WRECK POND BROOK WATERSHED RESTORATION PLAN FOR IMPAIRED WATERS

Prepared for
Wreck Pond Brook Watershed Technical Advisory Committee

Under the Authority of the
Wreck Pond Brook Watershed
Regional Stormwater Management Plan Committee

Prepared by

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Najarian Associates
30 years
The Science of Engineering

JANUARY 2015

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An ADDENDUM to the

WRECK POND BROOK REGIONAL STORMWATER MANAGEMENT PLAN

Prepared by:

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ABBREVIATIONS USED

AE – FEMA 1% Flood zone with elevation

BMPs – Best Management Practices

C1 – Category 1

CI – confidence interval

cfs – cubic feet per second

cfu – colony forming unit

CN – curve number

CWP – Center for Watershed Protection

DO – dissolved oxygen

FC – fecal coliform

FDA – U.S. Food and Drug Administration

FEMA – Federal Emergency Management Agency

FIRE – Flow-Integrated Reduction of Exceedances

FSCD – Freehold Soil Conservation District

FW2-NT – Fresh water 2 non-trout

GIS – Geographic Information System

HUC – hydrologic unit code

MC – Monmouth County

MCHD – Monmouth County Health Department

MCPB – Monmouth County Planning Board

mpn – most probable number

MTDs – manufactured stormwater treatment devices

NA – Najarian Associates

NAVD – National xxx Vertical Datum

NGVD – National Geodetic Vertical Datum

NJAC – New Jersey Administrative Code

NJDA – New Jersey Department of Agriculture

NJDEP – New Jersey Department of Environmental Protection

NSSP – National Shellfish Sanitation Program

P – Phosphorus

RCE – Rutgers Cooperative Extension

RSWMP – Regional Stormwater Management Plan

SE – Saline Estuarine

STEPL – Spreadsheet Tool for Estimating Pollutant Load

SWMM – Storm Water Management Model

TAC – Technical Advisory Committee

TC – total coliform

TP – total phosphorus

TMDL – Total Maximum Daily Load

TSS – total suspended solids

USACE – United States Army Corps of Engineers

USEPA – United States Environmental Protection Agency

USFWS – United States Fish and Wildlife Service

USGS – United States Geological Survey

VE – Velocity Zone (FEMA)

WPB – Wreck Pond Brook

WPBRSWMP – Wreck Pond Brook Regional Stormwater Management Plan

1 INTRODUCTION

This document is an Addendum to the Wreck Pond Brook Watershed Regional Stormwater Management Plan (RSWMP) completed in 2008 and satisfies USEPA's Nine Elements of a Watershed-Based Restoration and Protection Plan per the '*Handbook for Developing Watershed Plans to Restore and Protect Our Waters*' and other USEPA guidance. This document updates and expands the previous report prepared for the watershed as a Regional Stormwater Management Plan for the Wreck Pond Brook.

1.1 PROJECT HISTORY

Starting in 2005, NJDEP, Monmouth County and other study partners initiated development of the Wreck Pond Brook Watershed Regional Stormwater Management Plan (RSWMP). This plan was developed to address stormwater quantity and quality concerns within the watershed. The plan was developed in accordance with Subchapter 3 (Regional Stormwater Management Planning) of the New Jersey Department of Environmental Protection (NJDEP) Stormwater Management Rules (N.J.A.C. 7:8). The regional stormwater planning process is designed to address stormwater issues that are best managed on a regional, not a state or local basis.

The RSWMP provides a detailed description of existing watershed conditions including the results of several monitoring efforts and field investigations, modeling studies, identification of problems and proposed solutions. Book 1 of the RSWMP provides data on the characterization of the watershed and environmental concerns. Book 2 provides the Management Plan.

Wreck Pond Brook extends from its headwaters in Wall Township near Allaire Airport and flows east-southeast to discharge into Wreck Pond. Wreck Pond is located on the boundary between the boroughs of Spring Lake and Sea Girt in Monmouth County, New Jersey. Wreck Pond is approximately 73 acres in size and a portion of it is tidally influenced. The eastern end of the pond contains an outfall structure that exchanges water with the Atlantic Ocean. The watershed to the Pond extends to the northwest as shown on Figure 1. A watershed aerial photograph is provided in Figure 2.

The Wreck Pond watershed was identified as a watershed of concern by the NJDEP. Outflow from Wreck Pond to the Ocean during storm events has been identified as the cause of swimming beach closings in Spring Lake and Sea Girt. The Monmouth County Health Department (MCHD) regularly monitors bacteria levels at Ocean swimming beaches. Using those data, MCHD found that bacteria levels exceeded the Ocean bathing beach standards at Ocean beaches in the vicinity of the outfall following storm events. In 2002, the Health Department instituted a 24-hour swimming ban that is implemented whenever rainfall exceeds 0.1 inch or when a plume from the outfall is visible, along with a 48-hour ban when rainfall exceeds 2.8 inches in 24 hours. This ban

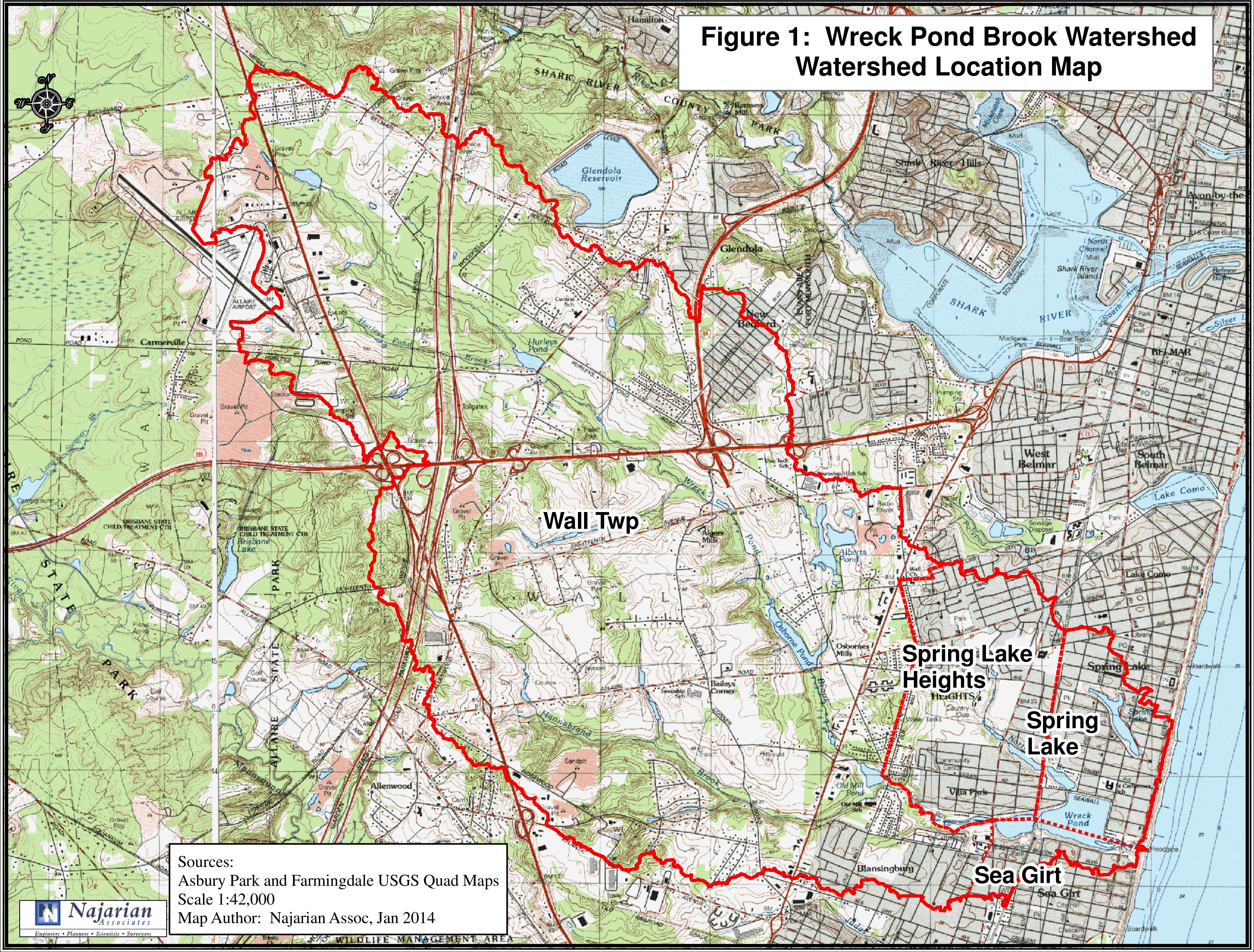
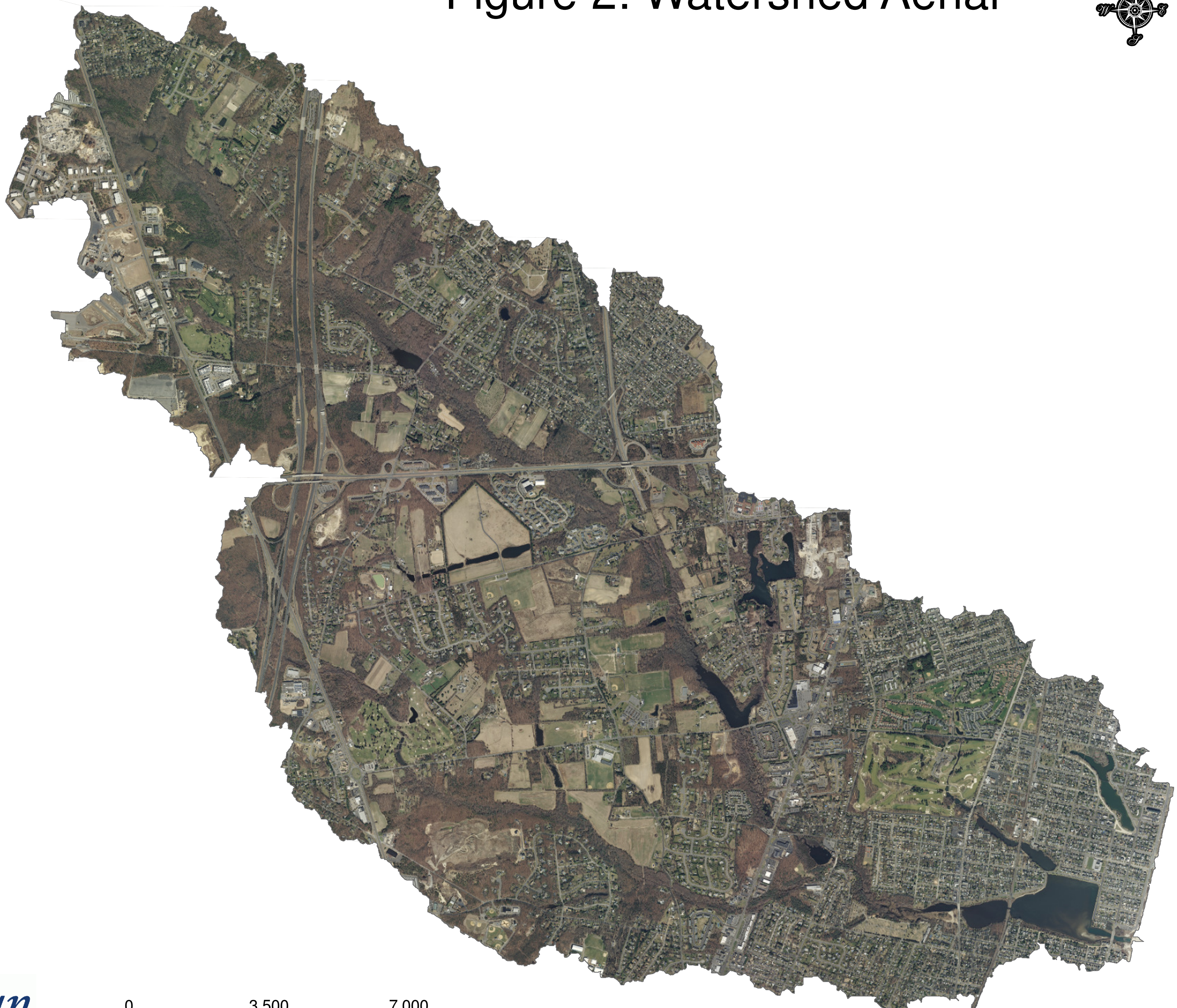


Figure 1: Wreck Pond Brook Watershed
Watershed Location Map

Sources:
Asbury Park and Farmingdale USGS Quad Maps
Scale 1:42,000
Map Author: Najarian Assoc, Jan 2014

Figure 2: Watershed Aerial



Sources:
2012 Aerial NJwebmap

Map Author: Najarian Assoc
1/29/14

0 3,500 7,000
Feet

Najarian Associates
30 years
The Science of Engineering

applies to the recreational bathing waters at the Brown and York Avenue beaches in Spring Lake and The Terrace and Beacon beaches in Sea Girt. Due to this provisional ban, the outfall from Wreck Pond has been the source of most of the swimming bans at the New Jersey Ocean beaches over the last several years.

In addition, the overall water quality of waters in the watershed, including Wreck Pond is of concern. Algal blooms, nutrient loads, and sedimentation are noted issues. Further, flooding has been noted in many parts of the watershed. The storm of October 2005 caused significant flooding, particularly in the lower portions of the watershed.

The local municipalities, Monmouth County and NJDEP identified certain initial goals for development of the RSWMP. These include reduction of beach closings, improvement of the overall quality of Wreck Pond and other water bodies within the watershed, and reduction of flooding.

In response to concerns about beach closings caused by Wreck Pond outflow, NJDEP developed a plan for Wreck Pond Restoration in 2004 to eliminate or reduce those closings. The plan identified four basic restoration measures including dredging, stormwater management measures, extension of the outfall to move the mixing zone farther from the swimming beaches and wildlife management measures to reduce bacteria levels.

Several elements of NJDEP's plan were implemented. The Wreck Pond outfall was extended about 300 feet further from shore and a portion of the pond closest to the outfall was dredged. This work was completed in 2006. Further dredging of the pond is not currently planned, with the exception of some localized projects undertaken by Monmouth County. NJDEP also provided funds for goose management efforts.

NJDEP also provided financing and personnel to assist the County of Monmouth and NJ Department of Agriculture (NJDA) to prepare a Regional Stormwater Management Plan for the Wreck Pond Brook Watershed. Stormwater management throughout the watershed to reduce sediment loading was required prior to any funding to dredge the entire pond to ensure that dredging would provide a long-term solution.

NJDEP then requested that the Monmouth County Planning Board (MCPB) act as a Lead Planning Agency to complete and move to adoption a Wreck Pond Brook RSWMP. NJDEP offered a $350,000 grant to aid in the planning process. The MCPB and its staff agreed and work commenced immediately to develop a Scope of Work and Budget for review and approval by the Department.

MCPB staff determined that the Wreck Pond Brook RSWMP project could provide the framework for all RSWMPs that might be initiated in the County of Monmouth in the future. Therefore, a primary objective of the project was to institutionalize the planning process as much as possible. Additionally, it was recognized that a substantive amount of technical work would need to be done in order to accumulate a body of hydrographic, hydraulic, topographic, geographic, water quality, land use planning and character assessment data that could be used in the planning process. In order to meet the institutional and data management objectives of the project, Planning Board staff polled: the Chief Engineer for the New Jersey Department of Agriculture's (NJDA) State Soil Conservation Committee; the Freehold Soil Conservation District (SCD); the Monmouth County Engineering Department; the Monmouth County Planning Board's Engineering Section; the Monmouth County Office of Geographic Information Systems (GIS) Management; and the Monmouth County Health Department and asked if they would serve as a Technical Advisory Committee (TAC) for the project. All agreed to serve on the TAC and to contribute as much of their staff time to the project as they could.

The initial Scope of Work focused almost entirely on reducing sediment loadings to the pond in support of dredging. However, as the planning process proceeded, the Scope of Work for the Regional Stormwater Management Plan expanded to include load reductions for bacteria, nutrients and other water quality parameters. The scope further expanded to encompass flooding concerns, particularly after the October 2005 storm. The timeframe for project completion was expanded accordingly.

The RSWMP Committee initiated its work as set out in the approved Scope of Work in August of 2004. Various technical partners contributed to the technical studies in the Plan. The Plan was completed and submitted to NJDEP in 2008. The next step in the process would have been to have the local municipalities take on implementation of the Plan. However, no agreement could be reached among the municipalities and this process went no further.

Additionally, due to funding and staffing deficits, the NJDEP shifted its focus from adopting and implementing Regional Stormwater Management Plans, per the Stormwater Management Rules (N.J.A.C 7:8), to developing and implementing Watershed Restoration and Protection Plans (WR&PPs) under Section 319(h) of the Federal Clean Water Act. Toward that end, and so as not to let the prior planning efforts go to waste, NJDEP began the process of amending the RSWMPs and developing them into WR&PPs, Thus, it was determined that a Watershed Restoration Plan that fully complied with the USEPA's Nine Elements of such a plan would be advantageous for the Wreck Pond Watershed. It is the purpose of this addendum document to enable the Wreck Pond RSWMP to satisfy the Nine Elements, which will make this watershed eligible for 319(h) watershed restoration funding for implementation projects.

1.2 RSWMP ISSUES OF CONCERN

At the start of this process, the NJDEP and Monmouth County Planning Board staff had identified the following issues of concern

- Erosion in the watershed.
- Sediment loads and deposition at Wreck Pond and other watershed ponds.

- Bacteria, nitrate and phosphorus loads discharged to Wreck Pond.
- Beach closings near the Ocean discharge of Wreck Pond.
- Stream base flow to maintain/improve dilution factors.
- Stream peak flow and the connection to stream bank erosion and sediment transport.
- Stream passing flow and potential as a future surface water supply.
- Existing impoundments as stormwater management, scenic and recreation features.
- Municipal stormwater management planning efforts.

The initial planning process expanded the scope to include flooding, algal blooms and sediment in other watershed ponds. The need for improvements in flood control was further highlighted by the storms of October 2005.

During development of the plan, additional issues related to stormwater in the watershed were identified by the County, NJDEP, other agencies, municipalities, and local residents. In addition to flooding and beach closings, Wreck Pond also has reportedly become very shallow with mucky sediments and other signs of water quality impairment. The tidal fluctuation within the Pond is reportedly reduced, particularly after the outfall pipe was extended. The impounded portion of Black Creek is noted to be very shallow and mucky and subject to algal blooms. Algal blooms and mucky bottoms are also reported for the upstream ponds, along with other signs of diminished water quality.

The streams within the watershed also are of concern for water quality and flow issues. Both major tributaries to the Pond have been found by NJDEP to be in non-attainment status for certain designated uses, including Aquatic Life and/or Recreation, as discussed further below.

1.3 RSWMP PARTNERS AND COMMITTEES

Monmouth County Planning Board was the initial lead agency for this project under the leadership of Tom Kellers and then Turner Shell. The process, under the continuing direction of Mr. Shell, was then transferred to Monmouth County Division of Engineering. The planning process and development of this plan has primarily been conducted by the Wreck Pond Watershed Technical Advisory Committee, along with input from the RSWMP Committee. The RSWMP Committee continues to meet regularly, with 25-30 regular attendees including those on the TAC, municipal officials and staff, as well as other interested parties, including local residents. There is an email list for notifications that includes more than 250 names.

Current agencies, institutions and firms represented on the TAC or the Stormwater Committee include Monmouth County Office of GIS, Monmouth County Division of Engineering, NJDEP Division of Water Monitoring and Standards, NJ Department of

Agriculture, Rutgers Cooperative Extension, Freehold Soil Conservation District, Monmouth County Health Department, Monmouth Regional Health, Najarian Associates, American Littoral Society, US Fish and Wildlife Service, Monmouth County Health Department, US Army Corps of Engineers, NJDEP Bureau of Marine Water Monitoring, and municipal staff and engineers. Other past TAC members that completed studies in the watershed included the NJ Department of Agriculture, Monmouth University, and AECOM.

Other agencies that assisted or provided data include Monmouth County Health Department, who collects weekly beach bacteria data and the Southern Monmouth Regional Sewerage Authority who provided laboratory services for bacteria analyses for County Monitoring Data.

The study partners, other members of the TAC, and the RSWMP Committee used the data and results of the detailed watershed studies, monitoring, field studies, and modeling analyses to develop the Management Plan, including the stormwater specific mitigation projects, design and performance standards and the implementation strategy. These elements are provided in Book 2 of the WPBRSWMP.

1.4 WATERSHED RESTORATION AND PROTECTION PLAN

This restoration plan includes the required Nine Elements as per USEPA guidance in the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.* The document is organized to include each element as a section. The NJDEP provided comments on the RSWMP and guidance on completion of this plan.

2 ELEMENT A: IMPAIRED WATERS, SOURCES AND LOADINGS

Element A requires identification of the impaired waters within the watershed, sources of the impairments, and estimated loadings. Book 1 of the RSWMP provides a detailed description of the waters and watershed and land uses. This section provides an overview of the watershed and its waters, summarizes the impaired waters, and calculates loads from the identified sources leading to these impairments.

2.1 WATERSHED AND WATERS

The Wreck Pond Brook Watershed includes about 8,174 acres (±12.74 sq. miles) in southern Monmouth County New Jersey as shown on Figure 1. The western boundary of the watershed is in Wall Township and extends east-southeast to Wreck Pond on the border of Spring Lake and Sea Girt. The Pond discharges through an outlet structure into the Atlantic Ocean. The watershed also includes lands in Spring Lake Heights. The major tributaries are Hannabrand Brook, Wreck Pond Brook and the North Branch of Wreck Pond Brook (known as Black Creek). Numerous ponds are found within the watershed.

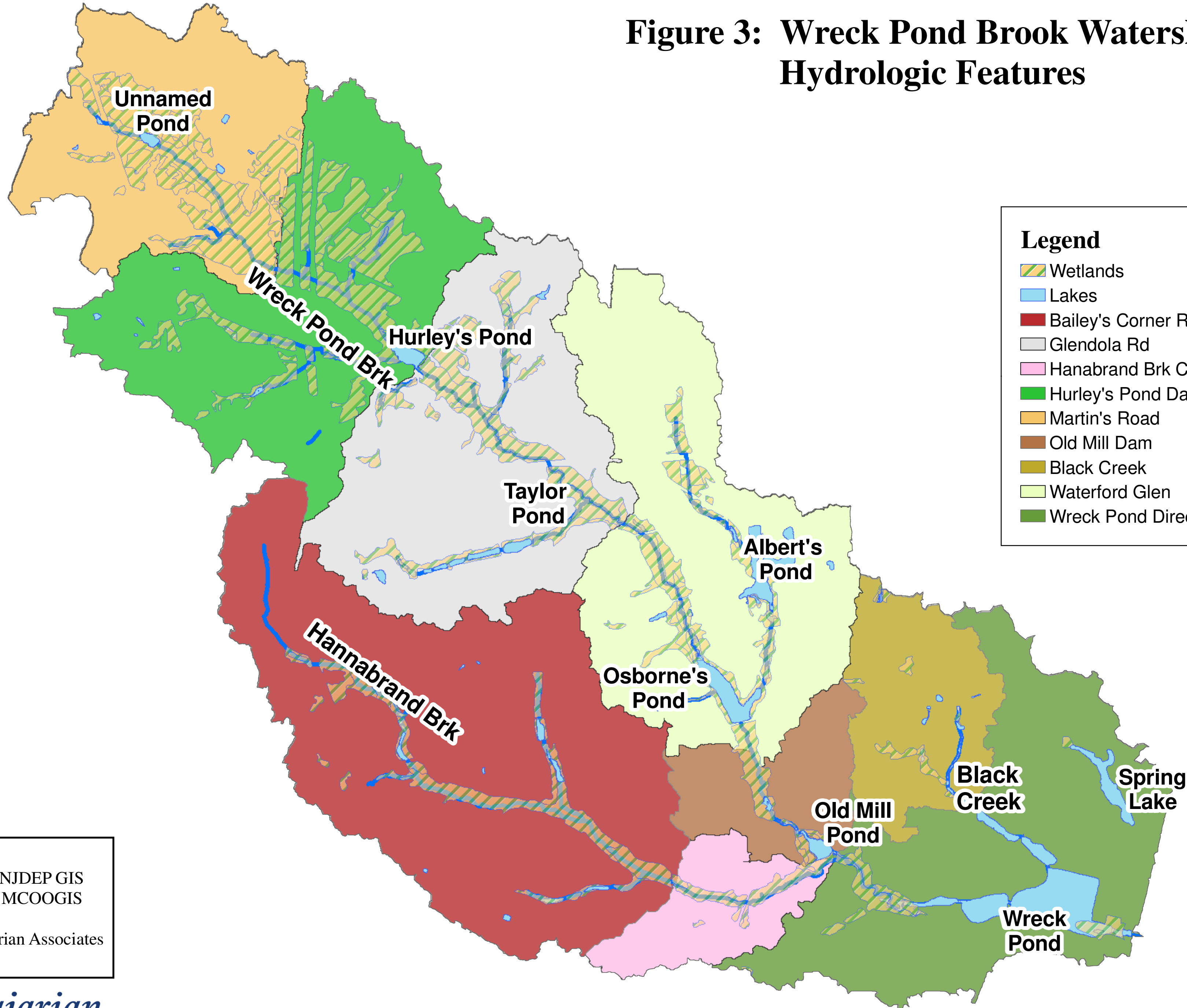
The Wreck Pond Brook Watershed includes several major streams. These streams drain to Wreck Pond, which has tidal exchange with the Atlantic Ocean. Wreck Pond Brook is the major stream within the watershed. Figure 3 shows the major hydrologic features within the watershed and the subwatershed boundaries. Table 1 provides data on the various subwatershed areas.

All of the streams within the watershed are classified as FW2-NT (Freshwater 2, Non-trout) in the New Jersey Surface Water Quality Standards. None of the streams are designated as Category 1 (C1), which would require special protection. None of the ponds or lakes are specifically listed in the Standards. Thus, these are also classified as FW2-NT. Non-trout waters are not considered suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species.

In all FW2 waters the designated uses are:

1. Maintenance, migration and propagation of the natural and established biota;
2. Primary and secondary contact recreation;
3. Industrial and agricultural water supply;
4. Public potable water supply after conventional filtration treatment and appropriate disinfection; and
5. Any other reasonable uses.

Figure 3: Wreck Pond Brook Watershed Hydrologic Features



Legend

- Wetlands
- Lakes
- Bailey's Corner Rd
- Glendola Rd
- Hanabrand Brk Culvert
- Hurley's Pond Dam
- Martin's Road
- Old Mill Dam
- Black Creek
- Waterford Glen
- Wreck Pond Direct

Sources:
Wetlands, Lakes, NJDEP GIS
Sub-Watersheds, MCOOGIS

Map Author Najarian Associates
3/26/2008

Najarian Associates
30 years
The Science of Engineering

0 3,500 7,000
Feet

Table 1: Waters and Subwatershed Area		
Stream	**Subwatershed** *(as defined in the RSWMP)*	**Area (acres)**
Black Creek*	Spring Lake Golf Course	416.40
Total		**416.40**
Wreck Pond Brook	Martin's Road	821.23
	Hurley's Pond Dam	1164.00
	Glendola Rd @ Wreck Brook	1121.17
	Waterford Glen	1231.78
	Old Mill Dam Culvert	303.06
Total		**4641.24**
Hannabrand Brook	Bailey's Corner Rd	1716.75
	Hannabrand Brook Culvert	259.71
Total		**1976.46**
Wreck Pond Direct	Wreck Pond	**1137.96**

*Black Creek is also known as the North Branch of Wreck Pond Brook

Wreck Pond Brook drains the central portion of the watershed, originating just north of Allaire Airport in Wall Township and flowing to the southeast. The drainage area above the confluence with Hannabrand Brook is about 4,640 acres, about half the entire watershed area. The main stem of the stream is about 7.6 miles long. Depending on the time of year, average base flows can range from 2.5 cfs to 7.5 cfs in the upstream portion of the stream and from 7.5 cfs to 18 cfs in the downstream portions.

The Wreck Pond Brook headwaters are at the Route 34 divide and drainage from the upland flows to a wetland complex associated with the Brook and Kellers Pond, which has a timber dam. The area was previously a sand and gravel mining facility and the pond was likely a source for wash water for the production of washed sand and gravel. The operation was active from the late 19^{th} century through the 1950s. The timber dam and berm have been breached and as a result, the impoundment was lowered, according to earlier NJDEP studies.

The Brook flows through Hurley's Pond. This Pond also receives drainage from an unnamed tributary and directly from developed areas in the Glendola section of Wall Township. The Pond is contained by a dam and Hurley's Pond Road is located on top of the dam. Downstream of this Pond, several tributaries join the Brook which then flows into Taylor's Pond where another tributary joins the Brook. Further downstream, Wreck Pond Brook flows into Osborne Pond (sometimes called Trimmers Pond) which is controlled by a dam under Allaire Road. As discussed below, this dam is in poor shape and the control structure at the outlet is damaged.

A major tributary discharges to the northern leg of Osborn's Pond. This drains a sub-watershed that includes a pond and wetland complex associated with an historic sand

and gravel mining and washing operation that was located just south of Eighteenth Avenue. A large pond complex known as Albert's Pond is still present in this area. Reportedly, this pond is up to 60 feet deep.

Downstream of Osborne Pond, the Brook flows into the Old Mill Pond. Hannabrand Brook (discussed below) joins Wreck Pond Brook just downstream of Old Mill Road. The Brook then discharges into the Wreck Pond. The Brook continues for about 2,200 feet before the generally accepted inland boundary of the Pond.

