1 INTRODUCTION

The Wreck Pond Brook Regional Stormwater Management Plan (WPBRSWMP) has been developed to address stormwater quantity and quality concerns within the watershed. The Plan has been developed in accordance with Subchapter 3 (Regional Stormwater Management Planning) of the New Jersey Department of Environmental Protection (NJDEP) Stormwater Management regulations (NJAC 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 Plan 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. This document is Book 1 of the RSWMP and 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.

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 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.

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 waters, 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. NJDEP also provided funds for goose management efforts.

NJDEP also provided financing for 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) Soil Conservation Committee, the Freehold Soil Conservation District, 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.

MCPB staff then developed a Scope of Work and an operating budget for the project. NJDEP approved the Scope of Work in April 2004 and asked that the project be

completed in two years. The MCPB agreed to the project time frame. Two meetings between MCPB staff and the municipalities in the watershed were held in May and June of 2004 and an initial meeting of a proposed RSWMP Committee was held in August 2004.

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.

1.1 Lead Planning Agency and Authority

The RSWMP Committee initiated its work as set out in the approved Scope of Work in August of 2004. The Monmouth County Planning Board was selected by the RSWMP Committee to act as the Lead Planning Agency for the project at their regular meeting of June 2005 and the Monmouth County Planning Board agreed by Resolution to serve as Lead Planning Agency on June, 20, 2005. The RSWMP Committee's authority to select a lead planning agency was granted to it by the State of New Jersey under N.J.A.C. 7:8-3.2 et seq. A request to recognize the Wreck Pond Brook RSWMP Committee was mailed to NJDEP on June 24, 2005 and subsequently approved.

1.2 Purpose and Goals

This Wreck Pond Brook RSWMP is designed to meet the requirements for a regional stormwater plan in accordance with under NJAC 7:8-3. According to that regulation "A Regional Stormwater Management Plan shall address stormwater-related water quality, ground water recharge and/or water quantity impacts of new and existing land uses in a Regional Stormwater Management Planning Area."

The overall goal of this management plan is to improve the water quality of the ponds and streams within the watershed, to reduce watershed loadings of pollutants associated with current and future land uses, to reduce flooding, and to eliminate or greatly reduce beach closings from the discharge from Wreck Pond to the Atlantic Ocean. The Plan is to develop workable solutions that can be implemented by the municipalities and standards that may be employed in review of new projects. The Plan also will be reviewed and updated as needed to ensure it continues to be responsive to changing watershed conditions.

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. 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.

1.3 Partners and Committees

Monmouth County Planning Board has been the lead agency for this project under the leadership of Tom Kellers and then Turner Shell. 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. As noted, the RSWMP Committee has been meeting regularly, with over sixty members including those on the TAC, municipal officials and staff, as well as other interested parties, including local residents.

Agencies, institutions and firms represented on the TAC or the Stormwater Committee include Monmouth County Office of GIS, Monmouth County Engineering, NJDEP, Division of Watershed Management, NJ Department of Agriculture, Rutgers Cooperative Extension, Freehold Soil Conservation District, Monmouth University, Najarian Associates, US Fish and Wildlife Service, Monmouth County Health Department, NJDEP Marine Water Monitoring, and the Municipalities.

1.4 Scope

The project scope is to provide a Regional Stormwater Management Plan that characterizes the watershed, identifies stormwater related problems, proposes solutions to those problems, conforms to regulatory requirements and provides guidance to regional and local stakeholders. The Plan includes overall watershed characterization, stream assessments, agricultural land analysis, water quality data collection and analysis, watershed land use review, build-out land use analysis, hydrologic and hydraulic modeling, watershed water quality modeling and a bacteria source tracking study. The results of these studies have been synthesized to focus areas of concern and to develop management measures and restoration options within the watershed.

NJDEP provided ongoing guidance in the Plan development process. The Plan includes several elements undertaken by the County and the study partners. These elements are discussed in detail within the body of this report.

- Monmouth County Planning Board: Overall study coordination, identification of areas of concern, proposed mitigation measures

- Monmouth County staff, in particular the GIS Office, assessed the preliminary data and support with the County GIS system. The GIS data was then used to develop GIS thematic layers unique to the Wreck Pond Brook Watershed. The GIS data were used by the other partners in preparing their studies and to identify management and restoration options for the watershed.

