project successes and progress towards achieving water quality goals.

A list of activities and a proposed schedule is provided on **Figure 5-19**.

Section 6
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