Hannabrand Brook flows through the southern portion of the watershed. It is about 4 miles long and has a drainage area of about 1,976 acres. Average base flows along the stream can range from 2 cfs to 4 cfs, depending on the time of year.

Black Creek, also known as the North Branch of Wreck Pond Brook, drains the northern portion of the watershed and is the shortest tributary at about 1.2 miles. The lower portion of this Creek is impounded and controlled by the weir structure at Ocean and Shore Roads in Spring Lake. The impounded area covers about 11 acres and is subdivided by railroad tracks. Average base flows along the stream can range from 2 cfs to 3.5 cfs, depending on the time of year.

The other hydrologic features of the watershed are numerous lakes and ponds. These are generally human made structures. Figure 3 shows the ponds within the watershed, which are summarized in Table 2. Other unnamed small ponds are also found throughout the watershed, including some impounded areas along the streams.

Table 2: Lakes and Ponds

Name	Area (ac)
Unnamed (Kellers) Pond	2.72
Hurley's Pond	6.46
Taylor Pond	0.71
Albert's Pond	25.75
Osborne Pond	20.21
Old Mill Pond	6.13
Spring Lake	14.38
Wreck Pond	73.36

Wreck Pond covers about 73 acres. It was originally an estuary open to the Ocean, at the Sea Girt Inlet. However, as early as 1888, a topographic map shows the Pond was divided at Black Creek and that the general shape along the roads was in place. During the 1930s, the outlet structure was constructed. The outlet structure allows exchange with the Ocean and there is a noticeable tidal fluctuation in the eastern portion of the

Pond. Recently, residents of the area have reported a noticeable decline in the degree of tidal fluctuation. However, as discussed later herein, fluctuations in salinity in the pond are still observed.

Wreck Pond can be divided into several sections. The eastern portion of the Pond extends from the bridge on First Avenue to the outfall structure and is about 1.4 acres in size. This section of the pond is the most influenced by tidal exchange. According to the NJDEP, the pond bottom in this area is primarily sandy. Both shorelines are vegetated, and are associated with back dune areas. Much of the vegetation on the northern shoreline was damaged or destroyed by Hurricane Sandy. The northwestern portion includes some wetlands vegetation and is primarily *Phragmites.* The southeastern shoreline, in Sea Girt, contains a more varied vegetative community.

Moving west, the pond is relatively narrow between First and Second Avenues and the bottom is primarily sandy. Along Second Avenue, the pond opens to its widest expanse, about 1,400 feet wide. This section of the pond extends from Second Avenue to the Railroad Bridge, a distance of about 2,000 feet, and is about 57.6 acres in size. Within this section of the Pond, both the northern shoreline (along Ocean Road) and the eastern shoreline (along Second Avenue) are either bulkheaded or rip-rapped. A narrow strip of mowed grass with occasional trees is present between the road and shoreline in this area. The northwestern shoreline, along Shore Road, is not bulkheaded but contains a more natural shoreline, although this is mowed grass, not natural vegetation. The area under the railroad bridge appears to be rocky and this structure, including the rocks, reportedly impacts flow.

The southern shoreline of this part of the Pond, in Sea Girt, contains wetlands and vegetated shoreline. Homes generally are present at a higher elevation farther from the shoreline. This section of the Pond is generally shallow and the bottom is very mucky

The western portion of the pond extends from the railroad bridge to the end of the Pond at Route 71. It is somewhat narrower and generally has only limited tidal exchange. This portion of the Pond is about 14.2 acres in area. The northern shoreline contains a park right along the shore that is vegetated with treed and shrubs. The southern shoreline contains a wooded area that is a public park to the east, with homes along the remainder of the shoreline.

The end of the Pond is considered to be Route 71. However, Wreck Pond Brook west of this road is still somewhat ponded.

Spring Lake is a pond located about four blocks north of Wreck Pond. Previously, it discharged into Wreck Pond. Spring Lake is also connected to the Ocean by a control valve and piping system that was utilized during the dredging of Spring Lake in the early 1990s. The control valve is closed at all times and is maintained by the Spring Lake Department of Public Works. Recently, the Borough diverted this pond to flow directly to the Ocean and it no longer discharges to Wreck Pond.

Besides Wreck Pond, the largest ponds are Albert's Pond at about 26 acres and Osborne's Pond at about 20 acres. Both of these ponds are located in the Waterford Glen sub-watershed.

Further downstream is Old Mill Pond, located at the Old Mill Inn, just north of Old Mill Road. This pond has a surface area of about 6.1 acres. Further northwest is Hurley's Pond, with a surface area of ±6.5 acres. This pond is fed by the main stem of Wreck Pond Brook and a tributary from the west, along Hurley Pond Road.

2.2 FLOODING

Flooding is a concern within certain parts of the watershed. Within the watershed about 651 acres are within Zone AE, based on the older flood maps. This zone corresponds to "the 1-percent annual chance floodplains that are determined in the Flood Insurance Study by detailed methods of analysis. The 1-percent annual chance flood is commonly called the 100-year flood as it is anticipated that one such event would occur every 100 years. Another 4 acres are in the A zone, which is defined as an area subject to inundation by the 1-percent annual chance flood but in which no flood depth has been determined.

The Federal Emergency Management Agency (FEMA) recently updated the maps and published Preliminary Flood Insurance Rate Maps (PFIRMS) for areas that are within the coastal zone. Figure 4 shows the new boundaries for the lower watershed and the adopted zones for the remainder. The area around the Pond is classified as AE (the 1% chance storm) with the based flood elevation at 10 NAVD88, with AE 11 NAVD88 in the pond and a narrow band around some of the shoreline.

About 3.5 acres are within the VE zone, at the mouth of Wreck Pond. This is the area within the "1-percent annual chance floodplain that has additional hazards associated with storm waves".

The lower part of the watershed experienced significant flooding in October of 2005. Within Spring Lake and Spring Lake Heights streets and homes were flooded. The flooding resulted from rainfall in the amount of ±11.58 inches over a period of 3 days. The actual flooding occurred rapidly, during an overnight period, surprising residents. On the evening of October 14, 2005, a flood elevation of 10.55 (National Geodetic Vertical Datum 1929 NGVD29) at the Wreck Pond weir structure was obtained by Najarian Associates, under work being performed for the Borough of Spring Lake. This water surface elevation was collected prior to what was suspected to be the maximum peak flood elevation, which occurred in the early morning of October 15, 2005. The flood waters could not flow over the outfall structure, due to the dunes that protect against tidal flooding. An opening was cut through the dunes to alleviate the flooding.

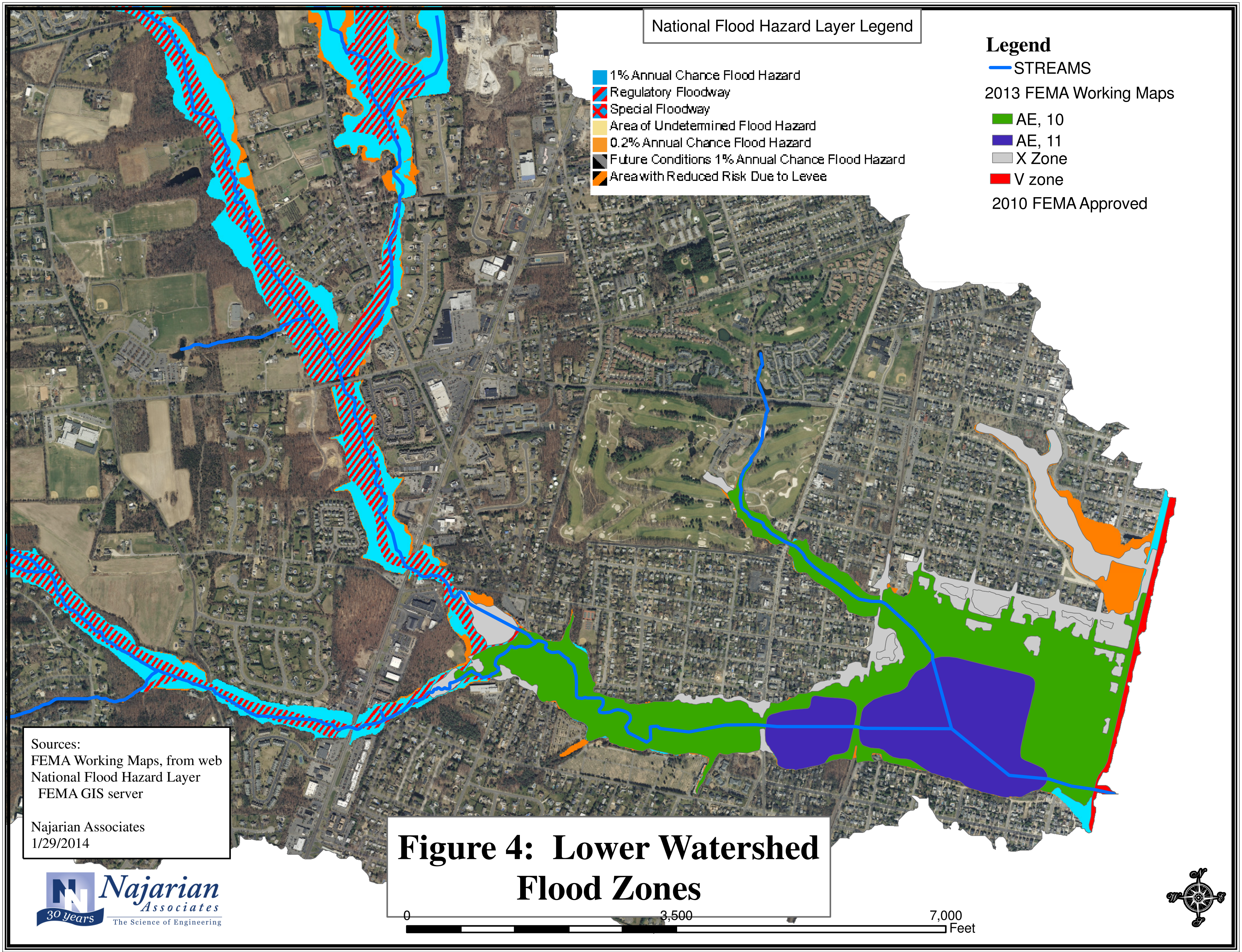


Figure 4: Lower Watershed Flood Zones

Hurricane Sandy in October of 2012 caused a breach in the dune and a portion of the outfall structure. The "emergency spillway" uncovered by this event is at about elevation 3 feet. This allowed any fluvial flood waters within the pond to exit. The elevation of this outfall does not allow regular tidal exchange and flow is only observed after rain events. Local residents credit the outfall with allowing water to exit quickly and avoid flooding during a storm event at the end of December, 2012. However, the natural littoral sand drift has closed the path to the Ocean and the Pond outflow is not enough to keep this open. As discussed below, the Borough and USFWS are considering means to enhance tidal exchange and increase outflow during floods at the Pond outfall.

2.3 ECOLOGICAL CONDITION

The Wreck Pond Watershed includes developed and undeveloped lands. Approximately 53 percent of the watershed is currently undeveloped, including about 1,100 acres of wetlands and ±2,270 acres (28%) of woodland.

Of the approximately 1,100 acres of wetlands, about 800 acres (72%) are wooded deciduous wetlands classified as either deciduous wooded wetlands or mixed forested wetlands (deciduous dominant). Only very small areas of freshwater (±4.81 acres) and saline (±9.98 acres) tidal marsh is noted. Wetlands are shown on Figure 3.

These wetlands were not previously mapped as habitat for threatened or endangered species habitat. However, the most recent version of the Landscape Project maps identify some of the wetlands as habitat for threatened bird species. The wetland buffer would be expected to be 150 feet along wetlands that provide this habitat, providing the mapping is correct.

The stream corridor (riparian zone) in the upper watershed is primarily wooded, even in areas of development. Preservation of these wooded buffers is a key concern in the watershed.

2.4 WATER POLLUTANT SOURCES

Book 1 of the RSWMP provides detail on the watershed characteristics, monitoring results, and pollutant sources. The following summary from that report outlines the sources.

The Wreck Pond Brook Watershed has been the subject of two modeling studies and several water quality monitoring programs including the County weekly sampling and the year-long ambient sampling done for the Borough of Spring Lake's Wreck Pond Environmental Study by Najarian Associates (NA). In addition, Monmouth University and Rutgers Cooperative Extension collected water quality data as part of their studies. Further, MCHD continues to conduct summer bacteria monitoring at the beaches. The

NJDEP Marine Watering Monitoring has been conducting storm event monitoring in the Pond and at the beach. However, no additional ambient monitoring has been undertaken since that done for the RSWMP. The available water quality data are used to characterize the water quality in the tributary streams and Wreck Pond.

Stream reconnaissance, fish studies, local residents' observations and other watershed knowledge have added to the identification of impairments and likely pollutant sources. In addition to the monitoring and local studies, relevant literature was examined to evaluate the potential for watershed features to generate water pollutants.

The watershed contains a number of sources that may contribute to the loading of bacteria, nutrients and other pollutants. However, some sources are not known to be present, including:

- **Point Sources other than Stormwater:** There are no known point source discharges in the watershed.

- **Septic Systems:** There are no known septic systems within the watershed, the area is entirely sewered. It is possible that unknown historic septic systems are present.

The primary nonpoint sources of stormwater pollution are the land surfaces within the watershed. The various land uses generate water pollutants. Another potential non-point source is failing sewer infrastructure. Processes within the waters, particularly the ponds, along with water fowl and wildlife, and possibly tidal flow are other potential sources.

2.5 ASSESSMENT OF NON-POINT SOURCES

The watershed contains mixed land uses. The water quality modeling study results, described in the RSWMP and summarized in section 2.6, following, indicate that Wreck Pond Brook produces most of the actual pollutant loads. As the land uses are mixed, it was not possible to use the SWMM model results to directly determine the contribution of each land use. However, the USEPA Spreadsheet Tool for Estimating Pollutant Load (STEPL) model was used to develop loading estimates from various land uses.

SWMM (Stormwater Management Model) is a dynamic rainfall-runoff simulation model from the USEPA. It can be used to model pollutant loads from urban and suburban land uses. When the previous Wreck Pond studies were completed, SWMM was applied to the Wreck Pond watershed using rainfall and flow data collected within the watershed. Pollutant loads were based on land uses. The model was calibrated using storm event water quality data collected at three stations. Initially, it was hoped that the model could be used to identify particular sources of water pollutants and thus focus pollutant-reduction efforts. However, the land uses throughout the watershed are very similar and each subwatershed contained a mixture of land uses. Thus, the model was not able to serve this purpose.

The STEPL model is an EPA spreadsheet model that calculates pollutant loads and also calculates load reductions from implementation of BMPs. The model uses simple algorithms to calculate pollutant loads from different land uses. The model has estimated loadings for nutrients and sediment for urban, cropland, pastureland, feedlots, and forests. The model then calculates how much loads from each land use would be reduced by the implementation of certain BMPs.

The modeling results, the results of the agricultural and recreational land surveys and literature information are used to assess the contribution of various land uses.

2.5.1 Land Uses

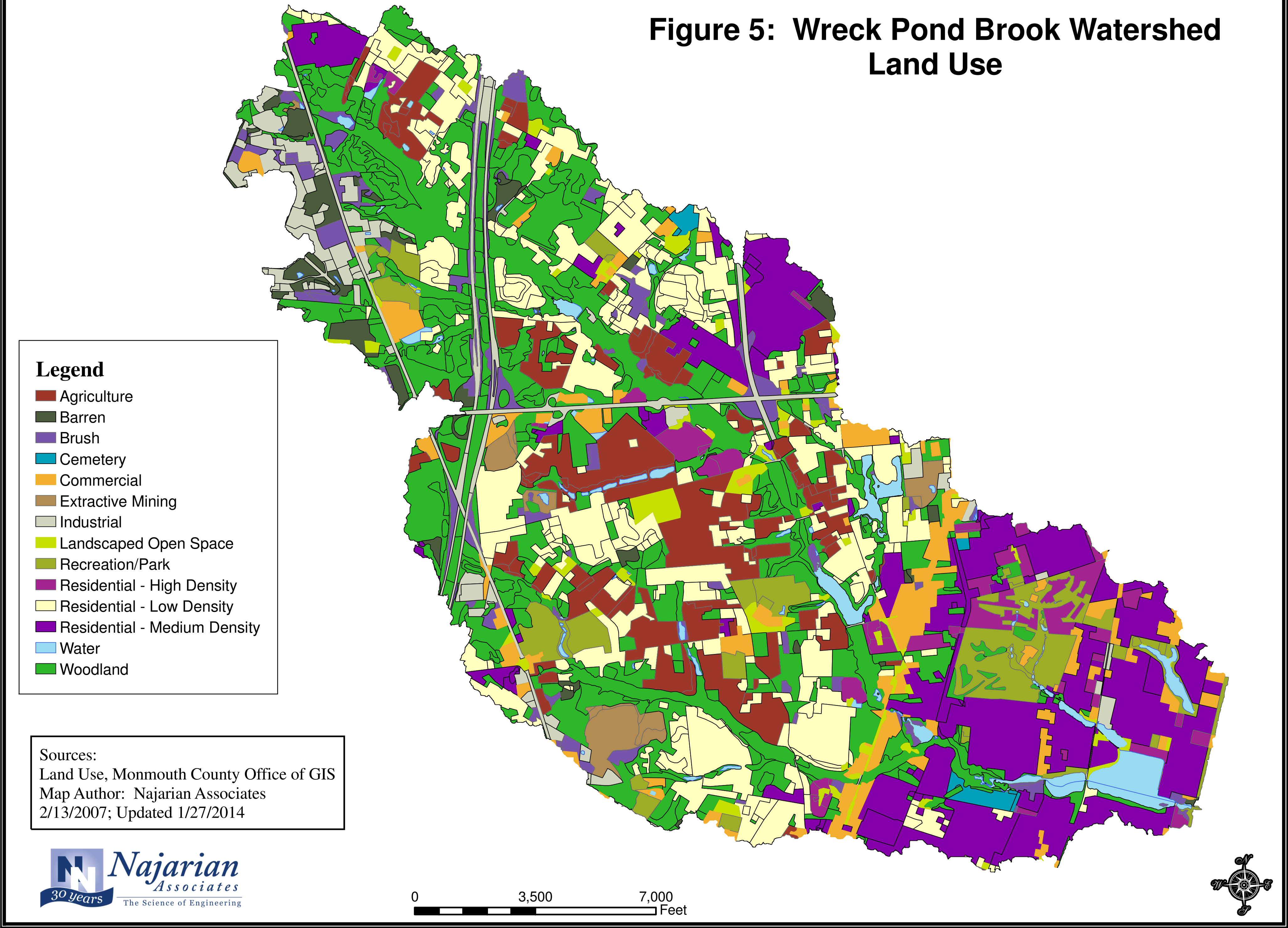
Description of land uses were obtained from the Monmouth County GIS in 2005 and 2006. Available land use GIS files from Monmouth County and the NJDEP use the Anderson system, which assigns a code to each land use. The Anderson system codes can be very specific or may be more generally applied. For example, wooded lands are subdivided in that system into categories such as “Deciduous forest (>50% crown closure)” or “Mixed forest (>50% deciduous with >50% crown closure)”. For the purposes of pollutant study, land use is of concern for generation of stormwater and impacts to water quality. Pollutant loading estimates are not available at this level of detail. Thus, in the RSWMP the detailed land uses were combined to define land use. Figure 5 and Table 3 summarizes the land use in the watershed.

As seen in the Table, about 1/3 of the watershed is wooded or recreation/park use. Further, the stream corridors are primarily wooded, especially in the upper watershed.

For the loading analysis in Section 2.4, the USEPA STEPL model was used along with other watershed data. This model uses somewhat different land use categories, combing some of the suburban-urban categories, but requiring input of both cropland and pastureland under the agricultural land use. The detailed GIS land use data were used to determine the percentage of agricultural land this is farmed for crops. Table 4 provides a land use summary based on the STEPL Model categories. Within the model, the land use categories in Table 3 were used to subdivide the urban category into commercial, industrial, high density residential and low density residential. The water category was taken out of the land use evaluation, since water does not generate pollutants (wetlands are included in the forest or field category).

Agricultural Lands: The Rutgers Cooperative Extension survey of agricultural land, discussed in RSWMP, determined that agricultural lands are not having a “significant” impact on the “overall health of the Wreck Pond Brook Watershed”. This finding is based on water quality data collected indicating that standards are rarely exceeded during routine sampling for pH, nutrients and other parameters using a meter (however, some of the data were not in line with the laboratory data from other studies). While the

Figure 5: Wreck Pond Brook Watershed Land Use



agricultural lands were not considered a major source in the survey, runoff from these lands is likely adding to the overall load of bacteria, nutrients and sediment in Wreck Pond.

Table 3: General Land Use Categories		
General Land Use Category	**Area (Acres)**	**% of Watershed**
Agriculture	820.3	10.0%
Barren	165.5	2.0%
Cemetery	38.4	0.5%
Brush	283.7	3.5%
Commercial	404.6	4.9%
Extractive Mining	120.9	1.5%
Industrial	428.1	5.2%
Landscaped Open Space	163.4	2.0%
Recreation/Park	403.4	4.9%
Residential - High Density	239.5	2.9%
Residential - Low Density	1413.4	17.3%
Residential - Medium Density	1247.1	15.3%
Water	215.9	2.6%
Woodland	2229.9	27.3%

Table 4: Land Use for STEPL Model								
Watershed	**Combined Land Use (Area in acres)**							
	Urban		**Cropland**		**Pastureland**		**Forest**	
	Area	**%**	**Area**	**%**	**Area**	**%**	**Area**	**%**
Wreck Pond Brook	2543	55%	392	8%	124	3%	1585	34%
Hannabrand Brook	1017	51%	230	12%	73	4%	656	33%
Black Creek	375	90%	0	0%	0	0%	41	10%
Wreck Pond Direct	975	86%	0	0%	0	0%	163	14%
TOTALS	**4910**		**622**		**197**		**2445**	

Monmouth GIS Land Use GIS Shapefiles

The Rutgers survey found that farmers reported fertilizer use within the range that would be taken up by the crops and thus excessive nutrient loading from this source was not expected. However, manure management was of concern at a few farms. These farms generally had few farm animals and thus are not likely a major source of bacteria. However, only some of the farmers responded and only some of the farms were visited by the RCE. Further, this effort was undertaken about 10 years ago and different farming practices and farmland uses could be expected. Thus, the agricultural lands are considered a potential source. Agricultural practices can impact sediment, nutrient and bacteria loading.

Park and Recreational Land: The Rutgers survey of park and recreational land also found these lands did not appear to be having a major impact on water quality.

Urban/Suburban Land: Residential land uses are dominant in the lower watershed and are sources of sediment and nutrients as well as excess flows which can lead to erosion. Use of fertilizer can generate phosphorus loadings from lawns, parklands or landscaped open space. Construction activity is a source of sediment. Landscaping also can be a source of sediment and nutrients. Human use and pets are a source of bacteria.

2.5.2 Streams

A stream assessment and survey was conducted by the Freehold Soil Conservation District (FSCD), as discussed in the RSWMP and later below. The results reveal that certain stream segments are contributing sediment and possibly associated pollutants due to bank instability.

2.5.3 Pond Processes

The ponds in the upper watershed appear to act as retention structures that slow the flow of water and allow settling of sediment and associated pollutants under certain flow regimes. Under certain conditions, the sediments in these ponds may become re-suspended in high flows and be transported downstream. Further, the sediment in Wreck Pond itself can be stirred up by tidal action, winds, and storm events.

The sediments and organic matter in the bottom of the upstream ponds and of Wreck Pond were found to contain bacteria and nutrients. Under certain environmental conditions, these pollutants may be released from the sediments back into the water column. The studies conducted thus far have not quantified these processes.

2.5.4 Water Fowl and Wildlife

Wreck Pond, Black Creek and the watershed ponds are home to a variety of water fowl including mute swans, geese and ducks and other birds. In particular, the water fowl are found on the island and wetlands just west of the First Avenue Bridge. These water fowl produce fecal matter that adds bacteria directly to the ponds and is deposited along the shorelines. Other wildlife including deer may produce fecal matter that is carried to the waterways. Deer and other wildlife also use the stream corridors and the watershed in general. They impact stream and area vegetation by over-grazing sometimes stripping areas of plants, which can increase erosion.

2.5.5 Natural Conditions

The low pH in the western portions of the streams may be due to the naturally acidic soils found in the Pineland type woodlands and soils, as discussed below. The tidal waters from the Ocean also impact the flow and pollutant regime in the Pond.

2.5.6 Pollutant Source Summary

For the Wreck Pond Watershed, the mixed land uses are a major source of all pollutants of interest. The results of the watershed modeling, agricultural survey, stream assessments, and bacteria source tracking did not identify one source of highest importance. For each pollutant group, identified sources are noted below.

Nutrients: Developed land uses, agricultural lands, fertilizer application

Bacteria: Developed land use, manure management in farmlands, water fowl, possible leaking infrastructure, wildlife, pets, release from Pond sediments

Sediment: Developed lands, agricultural land, un-vegetated uplands, construction sites, stream erosion, re-suspension of pond sediments

The analyses in this study did not find a particular source that was the most important component of sources for each pollutant. Thus, the sources are not ranked

2.6 WATER QUALITY IMPAIRMENT AND LOADING ANALYSIS

The NJDEP has identified two sections of Wreck Pond Brook and Hannabrand Brook as water quality limited and listed on the 303(d) List in the Integrated Report. The watershed is divided into 2 subwatersheds:

Wreck Pond Brook (above Rt35) (HUC14 Code: 02030104090070): This subwatershed includes most of the Wreck Pond Brook Watershed, ending at Route 35 just above Old Mill Pond.

Wreck Pond Brook (below Rt35) (HUC14 Code: 02030104090080): This subwatershed includes the watersheds associated with Hannabrand Brook, the lower part of Wreck Pond Brook, Black Creek, and Wreck Pond itself. In addition, this subwatershed encompasses the Atlantic Ocean coastal drainage areas north to the Shark River including the water bodies of Spring Lake, Lake Como and Silver Lake. Most of these areas drain directly to the Atlantic Ocean and do not impact water quality in Wreck Pond. In the past, Spring Lake drained to Wreck Pond, but the Borough of Spring Lake modified this discharge to be directly to the Atlantic Ocean. Thus, much of this sub-watershed/assessment unit does not actually drain to Wreck Pond.

In the 2012 Integrated Report, both of these waters are listed as impaired for phosphorus and pH. In addition, although not listed on the Integrated List, sediment is of concern in the watershed as evidenced by the accumulated sediment in the ponds throughout the watershed. Habitat degradation is also of concern. In addition, a TMDL has been issued for bacteria for both Wreck Pond Brook (based on the station at Allenwood Road in Wall) and Hannabrand Brook.

Figure 6 shows the monitoring locations and subwatersheds referenced in the following sections. The points labeled as "W1-W9" are the County water quality sampling locations and also the NJDA water depth stations. These stations are also noted as Wreck 1 – Wreck 9. W2 and W3 are also the locations at which Najarian Associates sampled for the Borough Study at the locations labeled as Hannabrand Brook and Wreck Pond Brook, respectively, both at Old Mill Road. The WP1-WP3 points are the ambient locations in the Pond where NA sampled for the Borough Study.

The following sections summarize the water quality by parameter and location.

2.7 pH

The streams were listed for pH starting in 2006. At that time, the standard for all FW2-NT streams, such as Wreck Pond Brook and its tributaries was 6.5 to 8.5. In 2011, NJDEP revised the Surface Water Quality Standards for pH for streams in the Atlantic Coastal drainage. The Department recognized that many of these streams are more similar to those in the Pinelands and that low pH is a natural condition. Further, absent acid mine drainage, water pollution tends to increase rather than decrease pH levels. The standard was revised to a range of 4.5 to 7.5.

Under the previous standard, both assessment units in the Wreck Pond Brook Watershed were listed as impaired for pH, apparently due to occasional reading below 6.5. Given the change in standard, the available data were compared to the new range.

pH was measured throughout the watershed during monitoring programs by Monmouth County (MC) and by Najarian Associates (NA) during previous studies of Wreck Pond and the watershed. More details on this monitoring are provided in the RSWMP. Further, USGS maintains a station at Hannabrand Brook at Old Mill Road.

The following analyzes the pH data by water segment.