- Monmouth County Staff: Collection of weekly water quality data

- NJ Department of Agriculture, State Soil Conservation Committee: Measured stream flow and analyzed stream and watershed runoff characteristics in order to develop stream flow models and comprehensive watershed runoff models. These models were designed to assess they hydrologic condition of the watershed and assist in the development of management recommendations for land and water resources.

- Freehold Soil Conservation District: Conducted stream assessments along the streams and tributaries within the watershed.

- Monmouth University: Microbial Source Tracking Study: Employed the Multiple Antibiotic Resistance technique to attempt to identify the sources of bacteria in samples taken from Wreck Pond and other watershed waters along with collection of water quality data.

- Rutgers Cooperative Extension: Surveyed agricultural and recreational lands within the watershed for pollutant generation sources. Conducted water quality and soils monitoring, analyzed current management techniques and proposed management recommendations.

- Najarian Associates: The County contracted with Najarian Associates (NA) to coordinate the plan document, including detailed analysis of the County water quality data, development of the watershed characterization portion of the Plan and writing of the report based on technical studies, field investigations and data from the County and other study partners. The watershed characterization included the synthesis and mapping of GIS data from the MC Office of GIS and NJDEP as well as other watershed information. NA also participated in watershed modeling and conducted surveying of stream sections.

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.

1.5 Introduction to Book 1

This volume is Book 1 of the Regional Stormwater Management Plan. It presents the General Watershed Characterization as well as results from various technical studies conducted for the watershed. These include Stream Assessments, Microbial Source Tracking, Water Quality Monitoring, Hydrologic and Hydraulic Modeling and Watershed Hydrologic and Water Quality Modeling.

2 WATERSHED CHARACTERIZATION

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 Black Creek. Numerous ponds are found within the watershed.

The watershed characterization is based primarily on existing data. Much of the data was provided by the MCOOGIS office as data layers from the GIS mapping. Additional data was taken from the NJDEP GIS data layers. Other available local data was used including NJDEP, USGS, Freehold Soils, EPA, County and other reports.

The characterization also includes technical studies done for this project. These are discussed in separate sections, below.

2.1 Location and Jurisdictional Boundaries

The watershed is located entirely within Monmouth County and NJDEP Watershed Management Area No. 12. Four municipalities are included in the watershed, as noted on Figure 1. Wall Township comprises about 84% of the watershed, or ±6890 acres. Table 1 summarizes the acreage within each municipality.

Table 1: Jurisdictional Boundaries

Municipality	Area (Acres)	Percent of Watershed
Wall Township	6890	84%
Spring Lake Borough	407	5%
Spring Lake Heights Borough	736	9%
Sea Girt Borough	139	2%
TOTAL	8172	

2.2 Topography

The watershed varies from essentially flat around Wreck Pond, to gently rolling to the west. Figure 2 shows the general topography of the watershed. Elevations vary from about 155 feet in the northwestern portion, to just above sea level at Wreck Pond. Slopes are generally mild, but are steeper in the upper watershed, particularly along the