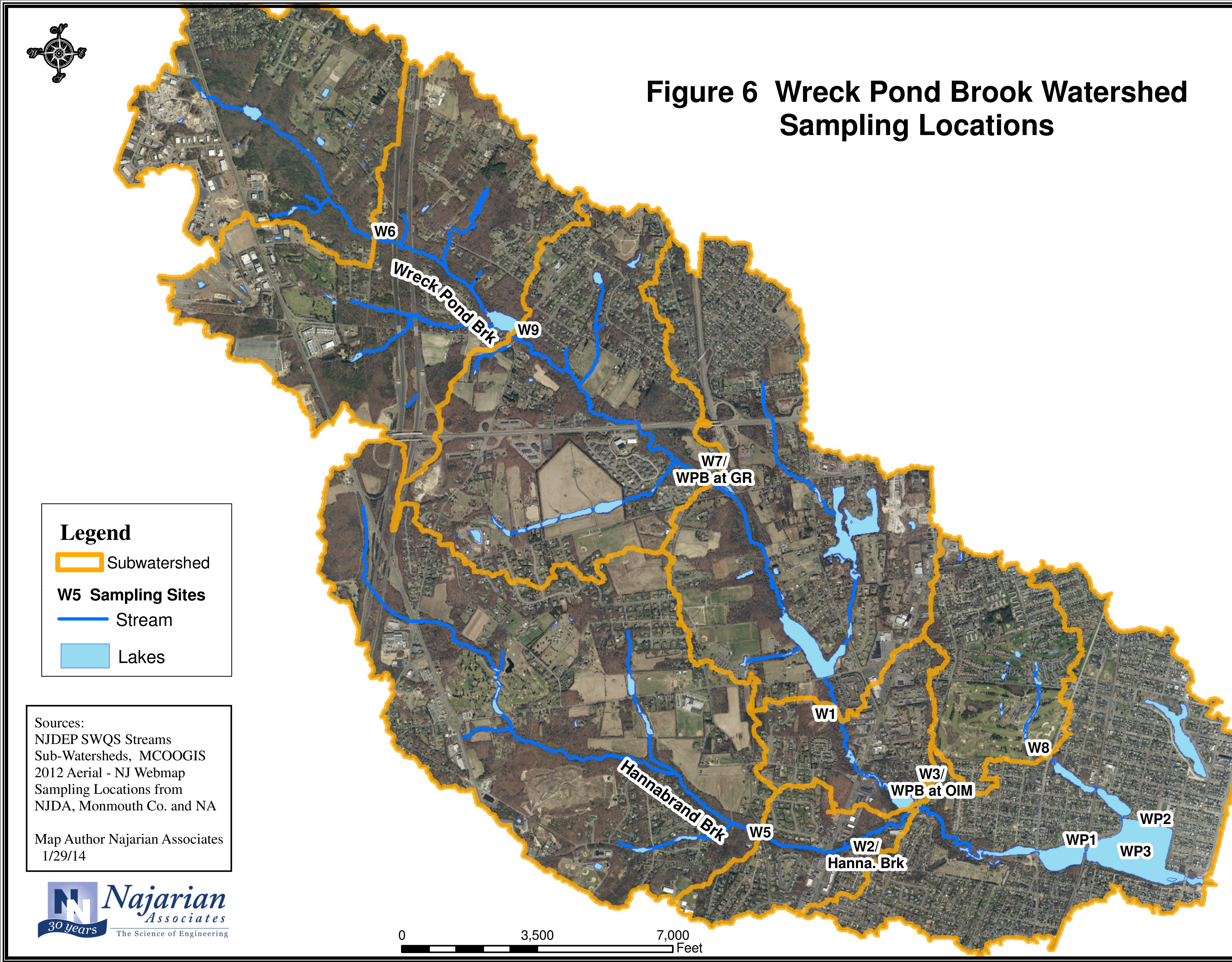


Figure 6 Wreck Pond Brook Watershed Sampling Locations

2.7.1 Hannabrand Brook

Hannabrand Brook is characterized by four stations:

Monmouth County Sampling (2005-2006):

- W2 (Wreck 2) at Old Mill Road
- W5 (Wreck 5) at Baileys Corner Road

Sampling conducted by Najarian Associates for the Borough's Wreck Pond Environmental Study for Spring Lake (2005-2006):

- HB or 2B at Old Mill Road (same general location as W2)

USGS Station 1407806 is also on Hannabrand Brook at Old Mill Road. Tables 5 and 6 summarize these data.

Table 5: Ambient Monitoring pH (su)
Hannabrand Brook
(Monmouth County for WP Studies)

	W2- Hannabrand at Old Mill Road	W5 – Hannabrand at Baileys Corner Road
Mean	6.70	6.66
Median	6.60	6.55
Max	8.43	8.60
Min	5.82	6.00
25th	6.52	6.47
75th	6.72	6.76
N	63	63

Table 6: Ambient Monitoring – pH(su) Hannabrand Brook at Old Mill (NA for Borough Study)	
Wreck Pond Environmental Study	
Mean	6.32
Median	6.35
Max	7.09
Min	5.96
75th%	6.42
25th%	6.07
N	12
USGS Station	
Mean	6.6
Median	6.5
Standard Dev	6.5
Max	7.3
Min	6.1
75th%	6.7
25th%	6.4
N	16

Table 7 summarizes all of the data collected within Hannabrand Brook for pH. This includes the weekly data collected by Monmouth County in 2005 and 2006. These samples were collected at County Station Wreck 2, at Old Mill Road, and Wreck 5 at Baileys Corner Road. The Wreck Pond environmental study and the USGS stations are also at Old Mill Road. In total, 154 samples were collected.

Table 7: Summary of pH Data Hannabrand Brook (All Combined Data pH (su))	
Mean	6.6
Median	6.6
Max	8.6*
Min	5.8
25th	6.5
75th	6.7
95th	7.4
N	154

*Outlier

The NA data and the USGS station do not show any values out of range for pH. The County data, however, show five values (3%) above the standard range. In all cases, the value taken the next week was well within range. Four of the results (two at each station) of these readings appear to be outliers. These values were also out of range at seven out of the eight samples taken throughout the watershed on both March 14, 2005 and on May 31, 2005 (see Section 2.7.2 on Wreck Pond Brook, following. That is these readings were found on at least two of three watershed streams. This suggests a probe error or other sampling problem. The fifth value was 7.57 at Wreck 2. Thus, the stream generally meets the revised pH criteria and no impairment is indicated.

2.7.2 Wreck Pond Brook at Old Mill Road

This analysis considers Wreck Pond Brook (WPB) from its headwaters to Old Mill Road, at the confluence with Hannabrand Brook. The combined Brook flows further downstream before entering the Pond. The lower section is discussed in the section for Wreck Pond, following.

The County collected data at five stations along Wreck Pond Brook:

- W6 at Martins Road
- W9 at Hurley's Pond Dam
- W7 at Glendola Road
- W1 at Waterford Glen
- W3 at Old Mill Dam Culvert

NA collected data at Old Mill Road also (Wreck Pond Brook or WPBOM) for the Spring Lake study.

NJDEP collected 3 samples each at two stations at Osborne Pond in 2007 (April, July and September). These stations are listed as:

NJW04459-117-0 – Osborne Pond Outlet

NJW04459-117-1 – Osborne Pond

The County data are summarized in Table 8. At Wreck Pond Brook, 12 of the 318 samples (3.8%) collected by the County exceeded the 7.5 limit for pH. In this case, 10 of the 12 out-of-range values were at all stations on 5/31/2005 and 3/14/2005. The May sample was above the 99^{th} percentile at all stations and also exceeded the 99^{th} percentile calculated from the Hannabrand Brook data. This did not coincide with a period of rainfall. Thus, this appears to be an anomalous reading, possibly due to a meter problem or other sampling error and is not considered to be a valid measurement.

The readings on 3/14/2005 also coincided with high readings at the Hannabrand Brook stations. These levels were not as high as the May 31 results and were associated with only limited antecedent rainfall (0.24 inches 6 days prior). The values taken in WPB ranged from 7.6 to 8.0 and the next week the readings ranged from 6.36 to 6.8. The week prior, only the result at W1 was above the range at 7.9. Thus, this appears to be either a transient event or a sampling error.

The other two readings that exceeded the standard range were 7.58 and 7.9 at individual stations, with readings within range at the other stations.

Table 8: Ambient Monitoring pH (su) **Wreck Pond Brook** **(Monmouth County for WP Studies)**								
Station	**N**	**Mean**	**Median**	**Max**	**Min**	**25th**	**75th**	**StdDev**
W9	64	6.15	6.07	7.90	5.17	5.79	6.49	0.53
W7	64	6.40	6.30	8.68	5.46	6.07	6.54	0.55
W1	63	6.58	6.50	7.94	5.88	6.32	6.73	0.41
W3	64	6.78	6.73	8.00	5.93	6.63	6.90	0.40
W6	63	6.80	6.74	8.45	6.01	6.63	6.89	0.35
ALL DATA								
	318	6.54	6.55	8.68	5.17	6.20	6.81	0.51

For the Borough study of Wreck Pond, NA collected water quality samples in Wreck Pond Brook at Old Mill Road during 2005 and 2006. The results are summarized in Table 9. Only one sample exceeded the upper pH limit of 7.5 and that was at 7.6.

Table 9: Ambient Monitoring - pH (su) **Wreck Pond Brook** **(NA for Borough Study)**	
Mean	6.86
Median	6.83
Std. Dev	0.30
Max	7.60
Min	6.51
75th%	6.94
25th%	6.65
95th	7.36
N	12

The data from the short study by NJDEP on Osborne Pond (samples taken in April, July and September, 2007), show an average pH of 6.4 and all six samples were within the standard range. The maximum was 6.7.

For the most part, the pH levels in Wreck Pond Brook meet the applicable pH range of 4.5 to 7.5. There are a few instances in which the pH is just above the 7.5 limit. The NJDEP set the standard range for pH in coastal streams to that of Pinelands waters. However, the streams in the watershed are not Pinelands streams. The average pH is 6.5 when all of the data are taken into account and the minimum is 5.21, with the 25th percentile at 6.2 and the 10th at 5.91. Only 7 samples were less than 5.5 (2%). Thus, it appears that the natural pH range at Wreck Pond Brook (and Hannabrand Brook as well) may be closer to 5 to 8, than 4.5 to 7.5. This seems consistent for a stream that is within the Coastal Plain and not within the Pinelands.

Any exceedances of pH at these stations are fleeting and do not exceed 8 (except for the outliers discussed above). Thus, these values do not appear to be associated with water quality impairment.

2.7.3 Black Creek

Black Creek was sampled at one station by the County and one by NA for the Borough Study. County sampling location Wreck 8 is farther upstream at Route 71 while the NA station (2C Black Creek) was at Shore Road in Spring Lake, where the ponded portion of Black Creek enters Wreck Pond.

Table 10 summarizes the results for these two stations. Clearly, the two stations are very different. The results at W8 are very similar to those at WPB and Hannabrand Brook, with the mean pH at 6.7 and the minimum at 5.9. The maximum here is 8.45 which was collected on 5/31/2005; this appears to be an outlier or sampling error as it was at the other stations as discussed above. Interestingly, the reading on 3/14/2005, which was very high in the other two streams, was 7.2 here. No other results exceeded the standard range. Thus, this segment meets the standards.

In contrast, the mean value at NA Station 2C, the outlet to Wreck Pond, exceeds the revised standard of 7.5. Even the 25th percentile value of 7.43 is close to the top of the range. However, only two of the samples exceed the previous standard of 8.5.

This location is at the outlet from the ponded portion of Black Creek. This water is subject to algal blooms and other signs of eutrophic conditions. Thus, the elevated pH here may be indicative of water quality impairment.

2.7.4 Wreck Pond

The quality within Wreck Pond was sampled by NA as part of the Borough study. As shown on Figure 6, Station WP1 is located between the railroad bridge and Route 71

Table 10: Ambient Monitoring -pH (su) Black Creek (Monmouth Cty and NA for WP Studies)		
	Wreck8	**2C Blk Creek**
Mean	6.73	7.95
Median	6.69	7.53
Max	8.45	10.63
Min	5.89	6.99
25th	6.55	7.43
75th	6.83	8.00
Std. Dev	0.38	1.01
N	63	12

while the other two locations are within the main part of the Pond between First St and the railroad bridge. Table 11 summarizes these data. Clearly, pH at Station WP1 differs from the other two with a mean almost 1 unit lower although the maximum pH is similar. WP1 is just downstream of where the Brook becomes ponded and thus seems to have characteristics of both. This part of the Pond does not appear to be tidally influenced enough to reach saline levels under the monitored condition. At this location, one sample, the first one collected, exceeded the upper limit. Otherwise, the station was in compliance with the 4.5 to 7.5 range. There was no correlation here between pH and chlorophyll a.

Table 11: Ambient Monitoring - pH (su) Wreck Pond (NA for Borough Study)			
	WP1	**WP2**	**WP3**
Mean	6.95	7.92	7.63
Median	6.87	7.81	7.64
Max	8.26	8.40	8.18
Min	6.26	7.52	7.04
25th Percent	6.54	7.72	7.44
75th Percent	7.26	8.20	7.79
Std. Dev	0.54	0.32	0.31
N	12	12	12

The pH in Wreck Pond is generally higher than that in the tributary brooks. The pH at WP2 was above the upper standard limit of 7.5 during all sampling events; the minimum value was 7.52. pH may be increased during times of higher algal growth. At Station WP2, there is a significant correlation between pH and chlorophyll a, although the r^2 is just 0.5, meaning this only explains about half the variance. However, at WP3 there is no correlation between pH and chlorophyll a.

Furthermore, the standard that would be applicable in the eastern Pond is complicated by the fact that the Pond is tidally influenced. The NA data were collected at around low tide to ensure that the water sampled was not ocean water. As discussed below, NJDEP sampling shows that that salinity is over 3 ppt in the main part of the Pond at times. The designation of Saline Estuarine (SE) waters is assigned when salinity is above 3 ppt at high tide. Therefore, this part of the Pond may be considered SE and thus the pH standard range would be 6.5-8.5. In this case, the results from WP2 and WP3 meet the standard.

NJDEP conducted additional sampling in the pond, primarily for bacteria levels and track down of bacterial sources. Most of the sampling did not include pH. During March of 2013, a three-day sampling event occurred during a rain storm with 4 samples taken at various locations in the Pond ranging from the bridge at Route 71 to the outfall structure. A total of 24 samples were taken in the Pond during this rainfall event.

Table 12 presents the results of the combined data. These data are comparable to the results at Station WP2 and WP3. Interestingly, there was no significant difference in pH from the western-most station at Route 71 (Station 34) and at the outlet, although the salinity differed significantly. Station 34 is still east of the portion of the Pond where WP1 is located. The average pH was 7.6 at both stations, while the salinity averaged 0.2 at Station 34, and 7.1 at Station 17. The sampling began after the rain had started. The pH generally dropped from the first sample to the next two and then increased in the last sample.

Table 12: NJDEP Storm Event Monitoring **pH (su) - October 2013** **(All Wreck Pond Data)**	
Mean	7.7
Median	7.6
Max	8.4
Min	7.2
25^{th} Percent	7.5
75^{th} Percent	7.8
N	24

The data from NJDEP Station 34 and from NA Station WP1 suggest that the Pond salinity remains fresh, at least under most circumstances. At that station, the pH over the 3-day period in October 2013 varied from 7.4 to 7.8, just above the FW2-NT limit. However, salinity at NJDEP Station 33 at the other end of this section of the Pond, reached over 9 ppt. Thus, it is not known if the salinity at Station 34 would also be over 3 ppt at high tide under typical circumstances and the higher upper pH limit for SE waters of 8.5 would then apply.

2.7.5 Summary of pH Impairment Findings

The watershed includes two assessment units. Findings for these units can be summarized as follows:

Wreck Pond Brook Above Route 35: Based on the new water quality criteria for Atlantic Coastal waters, there are no impairments in Wreck Pond Brook above Route 35. The few measurements over the upper range of the standard were determined to be inaccurate readings as they occurred at all stations and the pH dropped substantially the next week.

Wreck Pond Brook Below Route 35: This assessment unit contains several different water bodies and drainage areas. The analysis herein is only for the waters associated with Wreck Pond and its tributary streams. Within this unit, there are some segments that meet the applicable standard, one that clearly does not, and one that is questionable. That is, the ponded portion of Black Creek and portions of Wreck Pond itself do not meet the current standard range for FW2NT-Atlantic coastal waters. The readings found are below the upper range in the previous standard of 8.5. Thus, it is not clear if this represents a water quality impairment or a natural condition of the ponded areas.

Analysis by water can be summarized as:

1. **Hannabrand Brook:** This segment meets the applicable standard, when the outliers are removed from the data set. As discussed above, there appeared to be sampling error or a transient event on two of the sampling weeks as pH at seven of the eight stations throughout the watershed were above the standards range. On this basis, four of the five standard exceedances were considered outliers
2. **Black Creek (N. Branch of Wreck Pond Brook):** The upstream station, Wreck 8, meets the applicable standards when the outlier is removed from the data set. Thus, Black Creek above Route 71 is in compliance.

   The ponded portion of Black Creek, however, has pH values that exceed the upper end of the range at 7.5. In fact, the mean value is 7.95 at this station. Thus, this segment is impaired.

3. **Wreck Pond:** Wreck Pond includes the segment of Wreck Pond Brook below Old Mill Road. The dividing line between the Brook and the Pond is generally considered to be at Route 71, although the Brook is somewhat ponded above this point. Limited data are available for this section of the Brook, with NJDEP Station 34 providing information only over a 3-day period. The data showed an average pH here of 7.6, which is above the standard range.

   Further east within the Pond, it becomes saline. As noted above, the data were not collected at high tide in the Pond. Thus, it is not known what the salinity profile is at high tide, which defines the difference between the SE1 and FW2-NT classifications and the pH standard. The data suggest that most of the Pond has a salinity of over 3 ppt at high tide. In that case, the pH standard range would be 6.5 to 8.5 and the standard would be met.

Therefore, major water quality limited segment for pH is the ponded portion of Black Creek.

2.8 PHOSPHORUS

Both assessment units were also listed for phosphorus on the Integrated List. The NJDEP FW2NT Phosphorus standard is 0.1 mg/l in tributaries. However, the lake standard is 0.05 mg/l and this standard is also applied to tributaries that are upstream of lakes. The standards also include non-numeric criteria that require phosphorus load reductions if the downstream water quality is compromised. Therefore, both tributaries are considered impaired for phosphorus due to findings downstream in the Pond itself.

More limited data is available for this parameter than for pH, as the County did not monitor for phosphorus. Thus, the USGS data taken at their station on Hannabrand Brook, the NA data for the Wreck Pond Environmental Study and the limited NJDEP freshwater data at Osborne Pond are the basis for this assessment.

2.8.1 Hannabrand Book

The data from the USGS station and the NA station at Hannabrand Brook at Old Mill are summarized in Table 13. All of the data from both sets of monitoring data meet both the 0.1 mg/l stream standard and the 0.05 mg/l lake standard. Therefore, under the ambient monitoring conditions no violation of the total phosphorus standard was found at Hannabrand Brook. The NA Wreck Pond Environmental Study, however, specifically targeted dry weather conditions to determine the general status of the Pond and tributaries. Given the lack of data above standard, no reduction in load can be calculated as there is no numerical violation of the standard.

Storm event sampling was also conducted for two events at this station. Table 14 provides the total phosphorus data for those storms. It should be noted that only partial sampling was possible during Storm 1. The rainfall did not occur as predicted early in the storm and significant rainfall began later, so that the timing of the monitoring did not capture the peak storm event flows. However, the available data were used. The entire storm event was monitored during Storm 2. Further details on this monitoring are provided in the RSWMP. Figure 7 graphs the flow and total phosphorus concentration for both storms. The TP generally increases with increasing flow.

2.8.2 Wreck Pond Brook at Old Mill

Table 15 provides the data for Wreck Pond Brook at Old Mill. All of the data conform to the stream standard of 0.1 mg/l. However, the Standards also impose a limit of 0.05 mg/l for streams that enter ponds. The NA data show that the 75th percentile value is just above the 0.05 limit. Thus, about 25% of the samples exceed the standard for lakes.

Table 13: Ambient Monitoring –Phosphorus Hannabrand Brook at Old Mill (mg/l)	
Wreck Pond Environmental Study by NA	
Mean	0.032
Median	0.031
Max	0.046
Min	0.01
75th%	0.044
25th%	0.025
N	12
USGS Station	
Mean	0.010
Median	0.008
Std. Dev	0.008
Max	0.020
Min	0.004
75th%	0.012
25th%	0.006
N	16

Flow data were available for some of the period from the recording flow gauge installed by the NJ Department of Agricultural for the watershed modeling. For other water quality samples, water depth was measured on the staff gauge installed. For those samples, the water depth was translated to the water surface elevation at the recording gauge. The same methods were used to calculate flow as described in 2.5.1 from the NJDA rating curves.

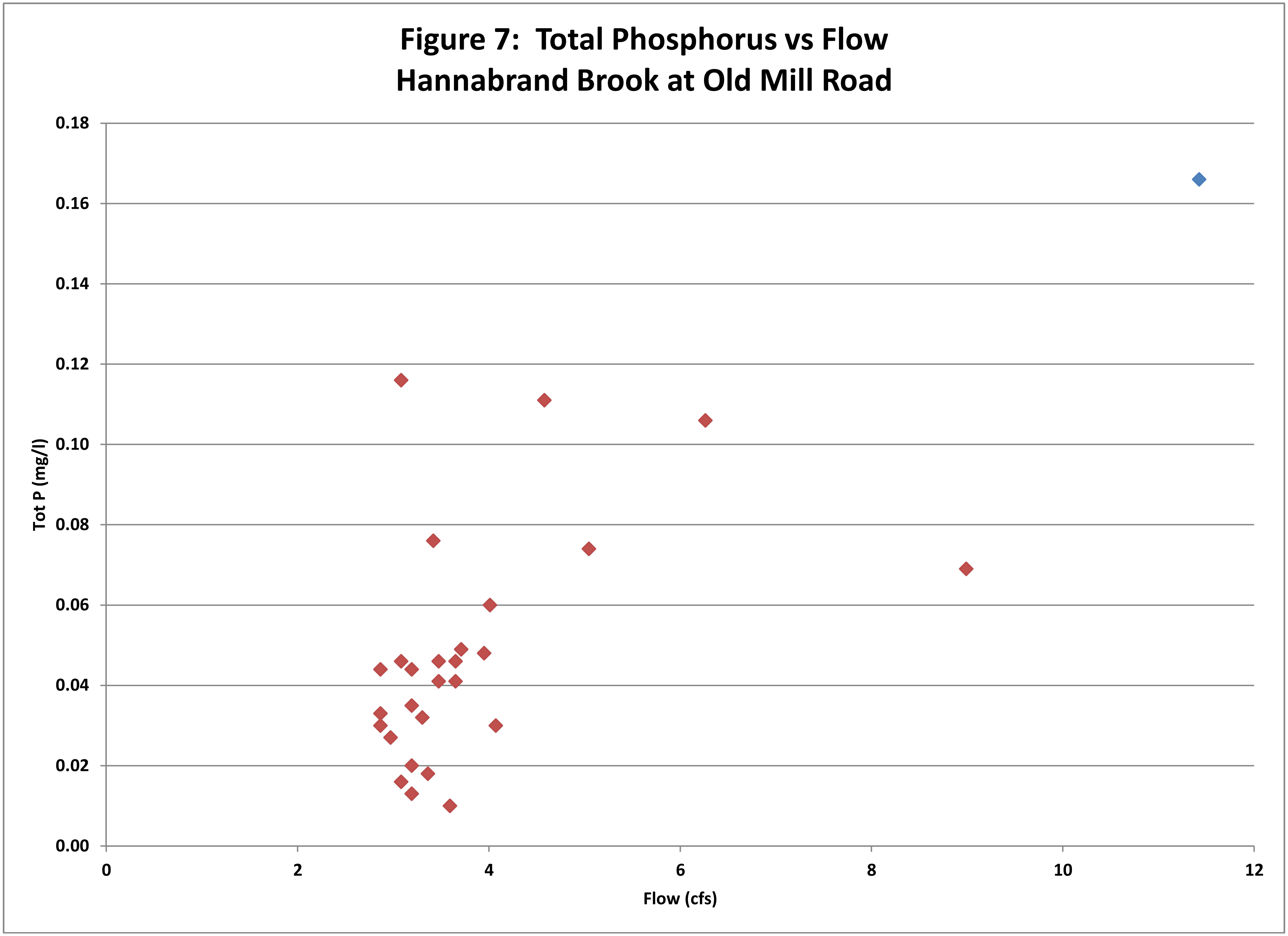


Figure 7: Total Phosphorus vs Flow
Hannabrand Brook at Old Mill Road
Tot P (mg/l)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0
2
4
6
8
10
12
Flow (cfs)

As discussed above, storm event sampling was conducted for two separate storms. Table 16 provides the flow and total phosphorus data from these storms. The flows were based on depth readings taken in the field at the time the samples were collected. These depth readings were translated to the equivalent water surface elevation at the recording gauge. The rating curve was then used to calculate flow. These data, along with the ambient data, are graphed on Figure 8. Unlike the similar graph for Hannabrand Brook, the data do not show a pattern of increasing TP concentrations with flow.

The highest flow occurred during storm event sampling. The storm did not result in higher phosphorus concentrations (or TSS as discussed below) as would be anticipated. This may be because the station is just downstream of Old Mill Pond and its dam. The TSS and total phosphorus may be trapped in the pond.

Table 14: Storm Event Sampling – Phosphorus
Hannabrand Brook at Old Mill
(NA for Borough Study)

Sample Date-Time	Flow (cfs)	Total Phosphorus (mg/l)
STORM 1		
9/14/06 2:10	3.08	0.116
9/14/06 3:15	3.42	0.076
9/14/06 10:30	3.48	0.046
9/14/06 0:00	3.71	0.049
9/14/06 13:55	4.01	0.06
9/14/06 17:25	3.95	0.048
9/15/06 12:59	11.42	0.166
9/18/06 10:05	3.19	0.035
STORM 2		
10/17/06 11:55	3.08	0.016
10/17/06 15:14	3.48	0.041
10/17/06 16:50	4.58	0.111
10/17/06 20:15	6.26	0.106
10/17/06 23:37	8.99	0.069
10/18/06 5:35	5.04	0.074
10/18/06 13:50	3.65	0.041
10/19/06 14:15	3.19	0.013

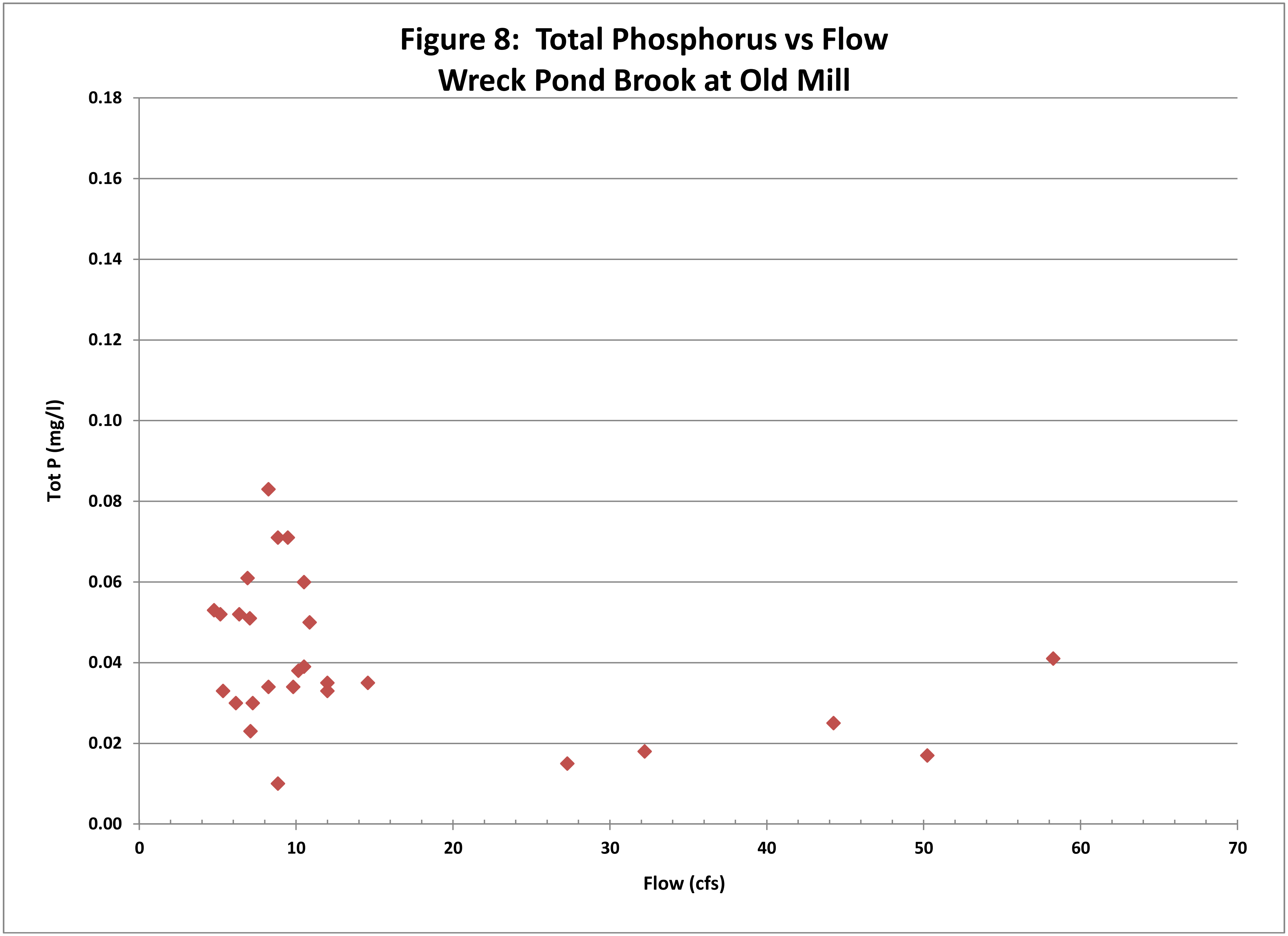


Figure 8: Total Phosphorus vs Flow
Wreck Pond Brook at Old Mill
Tot P (mg/l)
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
10
20
30
40
50
60
70
Flow (cfs)

Table 15: Ambient Monitoring Phosphorus Wreck Pond Brook at Old Mill (mg/l) (NA for Borough Study)	
Mean	0.040
Median	0.044
Max	0.061
Min	0.010
75th%	0.052
25th%	0.030
N	12

Table 16: Storm Event Sampling – Phosphorus Wreck Pond Brook at Old Mill (NA for Borough Study		
Sample Date-Time	Flow (cfs)	Total Phosphorus (mg/l)
Storm 1		
9/14/06 2:15	8.24	0.083
9/14/06 3:20	8.84	0.071
9/14/06 10:35	9.48	0.071
9/14/06 0:10	10.50	0.039
9/14/06 13:45	12.00	0.035
9/14/06 17:30	12.00	0.033
9/15/06 13:07	58.26	0.041
9/18/06 10:20	10.50	0.060
Storm 2		
10/17/06 12:01	8.24	0.034
10/17/06 15:16	9.81	0.034
10/17/06 16:56	14.57	0.035
10/17/06 20:25	27.28	0.015
10/17/06 23:49	50.23	0.017
10/18/06 5:45	44.25	0.025
10/18/06 14:00	32.22	0.018
10/19/06 14:25	10.86	ND

This pattern was evaluated during the storm event sampling as discussed in the RSWMP. The anticipated increase in concentrations of stormwater-related parameters, found at Hannabrand Brook and at the upstream station on Wreck Pond Brook at Glendola Road, was not apparent at this station (see Section 3.2.3 of the RSWMP). This was attributed, at least in part, to the presence of Old Mill Pond just upstream of this station. The lake may trap sediment and associated pollutants.

During the first storm, only partial data were available as the rainfall pattern was not as predicted. During this storm, the total phosphorus concentrations decreased during the peak of the flows, and were above standard at times of lower to moderate flows. Given that the TP violates standards during the lower flows, there may be some influence from groundwater or from flow from the Pond. During the second storm, there were no exceedances of the TP standard of 0.05 mg/l.

2.8.3 Wreck Pond Brook at Glendola Road

This station was only monitored for phosphorus during storm events. The purpose of the monitoring was to attempt to evaluate the differences in loading from the upper and lower portions of the Wreck Pond Brook Watershed. During the storm event sampling, water depths were collected at the staff gauge.

The NJDA had a gauging station at this location, Wreck 7 (W7). However, the NJDA noted that this location was not ideal for flow monitoring, due to the accumulation of sediment, the sluggish flow, and the vegetation in the channel. The recording gauge was no longer operational at the time of the storm event monitoring. Thus, it was not possible to compare the measured staff gauge elevations to the recording gauge.

The rating curve from NJDA was developed from only a few points and was based on the recording gauge elevations. The purpose of the rating curve was to ensure that high flow events could be properly routed through the watershed. Using the rating curve with the elevations measured at the staff gauge during the storm events resulted in flows that were greater than the flows at the downstream station at Old Mill Road. These flows did not make sense as the Glendola station captures about 70% of the watershed and the CN numbers for both sub-basins are approximately the same. Thus, the flows should be smaller at the upstream station. It is possible that the timing of the flow is such that the flows peaked earlier in the upstream station, but this would not be expected during the entire storm event.

Storm events monitored by NA were used to develop the SWMM model and flow was estimated for that purpose at this location. Thus, the flow estimates from the field measurements and NA rating curve were used to calculate loading here.

Figure 9 plots the TP concentration versus flow for this station for both storms. Some increase is noted with flow.

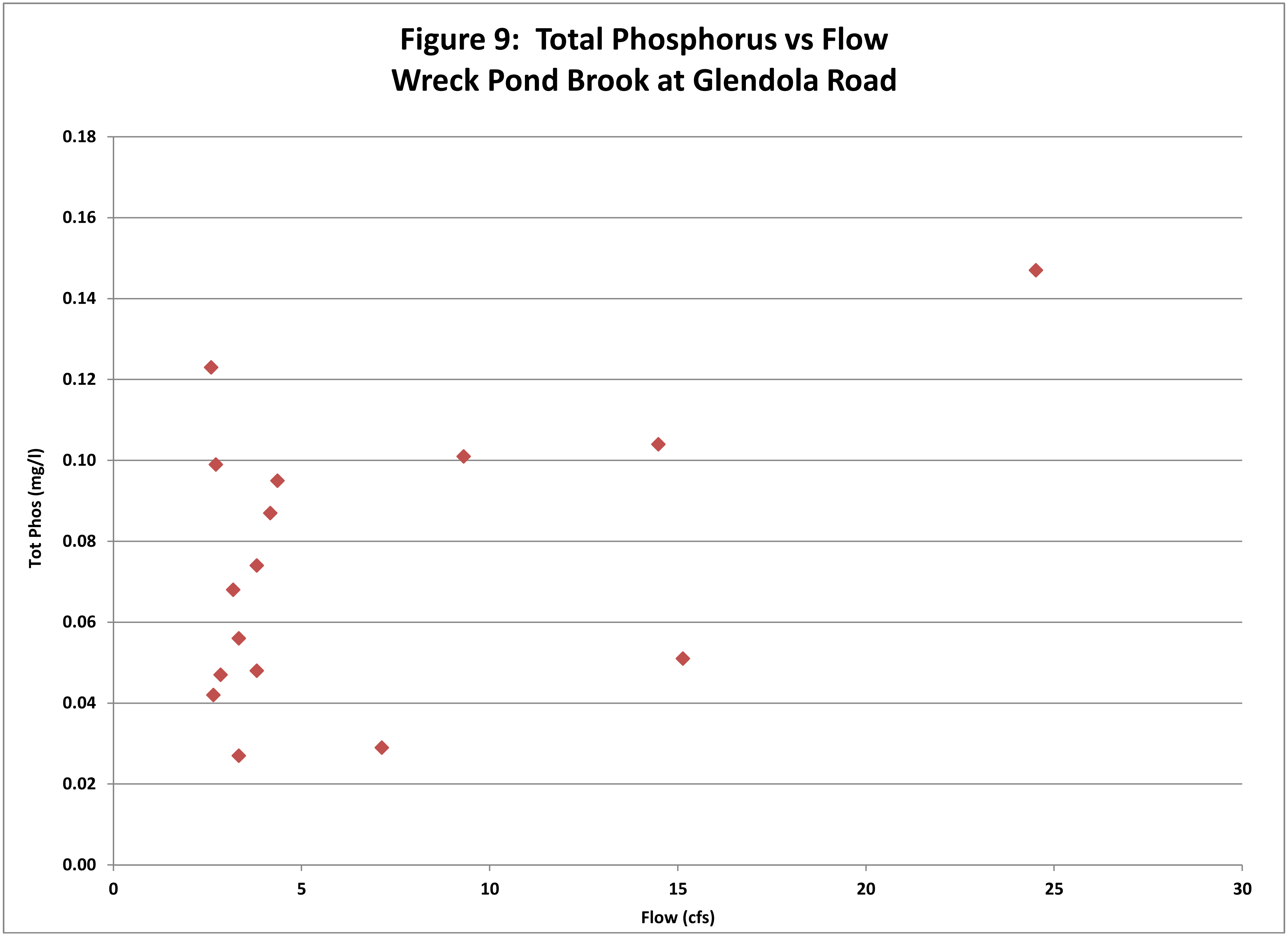


Figure 9: Total Phosphorus vs Flow
Wreck Pond Brook at Glendola Road
Tot Phos (mg/l)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0
5
10
15
20
25
30
Flow (cfs)

2.8.4 Wreck Pond

In addition to the tributaries discussed above, about 1,138 acres discharge directly to Wreck Pond or to the portions of the streams downstream of the County monitoring sites. Flows in these areas are difficult to gauge due to the distributed stormwater outfalls and the tidal influence within the lower portions of Wreck Pond Brook. However, these areas are highly developed with residential and commercial uses and thus generate loadings to the Pond. Thus, an analysis of flows and loadings was conducted in these areas.

Table 17 summarizes the total phosphorus concentration data in Wreck Pond. The sampling stations are shown on Figure 6 and the locations are described in Section 2.4.

The pond shows elevated phosphorus. The mean is 0.045 mg/l in the eastern part of the pond, which is just below the standard and 0.05 mg/l in the western part, which is just at the standard. The maximum concentration is 0.11 mg/l to the east and 0.077 mg/l to the west. Analysis of the Pond is complicated by the tidal flows. The NA study took samples at low tide, which is reflected in the generally low salinities in the Pond. However, the tidal exchange impacts the normal water height and outflow rate. This, in turn, impacts the residence time and the volume of water in the Pond. Thus, it is not possible to use a simple lake model here to evaluate the load and Pond volume.

Table 17: Ambient Monitoring – Phosphorus
Wreck Pond
(NA for Borough Study) (mg/l)

	WP1	WP2 & WP3
Mean	0.050	0.045
Median	0.048	0.039
Max	0.077	0.110
Min	0.020	0.010
25th	0.034	0.027
75th	0.066	0.058
Std. Dev	0.020	0.026
N	11	24

NA conducted modeling of the watershed using the US EPA SWMM model, as discussed in the RSWMP. The calibrated model was run using the rain flow profile for a 2-year storm as well as for a wet year and a dry year. The model simulated the total inflow and phosphorus loading to the Pond over each of these time periods.

The results for flow, phosphorus and total suspended solids (TSS Is discussed in Section 2.6, following) are provided in Table 18. As can be seen from that table, while the loading amounts vary depending on the flow regime, the percent contribution is similar under each scenario. The table calls out the upper Wreck Pond Brook separately, but these numbers are included as part of the overall Wreck Pond Brook values. Thus, the values for Upper Wreck Pond Brook in the table are included in the Wreck Pond Brook numbers and not added to the overall total. This was done to get some idea of the contribution of the upper part of the watershed. However, there appeared to be some settling in the upstream ponds between the Glendola Road station that modeled the upper watershed and the Old Mill Road station. This meant that the upper watershed totals exceeded the downstream totals so that the relative contribution of the upstream portion of the watershed could not be evaluated.

Table 18: SWMM Model Results for Wreck Pond Loadings
(NA for Borough Study)

	Flow (cf*10^6)		TP (lb)	TP (%)	TSS (tons)	TSS (%)
2-Year Storm						
*Upper WPB**	*22.7*		*29*			
Wreck Pond Brook	33.70	57%	18	30%	3	48%
Hannabrand Brook	12.71	22%	18.83	31%	2	32%
Black Creek	3.52	6%	7.72	13%	1	16%
Wreck Pond Direct	8.97	15%	15.26	26%	0.2	3%
TOTAL	**58.90**		**59.81**		**6.2**	
1996 Wet Year						
*Upper WPB**	*371.5*		*1922*		*278*	
Wreck Pond Brook	529.7	55%	1236	34%	163	47%
Hannabrand Brook	199.4	21%	1065	29%	127	37%
Black Creek	64	7%	529	14%	46	13%
Wreck Pond Direct	177.2	18%	840	23%	9	3%
TOTAL	**970.3**		**3670**		**345**	
2001 Dry Year						
*Upper WPB**	*177.3*		*1559*		*118*	
Wreck Pond Brook	254.2	47%	1001	34%	58	35%
Hannabrand Brook	116.1	21%	789	26%	71	42%
Black Creek	29.79	5%	491	16%	35	21%
Wreck Pond Direct	145.8	27%	705	24%	4	2%
TOTAL	**545.9**		**2986**		**168**	

* Upper Wreck Pond Brook included in Wreck Pond Brook totals; due to settling in downstream ponds, the percentage contribution of pollutant loads cannot be properly assessed;
Percentages may not add to 100% due to rounding.

For phosphorus, a check on these loads was done by calculating the resulting concentration in the Pond, using the total inflow and load:

Dry Year:	0.088 mg/l
Wet Year	0.061 mg/l

While somewhat counter-intuitive, this result occurs because the flow in the dry year is only about 56% of that in the wet year, while the total phosphorus load in the dry year is about 81% of that in the wet year. That is, the phosphorus still builds up on the landscape at the same rate and each storm likely carries a great load. Since there is less water to dilute the load in the dry year, the concentration is higher.

In any event, these concentrations are in line with those seen in the Pond as monitored in 2005 and 2006. Both of these years saw about average rainfall or slightly above. Thus, they are more typical of an average year. As a rough approximation, the dry year and wet year flows and load were averaged, with a resulting concentration determined to be 0.07 mg/l.

The calculated 0.07 mg/l concentration does not take into account any storage in the Pond, which may be due to the outflow being less than the inflow and to any processes that may either add or reduce the concentration over time, including algal growth, tidal exchange, settling, direct loads to the Pond (waterfowl) and other processes.

2.8.5 Black Creek

The third stream sampling point in the NA Wreck Pond Environmental Study was at the outlet from Black Creek into the Pond. The NJDA stopped their hydraulic study upstream at Wreck 8 (W8), which is Black Creek at Route 71. Analysis of the available flow data at that location calculated from the water level measurements for the sample data and time at the Black Creek station suggested that flows were greater there than at Hannabrand Brook. Given that the watershed size of Black Creek is about 21% of the Hannabrand Brook Watershed, it seems unlikely that the flows would be greater at this point. Review of Table 18, the SWMM model results, shows that only about 5% to 7% of the watershed flow comes from Black Creek up to Route 71.

Further, the water quality data were taken at the outlet from the ponded portion of Black Creek. This station is included in the “Wreck Pond Direct” sub-watershed and not in the Black Creek sub-watershed. Thus, the load cannot be calculated using the W8 flow point.

The hydrologic characteristics of the ponded portion of Black Creek are also not known at this time. Therefore, it is not possible to do a lake model to evaluate the required reductions.

Table 19 provides the total phosphorus monitoring data for this point. As can be seen, the data show the highest concentration of total phosphorus of any of the sampling locations. Given that this is the outlet from the ponded portion of Black Creek, it is possible that the data reflect conditions in that pond area, which tend to be stagnant and is subject to algal blooms. The data suggest that this part of Black Creek is highly enriched with phosphorus.

The NJDEP water quality standard for total phosphorus is 0.05 mg/l for lakes or tributaries upstream of lakes. The mean concentration in the Black Creek discharge is 0.094 mg/l. Thus, a 50% reduction in concentration would be required to meet this standard.

Table 19: Ambient Monitoring - Phosphorus **Black Creek Outlet** **(NA for Borough Study) (mg/l)**	
Mean	0.094
Median	0.087
Max	0.273
Min	0.010
75th%	0.129
25th%	0.021
N	12

2.9 SEDIMENT

The streams and ponds in the watershed are not listed as impaired for sediment. No TMDLs appear to have been completed for this parameter within any waters in New Jersey, according to the TMDL list on the NJDEP website. However, it is well known that Wreck Pond and the other smaller ponds in the watershed are laden with sediment. This may not be reflected in the water quality data, as the sediment may be on the streambeds or the pond bottoms. Wreck Pond is full of very fine, mucky sediment that is easily disturbed. The depths in the Pond are reportedly much shallower than in the past. In fact, one of the main drivers for the initiation of studies of Wreck Pond was to conduct dredging, which required ensuring that future sediment loads would be controlled upstream.

The water quality data, however, do not reflect a water quality impairment in the tributary streams for TSS. Table 20 summarizes the County sampling data.

The County data show exceedances of the 40 mg/l standard on at least one occasion at all but two of the stations. Of the 508 TSS samples analyzed by the County, 8 (1.6%) exceeded the TSS standard. These are shown in Table 21. Four of the exceedances were on October 12, 2005 which was very rainy. Over 3 inches of rain were reported at

Newark Airport on that day. Two were on June 6, 2005 at two of the stations. In no case does any one station show more than two exceedances. Only two of these results were more than 1.5 times the standard.

Table 20: Ambient Monitoring – TSS (mg/l) (Monmouth County for Wreck Pond Studies)								
	N	**Mean**	**Median**	**Max**	**Min**	**25th**	**75th**	**StdDev**
WRECK POND BROOK								
W6	58	6	4	47	1	3	8	7
W9	58	11	7	114	2	5	12	16
W7	58	7	4	26	2	3	7	6
W1	69	7	4	49	1	2	10	8
W3	58	6	3	31	2	3	6	5
HANNABRAND BROOK								
W5	69	7	3	59	1	2	7	10
W2	69	7	4	54	2	3	7	8
BLACK CREEK								
W8	69	10	4	197	2	3	8	24

Table 21: Ambient Monitoring TSS Exceedances (Monmouth County for WP Studies)		
Station	**Date**	**TSS (mg/l)**
Wreck 1	6/6/2005	49
Wreck 2	10/12/2005	54
Wreck 5	5/2/2005	53
Wreck 5	10/12/2005	59
Wreck 6	10/12/2005	47
Wreck 8	6/6/2005	197
Wreck 9	5/31/2005	114
Wreck 9	10/12/2005	50

The NA monitoring data for the Borough Study did not show any exceedances in the twelve sampling events (Table 22). As noted previously, these were generally done during low flow period. As expected, these two data sets do not show regular sediment input to the Pond from the watershed flows associated with storm events.

Table 22: Ambient Monitoring Data – TSS (mg/l) (NA for Borough Study)								
	n	**Mean**	**Median**	**Std Dev**	**Max**	**Min**	**75th Perc**	**25th Perc**
Wreck Pond Brook at OM	12	3.9	3.7	1.4	7.7	2.0	4.2	3.2
Hannabrand Brook	12	2.8	2.7	0.8	4.3	2.0	3.2	2.0
Black Creek	12	7.7	6.0	6.4	26.7	2.0	7.7	4.9

Table 23 provides the storm event sampling done by NA for the Borough Study. These were moderate storms and thus would not be expected to demonstrate the level of sediment loading that could occur during high flow events. Some studies have indicated that most of the sediment loads to streams come during few high flow events.

In this case, the TSS concentrations increase over the course of the storms (more detail on the flow during these storms is provided in Section 2.8, Phosphorus, above). However, only at Hannabrand Brook did the TSS concentration ever exceed the standard of 40 mg/l.

Given the lack of data showing standard exceedances, the flow-weighted exceedances method could not be used to calculate a loading reduction requirement to meet the standard. Table 18, (in Section 2.8 above) provides the SWMM model results for TSS. The results show that 345 tons of sediment are estimated to be transported into Wreck Pond during a wet year. However, when this is divided by the total flow from the tributaries, the resulting concentration is 11 mg/l, which does not exceed the standard. In this case, however, Wreck Pond provides a depository for that sediment. Wreck Pond (and other smaller ponds upstream), traps the sediment and does not transport it to the Ocean. The conditions in the pond clearly show excess sediment which indicates an impairment.

2.10 BACTERIA

A bacteria TMDL was developed for 31 streams in the Atlantic Coastal drainage, including Wreck Pond Brook (NJDEP, 2003). The TMDL was based on data collected at a station on Allenwood Road, the outlet of Hurley's Pond. This station is at the same location as W9, which was sampled by the County planning department as part of the Wreck Pond studies. Monmouth County Health Department (MCHD) also samples at this location on occasion as part of their ambient water quality monitoring program.

A TMDL has also been developed for Hannabrand Brook based on data collected at Old Mill Road (NJDEP, 2005).

Table 23: Storm Event Sampling TSS (mg/l) (NA for Borough Study)			
	Wreck Pond Brook at Old Mill	**Hannabrand Brook**	**Wreck Pond Brook at Glendola Rd**
Storm 1 – September 14, 2006			
Pre-Storm	3.0	2.0	4.3
Sample 1	4.3	5.0	4.7
Sample 2	3.0	5.7	4.7
Sample 3	3.7	8.3	8.0
Sample 4	2.5	12.0	11.0
Sample 5	3.0	10.0	7.0
Sample 6	2.3	90.0	23
Post-Storm	4.8	2	2.4
Storm 2 - October 17, 2006			
Pre-Storm	ND	ND	2.3
Sample 1	ND	3.0	4.3
Sample 2	ND	24.3	14.0
Sample 3	2.0	46.0	28.7
Sample 4	2.3	22.0	21.3
Sample 5	2.3	14.0	14.3
Sample 6	2.7	4.3	8.3
Post-Storm	ND	ND	4.0

The past fecal coliform standard was 200/100ml with no more than 10 percent per 30 day period above 400/100ml. Both TMDLs used state-wide fecal coliform data to determine that a summer geometric mean of 68/100 ml was required to ensure that the levels are not above 400/100 ml more than 10% of the time. Given this is lower than the 200/100 ml geometric mean standard, the target for the TMDL is 68/100 ml. The TMDLs note that bacteria is different than other pollutants in that it is the bacteria counts, not loading, that is the target. This is due to the complexity of bacteria levels in that counts depend on a myriad of factors including temperature and possibly media regrowth.

Table 24 summarizes the bacteria data collected by the County for the Wreck Pond Regional Stormwater Study. Table 25 compares the same data by station in comparison to the standards. This table shows that the geometric mean did not exceed the 200/100 ml standard at any station, but that the upper tenth percentile exceeded the maximum standard at four of the eight stations for both all data and summer data. Within Wreck Pond Brook, the exceedances were all in the upper watershed, with 33% above 400/100ml at W7 and 50% at W9 during the summer. The station at Old Mill Road (W3) met the fecal coliform standard. The summer data meet both standards at W1, W3 and W6 for both the geometric mean and the 10% requirement. However, only counts at W3 meet the TMDL target level of 68/100 ml.

Table 24: Ambient Water Quality Data Bacteria
(Monmouth County Wreck Pond Watershed Studies; all units #/100ml)

Station	N	GeoMean	Median	Max	Min	25th	75th
WRECK POND BROOK							
Fecal Coliform							
W6	70	40	25	3900	4	10	156
W9	70	174	209	TNTC*	4	69	528
W7	70	96	140	5300	4	40	298
W1	70	41	34	9200	4	10	105
W3	70	49	58	3700	4	17	123
Enterococci Bacteria							
W6	70	45	40	5100	4	10	178
W9	70	149	150	TNTC*	4	49	416
W7	70	97	100	6600	5	34	260
W1	70	36	30	TNTC*	4	10	100
W3	70	46	40	TNTC*	4	16	100
HANNABRAND BROOK							
Fecal Coliform							
W5	70	56	45	20000	4	16	160
W2	70	75	100	12100	4	15	283
Enterococci Bacteria							
W5	70	59	48	12000	4	15	220
W2	70	75	70	5800	4	20	290
BLACK CREEK							
Fecal Coliform							
W8	70	61	90	5200	4	13	230
Enterococci Bacteria							
W8	70	54	60	7300	4	13	159

*TNTC: Too numerous to count

In contrast in the Hannabrand Brook subwatershed, counts at W2 at Old Mill Road, exceeded the standard but those at the upstream station (W5) did not. The results at W2 exceeded the 200/100 ml geometric mean for the summer data, but not for all data; 29% of the summer data exceeded 400/100 ml. The W5 station met both elements of the standard and also met the TMDL target concentration 68/100 ml for all data, but not for the summer data. At the Black Creek outlet, the bacterial counts met the geometric mean requirement for both all data and summer data, but did not meet the "no more than 10% exceedances" of the 400/100 ml requirement nor did the summer geometric mean meet the 68/100 ml TMDL target.

Fecal coliform also was monitored for the Wreck Pond environmental study in 2005 and 2006 by NA. Table 26 summarizes the results. In Wreck Pond Brook, the data were collected at Old Mill Road and met the standards as did the data at the outlet of Black Creek. At Hannabrand Brook, also at Old Mill Road, the geometric mean was below 200/100 ml, but 2 samples, which represented 17% of the 12 samples collected, were above 400/100 ml. These data are generally from the summer months in that data were collected from May through October, with twice monthly samples in the summer. This monitoring is consistent with the County monitoring done for the RSWMP studies showing that WPB at Old Mill meets the standards and has lower bacteria levels than at W9, the station used in the TMDL.

Table 25: Fecal Coliform Summary Data and Exceedances
(Monmouth County for Wreck Pond Watershed studies; all units #/100 ml)

Station	ALL Data				Summer Data			
	Geomean	90th %	#> 400 N=70	% Exceed 400	Summer Geomean	90th %	#> 400 N=24	% Exceed 400
WRECK POND BROOK								
W1	41	306		9%	48	247	1/24	4%
W3	49	261	4	6%	103	254	0/24	0%
W6	40	392	7	10%	79	356	2/24	8%
W7	96	648	13	19%	236	696	8	33%
W9	174	1027	21	30%	381	1069	12	50%
HANNABRAND BROOK								
W2	75	539	12	17%	232	718	7	29%
W5	56	373	6	9%	123	280	2	8%
BLACK CREEK								
W8	61	566	10	14%	90	522	4	17%

Table 26: Ambient Water Quality Data Bacteria – WP Study Fecal Coliform (#/100 ml) (NA for the Borough Study)								
	N	**Median**	**Geometric Mean**	**Max**	**Min**	**75th%**	**25th%**	**%>400**
WPB	12	100	92	550	10	200	67	8%
Hannabrand	12	265	186	900	10	340	165	17%
Black Creek	12	65	45	400	10	130	10	0%

The current freshwater standards are in terms of E. Coli. The E. Coli standard for all FW2 waters is:

> E. Coli levels shall not exceed a geometric mean of 126/100 ml or a single sample maximum of 235/100 ml.

Data were not collected for this parameter as part of the Wreck Pond RSWMP studies. However, Monmouth County Health Department (MCHD) collects water quality data on E coli at one station in the watershed on Wreck Pond Brook at Allenwood Road; this is the station used in the bacteria TMDL for this stream. These data are included in the NJDEP Wreck Pond database for the period from 2007 to 2013. Fecal Coliform levels were monitored until 2008, while E. Coli monitoring began in 2008 and data is reported through 2013.

As shown in Table 27, bacteria levels, at the Allenwood Road station as monitored by MCHD continue to exceed standards at times. The overall geometric mean for E. Coli is 181/100ml, for data collected from 2007 through 2013, which exceeds the geometric mean standard. In addition, about 42% of the data exceed the 235/100ml maximum. During 2012 and 2013 data were generally collected weekly during June and into early July with some other occasional tests at other times; four samples were collected in this period in 2012 and five in 2013. If just these data are considered, the geometric mean is 120/100 ml which is just below the standard. During summer of 2012 there were no exceedances of the single-sample maximum but in 2013 there were two such exceedances. Thus, over the past 2 years, 2 of the 9 summer samples exceeded the single-event sample or 9% and the overall geometric mean met the standard.

It also should be noted that monitoring station W9 from the Wreck Pond RSWMP study is at the same location as the MCHD Allenwood Road station. Looking back to Tables 24 and 25, the fecal coliform counts at W9 are higher than at all the other stations on Wreck Pond Brook and in fact at all of the monitoring locations in the watershed. That is, the geometric mean at W9 is 174/100ml while at W1, W3 and W6, the geometric mean ranges from 40-49/100ml. The same pattern of highest values at W9 holds true for enterococci. This station is at the outlet from Hurley's Pond. The station is about 4,200 feet (along the stream) downstream of the W6 station at Martins Road and the stream corridor between the two stations is wooded, including along the tributaries. Thus, the W9 and the MCHD stations may be monitoring conditions in Hurley's Pond or other local effects and not the overall condition of the stream itself. Therefore, the E. coli data from this station may not provide an accurate assessment of the bacteria levels in the stream.

The Wreck Pond Brook TMDL calls for a 51% reduction in bacteria levels, using a summer geometric mean of 84/100 ml, based on 7 samples at the Allenwood Road station. This level is lower than that reported by MCHD as per Table 27, but in line with the monitoring of the Brook at other stations. The NA sampling shows a geometric mean of 92/100 ml for Wreck Pond Brook at Old Mill Road, which is similar to that in the TMDL. For the Monmouth County data presented in Table 25, the summer geometric mean counts ranged from 40 to 174/100 ml. Thus, the 84/100 ml used to develop the TMDL appears within the range of more recent fecal coliform counts in this water.

Table 27: Ambient Water Quality Data Bacteria
Wreck Pond Brook at Allenwood Road (MC Health #14)
(Monmouth County Health Department (#/100ml))

Parameter	N	GeoMean	Median	Max	Min	25th	75th	% > Standards
Fecal Coliform	8	208	360	1320	10	190	838	
E. Coli	14	181	170	2400	10	48	800	

The TMDL for Hannabrand Brook lists a geometric mean of 384/100 ml based on 7 samples at Old Mill Road, which is the level used to calculate required reductions. The County monitoring for Hannabrand Brook, which had about 70 samples, shows a much lower overall geometric mean of 75/100ml at W2, which is at Old Mill Road. The summer geometric mean of 232/100 ml is above the 200/100 ml standard, but also is lower than the 384 reported in the TMDL. Less than 30% of samples exceeded 400/100 ml. The NA data had a geometric mean of 186/100 ml, which is slightly lower than the County data, but included some October values.

The Hannabrand Brook TMDL calls for a 91% reduction in bacteria concentrations. The Wreck Pond study summer geometric mean of 232/100ml is 40% lower than the TMDL starting count, while the NA data of 265/100 ml is about 31% lower than the TMDL starting point Thus, either the TMDL over-estimated the bacteria levels in Hannabrand Brook, or progress has been made in lowering the bacteria levels.

Table 28 summarizes the ambient bacteria data collected in Wreck Pond during the Borough Study. At Station WP1 (located in the mostly non-tidal area west of the railroad tracks) the fecal coliform geometric mean of 250/100 ml exceeds the 200/100 ml standard and about 33% of the samples were above 400/100 ml. At WP2 and WP3, the geometric mean of the fecal coliform counts is below the standard. However, the standard is not met, as 25% and 17% of the readings were above 400/100 ml at WP2 and WP3, respectively. The geometric means at WP2 and WP3 also exceed the 68/100 ml target in the TMDL. The 51% reduction would bring the WP2 and WP3 levels to below the 68/100 ml target.