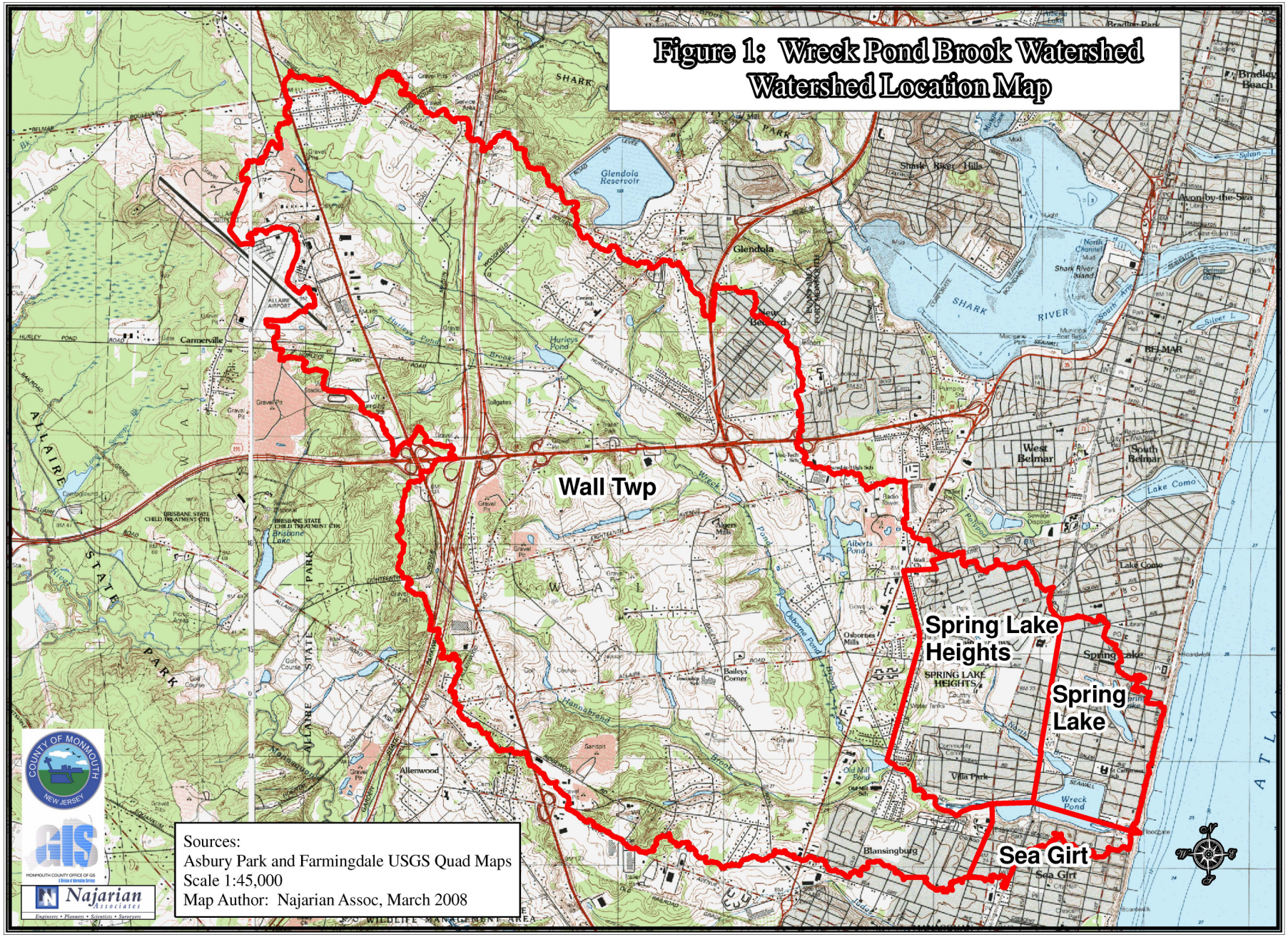


Figure 1: Wreck Pond Brook Watershed
Watershed Location Map
Wall Twp
Spring Lake Heights
Spring Lake
Sea Girt
Sources:
Asbury Park and Farmingdale USGS Quad Maps
Scale 1:45,000
Map Author: Najarian Assoc, March 2008
Najarian Associates
Engineers • Planners • Scientists • Surveyors
COUNTY OF MONMOUTH NEW JERSEY
GIS
MONMOUTH COUNTY OFFICE OF GIS