Table 28: Ambient Monitoring Wreck Pond
Bacteria Data Summary (#/100 ml)
(NA for Borough Study)

Parameter	N	Median	Geo-mean	Max	Min	25th Percent	75th Percent	% >400
WP1								
Total Coliform	12	1150	957	4600	150	500	2250	--
Enterococci	12	120	118	2300	10	55	285	--
Fecal Coliform	12	250	250	4600	50	120	500	33%
WP2								
Total Coliform	11	300	216	4600	30	80	780	--
Enterococci	12	75	47	500	1	18	115	--
Fecal Coliform	12	160	137	1700	10	50	338	25%
WP3								
Total Coliform	12	450	382	3500	70	107.5	900	--
Enterococci	12	85	119	1600	30	65	217.5	--
Fecal Coliform	12	120	114	900	10	57.5	215	17%

In addition to the stream monitoring, MCHD conducts weekly beach sampling for bacteria during the summer months at the beaches near the Wreck Pond outfall. The sampling is done weekly on a set day and does not depend on whether or not a storm event has occurred. Bacteria-laden flows from Wreck Pond after a storm had been identified as the cause of elevated bacteria levels at the Ocean bathing beaches near the outfall in Spring Lake and Sea Girt. Using historic beach monitoring data, MCHD found that bacteria levels exceeded the Ocean bathing beach standards at beaches in the vicinity of the outfall following storm events. In 2002, the Health Department instituted a precautionary 24-hour swimming ban that would be implemented whenever rainfall exceeds 0.1 inch or when a plume from the outfall was visible, and a 48-hour ban when rainfall exceeds 2.8 inches in 24 hours. This ban applies to the recreational bathing waters at the Brown and York Avenue beaches in Spring Lake and The Terrace and Beacon beaches in Sea Girt. Due to this provisional ban, the outfall from Wreck Pond has been the source of most of the swimming bans at the New Jersey Ocean beaches over the last several years.

The beach bacteria loads were what prompted NJDEP to extend the outfall by 300 feet, to increase mixing and dilution and thus reduce concentrations to acceptable levels at the bathing beaches. If this were the case, the precautionary bans could be discontinued. Continued weekly beach monitoring by MCHD found no to very occasional violations of the actual bathing beach standard, even after rainfall events. However, since MCHD only monitors on Monday mornings, there was not enough data directly after rainfall events to determine whether the precautionary ban could be lifted.

NJDEP Marine Water Monitoring conducted storm-event monitoring at the beaches to evaluate the impact of pond discharge after rainfall events to evaluate the continued need for the precautionary rainfall beach closings. Review of the data by NJDEP and MCHD determined that the precautionary beach closings were no longer needed.

In June of 2014, the precautionary beach closing was lifted. NJDEP monitored water quality following storms in the summer of 2014 and found that the bacteria levels did not exceed standard except when the "emergency spillway" was opened to alleviate threatened flooding. Thus, the precautionary ban will not be re-instated.

Depending on the implementation of proposed modifications to the Wreck Pond outfall structure, additional tidal exchange may be provided in the future, this could reduce bacteria counts by enhancing mixing and flushing.

As discussed elsewhere herein and in the RSWMP, the source of the bacteria is not known. There are no clear human sources (especially considering the infrastructure studies). Additional monitoring of E. coli will provide additional information on the level of impairment and the need for action.

2.11 HABITAT DEGRADATION

An additional impairment is habitat degradation. Monitoring of Wreck Pond found that the Pond habitat is degraded (see the RSWMP for details). The Pond is eutrophic and at times dissolved oxygen (DO) levels in parts of the Pond are low.

The Pond shoreline is highly developed on the northern and northeastern sides, with wooden and stone bulkheads, with mowed turf grass on the shoreline. The southern side generally contains more natural vegetation including wetlands and a naturally vegetated riparian zone.

The natural tidal exchange between Wreck Pond and the Ocean is impacted by the outfall structure. NJDEP increased the length of the outfall pipe in 2005. This appears to have led to further dilution of the bacteria load discharged into the ocean at the bathing beaches, but may have reduced fish passage into and out of the Pond. It may have reduced tidal exchange as well. Increasing tidal exchange is a goal of the watershed restoration plan to improve water quality and enhance fish passage.

Streams in the watershed were generally ranked as sub-optimal in the field-based stream study conducted by Freehold soils. Details on this study are given in RSWMP. However, certain segments were found to have highly eroded banks and other features that require remediation. This is discussed later herein.

The other upland ponds are also degraded. The ponded portion of Black Creek appears highly eutrophic and subject to algal blooms. It is very mucky with much sediment in the bottom. The Osborne Pond's dam structure is non-functional and in need of repair. This repair could also enhance the pond's environment.

2.12 OTHER CONCERNS: FLOODING

As discussed above, flooding associated with both tidal and fluvial events occurs in the vicinity of Wreck Pond. This is a major concern of the Boroughs of Spring Lake and Spring Lake Heights and the residents of the areas that frequently flood. Any work done in the watershed should be designed to help to alleviate these concerns.

2.13 EXISTING POLLUTANT LOADS AND GOALS

The watershed monitoring was used to determine impaired water segments. As noted above, the watershed does not contain any point sources so that the primary source of pollutants is stormwater runoff from land uses as well as natural conditions or sources such as wildlife. Therefore, in order to evaluate existing pollutant loads, land use patterns must be understood. Land uses are described in Section 2.5, above.

For the RSWMP, land use in the watershed was analyzed using the available Monmouth County Land Use data at the time. Because the number of land use categories mapped by the county was large, some categories were combined to develop more generalized land use categories. Figure 5, above, provides the general land use categories. Those categories were further combined to reflect the land use types generally used in loading analyses. Table 29 provides a summary of the land use in the watershed by these combined categories.

The US EPA STEPL model was used to develop a relative analysis of loading by land use. As discussed above, this model uses simple algorithms to calculate pollutant loads from different land uses. The model has estimated loadings for nutrients and sediment for urban, cropland, pastureland, feedlots, and forests. The land uses from Table 29 were further subdivided within the model as discussed in Section 2.5.1, above. Other needed parameters in the model were set such that the loads were in line with the annual loading from the SWMM modeling. The STEPL loads for phosphorus were similar to the "wet year" SWMM model results, but the STEPL loads for TSS were higher. This is likely due to the lower than expected sediment concentration at lower Wreck Pond Brook, due in part to sediment capture in upstream ponds. The loadings in Table 30, from the STEPL model, provide the initial basis for the loading analysis. It should be noted that the model does not include any loading estimates for bacteria.

Table 29: Generalized Land Use		
Land Use	**Area (ac)**	**% of Total**
Agriculture	820.27	10.0%
Barren/Brush	449.19	5.5%
Commercial	404.65	5.0%
Industrial	548.98	6.7%
Open Space	605.22	7.4%
Low Density Residential	1413.36	17.3%
Medium/High Density Residential	1486.66	18.2%
Water/Forest/Wetlands	2445.74	29.9%

Table 30: STEPL Estimated Loading by Subwatershed		
Watershed	**P Load (no BMP)**	**Sediment Load (no BMP)**
	lb/year	**ton/year**
Wreck Pond Brook	2074.8	296.3
Hannabrand Brook	959.5	153.4
Black Creek	133.5	19.4
Wreck Pond Direct	417.7	54.3
Total	3585.5	523.4

The STEPL model provides generalized estimated loads by land use as shown in Table 31. The model internally differentiates among land uses, but reports the results by wider categories as shown in that table.

As expected, the highest loads are from the urban land uses – almost 60% for both phosphorus and TSS.

The required load reduction for bacteria is covered by the TMDL. Further, limited data is available to generate land-based loading for bacteria and this parameter is not included in STEPL.

Section 3 uses this information to develop required load reductions.

Table 31: STEPL Initial Loading by Land Use				
Sources	**P Load (lb/yr)**	**% of Total**	**Sediment Load (ton/yr)**	**% of Total**
Urban	2096.9	58%	301.10	58%
Cropland	1065.1	30%	200.49	38%
Pastureland	105.1	3%	12.48	2%
Forest	318.4	9%	9.41	2%
TOTAL	**3585.5**		**523.5**	

3 ELEMENT B: GOALS AND LOAD REDUCTIONS

Specific water quality and quantity objectives for the plan are to reduce pollutant loading levels and remove accumulated pollutants to allow attainment of all designated uses that are not limited by natural conditions and to reduce flooding. The parameters causing impairments due to exceedances of surface water quality standards are total phosphorus and, in some segments, pH. Bacteria levels also are a concern and are addressed by two TMDLs. TSS is a concern due to the excess sediment in the waters, particularly sediment clogging Wreck Pond. The general goals are:

- Reduce bacteria levels in Wreck Pond and tributary streams to attain standards and support the designated uses;
- Eliminate or greatly reduce beach closings due to outflow from Wreck Pond or other watershed sources;
- Reduce sediment loads to Wreck Pond and other ponds from both existing sources and new development;
- Reduce phosphorus loads and concentrations in order to meet standards, reduce eutrophication of ponds, reduce algal blooms and support the designated uses;
- Reduce nitrogen loads to minimize eutrophication and algal blooms;
- Remove existing accumulated sediment from Wreck Pond and other waters;
- Improve the water quality, ecological health and aesthetics of Wreck Pond, Black Creek, other Ponds and the overall watershed;
- Identify key areas within the watershed that have a beneficial or negative impact on stream flow dynamics or stream processes and flooding;
- Mitigate the potential for flooding in the lower watershed.

The following sections discuss the loading reduction required for each pollutant, based on the existing loads estimated in Section 2, Element A.

3.1 pH

The analyses concluded that the pH standard is met in most of the water segments in the watershed. The only segment impaired for pH is the ponded section of Black Creek, as measured at Station 2C (Black Creek) in the Borough Study (data by NA). It should be noted, however, that most of the data at that station fell within the previous standard of up to 8.5. Thus, this water may naturally not be as acidic as some of the other waters in the area. However, two of the samples were above 8.5, which may be associated with algal blooms.

Since pH is not a load-based parameter, no load reduction is proposed. However, it should be expected that if the overall water quality is improved in this subwatershed, the pH will fall into a more natural range in Black Creek. Additional data should be collected to possibly remove most of the segments from the 303(d) List of Impaired Waterbodies based on the new standards range for FW2-NT waters in the Atlantic Coastal drainage area.

3.2 PHOSPHORUS LOADING

The Flow-Integrated Reduction of Exceedances (FIRE) method was selected to evaluate the needed load reductions to achieve the phosphorus standard in the tributaries. The FIRE method requires concentration and flow data to calculate load at the sampling locations and times. The required load reduction is evaluated by comparing the load at times when the concentrations exceed the standard to what the load would be at those flows if the parameter was at the standard. The lines are compared with a "0" intercept to ensure that if there is no flow, there is no load. This also allows direct comparison of the slopes.

The analysis is done by comparing the slope of the regression line with "0"-intercept of flow and loading for data that exceed the concentration (actual loads) to the slope of the regression line with "0" intercept for the water quality standard times the same flows (target loads). A regression line based on the upper 95th confidence interval on the actual load slope is compared to the target slope to determine the required load reduction with a margin of safety.

NJDA sampled water depths at the County stations using a recording gauge. They measured flow on certain occasions to develop rating curves. These curves estimate flow based on water depths. NA collected the phosphorus data at some of the same locations as the NJDA flow stations.

Thus, if available, the recording gauge depth at the stations could be used to determine flow. Staff gauges were also located at each station and surveyed for elevation. During each sampling event, NA recorded the water depth. Therefore, when the recording gauge data were not available, staff gauge elevations could be used.

NJDA also estimated the difference in water elevation between the staff gauge readings and the recording gauge readings. These did not always differ by the same amount due to a variety of reasons, particularly shifting sediment loads in the stream that could impact the actual elevation of the recording gauge.

The water depth at the time of sampling was determined from either the recording or staff gauge reading. The water depth was then translated to the water surface elevation of the recording gauge as per the topographic information provided by the NJDA in their hydrologic and hydraulic study. The rating curves developed by the NJDA and NA were used to estimate flows for each sampling event.

There are inherent sources of potential error in this process. First, the NJDA used the recording gauge, not the staff gauge, to develop the rating curves. There was some level of disagreement in the water surface elevations determined by each gauge. Further, the rating curves were based on measured flow in the stream at only a few points in time. Thus, the rating curves may not be accurate over all ranges of flow. Further, extreme or unusual flow events may cause different flow rates. However, the NJDA calibrated their hydraulic and hydrologic model using these rating curves and the accuracy is within the range expected of such models and these types of loading analyses

3.2.1 Hannabrand Brook Loading Analysis

Figure 7 graphs the flow and total phosphorus. This includes both the ambient and the storm data. The total phosphorus data are generally correlated with flow; however there is significant variability in the data.

As per the FIRE model, the data for which the total phosphorus concentration exceeded the lake standard of 0.05 mg/l were used to calculate instantaneous load by multiplying flow by the associated concentration. This is shown as “actual load” on Figure 10. A regression line with a “0” intercept was calculated for those data, as shown in Figure 10.

Also shown is the “target load” line, which is calculated from the water quality standard of 0.05 mg/l times the flow. The target regression line with an intercept of 0 is also shown on Figure 10. As per FIRE, the upper 95th percent confidence interval slope line is also shown. This is to provide a margin of safety in the analysis.

As can be seen in Figure 10, one point exceeds the 95th and 99th percent confidence interval on the regression line. This would be considered an outlier for the loading analysis, so a fourth line is shown which is the loading line without the outlier.

Figure 11 is the final graph showing the observed loads vs flow after removal of the outlier load. The exceedance regression line, the 95th CI regression line and the target loading line with the applicable slopes are shown. Table 32 summarizes the FIRE analysis results.

The percent reduction is determined by:

$$Percent\ Reduction = 1 - \frac{0.2698}{0.4476} * 100\% = 1 - 60.3\% = 39.7\%$$

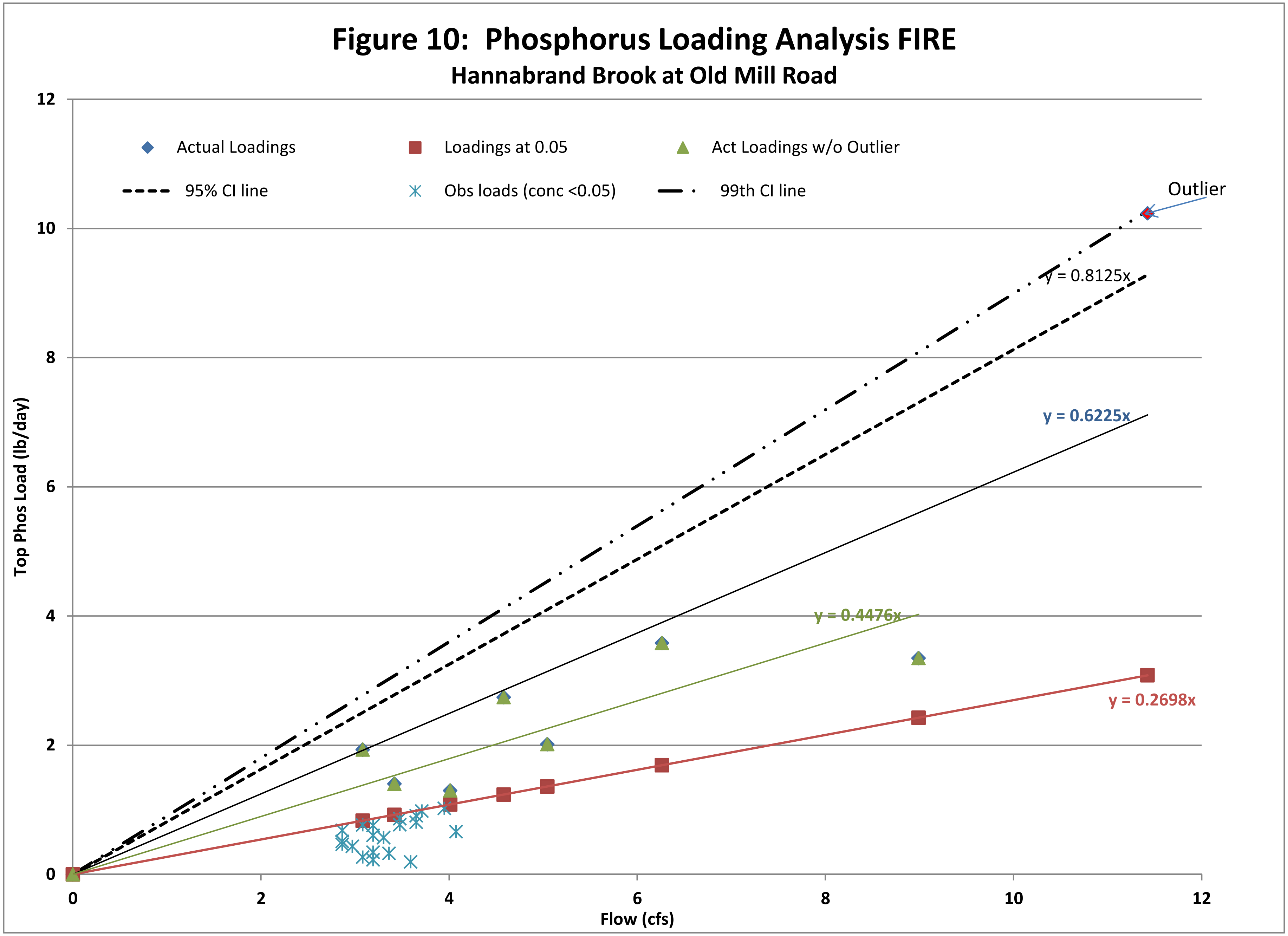


Figure 10: Phosphorus Loading Analysis FIRE
Hannabrand Brook at Old Mill Road
Actual Loadings
Loadings at 0.05
Act Loadings w/o Outlier
95% CI line
Obs loads (conc <0.05)
99th CI line
Outlier
y = 0.8125x
y = 0.6225x
y = 0.4476x
y = 0.2698x
Top Phos Load (lb/day)
Flow (cfs)
0
2
4
6
8
10
12

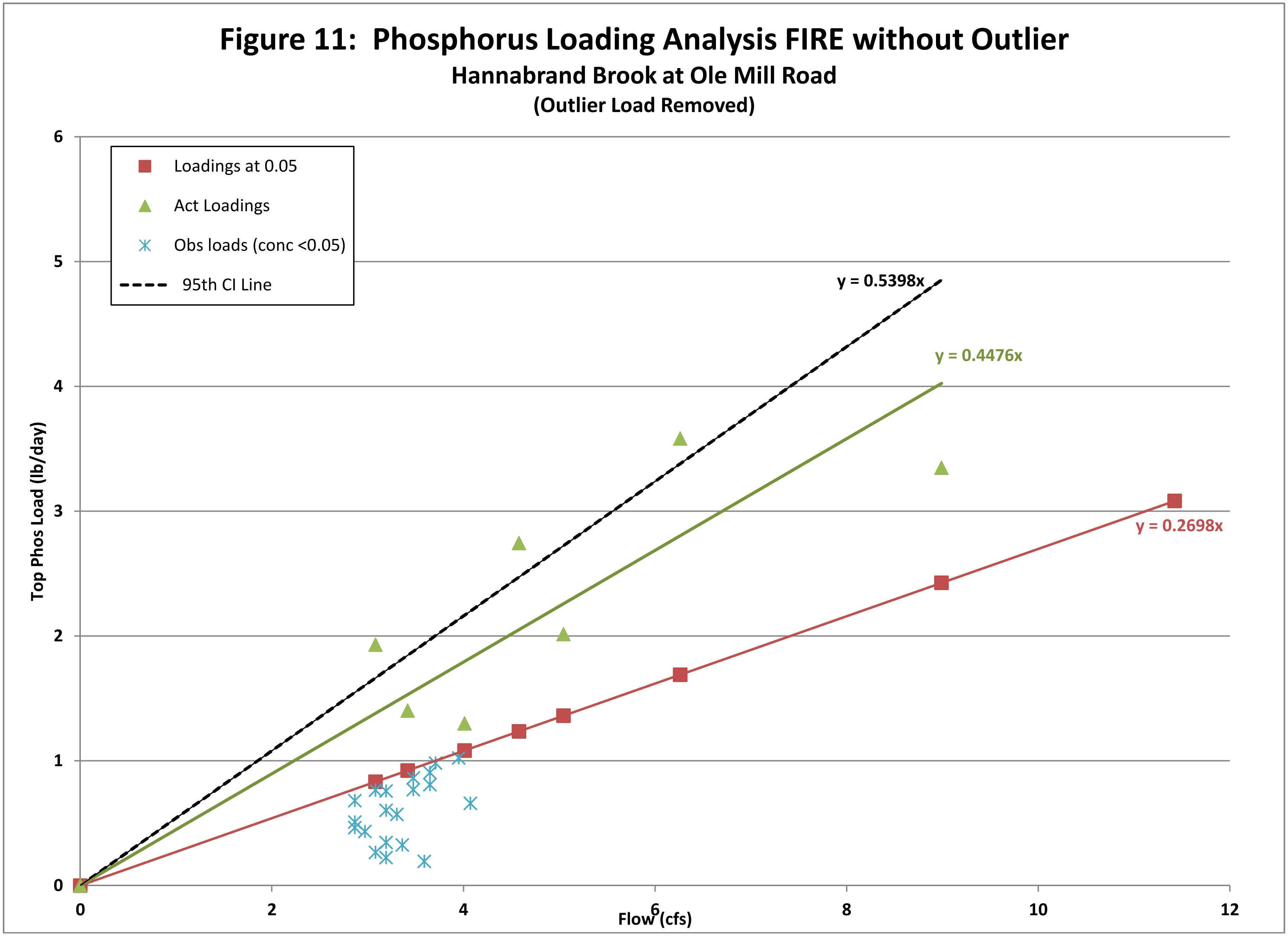


Figure 11: Phosphorus Loading Analysis FIRE without Outlier
Hannabrand Brook at Ole Mill Road
(Outlier Load Removed)
Loadings at 0.05
Act Loadings
Obs loads (conc <0.05)
95th CI Line
y = 0.5398x
y = 0.4476x
y = 0.2698x
Top Phos Load (lb/day)
Flow (cfs)
0
1
2
3
4
5
6
0
2
4
6
8
10
12

Table 32: Load Reduction Analysis from FIRE Regression Line **Phosphorus – Hannabrand Brook** *(without outlier)*	
Target Loading Slope	0.2698
Exceedance Regression Slope	0.4476
Upper 95% Confidence Limit of Slope	0.5398
Overall Percent Load Reduction	50% using the 95^{th} CI Slope

The margin of safety (MOS) reduction is calculated using the upper 95^{th} Percent confidence interval on the slope as follows:

$$Percent\ Reduction = 1 - \frac{0.2698}{0.5398} = 1 - 50.0\% = 50.0\%$$

3.2.2 Wreck Pond Brook

Similarly, the FIRE method was employed for Wreck Pond Brook at Old Mill. Figure 8 shows the flow vs concentration at this station. Figure 12 shows the regression lines determined as discussed above. Table 33 summarizes the results of the FIRE analysis.

Table 33: Load Reduction Analysis from FIRE Regression Line **Phosphorus - WPB at Old Mill Road**	
Target Loading Slope	0.2698
Exceedance Regression Slope	0.3681
Upper 95% Confidence Limit of Slope	0.3989
Overall Percent Load Reduction	% using the 95^{th} CI Slope

Using the slopes:

$$Percent\ Reduction = \ 1 - \frac{0.2698}{0.3681} * 100\% = 100\% - 73.3\% = 26.7\%$$

$$Percent\ Reduction = \ 1 - \frac{0.2698}{0.3989} * 100\% = 100\% - 67.6\% = 32.4\%$$

As expected, the percent reduction required to meet standards is lower at this station than at Hannabrand Brook. As noted above, the storm event sampling did not show increased total phosphorus concentrations at this station. Few samples exceeded the 0.05 mg/l concentration.

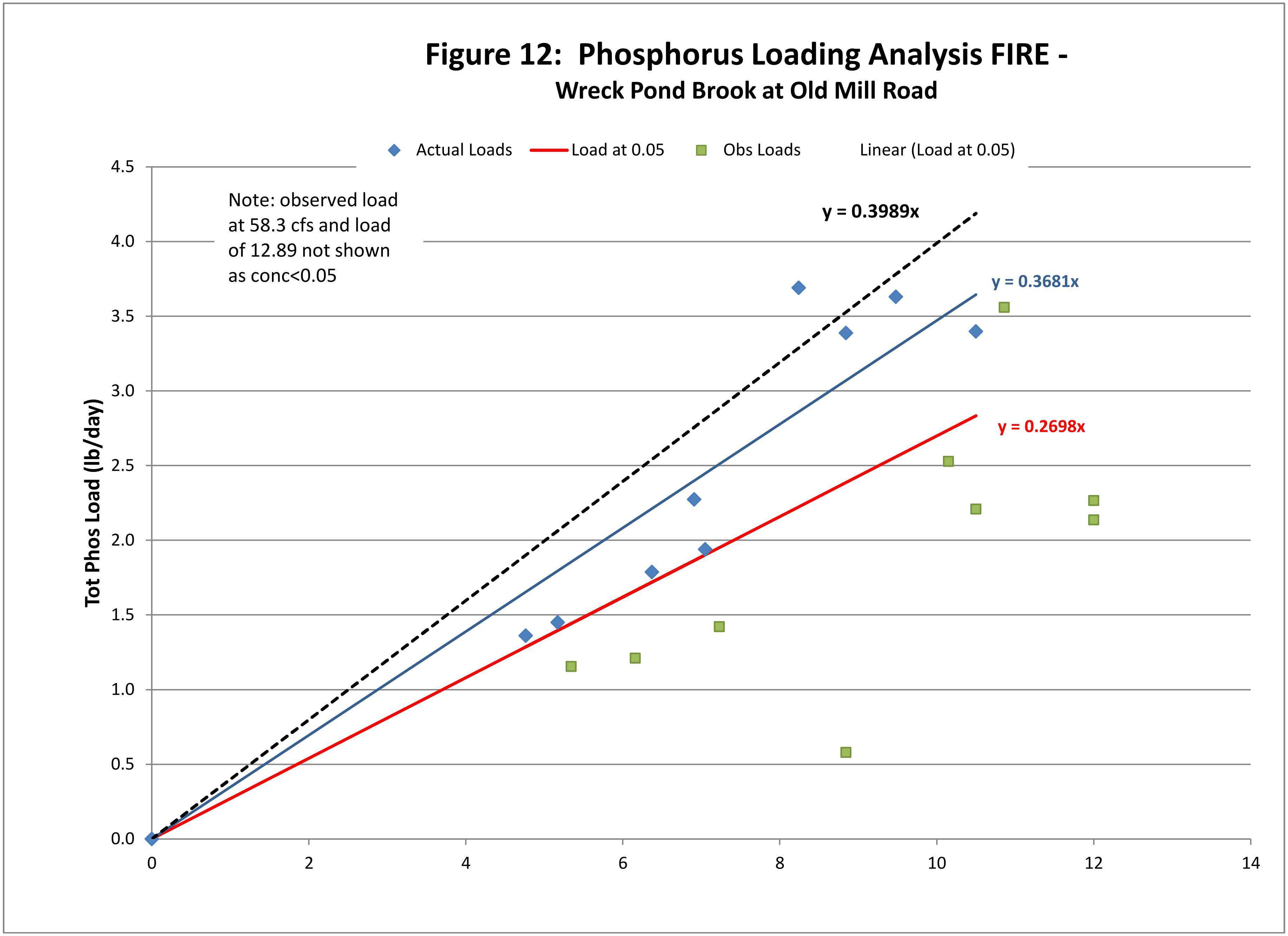


Figure 12: Phosphorus Loading Analysis FIRE -
Wreck Pond Brook at Old Mill Road
Actual Loads
Load at 0.05
Obs Loads
Linear (Load at 0.05)
Note: observed load at 58.3 cfs and load of 12.89 not shown as conc<0.05
y = 0.3989x
y = 0.3681x
y = 0.2698x
Tot Phos Load (lb/day)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14

3.2.3 Wreck Pond Brook at Glendola Road

As discussed above, only storm sampling was available for this station. Figure 9 graphs the total phosphorus concentration vs flow for this station. Also as discussed above, the NJDA flow rating curve did not provide appropriate results. Therefore, the flows were determined from the SWMM results and NA rating curves. The phosphorus concentrations are somewhat related to flow. Figure 13 provides the regression lines as calculated according to the method noted above. Table 34 provides the slopes using the FIRE analysis.

Table 34: Load Reduction Analysis from FIRE Regression Line **Phosphorus - WPB at Glendola Road**	
Target Loading Slope	0.2698
Exceedance Regression Slope	0.6134
Upper 95% Confidence Limit of Slope	0.7558
Overall Percent Load Reduction	65% using the 95^{th} CI Slope

Using these results, the reductions can be calculated as:

$$Percent\ Reduction = 1 - \frac{0.2698}{0.6134} * 100\% = 100\% - 44.0\% = 56\%$$

$$Percent\ Reduction = 1 - \frac{0.2698}{0.7758} * 100\% = 100\% - 35.7\% = 65.3\%$$

3.2.4 Wreck Pond

As discussed above, a lake loading analysis is not possible for Wreck Pond because of the lack of accurate lake volume calculations due to the lack of tidal flow data. Thus, the residence time cannot be accurately estimated.

Using the SWMM results, an analysis was done to establish the percent reduction required to meet the 0.05 mg/l standard. This is clearly a rudimentary approximation, as it does not take into account the tidal exchange or the pond volume and storage characteristics. However, it provides a reasonable estimate that may be used in conjunction with the other analyses presented herein.

Table 35 summarizes the results. As can be seen, the required percent reduction varies between the wet and dry year. The average estimated reduction is nearly 30%.

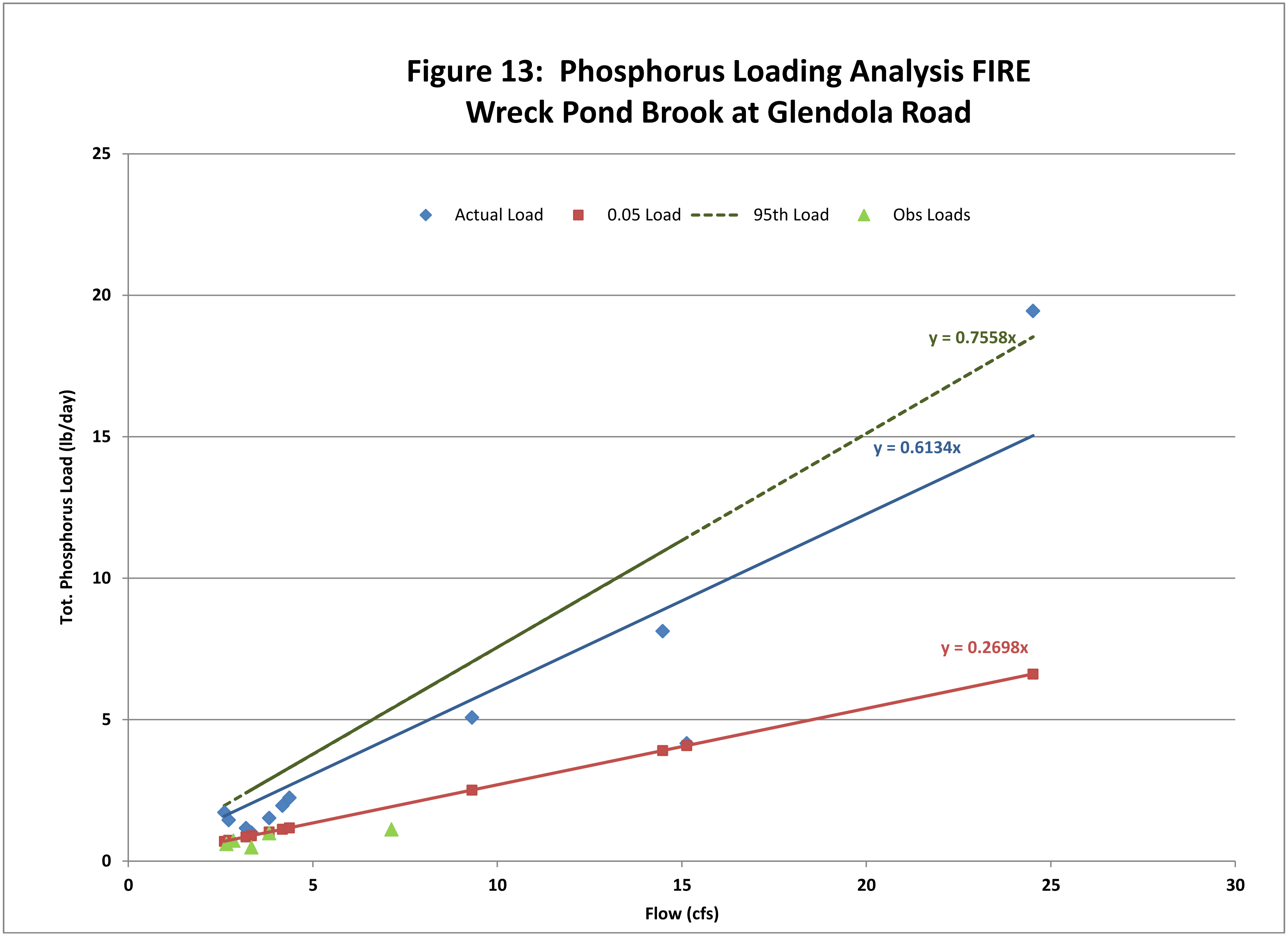


Figure 13: Phosphorus Loading Analysis FIRE
Wreck Pond Brook at Glendola Road
Actual Load
0.05 Load
95th Load
Obs Loads
y = 0.7558x
y = 0.6134x
y = 0.2698x
Tot. Phosphorus Load (lb/day)
Flow (cfs)
0
5
10
15
20
25
30

Table 35: Rudimentary Pond Loading Analysis - Phosphorus		
CALCULATED AVERAGE YEAR		
	Flow (cf*10^6)	**TP (lb)**
TOTAL to Pond	758.1	3328
ESTIMATED ALLOWED LOADING - 0.05 mg/l Standard		
	Allowed TP Load (lb)	**% Reduction from Existing**
Average Year	2366	29%
Wet Year	3029	17%
Dry Year	1704	43%

3.2.5 Black Creek

Flow data were not available to calculate flow and load data for Black Creek. Until additional data are available, it is assumed that the overall load reductions estimated for the watershed will be sufficient for this sub-basin.

3.2.6 Overall Phosphorus Load Reduction for the Wreck Pond Watershed

The total phosphorus impairment is based on the fact that the streams flow into a pond and thus the lake standard of 0.05 mg/l must be met. If the streams did not enter Wreck Pond, the standard would be 0.1 mg/l and both Hannabrand Brook and Wreck Pond Brook at Old Mill Road would not be considered impaired, based on the ambient sampling. However, storm event sampling did show concentrations above 0.1 mg/l at Hannabrand Brook and at the upstream storm event station at Glendola Road. Surprisingly, the results at Wreck Pond Brook did not show increased total phosphorus during the storm event.

Black Creek outlet exceeded both the 0.05 mg/l lake standard and the 0.1 mg/l stream standard. However, as discussed above, no flow data were available to accurately assess loading.

Four separate analyses were conducted to evaluate the required load reduction rate for phosphorus. The available data were not collected for the purpose of evaluating phosphorus loading to Wreck Pond. However, the data provide significant information to make those evaluations. The FIRE results, using the 95th upper CI slope for the existing load, are:

- Hannabrand Brook: 50%
- Wreck Pond Brook at Glendola Road 65%
- Wreck Pond Brook at Old Mill Road 32%
- Wreck Pond Analysis (maximum) 43%

Glendola Road is the most upstream segment on Wreck Pond Brook. It does not discharge directly to a lake or pond. No ambient data were available here to evaluate the extent of standard exceedances. Plus, the flow data here are considerably less reliable than those for Wreck Pond Brook at Old Mill and Hannabrand Brook. The NJDA concentrated their modeling effort at these stations, as these were the most downstream. Conversely, the Wreck Pond at Old Mill Road station is less reliable due to the lack of response from the phosphorus (and TSS) concentrations during the storm event.

Overall, the Hannabrand Brook data are the most reliable on both concentration and flow and the value is intermediate. Thus, a load reduction of 50% would be the goal in order to enable the removal of sufficient total phosphorus load to meet the downstream lake standard. Future monitoring results may allow adjustments to this estimate.

3.3 SEDIMENT

As discussed above, the TSS data do not exceed the standard, even during the storm sampling for the most part. The very limited data above standard suggests that the application of the FIRE model could lead to high levels of uncertainty in the result. Comparison of the slopes of the exceedance line (with only two points) and the standard line shows that the slope of the exceedances line (431) is about twice that of the standard line (215), indicating a 50% reduction in loading would be required. With only two data points, the 95th confidence band would be very wide and not accurate. Additional high flow data would be required to accurately assess the necessary load reduction.

Given that phosphorus is associated with sediment, a reduction of 50% of the phosphorus load would also reduce the sediment load to the ponds and streams significantly, as shown in the following sections. Thus, a 50% target is also used for sediment.

3.4 LOAD REDUCTION TARGETS FOR PHOSPHORUS AND SEDIMENT

Sections 3.2 and 3.3 provided an analysis of the required reduction in each of these parameters to meet the water quality standards and thus attain the designated uses. Table 30, above, provides the estimated existing loads using the STEPL model as modified for the watershed.

The next step is to determine the load reductions that would achieve the allowed total load. In this case, there are no point sources so the reductions would come from controls on nonpoint sources. For both pollutants, it is assumed that no direct BMPs would be placed on forested lands. Thus, the load reductions must come from the developed land uses on the upland areas in the watershed.

The reduction for phosphorus is proposed to be 50%. Approximately a 55% reduction in load for the urban and agricultural uses would achieve these load reductions. Similarly, to achieve a 50% reduction in TSS, a 51% reduction in loading would be required.

Further analysis, however, determined that the agricultural BMPs could not achieve a 55% reduction, based on the land area in cropland, the limited location of the streams adjacent to the agricultural lands, the results of the farm surveys, and the nature of farming in the watershed. Further, some of the measures proposed for reduction are within the waters, including streambank stabilization and riparian zone enhancement. These are not dependent on land use. Thus, the allowed loads by land use were re-balanced to achieve the reductions in phosphorus loadings.

For sediment, the reductions achieved by implementation of the phosphorus load reduction measures were analyzed. These achieved a reduction of greater than the 50% goal for TSS, with an overall reduction of 123% of that goal.

Table 36 summarizes the allowed pollutant load by land use and the % reduction required. The analysis shows a 50% reduction for total phosphorus and a 62% reduction for TSS.

The next step in this process is to develop a suite of BMPs that can be employed in the watershed and a rough estimate of the anticipated load reductions from those BMPs. Table 37 provides a summary of the management measures required by land use. Section 4 (Element C), following, provides details on the management measures to achieve these goals.

Table 36: Allowed Pollutant Load by Land Use				
Source	**Allowed P Load (lb/yr)**	**% P Reduction by Land Use**	**Allowed Sediment Load (ton/yr)**	**% Sed Reduction by Land Use**
Urban	744.5	64%	175.9	42%
Cropland	720.1	32%	120.6	40%
Pastureland	80	24%	9.4	25%
Forest	318.4	0%	9.4	0%
Other Reductions	-71.4		-114.4	
TOTAL FUTURE LOAD	**1793.8**	**50% Total Reduction**	**200.9**	**62% Total Reduction**

Table 37: Overall General Reductions by Land Use Category				
Sources	**Total Phosphorus (lbs/yr)**	**% of Total Reduction**	**TSS (tons/yr)**	**% of Total Reduction**
Urban Stormwater Management	1352.4	75%	125.2	39%
Agricultural	370	21%	83	26%
Stream Restoration	49.1	3%	112.2	35%
Riparian Zone Enhancement-Wreck Pond and others	22.3	1%	2.2	1%
TOTAL REDUCTION	**1793.8**	**100%**	**322.6**	**100%***

* Numbers do not add to 100% due to rounding

3.5 BACTERIA

The bacteria data show that this parameter exceeded the fecal coliform standard during the sampling period. As noted above, there are TMDLs for both streams that require a 51% reduction in bacteria counts in WPB and a 91% reduction in Hannabrand Brook. However, the data for recent studies in this watershed suggest that progress has been made in Hannabrand Brook toward reduction bacteria levels.

Both TMDL documents discuss the challenge of reducing bacteria levels and of even determining the proper target. As noted therein:

> *Relating pathogen sources to in-stream concentrations is distinguished from quantifying that relationship for other pollutants given the inherent variability in population size and dependence not only on physical factors such as temperature and soil characteristics, but also on less predictable factors such as re-growth media. Since fecal coliform loads and concentrations can vary many orders of magnitude over short distances and over time at a single location, dynamic model calibrations can be very difficult to calibrate. Options available to control nonpoint sources of fecal coliform typically include measures such as goose management strategies, pet waste ordinances, agricultural conservation management plans, and septic system replacement and maintenance. However, the effectiveness of these control measures is not easily measured. Given these considerations, detailed water quality modeling may not provide adequate insight or guidance toward the development of implementation plans for fecal coliform reductions.*

Determining the suite of measures for reduction of bacteria loads is also difficult. There are very few BMPs that effectively reduce bacteria. The primary means are reduction of sewage loads by repairing infrastructure and malfunctioning septic systems, adding sewer systems in un-sewered areas, or controlling large farms and animal feeing operations. None of these measures are appropriate in this watershed as those sources are not present. The TMDL reports recognize these issues and state:

> *The Department will address the sources of impairment through systematic source trackdown, matching strategies with sources, selecting responsible entities and aligning available resources to effect implementation.*

Source tracking has been found to be difficult in areas without clear cut sources, such as this watershed. Additional data are needed to better define the sources of the bacteria loading. If these sources are definitively found to not be from human sources, it may be from more natural conditions.

Further, new monitoring is needed to measure the appropriate pathogens and determine if the newer standards are being met. This may result in a modification to the load-reduction goals.

3.6 OTHER GOALS

This section identifies other key goals for this watershed. In addition to water quality improvements, measures to restore ecological health to Wreck Pond, reduce flooding, enhance terrestrial and aquatic habitats, and enhance tidal flushing and fish passage are listed below.

1. Pond Ecologic Health

Goal: Restore the ecologic health of Wreck Pond and of the impounded portion of Black Creek. Specific goals include:

- Enhanced tidal flushing (while protecting from flooding)
- Enhanced fish passage to and from the Atlantic Ocean
- Increased fish populations and return of anadromous fish populations
- Improved aquatic and terrestrial biota
- Elimination of algal blooms

Cause of Impairment: Outfall structure restricts tidal exchange, yet also stabilizes the outlet. Sediment in the Pond has reduced depth, flushing and clarity, impacting recreational use. Nutrient loads have caused algal blooms, which also impact aquatic life and designated use. Bacteria levels do not meet all of the applicable water quality standards; therefore the recreational designated use of the pond is not supported.

Management Measures:

- Reduce loadings of sediment and nutrient from streams by implementing the pollutant load reductions in Element C.
- Develop a living shoreline, maritime forest, and riparian zone plantings along 50% of Wreck Pond.
- Conduct stream restoration measures on eroding stream segments, with priority segments completed within 7 years.
- Modify the outlet structure to improve flushing while controlling flooding.
- Improve fish passage.

Target: Meet the water quality standards. Return of anadromous fish to the Pond. Increase populations of other fish. Reduce algal blooms by 60%.

2. Flooding

Goal: Reduce flooding from Wreck Pond onto lower watershed lands.

Cause: Tidal flooding, high tides blocking flows through the outfall from storm events and preventing the stormwater from exiting the pond, lack of storage in upstream ponds, lack of adequate stormwater management.

Management Measures:

- Add an additional outfall structure for high flows.

- Addition of a tide or flood gate.
- Minimize flooding by increasing storage within Wreck Pond and upstream ponds.
- Improve flood control at individual developments or facilities by retrofit of older stormwater management systems as discussed in Section 4.
- Increase pond storage by managing outfall structure to eliminate incoming tide flows before and during major storms.
- Increase pond storage by increasing berm height, if feasible.

Target: Reduce the number of flooding events and the number of homes impacted by flooding.

3. Restore Stream and Riparian Habitat Throughout the Watershed

Goal: Improve habitat within the streams and associated riparian zones.

Indicators: Stream condition (bank stability, riparian zone condition), erosion potential, sediment load.

Cause: Development and use of upland areas leading to increased stream flows and increased erosion potential; stream condition.

Management Measures: Enhance bank and stream stability and stream vegetation in eroding sections. Restore stream segments identified as eroding by Freehold Soil Conservation District. Maintain or improve riparian zone conditions. Improve stormwater facilities as needed.

4. Enhance Tidal Flushing and Fish Passage

Goal: Increase tidal flushing in Wreck Pond to improve water quality and allow fish passage.

Cause: Outfall reduces tidal exchange and stormwater outflow, and pipe conditions at times, may deter fish passage.

Management Measures: Create greater tidal exchange while reducing flooding potential; pipe maintenance and cleaning, etc.; constructing an additional outfall pipe

4 ELEMENT C: PROPOSED MANAGEMENT MEASURES

The next step is to develop appropriate management measures and best management practices (BMPs) to meet the target reductions identified above. Table 38 summarizes the measures and anticipated costs, which are described in detail in the following sections.

The STEPL model was used to estimate load reductions from implementation of management measures (called BMPs in the model) for most of the proposed measures. For each measure, the model requires input of the percent of each land use on which the BMP would apply. For stormwater management techniques or buffers, the acreage of upland which would be "treated" by the BMP was estimated and used in the model. As noted in the EPA handbook, these estimates contain uncertainties.

Several sources were used to develop load reduction estimates. For management measures or BMPs included herein, the STEPL model defaults were used in most cases. For certain measures, rates were adjusted based on literature values or other information.

Significant data sources employed include the USEPA's Menu of BMPs, the Chesapeake Bay Program's BMP effectiveness data, including a study on the James River [Center for Watershed Protection (CWP, 2013)], Maryland WIP information, and the International BMP Database. The James River study was used for cost estimates, as it is up-to-date and in an area similar to New Jersey.

4.1 LONG-TERM QUANTIFIABLE MEASURES FOR PHOSPHORUS AND TSS

This section provides estimates on quantifiable BMPs to be employed to achieve load reductions. Application of all of these measures would be long-term. The primary challenge will be funding and implementation on private lands. Thus, the time frame to implement all measures is more than 25 years. In addition to changes that may be anticipated in the watershed or at the Pond itself over that time frame, it is anticipated that new, innovative and cost-effective BMPs may be developed. Thus, the implementation of these measures will be modified as appropriate in the future.

In that timeframe, changes to the Pond outfall structure may be anticipated to enhance tidal flushing and increase fish passage as discussed in Section 4.2. If modifications to the outfall are constructed, additional monitoring will be needed to determine the response in the Pond. Table 38 summarizes the proposed management measures.

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Table 38: Proposed Management Measures to Achieve Reductions							
Proposed Management Measure	**Unit Measure**	**Tot P Reduct. (lb/yr)**	**% of Tot. Reduct. Needed**	**TSS Reduct (ton/yr)**	**% of Total Reduct. Needed**	**Estimated Cost**	**Other Benefits**
Agricultural Nutrient Management	479 ac	270	15.1%	0		$9,100 per yr	Reduced cost, reduced N load
Other Agricultural Measures	500 ac	100	5.6%	83	25.7%	Depends on measure	Reduced N and bacteria loads
Priority Stream Segment[1]	2.03 Stream miles	15.1	0.8%	38.1	11.8%	$1.6 million	Habitat improvement, reduced N load
Other Stream Segments[1]	4.55 stream miles	34	1.9%	74.1	23.0%	$5.4 mill	Habitat improvement, reduced N load
Pervious Pavement	260 ac	100.2	5.6%	42.3	13.1%	*$0 to $30 million over regular paving cost	Reduced N load; flow control
Low P Fertilizer[2]	2628 ac	867	48.3%		0%	Comparable to existing fertilizer	
Wreck Pond Shoreline Stabilization/Riparian Zone	10,000 ft of shoreline; 40 acres of land	7.3	0.4%	1.5	0.5%	$2.4 million**	Shoreline Stabilization, habitat enhancement, in-water filtering, aesthetics, lower bacteria levels
Other Vegetative Filters/ Riparian Zone Enhancement	47	15	0.8%	0.7	0.2%	$705,000*	Aesthetics, education, open space, lower N

Table 38: Proposed Management Measures to Achieve Reductions (continued)							
Proposed Management Measure	**Unit Measure**	**Tot P Reduct. (lb/yr)**	**% of Tot. Reduct. Needed**	**TSS Reduct (ton/yr)**	**% of Total Reduct. Needed**	**Estimated Cost**	**Other Benefits**
Enhanced Municipal Operations		20	1.1%	8	2.5%	To be determined	Aesthetic, lower N and bacteria
MTDs – Installed in 2010	12 devices, 265 ac	48.6	2.7%	10.6	3.3%	Completed	
MTDs – Proposed	12 devices, 142 Acres	25.7	1.4%	5.7	1.8%	$800,000	
MTDs – Future	24 devices, 500 acres	99.7	5.6%	23.6	7.3%	$1.7 million	
Stormwater Management Basin Upgrades	982.5 acres	191.2	10.7%	35	10.8%	$3.75 million	Also reduces N, wet pond or wetland provide habitat, flow control
Sanitary Sewer Repairs[3]	*0.1% Homes or business*	*Up to 51*	*	*Up to 115*			*Up to 14,309 10^6 MPN*

[1]Prioirity projects are within publicly owned lands; other segments are on privately owned lands
[2]Credit for low P fertilizer law; applies to all pervious urban areas (estimated)
* Cost can be comparable to re-paving with asphalt; property owner pays costs
[3]Sanitary repairs estimated from literature values; local analysis suggests rate of failure is much lower
**Cost does not include flood control berm

The following provides details regarding the management measures outlined in Table 38.

4.1.1 Agricultural Nutrient Management

This BMP requires a comprehensive plan that describes the optimum use of nutrients (fertilizers) to minimize nutrient loss from crop lands while maintaining yield. This would be revised every 2-3 years. The estimated cost is $19 per acre per year. This would include both management of fertilizers and manure on crops and of farm animals.

The major obstacle would be to get farmers to agree to the recommended practices and implement the plan. The load reduction was taken from the STEPL model simulations to apply to the entire acreage of cropland.

4.1.2 Other Agricultural Measures

In order to achieve the TP reduction required, additional measures will be required on farmland. The specific measures must be determined in coordination with the farmers and the type of crops or other farming activity employed. Some of the potential measures could have large impacts on the loading estimates. For example, if low or no tillage practices are not currently employed, implementation of such practices on just 20% of the crop land would reduce TP loads by 169 lb/year and on TSS by 77 tons per year. Other measures could include fencing, animal management, stormwater management, and other agricultural practices. However, a data gap exists to identify:

- How much land is actively farmed
- What percentage of farmland is crop land, nursery, livestock, etc.
- What current BMPs have been implemented by the farmers.

4.1.3 Stream Restoration

This measure is discussed in further detail under priority projects. Phase 1 priority projects were selected as impaired stream segments that flowed through publicly owned lands. Given these are on county or township owned lands, there would be no acquisition costs and construction costs may be lowered if in-kind services are provided or local volunteers are employed. There is a wide range of cost estimates for such projects, depending on the bank condition and the method employed to stabilize the bank. For the publicly owned land, a cost of $150 per stream linear foot was used while for the Phase 2 private lands, $225 per stream linear foot was used to account for acquisition or easement costs and working with the land owners.

The reductions were calculated from STEPL. For the initial condition it was assumed that the eroding streams were accounted for in the overall TSS and TP loads. Thus, the entire reduction was credited.

The obstacles will be funding in all cases. NJDEP permitting will be required, but it is assumed that the projects will incorporate appropriate green streambank stabilization techniques and thus be approvable by NJDEP for most segments. Access and impacts to surrounding uplands could be an obstacle even for the publicly owned segments. While the streams flow through public land, some border private lands on one bank. For the privately owned segments, access and easements and acceptance by private land owners will be additional obstacles.

4.1.4 Stormwater Basin Retrofit

There are approximately 100 stormwater basins mapped throughout the watershed. The mapping was conducted by Freehold Soil Conservation District based on data available at the time. As discussed in the RSWMP, the vast majority of the existing development within the watershed occurred at least 25 years ago. This was determined by comparing the 1986 land use layer to the 2006 land use layer. Further, in the lower parts of the watershed development dates back to prior to any stormwater regulations. Thus, much of the existing development was installed when no or fewer regulations were in place regarding stormwater runoff management, particularly sediment load reduction.

The basins serve a variety of development types, primarily residential neighborhoods. However, there are also basins associated with local schools, commercial and industrial facilities and government buildings. The measures consist primarily of stormwater basins that vary in design. The permitting dates for these basins extend from the late 1970's through the 1980s. Many of these have concrete low flow channels designed to ensure that the basins stay dry. These channels direct the "first flush" of stormwater and other lower flows through the channel and out of the basin, without any beneficial treatment. Thus, the water quality benefits of many existing basins are none to very low.

Other dry basins may not conform to more recent NJDEP regulations. In addition to structural methods to control the peak flow and volume of runoff from a developed site, current stormwater management rules require infiltration and non-structural design methods that serve to minimize connected impervious area and direct stormwater runoff and improve water quality.

A variety of options are available to retrofit basins. All considered herein would include increasing detention storage and enhancing water quality. Removing the low flow channel and modifying the outfall structure is one method. A complete retrofit could convert a dry detention basin to a wet pond or a wet pond with wetlands. Other retrofits may include installing water quality improvements like sediment forebays, micropools, wetlands, or riparian buffer; modifying or replacing riser structures to reduce discharge rates; and adding infiltration features such as sand filters or bioretention areas. All of these will enhance the water quality treatment for the stormwater that flows through them.

Load reduction rates were assumed to be those noted in the USEPA BMP data base and the International BMP database for wet ponds. It was assumed that older basins do not offer any water quality treatment and those would be the most likely to be modified.

The long-term reductions were analyzed as assuming that basins serving about 20% of the urban area in the watershed could be upgraded. These would be either by adding a stormwater management feature where there is currently none, adding an additional stormwater management feature to the system, or by retrofit of basins.

This is a reasonable estimate as any new development or redevelopment that triggers the NJDEP Stormwater Management Rules (N.J.A.C. 7:8) would be required to provide stormwater treatment. In other cases, NJDEP or USEPA may provide funding for property owners to retrofit basins.

Costs are difficult to estimate, since they depend on the specifics of the site and the retrofit possible based on the existing basin and surrounding area and what is allowable by any permits. EPA estimates that a combined wetland-wet pond facility of 10-ac-foot costs about $300,000, but this is an older estimate on the BMP page. The Center for Watershed Protection (2013) synthesized costs and determined that retrofits cost about $12,500 per pound of phosphorus removed. This is the estimate used herein.

This is a long-term project, based on the cost and the need for private-public partnerships. Short-term goals would be to retrofit one basin in the next three years, funding permitting.

The primary obstacle is funding and private ownership of the existing basins. For local governments and private property owners, there is little incentive to expend funds to retrofit a stormwater basin unless required by regulation or at no or very low cost. In some cases, a wet pond may provide an aesthetic benefit over a dry pond to a community that could be worth the price of the retrofit.

4.1.5 Pervious Paving

Porous paving can replace regular paving in areas that have lighter traffic. New pervious pavements function better than those in the past. A pilot project under consideration at the Wall Township Municipal complex is discussed under priority projects. This can remove 40% of TP and 80% of total suspended solids. The cost estimates vary, from about the same as paving with regular pavement to about 20% to 50% more. As the cost does not consider that the area has to be re-paved over time, the cost differential should be analyzed.

The long-term load reductions in Table 38 were determined by estimating that about 10% of commercial, industrial and multifamily land uses could be converted to porous paving and 5% of the single-family home could be converted to pervious paving. This would include homeowners modifying their own driveways as well as parking lots at commercial and industrial sites. The estimate also includes conversion at some open space areas such as parkland parking lots and on agricultural sites.

Implementation of this measure would be long-term.

The major obstacle is demonstrating to the property owner that the porous paving will hold up as well as regular pavement in their parking area. The owner would also need to be assured that the maintenance requirements are not any more costly than maintaining regular parking lot materials. If the cost were comparable, property owners may be willing to use this material, but if the cost is significantly higher, some incentives likely would be required.

4.1.6 Wreck Pond Riparian Zone – Living Shoreline

This BMP is enhancement of the riparian zone along the Wreck Pond shoreline along with a living shoreline and maritime forest. The NJDEP recently applied for a grant from the National Fish and Wildlife Foundation to construct a living shoreline and a flood control berm along the Pond. The living shoreline portion would include both in water living shoreline and upland riparian zone enhancements. The proposed living shoreline would be along about 10,000 linear feet of shoreline. Most of the shoreline riparian zone is directly adjacent to roadways. The width of area discharging to the shoreline was estimated to be about 150 feet (up to the center of the first row of homes across the street. While much of the runoff in this area is collected in storm sewers, these will discharge into the living shoreline buffer. The area that will discharge into that buffer will be much larger than 150-feet along the shoreline but it is assumed that not all of the stormwater flow can be filtered. Thus, this was an intermediate approach.

The NJDEP is committed to developing a living shoreline along Wreck Pond, providing this is found to be feasibly and funding is available; funding is the primary obstacle. It is anticipated that a living shoreline can be developed along Shore Road, where the shoreline is mowed grass with no structure. It is expected that funding will be available here. However, the feasibility and cost of a living shoreline along the areas where there is currently a bulkhead and a very narrow band of grass is not clear.

The other potential obstacle is local acceptance of the project. Residents along the shoreline are used to having mowed turf grass and completely uninhibited access to the Pond. The flood control berm is under study and if found to be a feasible approach, this will be an incentive to local homeowners impacted by flooding.

The living shoreline will enhance habitat value (as discussed below) and provide in-pond water quality benefits by vegetative uptake and filtering of pollutants. The living shoreline will also provide reduction of nitrogen loads.

4.1.7 Stormwater Manufactured Treatment Devices (MTDs)

Manufactured treatment devices are pre-fabricated stormwater treatment structures utilizing settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to remove pollutants from stormwater runoff. With funding provided by NJDEP, fourteen devices of varying designs have been placed on outfalls that discharge directly to Wreck Pond. Additional systems have been designed and are awaiting funding for installation.

In August 2006, a preliminary engineering analysis for the installation of such devices was initiated. The devices were to be placed at the last outfall into a water body. After a thorough review of infrastructure mapping and field investigation, NA has identified approximately 71 known stormwater outfalls draining into the Wreck Pond system (54 into the Pond and lower tributaries, 14 into Spring Lake, 3 into golf course streams). Of the 54 draining into the Pond and tributaries, 36 are located east of Route 71.

The preliminary analysis included prioritization of unit placement, preliminary flow analysis, sizing, and preparation of cost estimates. Drainage area to each outfall was determined as part of the Borough Study, while additional work was done to evaluate the existing infrastructure at each of the outfalls under consideration. In order to reduce cost, the installations were targeted for roadways or other publicly owned lands to eliminate the need for easements on private lands or land acquisition. The next step was investigation of the existing infrastructure for each potential outfall as to the difficulty of conducting the retrofit. Using these criteria, 25 outfalls were identified as possible priority sites for retrofits. Of these, ten are located within Spring Lake, nine in Spring Lake Heights, two in Wall and four in Sea Girt. It was later determined that some of the drainage areas were split into two or three separate outfalls, so that 28 were prioritized.

Following contract award, detailed engineering and bid plans and other documents were prepared for all of the priority outfalls, which were then labeled as “Priority 1” or “Priority 2”.

The completed project included installation of several different types of MTDs. The plan was to monitor the outfalls to evaluate the pollutant removal efficiency at the MTDs under field conditions for the same storm events. NJDEP initiated a monitoring program, but additional data is needed to effectively evaluate the results.

For Table 38, the contributing area for each outfall were summed to determined the overall area to be treated by these outfalls. The land use was assumed to be all medium density residential, as this is the predominant land use in the areas served by the MTDs. This was used in the STEPL model to estimate the load reduction.

The future installation is estimated for outfalls to streams in other parts of the watershed. These would be in the upper watershed as well. It was estimated that 24 additional MTDs could be installed with an area of 21 acres per outfall for a treatment area of about 500 acres. This was applied to the commercial, industrial and residential land uses in the STEPL model to determine the load reduction.

Costs are estimated from the cost incurred for the installation of the devices already completed.

The local municipalities are supportive of the project and have been willing to undertake the future maintenance requirements. The obstacle to the Phase 2 installation is funding. Given that the engineering is complete, the project is ready to be implemented. The obstacles to later phases are to find appropriate sites to install the devices and the associated costs.

4.1.8 Other Municipal Measures

Municipalities can employ BMPs to enhance housekeeping activities. This can include increased street sweeping, better leaf litter management, increased pet waste management, and enhanced catch basin cleaning. The loading reduction was estimated by applying the weekly street sweeping reduction to the single-family home land use. This is a rough estimate. The cost is difficult to estimate as it depends on the measures the municipality is currently taking and how this can be enhanced.

Local education is a critical component of this element. Local homeowners and business owners need to understand the requirements in leaf management and pet waste regulations and ordinances.

Obstacles include the cost to the municipality and the difficulty of control efforts for individual behavior (such as pet waste control). Municipalities would not be expected to enhance their operations without regulatory requirements or financial or other incentives.

4.1.9 Sanitary Sewer Repairs

As discussed under in Section 3.5, Bacteria, a rough analysis was made of possible load reductions if sanitary sewer repairs were made. However, as discussed therein, the recent infrastructure study suggests that literature values over-estimate the number of illicit or broken connections in this watershed. Thus, while infrastructure repairs are important, no credit is taken for load reductions. If additional problems are found in the sanitary lines, the load reductions can be re-evaluated to reflect this.

4.2 BACTERIA REDUCTION ANALYSIS

The required reduction for bacteria is 51-91% based on the TMDLs. At this time, there is very limited data that provides either accurate estimates of bacteria loading by land use or on effective methods for reducing bacteria from non-point sources. Even in areas with Phase II Watershed Implementation Plans, such as the Chesapeake Bay, no approved BMPs for bacteria reduction are given on the applicable websites.

Further, as discussed in the RSWMP, it is not clear whether the bacteria in the waters are from human origin and thus of concern. The major means of reducing bacteria loads in waters is by managing point sources of wastewater, combined sewer overflows and septic systems. The Wreck Pond Watershed contains none of these sources.

Failing sewer infrastructure or illicit connections are another possible source of bacteria loads. Literature analysis suggests that about 1 home in 1,000 (0.1%) has an illicit connection. For business, it is estimated that about 9% have illicit wastewater connections, while about 0.1% of business also have illicit or problem connections. Thus, an analysis was done with those assumptions. The GIS building layer was combined with land use. The number of buildings in commercial land use were assumed to be businesses.

The number of homes was estimated by taking the total number of homes in the municipality as reported by the census, and adjusting by the percentage of the municipality within the watershed. On this basis, there are about 385 businesses and 7,571 homes in the watershed. The load is determined by the flow per home per day, times the concentration in wastewater times 0.1% (the percent of illicit connections expected). The number of bacteria that could be reduced on that basis is determined to be about 14.309 million MPN per year based on this literature estimates.

The recent study of the infrastructure in the Boroughs of Spring Lake and Sea Girt in the watershed found limited areas of clear sanitary line problems. However, other areas with aging sanitary sewer lines were found. Repair or replacement of these lines would be expected to have some impact on bacteria levels in the Pond. However, assuming no cross-connection, the leaking lines would impact the shallow groundwater and the impact on counts in the Pond would depend on distance to the Pond, the die-off rate in the groundwater and the groundwater flow. Thus, an accurate estimate of possible bacteria reduction is not possible.

Another source of bacteria can be from farms, particularly where farm animals have unrestricted access to streams or where poor manure management practices are employed. While about 1/3 of the watershed is mapped as agricultural use, the Rutgers Cooperative Extension's (RCE) Assessment of farms found that only about half of the acreage was actually farmed in 2005. The assessment also only found very limited animal populations on these farms, thus, limited areas where bacteria control could be improved. The BMPs proposed in Table 38 will also provide some reduction in bacteria levels. However, very little data are available to estimate loads.

Another approach would be to increase forested buffers to streams through agricultural lands. This measure was considered for nutrient and sediment management, as well as for bacteria. However, GIS was used to overlay a 50-foot buffer on stream segments within the watershed with land use. Outside of ponds, there are about 16 miles of stream within the watershed. The land use within the 50-foot buffer to these streams was determined by overlaying the 50-foot buffer and land use in the GIS system. About 82% of the stream buffers are within woodlands and only 3% is agricultural. Thus, most of the farmland is not close enough to streams for additional buffers to provide much benefit.

Recently, NJDEP and Monmouth County Health Department have concluded that the bacteria data at the bathing beaches show a dramatic reduction in exceedances of the bathing beach standard. Thus, the current “rainfall provisional ban”, which is the precautionary closing of ocean bathing beaches after 0.1 inch of rainfall, was lifted for the summer of 2014 and additional monitoring conducted during every storm event. That monitoring supported the continued lifting of the ban. This data will provide valuable information regarding bacteria levels in the ocean bathing beaches. Additional data on the bacteria levels in the Pond would help determine the level of non-compliance with the recreational standard there.

Again, a significant data gap exists both in this watershed and in the literature as to effective measures to reduce bacteria loads in the absence of sewage plant discharge, failing infrastructure or septic systems.

4.3 COMPLETED PROJECTS

Over the course of the past six years, since the water quality data were collected, several projects have been implemented in the watershed and others are in progress, as summarized in Table 39 These measures have reduced loadings in the watershed since the data were collected. The estimated load reductions from these projects are included in Table 38, where available.

4.3.1 Infrastructure Studies

Spring Lake and Sea Girt have completed infrastructure studies of the sanitary sewer lines within their boroughs in an effort to locate illicit connections or damaged or leaking sanitary sewer lines. Based on studies by NJDEP and Monmouth University, it was determined that some of the bacteria found in Wreck Pond contained a human component. In response, the borough engineer conducted a sanitary and storm sewer infrastructure study within the Wreck Pond drainage area in the Borough of Spring Lake. The project also included cleaning of the system components, some of which were impacted by Hurricane Sandy. The project was funded through a Federal EPA Grant. (Avakian, 2013)

The project involved cleaning, inspecting and televisioning both storm and sanitary sewer system components, followed by smoke testing of sanitary sewer lines as appropriate. The effort concentrated on suspected interconnections and other defects that might have compromised the water quality in the affected water bodies. The study was done in July and August of 2013.

Table 39: Completed Projects and Funding				
Project Description	**Location**	**Concerns Addressed**	**Funding Amount ($)**	**Current Status**
NJDEP Funded Projects				
Installation of Stormwater Manufactured Treatment Devices	Stormwater outfalls that discharge to Wreck Pond	Sediments and associated pollutants, TP, Floatables	1,200,000	Device installation COMPLETE; monitoring proposed; additional units designed and await funding for installation.
Restoration of Golf Course Ponds and Weir at Route 71	West of Route 71 at SL Golf Course	Flood Control, Sediment and associated pollutants (TP)	200,000 (plus SLGC funds)	COMPLETE
Rain Gardens	Various Locations in Watershed	Flow and General Water Quality; Education	$24,000	COMPLETE
Total Expended Construction Funds			**$1,424,000**	
Other Projects				
Spring Lake and Sea Girt Infrastructure Study	Sanitary and storm sewers in the WP Watershed	Source tracking for bacteria	Funded by US EPA Grant	Study complete; some additional repairs may be needed
Monmouth County - Public Works & Engineering Spot Dredging	Dredging within Wreck Pond	Sediment removal, habitat improvement	Internal County Funding	Initial project completed; additional projects expected

The study included video inspection of Sanitary and Storm Sewers in both Sea Girt and Spring Lake within the Wreck Pond Drainage area. The study revealed that Hurricane

Sandy had significant impacts on infrastructure, requiring at least double the normal cleaning effort with additional work required for components closest to the Ocean.

Based on bacteria data and the “human signature” previously reported, it was anticipated that significant defects in the sanitary system would be found. However, the work yielded “considerably fewer cross-contamination conditions than anticipated”. The smoke testing of the sanitary lines found some “minor defects” and “minor plumbing irregularities” in a few homes.

Overall, no repairs were necessary in Sea Girt and the storm and sanitary lines were reported to be in fair to good condition.

Infrastructure repairs were completed in Spring Lake, including:

1. Spot sanitary sewer repairs on Fourth Avenue and Union Avenue:
2. Spot storm sewer repair on Pennsylvania Avenue;
3. Sanitary sewer repair, water main relocation and fire hydrant installation on Brown Avenue;
4. Sanitary sewer replacement on Ocean Road;
5. Storm sewer replacement and sanitary sewer relocation on Ocean Avenue (between Union and Pennsylvania Avenues);
6. Storm sewer and inlet replacement on Ocean Avenue at Union, Salem, and Pennsylvania Avenues;
7. Sanitary sewer system reconstruction with roadway reconstruction on Central Avenue;

4.3.2 Installation of Manufactured Treatment Devices

NJDEP provided funding to Monmouth County to install Manufactured Treatment Devices on outfalls within the lower watershed that discharge directly to Wreck Pond. Table 40 provides a summary of the installed devices and the drainage area covered.

During the summer and fall of 2010, 14 stormwater manufactured treatment devices (MTDs) were installed throughout the lower portion of the watershed. One of the devices was installed on an outfall to Spring Lake, which used to flow into Wreck Pond. The highly developed nature of the lower watershed indicates that these were the best options to improve stormwater quality. The devices were fully operational in January of 2011. At this time, the NJDEP is undertaking a monitoring program to evaluate the effectiveness of these devices for removal of sediment, nutrients and possibly bacteria. Based on the manufacturer’s specifications, it is anticipated that these devices will improve stormwater quality.

Table 40: Installed MTDs		
Outfall No.	**Drainage Area (ac)**	**Location**
5A	20.02	West Chicago Blvd, Wall
5B	7.35	West Chicago Blvd, Wall
7	18.46	6th Ave, Sea Girt
10A	5.65	2nd Ave, Sea Girt
13	1.24	Brown Ave, Spring Lake
15	21.55	Ocean and Brown Aves., Spring Lake
19	68.82	Passaic Ave., Spring Lake
20	71.95	6th Ave, Spring Lake Heights
21	47.48	Salem Ave., Spring Lake
22A	30.49	Ocean Road, Spring Lake
24A	26.10	Ocean Road, Spring Lake
25A	0.08	Ocean Road, Spring Lake
25B	0.52	Ocean Road, Spring Lake
34A	17.43	Shore Road, Spring Lake Heights
Total Drainage Area		337.1 ac total; 268.3 ac to Wreck Pond

4.3.3 Rain Gardens

Rutgers Cooperative Extension successfully developed rain gardens within the watershed as demonstration projects, at publicly owned properties. The rain gardens have been successful and provide an educational opportunity on the use of these measures. The rain gardens provide some reduction in sediment and associated pollutants, including total P.

4.3.4 Improvements at Spring Lake Golf Club and Route 71 Culvert

This joint project between the NJDEP and the Spring Lake Golf Club removed sediment, repaired weirs and repaired the culvert at the crossing of Route 71. The project has been completed. The project does not have any direct impact on pollutant loading, although removal of sediment from the ponds reduces the potential for sediment to move downstream. The culvert repair has had positive benefits on flows.

4.3.5 Monmouth County Dept. of Public Works and Engineering –Pond Dredging

Monmouth County Engineering dredged a small area of Wreck Pond just upstream of Route 71. The project was conducted using County personnel and equipment. The material was processed on the Green Acres parcel located just northwest of the Route 71 crossing of the Pond and taken to the Monmouth County Reclamation Center as cover material. The project was highly successful and improved flow and habitat in this portion of the Pond. The County realized a significant cost savings by conducting this with County equipment and personnel, instead of using a contractor.

In December of 2012, the County also conducted dredging near the Wreck Pond outfall following Hurricane Sandy to remove some of the material that was transported into the pond from the storm. The County plans to conduct additional spot dredging projects as appropriate. This project removed accumulated sand that was placed back on the beach.

4.4 CURRENT STUDIES AND PROJECTS

A number of agencies have ongoing studies and possible construction projects within the watershed.

4.4.1 US ARMY CORPS OF ENGINEERS

In 2012 the US Army Corps of Engineers, NY District, completed a Reconnaissance Study of the watershed. The study determined that there is a federal interest in further study and the possible funding and implementation of projects in the Wreck Pond Watershed. The next step in the process is a Feasibility Study. This study has been funded and due to the Sandy Recovery process is fully funded at the federal level and does not require a local match.

The current scope of the Feasibility Study will examine the following ecosystem restoration objectives for Wreck Pond:

- Restore in-water and riparian habitat
- Restore anadromous fish passage (restoring tidal exchange)
- Improve aquatic diversity and health
- Restore wetland habitat
- Reduce sedimentation
- Restore water quality to support fisheries

Alternatives/measures will be formulated and evaluated to meet the planning objectives. The study will formulate and evaluate alternatives to improve the Wreck Pond aquatic ecosystem. Potential improvement measures are summarized below.

- Modify existing outfall and/or add an outfall from Wreck Pond to the Atlantic Ocean to allow for increased tidal exchange and anadromous fish passage.

- Establish tidally influenced wetland communities (all study reaches).

- Stabilize pond bank through the establishment of living shorelines and upland shrubland communities (all study reaches).

- Install in-water structures to increase aquatic diversity (all study reaches).

- Dredge material primarily from Wreck Pond.

- Modify drop structures, flow constraints and other transitions between Wreck Pond and Black Creek and other upstream points.

The study will also include a “No Action Plan”. As required by federal environmental regulations, the “No Action Plan” (Future without Project Condition) will be identified and the impacts will be clearly discussed and analyzed.

This is expected to be completed by 2016.

4.4.2 Wreck Pond Outfall Modification

The Borough of Spring Lake has used FEMA funding to install flow control tide gates in the existing outfall. The original outfall structure included plates that could be used to control flow and manipulate the pond elevation. These were removed in the past.

The purpose of the plates is to block ocean flow from entering the Pond prior to a predicted major storm event. As appropriate, the structure will be closed at high tides and opened at low tide to allow watershed flows to exit the Pond. The structure would not be opened during very high storm tides in the Atlantic Ocean or when such tides were predicted. The goal is to lower the pond elevation prior to a major storm and keep tides from filling the Pond. This will increase the available storage volume for upland storm flows.

The project will improve flood conditions, but is not expected to have much impact on pollutant loads or habitat.

4.4.3 US Fish and Wildlife Service Grant

The US Fish and Wildlife Service (USFWS) procured a grant for Wreck Pond to enhance habitat value, particularly fish passage. The $2 million grant is primarily to enhance fish passage and habitat value. The project is still in the planning phase. The priority project at this time is to add an additional outlet structure that will enhance tidal exchange and also allow fluvial flood waters to pass out of the Pond more quickly. The initial cost of the project exceeds the available funds, so additional funding sources are being investigated. If this is not possible, other aquatic habitat or fish passage projects will be investigated.

The project is expected to be completed within the next two to three years in accordance with the terms of the grant.

4.4.4 Water Quality Monitoring

Monmouth County Health Department continues to monitor bathing beach waters for bacteria and to monitor at their Station 14 in the watershed. As needed, NJDEP may conduct additional storm-event monitoring. The monitoring is designed to determine if the Pond outfall is still causing elevated bacteria counts at the bathing beaches.

4.4.5 Living Shoreline and Flood-Control Berm Feasibility Study

The County and NJDEP have provided funds to NA and Leon S. Avakian, Inc. to develop a conceptual plan for a living shoreline and riparian buffer enhancement and a flood control berm along the Wreck Pond Shoreline. The project also includes a study to evaluate the feasibility of the project and any unintended or possible negative impacts. The analysis was completed in fall 2014. It was determined that the shoreline should be raised to 6 feet to eliminate some flooding. However, any additional berm height would require raising the elevation along a large expanse of shoreline, including areas where this may not be feasible. Otherwise, a berm just around the Pond on the Spring Lake and Spring Lake Heights shoreline may increase flood elevations along Black Creek or even in Sea Girt. Thus, this may not be feasible.

For the living shoreline, several areas have been identified as candidates for living shoreline. However, in the areas where the Pond shoreline is currently bulkheaded, it may be difficult to develop a living shoreline that would not require grading into the Pond. It is not clear the extent to which such a plan would be either feasible or permittable. At this time, a pilot project for a Living Shoreline, including shoreline elevation, is planned along Shore Road in Spring Lake pending funding.

4.4.6 Stakeholder Meetings and Education

The watershed has active stakeholders. The Wreck Pond Regional Stormwater Management Planning Committee (RSWMPC) includes NJDEP, County staff and officials, the US Army Corps of Engineers, municipal officials and staff, local residents and other interested parties. In addition to the RSWMPC, an Education sub-committee has been established and remains active in the watershed. The Education Committee, along with NJDEP, has conducted several educational activities including rain barrel workshops and two walking tours of the watershed. The second walking tour included one of the installed rain gardens.

The TAC also conducted workshop meetings in each of the municipalities after the completion of the RSWMP. The RSWMP was presented. The goal was also to get local agreement with the plan.

4.5 PROPOSED PRIORITY PROJECTS

The projects and studies identified above have either been completed or are ongoing. The expected load reductions set long-term goals for pollutant reductions. The management measures in Table 38 set forth projects that will be implemented to meet those goals. However the time-frame for full implementation of those projects varies from a couple of years to more than two decades. Priority projects have been identified as the first steps in ensuring appropriate reductions.

In this watershed, the sources are diffuse and from land use loads. Thus, there are not clear areas of highest priority for implementation. Therefore, the priority projects were developed based on opportunities for projects developed by the TAC, the municipalities, other agencies and other interested parties. These include areas of identified environmental problems or other concerns. The cost, possibility of funding, and the ease of implementation were also considered when developing priority projects.

The following sections highlight a few of the priority projects identified.

4.5.1 Installation of Additional MTDs along Wreck Pond

A grant was received from NJDEP for the design of stormwater manufactured treatment devices (MTDs) on existing stormwater outfalls that discharge directly into Wreck Pond. As noted above, 14 MTDs were previously installed. In addition, 14 more MTDs have been designed to be installed at other outfalls around the Pond and lower tributaries. Table 41 summarizes the proposed Phase 2 MTDs and the acres of land area for which stormwater is captured by each device.

The removal efficiency of these MTDs are up to 80% for TSS and about 40% for total phosphorus, which is associated with the sediment. As shown in Table 38, these are projected to remove about 25.7 pounds of TP and 5.7 tons of TSS per year. Given the high density of homes within the area surrounding the Pond, there are limited options for stormwater management in this area. Thus, due to the treatment afforded by the MTDs and their small footprint, they are a good option for stormwater management in this area.

Table 41: Proposed MTDs	
Outfall No.	**Drainage Area (acres)**
1A	9.39
10B	4.6
14B	7.93
18	75.03
22B	0.15
23	17.6
24B	0.15
24D	5.75
26	0.23
32A	13.41
32B	1.06
32C	6.86
1A	9.39
10B	4.6
TOTAL AREA	**156.15 acres**

As part of the first MTD installation discussed above, engineering plans were developed for 14 additional MTDs at stormwater outfalls to Wreck Pond. Installation of these additional devices would cost approximately $729,000. Given that the design has been completed, the project has high priority.

4.5.2 Wall Township Porous Paving and Stormwater Retrofit

NJDEP has approached Wall Township about repaving the parking lots at the municipal complex with porous pavement. There are about 3.7 acres of parking area at the municipal complex. Figure 14 shows this area. The main parking lot for the municipal building and library contains green islands, but the sports field and other parking lots do not. The project would be a pilot project for the use of porous pavement in other parts of the watershed and in other areas of the state as well.

In conjunction with this, and depending on funding, the existing stormwater management system at the complex could be evaluated and modifications proposed to enhance stormwater management and removal of contaminants. The existing wet pond habitat could be enhanced to upgrade the habitat value.

Figure 14: Wall Township Muncipal Complex Porous Paving and Stomrwater Enhancements

Wall Township has expressed support for this or a similar project. However, funding would need to be secured and design studies undertaken prior to implementation. The implementation goal is within 3 years.

The project would have the added benefit of being a pilot and demonstration project for other porous pavement and basin upgrade projects. Cost estimate is to be determined as it depends on the type of pavement selected and the current status of the pavement at the facility (i.e., whether it needs replacement).

4.5.3 Stream Restoration

Figure 15 shows the stream segments and scores throughout the basin. This value is based on the overall score set by FSCD. Most of the streams were rated as sub-optimal. However, additional investigation of their stream reconnaissance revealed that while streams may be rated sub-optimal overall, the streambank stability and/or streambank vegetation may still be labeled as "poor". Thus, the score for streambank stability was mapped on the GIS.

The mapping revealed that several segments in upper Hannabrand Brook were in the poor range. This area also has publicly owned lands. Thus, segments that overlapped in the "poor stability" and flowed through public lands were selected as priority streams. Table 42 summarizes the segments by the FSCD segment ID. Figure 16 shows these segments which are on County-owned lands near or adjacent to Bel-Aire golf course. In addition, a long segment (hb18) is located across Allaire Road in property owned by Wall Township. This is also shown on Figure 16.

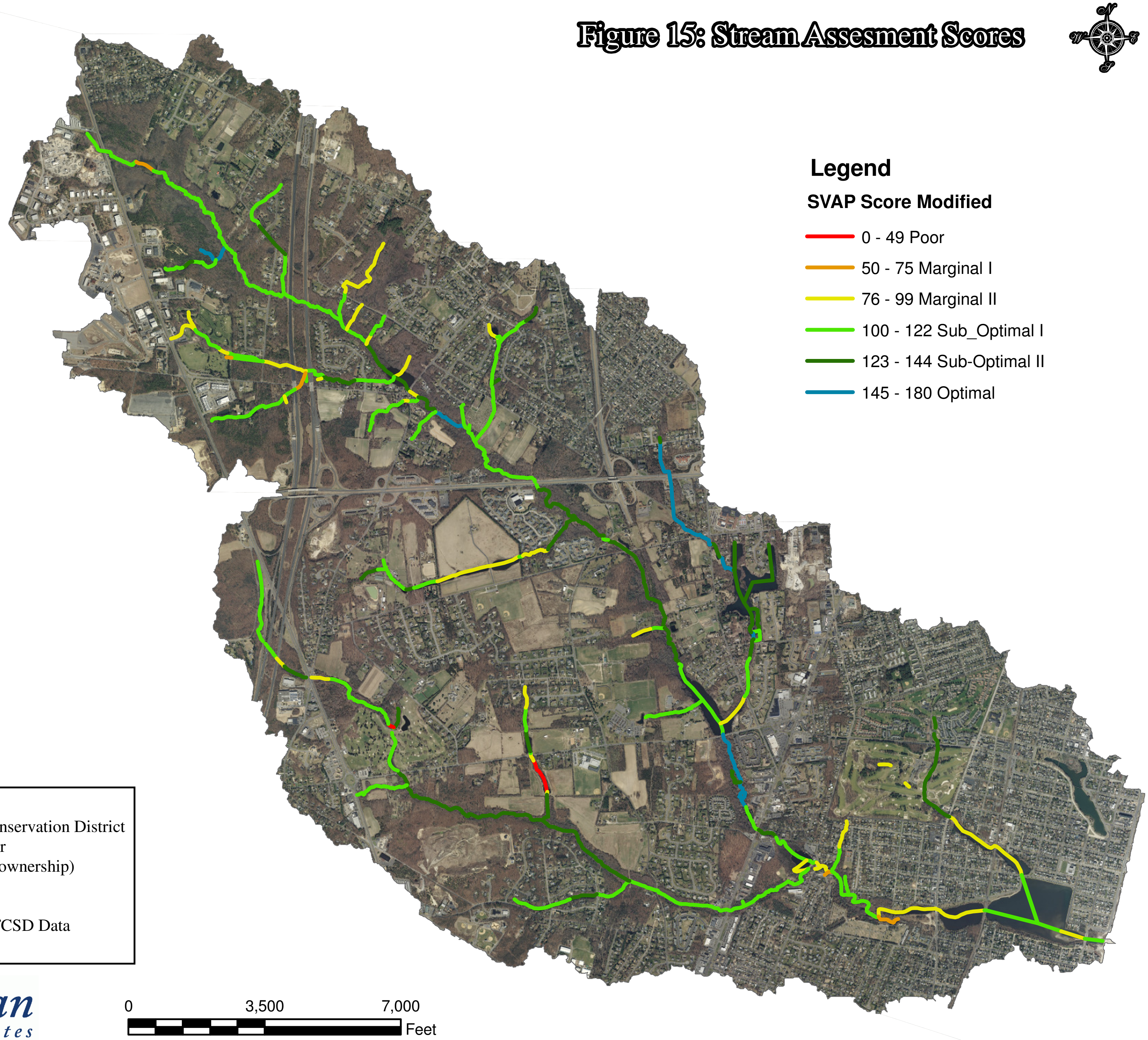
Similarly, segments with low stability scores at the lower end of Hannabrand Brook were found to be within lands owned by Wall Township. These are included in Table 42 and shown on Figure 17.

Stabilization of these segments would serve to reduce sediment and phosphorus loads associated with the bank erosion. The added benefit would be habitat enhancement. In addition, these would have the added benefit of providing pilot projects for green stabilization techniques that could be used to persuade other property owners to undertake similar projects.

The short-term goal would be to restore the segments on the County lands within the next 5 years. This includes about 2,650 linear feet of stream. Cost estimates are provided in Table 38.

The obstacles to implementation will be funding. Further, additional information is needed to evaluate the stream segments and determine the appropriate measures for stabilization. Permits for these proposed projects are anticipated to be issued, with the utilization of green techniques.

Figure 15: Stream Assesment Scores



Sources:
Stream Assessment, Freehold Soil Conservation District
Monmouth County Parcels, GIS Layer
Monmouth County Property Viewer (ownership)
2012 Aerial NJGINS

Map Author: Najarian Assoc, using FCSD Data
1/29/14

Najarian Associates
30 years
The Science of Engineering

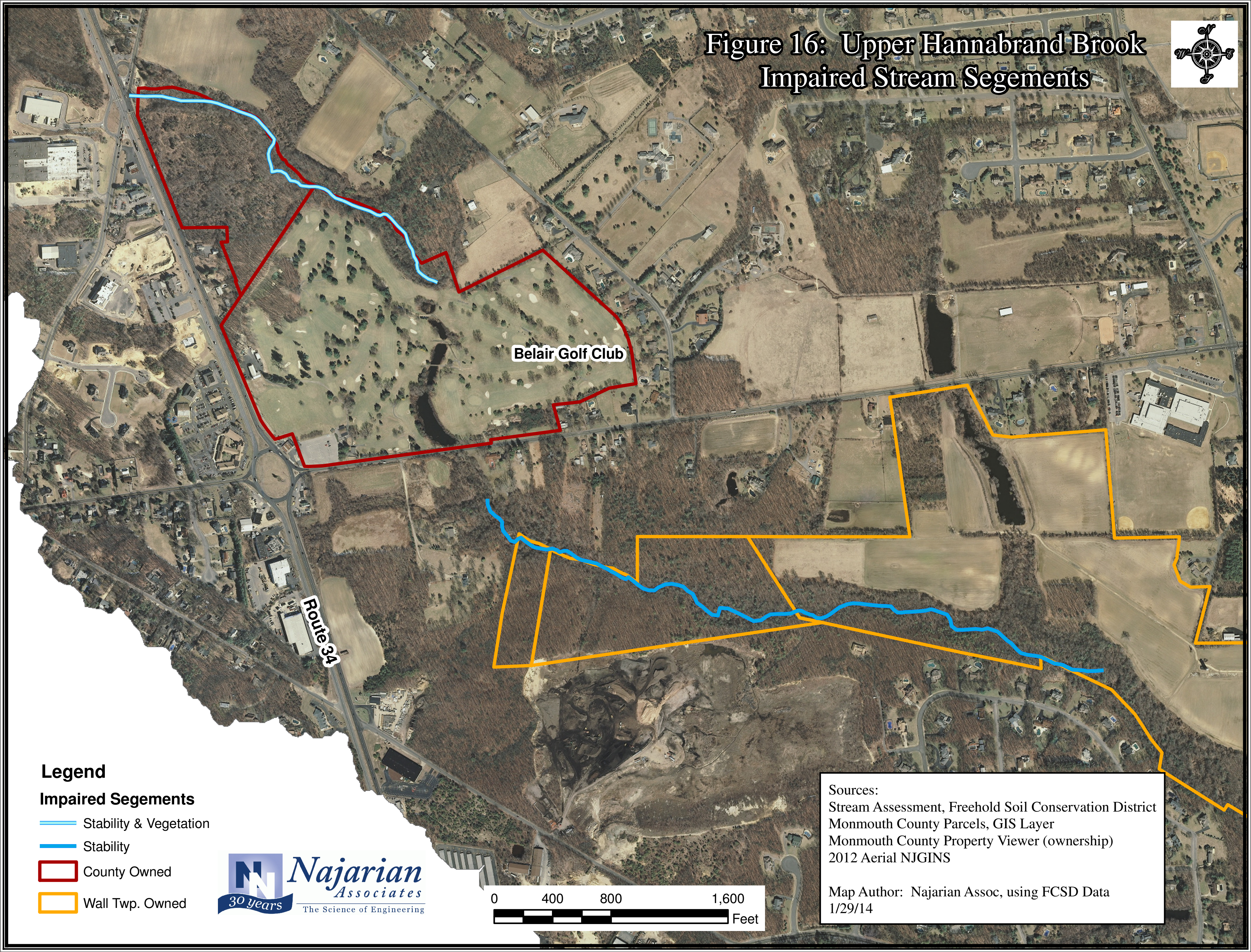


Figure 16: Upper Hannabrand Brook
Impaired Stream Segements
Belair Golf Club
Route 34
Legend
Impaired Segements
Stability & Vegetation
Stability
County Owned
Wall Twp. Owned
Najarian Associates
30 years
The Science of Engineering
0
400
800
1,600
Feet
Sources:
Stream Assessment, Freehold Soil Conservation District
Monmouth County Parcels, GIS Layer
Monmouth County Property Viewer (ownership)
2012 Aerial NJGINS
Map Author: Najarian Assoc, using FCSD Data
1/29/14


Figure 17: Lower Hannabrand Brook
Impaired Stream Segements
Ocean Rd
Old Mill
Pond
Old Mill Rd
Legend
Impaired Segements
Stability & Vegetation
Stability
County Owned
Wall Owned
Sources:
Stream Assessment, Freehold Soil Conservation District
Monmouth County Parcels, GIS Layer
Monmouth County Property Viewer (ownership)
2012 Aerial NJGINS
Map Author: Najarian Assoc, using FCSD Data
1/29/14
Najarian Associates
30 years
The Science of Engineering
0
150
300
600
Feet

Table 42: Stream Restoration Segments						
Segment ID	**Segment Length (ft)**	**Overall Score**	**Existing Streambank Stability**		**Existing Bank Vegetation Protection**	
			Right bank	**Left Bank**	**Right bank**	**Left Bank**
hb07a	1434	100	2	2	4	4
hb07	773	105	6	5	8	8
hb07b	444	96	7	7	4	4
hb18	4916	138	5	5	9	9
hb23	498	101	2	2	6	6
hb24	1701	100	2	2	8	8
wp32a	500*	92	2	2	9	9
wp04	950/3228**	24	2	2	1	1
Total Length: 11,216 linear feet (public lands only)						
*Segment mapped at 817 ft but enters Old Mill Pond at about 500 feet						
**About 950 ft of the 3,228-foot segment is on publicly -owned lands						
Stability Scores: 0-5 Poor, 6-10 Marginal, 11-15 Sub-Optimal, 15-20 Optimal						
Bank Vegetative Protection Scores: 0-2 Poor, 3-5 Marginal, 6-8 Sub-Optimal, 8-10 Optimal						

4.5.4 Osborne Pond

Existing Condition

Osborne Pond (aka Osbornes Mill Pond) is located just east of the municipal complex on Allaire Road. The pond is dammed at Allaire Road. The existing water control structure here is no longer functional. The pond occupies about 22 acres, with additional land area mapped as wetlands. Figure 18 is an aerial of Osborne Pond and the surrounding area. The pond dam is owned by Wall Township.

The 2013 regular dam inspection report labeled the structure as “poor” finding, stating:

> In general, Osbornes Mills Dam is in **POOR** condition and in need of maintenance, repair and long term improvements, which include studies to determine the adequacy and condition of the existing spillway and earthen dam to meet the Dam Safety Standards (French and Parrello, 2013).

The report noted the bulkhead damage as well as downstream slope erosion, partly from road drainage. Further, the low flow outlet appeared to not be operable. A verbal

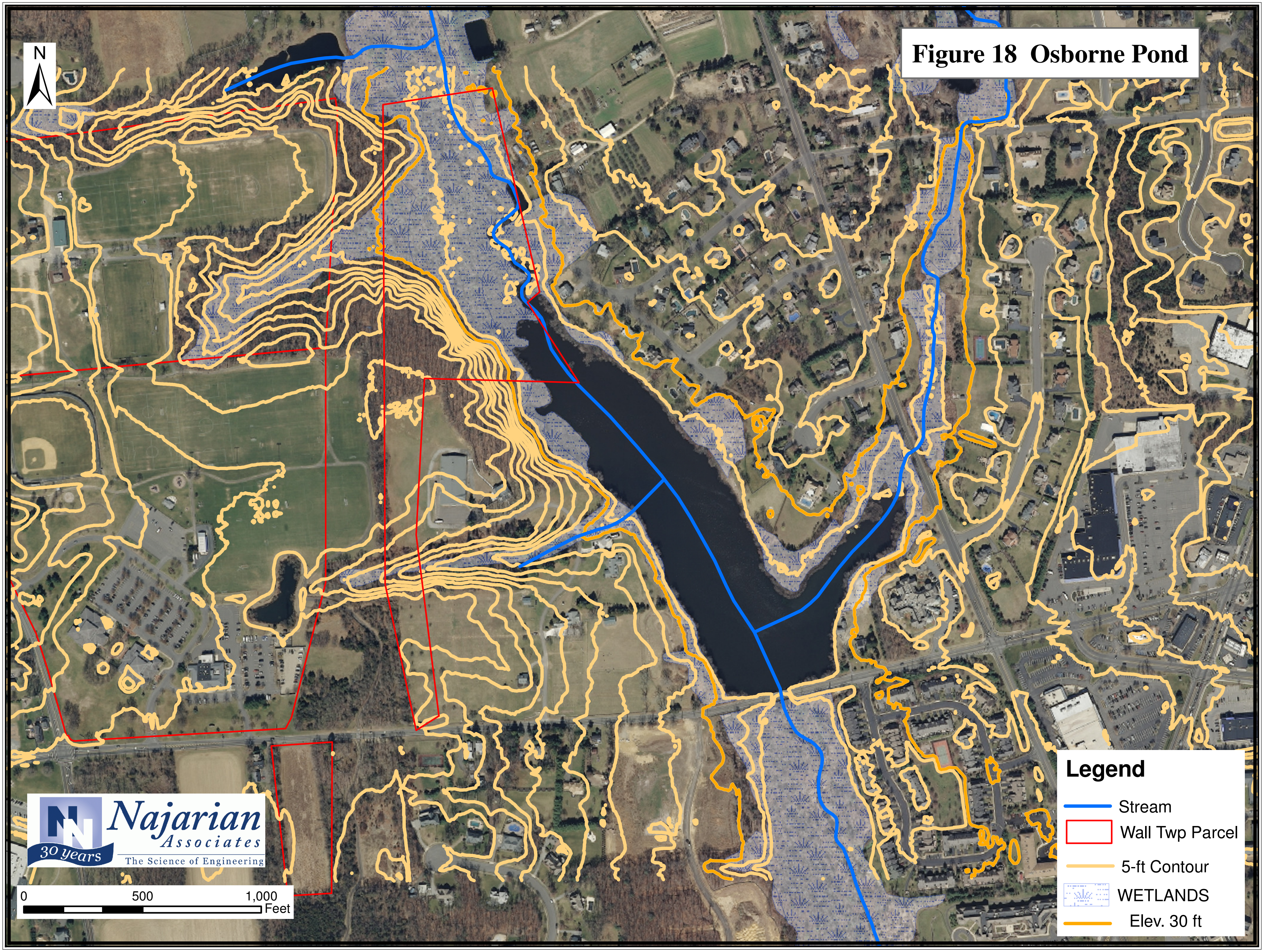


Figure 18 Osborne Pond
N
Legend
Stream
Wall Twp Parcel
5-ft Contour
WETLANDS
Elev. 30 ft
Najarian Associates
30 years
The Science of Engineering
0
500
1,000
Feet

report from the Wall Township engineer indicates that the flow control structure currently in place is no longer operational. This was confirmed by visual inspection.

Wall Township owns a flag lot that adjoins the northwestern end of the pond. Just west of that lot appears to be an easement, from the County parcel viewer, that further south contains the Wall Township bicycle path. West of that, is the municipal complex. The wet pond at the complex discharges to Osborne Pond. Although not shown as a specific stream, the sports fields appear to drain through a wetland area to this pond.

The recent FEMA PFIRM flood maps were updated in 2014, show Osborne Pond and the streams with both a floodway and with an AE flood zone. However, the maps do not give a flood elevation. FEMA indicates that is because detailed hydraulic analyses have not been performed, so no Base Flood Elevations (BFEs) or flood depths are shown. Using the LiDAR (a portmanteau of "light" and "radar") elevation data, the AE Zone boundary appears to coincide with around elevation 30 feet NVD88. However, the NJDEP supplemental flood study map shows the elevation several feet lower at about 26 feet NGVD29. On the eastern shoreline, there are some homes that appear to be within or just outside of the FEMA flood zone, but which are not in this zone according the NJDEP mapping. These properties are also mapped as LOMAs (Letter of Map Amendment) on the FEMA GIS layer. Thus, additional information is needed to evaluate the actual flood elevation here. Current NJDEP policy is to use the most restrictive elevation for permitting. On the western shoreline, the pond slopes rather steeply to about 65 feet. Thus, properties on the west side are not within the flood zone.

Proposed Project

As the dam is in need of repair, it may be possible to enhance the dam structure and the entire pond to enhance habitat value, enhance water quality downstream, and increase flood storage. Depending on the actual flood elevations and field conditions, increasing flood storage by modifications to the dam might be possible. Further, installing an outfall system that could allow drawdown of water in the pond prior to a major storm event could provide additional storage capacity to reduce flooding for the local residents, as well as those further downstream.

Several studies are required prior to developing a plan of action. First, detailed studies are required for the dam, associated road and outlet, including a structural analysis of the dam. The flood elevation must be confirmed. The existing environmental conditions within Osborne Pond and the adjacent uplands would be needed to determine the constraints to any modifications in the pond characteristics.

While dam repair is certainly permittable under NJDEP regulations, additional modifications to the Pond would need to be evaluated as to habitat and water quality benefits versus flood event storage impacts.

It is anticipated that this project could be implemented within five years, provided funding could be obtained. The cost estimate is to be determined.

4.5.5 Public Basin Retrofit or Enhancement

Long-term Reduction Estimates: The existing basins are primarily within existing residential communities or at commercial facilities. Using the available data, four basins were found that are publicly owned or operated, all within Wall Township. Three are at schools and one is at the Wall Municipal Complex. The three basins at the schools are dry basins, and two have concrete low flow channels. The municipal complex appears to have a dry basin which flows into a wet pond. These basins may be pilot project locations for these methods, if funding can be obtained. The short-term goal would be to retrofit two basins within the next five years. Cost estimate: $400,000.

4.6 OTHER FUTURE PROJECTS

4.6.1 Public Works Yards Restoration

The Spring Lake Borough Public Works Yard is located along the banks of Black Creek, east of the NJ Transit railroad tracks. The majority of the sub-drainage area drains into roadways, into a stormwater collection system and then into Black Creek. The lower portion of the yard discharges via overland flow to Black Creek. In recent years, the Borough constructed an earthen berm to encourage collection and infiltration of stormwater runoff from this lower portion of the yard.

Similarly, the Spring Lake Heights Public Works Yard is located on the western side of the NJ transit tracks, along the banks of Black Creek. The yard is fairly well contained however, a storm sewer discharge pipe drains into a ditch running between the yard and the tracks and empties directly into Black Creek, a few feet upstream of the culvert under the tracks. Evidence of erosion within the ditch and sediment deposition at the ditch outlet was visible in the past.

Wreck Pond Brook Watershed RSWMP Committee members met with representatives from both municipalities in February 2008 to identify potential locations for the installation of structures to control and mitigate runoff, nutrients and bacteria from both maintenance yards. A project under consideration is the construction of a bio-retention basin at each yard. The basins would provide for filtering of surface runoff, infiltration and controlled discharge to the creek. It is anticipated that nutrient and sediment loads delivered to the creek from these sites may be significantly reduced. Considerations include space needed to construct basins of sufficient size and the grading required to direct runoff to the basins. Other options may also be considered to manage the stormwater.

Goal Targeted: *Reduction of sediment load, reduction of nutrient load, reduction of bacteria load.*

Effectiveness: *Locally, high effectiveness. Overall watershed effect will depend on specific measures employed.*

Priority: *High to moderate. Local commitment and support required. Funding required.*

4.6.2 Dredging of Wreck Pond

Dredging of Wreck Pond, including the ponded portion of Black Creek, is a priority. Removal of the sediment in the Pond would reduce the muck and improve the overall water quality. This would enhance the opportunities to meet the aquatic life and recreation designated uses, which would better allow the public to use the Pond. Removal of pond sediments may also reduce nutrient and bacteria levels in the Pond.

Constraints to implementation of this measure are primarily cost and logistics. Additional investigation may be needed to determine if there is a more cost-effective way to dredge the pond.

Goal Targeted: *Enhance Pond ecology, meet aquatic life and primary and secondary recreation designated uses, enhance Pond aesthetics, and increase pond storage volume in conjunction with outfall modifications and a new outfall structure.*

Effectiveness: *Highly effective for reduction of sediment; may help with storage volume depending on operation of outfall.*

Priority: *High for achieving goal of removing sediment and increasing possible storage but low due to cost, and significant operational constraints that must be overcome to implement this project, thus giving it a lower likelihood of success.*

4.6.3 Dredging of Other Ponds

Water quality data and modeling efforts within the watershed demonstrate the importance of many of the ponds in regulating flows and allowing settling of sediment and associated water pollutants. Some ponds are known to contain significant quantities of sediment and are in need of dredging. Shoreline improvements and modifications, including the use of wetland plantings, would be introduced where needed in order to maintain/improve habitat, reduce geese populations and improve water quality features. The following projects were recommended by the Committee.

i) Dredge and restore Old Mill Pond in Wall Township to improve habitat and provide better stormwater management functions. Removal of sediments and outlet modification will be needed to increase stormwater flood control and enable future maintenance.

ii) Dredge and restore the impounded portion of Black Creek (aka North Branch of Wreck Pond) in its entirety between Route 71 and Ocean Road in Spring Lake and in the segment just west of the Route 71 Bridge.

iii) Dredge and restoration of Hurley's Pond, at Hurley's Pond Road. The pond is privately owned. It would require dredging from an existing average depth of about 2.5 feet to possibly 6 feet. The outlet weir under the road may also require modification.

As with the dredging of Wreck Pond, the anticipated cost and identification of management and disposal options are impediments to implementation.

Goal Targeted: *Enhance ecology of individual ponds, meet aquatic life and primary and secondary recreation designated uses, enhance pond aesthetics, possibly reduce flooding by allowing additional storage in ponds, reduce loadings of sediment to Wreck Pond.*

Effectiveness: *Highly effective.*

Priority: *High for achieving goal, but low due to cost, and significant constraints that must be overcome to implement this project, thus giving it a lower likelihood of success.*

4.6.4 Rain Gardens and Rain Barrels

Rutgers Cooperative Extension successfully developed rain gardens within the watershed as demonstration projects, at publicly owned properties. Expansion of this project would include other public locations as well as individual homeowners. The projects could be integrated with the stormwater facilities projects in some cases to further enhance stormwater management. The project could also be expanded to include rain barrels for public use. This project would also be part of the public education component.

Goal Targeted: *Reduction of sediment load and pollutant loads.*

Effectiveness: *Effectiveness depends on the number of rain gardens implemented.*

Priority: *Moderate. Rain gardens and rain barrels are easy and inexpensive to implement. However, a large number of homeowners would be required to participate to provide improvements at the watershed level.*

5 ELEMENT D: TECHNICAL AND FINANCIAL ASSISTANCE

5.1 COSTS

Table 43 summarizes the estimated costs of implementation of the proposed management measures and provides some possible funding sources for each project. The total estimated capital cost for the structure projects is $16.355 million. Additional costs of up to 10% of that figure could be expended for planning purposes. Additional planning and design work is required to evaluate the various BMP options, locate project sites, negotiate with property owners and obtain funding. Thus, the actual cost is likely closer to $18 million.

This cost does not include the cost of certain measures identified in Table 38, as these may be borne by the individual property owner. For example, installation of porous paving is most likely to be implemented on a site that needs re-paving. Thus, there would be a cost associated with paving that the property owner would be subject to with or without the BMP measure. The cost will depend on the type of pavement selected by the property owner.

Cost of additional operational measures including low P fertilizer on managed open space and homes will not be an additional project cost because these fertilizers will substitute for high P fertilizer and the cost will be borne by the property owner. Costs of increased municipal or farm maintenance projects cannot be determined at this time.

Table 43 also does not estimate other costs to implement the management plan, including planning. These costs are expected to be primarily in-kind services from NJDEP and the County. The US Army Corps study may also provide information to close some data gaps.

Additional data is needed to develop a comprehensive plan to reduce bacteria loadings. As noted, this is a data gap that requires additional monitoring to:

- Determine the level of bacteria and the level of violation based on the indicator bacteria currently used in the standard;
- Conduct additional source tracking to determine if the indicator bacteria indicate a human source;
- Using that data, determine the necessary reduction in bacteria loadings.

Funding will also be required for future monitoring in the watershed. Monitoring will be required to evaluate the actual efficacy of the installed BMPs. The Army Corps study is

Table 43: Funding and Schedule (costs from Table 38)			
Proposed Management Measure	**Estimated Cost**	**Possible Funding Sources**	**Schedule**
Agricultural Nutrient Management	$9,100 per yr	NJDEP, NJ Dept of Ag, Natural Resource Conservation Service (NRCS) , farmers	20% implementation every 5 years
Other Agricultural Measures	Depends on measure	NJDEP, NJ Dept of Ag, NRCS, famers	20% of farms to implement measures
Stream Restoration	$7 million	NJDEP, CWA Section 319(h) funds, USFWS, NRCS, County, Army Corps	One mile of stream resorted every five years
Pervious Pavement	$0 to $30 million over regular paving cost	Private property owners, municipalities, 319(h) grant, NRCS	Pilot project within 2 year; 10% re-paved every 3 years
Low P Fertilizer	Comparable to existing fertilizer	Property Owners	As per State fertilizer law
Wreck Pond Shoreline Stabilization/Riparian Zone	$2.4 million**	NJDEP Pilot Project Funding, 319(h) grants, USFW	Pilot project within 2 years; remainder within 7 years
Other Vegetative Filers/Riparian Zone Enhancement	$705,000*	NJDEP Pilot Project Funding, 319(h) grants, USFW	Enhancement of xx acres within 5 years
Enhanced Municipal Operations	To be determined	Municipal funds	Measures to be employed within 5 yr
MTDS – Installed in 2010	Completed	NJDEP 319(h)	Completed
MTDS – Proposed	$800,000	NJDEP 319(h)	Within 5 years
MTDs – Future	$1.7 million	NJDEP 319(h)	15 years
Stormwater Management Basin Upgrades	$3.75 million	NJDEP 319(h)	
Sanitary Sewer Repairs[3]		*Local Funds*	
Spring Lake Golf Club and Route 71 Culvert	$200,000 from State with additional funds from Club	CBT Funds and Golf Club funding	Completed
Wreck Pond Outfall Modifications		FEMA	In progress

Table 43: Funding and Schedule (continued)			
Proposed Management Measure	**Estimated Cost**	**Funding Sources**	**Schedule**
US Army Corps		US Army Corps	In progress, completion 2016
USFWS Grant	$2 million	USFWS	2015-2016
Outfall modifications		USFWS, other federal funds, local funds, NJDEP	If covered by USFWS grant, 2015; otherwise within 10 years
Black Creek Dredging and Enhancements	To be determined	NJDEP, USFWS, US Army Corps	15 years
Wreck Pond Dredging	$15 million	US Army Corps, NJDEP	15 years

*Cost does not include flood control berm

expected to update the water quality data throughout the watershed. Further, if changes are made to the Pond outfall and tidal exchange for the Army Corps or under the existing USFWS Grant, monitoring would be required to determine impacts on water quality.

5.2 TECHNICAL AND INSTITUTIONAL SUPPORT

The Wreck Pond Watershed has a high level of local and institutional support. Improvement to the Pond environment, elimination of beach closings, and reduction in flooding are the key issues of concern.

The Pond and associated projects currently receive support from local entities as well as ongoing work by the US Army Corps of Engineers, the US Fish and Wildlife Service, the NJDEP, Monmouth County, Rutgers Cooperative Extension, Freehold Soil Conservation District, municipalities, local residents and consultants. Monmouth University, NJ Department of Agriculture, and Clean Ocean Action have been involved in the past as well. The project has also gained support of state and federal representatives of the area.

While support has been high, securing the necessary funding has been challenging. Thus, several projects are awaiting funding and/or implementation.

Approval of this document by NJDEP will allow the watershed to be eligible for funding under CWA Section 319(h), which is a federal pass-through, competitive grant funding program for watershed restoration projects.

The US Army Corps feasibility study will determine if restoration projects in the watershed will be eligible for federal funds. Those projects will then go to Congress for authorization bills or be funded by Army Corps funds. Most projects will also require a local or regional matching funding. The feasibility study is expected to be completed in 2016.

The County has committed to additional small dredging projects in the Pond.

Local funds may come from the municipalities, foundations, or other private sources. Individual property owners or farmers may be requested to implement management measures or to provide access or land area to implement management measures.

The watershed also has significant local support from residents. Although much of the support is for flood mitigation, locals also support improvements to the Pond quality and recreational benefit.

5.3 DATA GAPS

As discussed previously, the primary data gap is for bacteria. The past data do not evaluate bacteria levels based on current standards. Also, source tracking is needed to determine if the indicator bacteria infer human health risk,

A further missing piece of critical information is related to the tidal exchange between the Pond and the Ocean. However, as part of the US Army Corps study and studies for the NFWF grant, tidal data were collected in the Pond and Ocean during the summer of 2014. The data will be used in modeling of the Pond and Ocean tidal interactions. Once fully analyzed and modeled, the Army Corps study should resolve this data gap.

Overall, data need to be updated to further define loads for all pollutants. The US Army Corps study is expected to fill a good part of these gaps.

6 ELEMENT E: INFORMATION AND EDUCATIONAL COMPONENT

The Wreck Pond RSWMP Committee has been meeting monthly since about 2005, as discussed above. The Committee will continue to meet and the agencies and TAC members will continue to update the Committee on the progress of projects within the watershed. The Committee will continue to have a role in setting priorities and selecting projects that will be implemented.

NJDEP maintains a website for the watershed at http://www.nj.gov/dep/wreckpond/. The website provides copies of the technical reports that have been prepared and other information. The website also includes an interactive data map that allows the public to view and download the monitoring data that has been collected.

Based on the findings of this study, other educational initiatives to be implemented include:

- US Army Corps of Engineers will conduct a public meeting regarding the Corps' Feasibly Study
- Enhancement of the web site to provide information on land use loading and the role of homeowners and business owners in generating nonpoint source pollutants.
- Provide information to local residents, business owners, and municipalities regarding projects that will involve private property owners, including porous paving and modifying stormwater basins.
- Solicit municipal and public opinion on proposed projects.

Other educational programs will be implemented as needed or appropriate.

7 ELEMENT F: SCHEDULE

Table 36 provides a list of probable management measures that will need to be implemented over the long-term to reach the pollutant reduction loads needed to meet the water quality standards in the watershed. Implementation of these measures is expected to take 25 years or more to complete. Table 43 summarizes these and other projects proposed in the watershed along with an anticipated schedule. The primary factor in implementing these projects is available funding. Lack of funding will slow the schedule.

The short-term schedule over the next few years can be summarized:

1. Living Shoreline and Berm Conceptual Plan and Feasibility Study

   The feasibility study was completed in fall 2014. The analysis identified areas in which a living shoreline is most feasible. It also determined that an increase in elevation at low spots around Wreck Pond is feasible to 6 feet, but any additional increase could have the potential to cause flooding in other areas. Similarly, development of a living shoreline will be more challenging along the portions of the Pond shoreline that are bulkheaded.

2. US Fish and Wildlife Service Grant

   This grant will be implemented within 2 years of the start date, currently estimated by 2016. The primary purpose of the grant is to improve fisheries by increasing aquatic connectivity, to include flood abatement measures if possible. The current plan is to develop a secondary outfall structure at an elevation that will promote fish passage as well as increased opportunity for flood flow discharge. The project is in the design phase.

3. US Army Corps of Engineers Feasibility Study

   This study is expected be completed by 2016 and will set the stage for obtaining large-scale Federal funds, if found to have a positive benefit to cost ratio in the study.

Other short-term projects within the next five years:

- Living Shoreline/Maritime Forest: Depending on funding and local support, a living shoreline will be constructed within Wreck Pond. Unless found to be infeasible due to environmental conditions, it is expected that the first pilot project location will be along Shore Road, if the anticipated funding is secured.

- Installation of the Phase 2 MTDs along Wreck Pond

- Development and completion of a porous paving project at the Wall Township Municipal Complex.

- Retrofit of one dry detention basin at a public facility to provide a higher level of water quality treatment.

- Restoration, including feasibility analysis, design and implementation for the restoration of about 2,650 linear feet of stream banks.

8 ELEMENT G: INTERIM MEASURABLE MILESTONES

The implementation milestones are presented in Table 43, which indicates the schedule for the management measures. Milestones are also noted in the projects completed and currently under way, which show continuing progress in the watershed.

The completion of major projects, such as the outfall modifications or the work under the USFWS grant will provide clear milestones for progress. The criteria outlined under Element H will also provide a means of measuring progress.

9 ELEMENT H: CRITERIA FOR PROGRESS

The primary goal of the loading reductions is to meet the surface water quality standards and thus achieve the full designated uses of the waters. Therefore, the water quality standards are the appropriate measures for evaluation of progress with the final goal being delisting from the 303(d) List. Ambient and storm monitoring within the Pond, the beaches and tributaries will be employed to determine the effectiveness of the measures already implemented as funding allows. Progress towards use attainment will be measured by reduction in standard exceedances.

The US Army Corps study is expected to include monitoring, which should provide a new baseline of water quality 9 to 10 years after the initial monitoring was completed. This will determine if progress has been made and identify any other pollutants of concern.

If after implementation of a significant number of measures in a sub-watershed, progress is not revealed by water quality monitoring, the overall water quality and source of any impairment will have to be reviewed. It may be that the measures employed were not designed appropriately to reduce the load. However, it may also be that the load cannot be sufficiently reduced by BMPs due to natural conditions or other sources, or that more time is needed to show water quality improvement through monitoring.

Progress will also be measured by acres of habitat enhancement and increasing fish stocks and aquatic biota.

An additional criterion is to eliminate beach closings. Removal of the provisional beach closing requirement and ongoing monitoring at the beach will determine compliance.

The Plan should be re-examined in five to ten years to evaluate progress and review any new data or conditions in the watershed. If necessary, the proposed load reductions and proposed BMPs will be adjusted as needed.

10 ELEMENT I: MONITORING

Monitoring is essential to determining attainment of the water quality standards. The Pond was monitored for a year between 2005 and 2006. Additional monitoring since that time has primarily focused on bacteria counts in and around the Pond and at the beach. Some additional ambient monitoring has been done by MCHD. The US ACE Feasibility study is expected to include a monitoring component which will update the water quality data on the Pond and tributaries close to 10 years later. The results may allow adjustment of the loading reductions and/or BMPs proposed herein.

Monitoring at the beach will continue under the Cooperative Coastal Monitoring Program by Monmouth County Health Department. This monitors bacteria levels at bathing beaches between Memorial Day and Labor Day. Future watershed monitoring will include the occasional water quality samples by the USGS and efforts by NJDEP and others, including MCHD. Funding will dictate the extent of monitoring possible.

For each initial project, a monitoring component will be included as feasible and fundable.

11 CONCLUSIONS

This Watershed Restoration Plan provides the framework to implement projects that will reduce pollutant loadings in the Wreck Pond Watershed. The overall goals of the plan are:

- Reduce loadings so that phosphorus concentrations meet the applicable water quality standards
- Eliminate beach closings due to Wreck Pond outflow
- Achieve an acceptable level of bacteria in Wreck Pond and eliminate any human sources to the extent feasible
- Improve the overall pond ecology to a healthy condition
- Enhance tidal flushing
- Improve fish passage and overall aquatic populations
- Improve water quality and habitat in other streams and ponds throughout the watershed
- Control flooding

The short-term priority projects and long-term reduction actions are expected to achieve these overall goals. The major obstacles are funding and the complexity of implementing nonpoint source BMPs in a developed watershed.

The interim goals and priority projects will provide milestones to ensure progress is being made.

The involvement of the US Army Corps of Engineers is expected to generate additional water quality data in the Pond, propose more restoration projects, and possibly enable receipt of additional federal funds. The USFWS grant is expected to result in a new outfall structure that will benefit habitat value and water quality in the Pond.

The plan should also be revisited after five to ten years to assess progress and modify planning, especially after implementation of any major projects. However, the opportunity for this will again depend on availability of funding and on funding priorities.

The watershed has an active partnership among agencies, municipalities and citizens committed to restoring Wreck Pond and its tributaries and reducing flooding. With the inclusion of additional funding and support, progress toward these goals is anticipated.