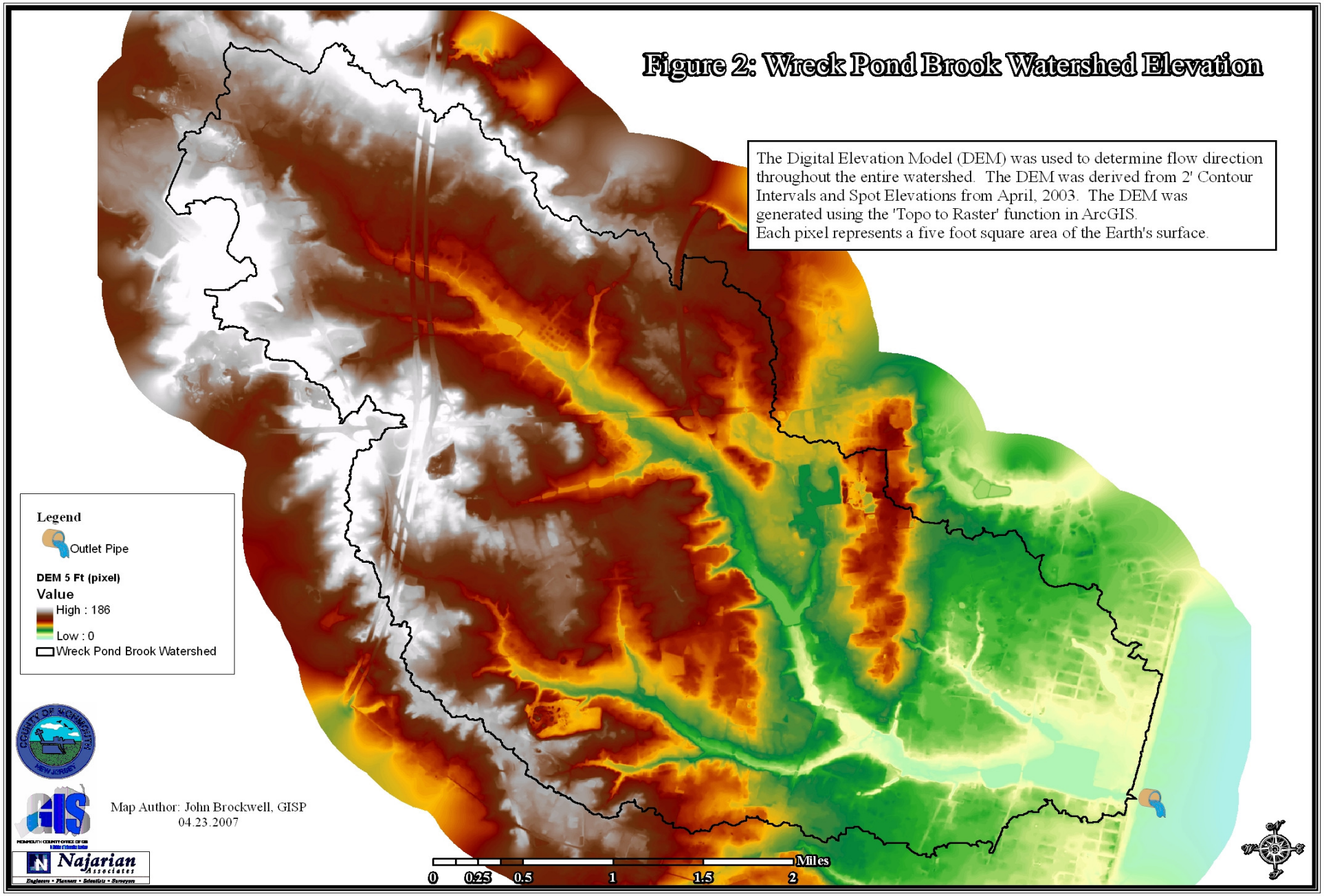


Figure 2: Wreck Pond Brook Watershed Elevation
The Digital Elevation Model (DEM) was used to determine flow direction throughout the entire watershed. The DEM was derived from 2' Contour Intervals and Spot Elevations from April, 2003. The DEM was generated using the 'Topo to Raster' function in ArcGIS.
Each pixel represents a five foot square area of the Earth's surface.
Legend
Outlet Pipe
DEM 5 Ft (pixel)
Value
High : 186
Low : 0
Wreck Pond Brook Watershed
Map Author: John Brockwell, GISP
04.23.2007
Najarian Associates
0
0.25
0.5
1
1.5
2
Miles

stream corridors. Manmade steeper slopes are located in the remnant sand and gravel mines in Wall Township. However, the watershed generally contains slopes less than 15%.

2.3 Geology and Hydrogeology

The Wreck Pond watershed is located within the New Jersey Coastal Plain physiographic province. The Coastal Plain consists of unconsolidated sand and gravel formations inter-layered with clayey materials. The sand and gravel layers generally are good water-bearing zones or aquifers. According to the NJ Geologic Survey mapping, the site is underlain by the Cohansey formation and the lower member of the Kirkwood Formation (see Figure 3).

The Cohansey sand is a medium to coarse grained quartz sand with "minor amounts of pebbly sand, fine- to coarse-grained sand, silty and clayey sand and inter-bedded clay (USGS, 1989). Locally, there can be relatively thick clay beds. The Kirkwood formation is variable, with thick clay beds along the coast and inter-bedded gravels and sands. Together, these two formations form the Kirkwood-Cohansey aquifer. This aquifer is predominately a water-table aquifer.

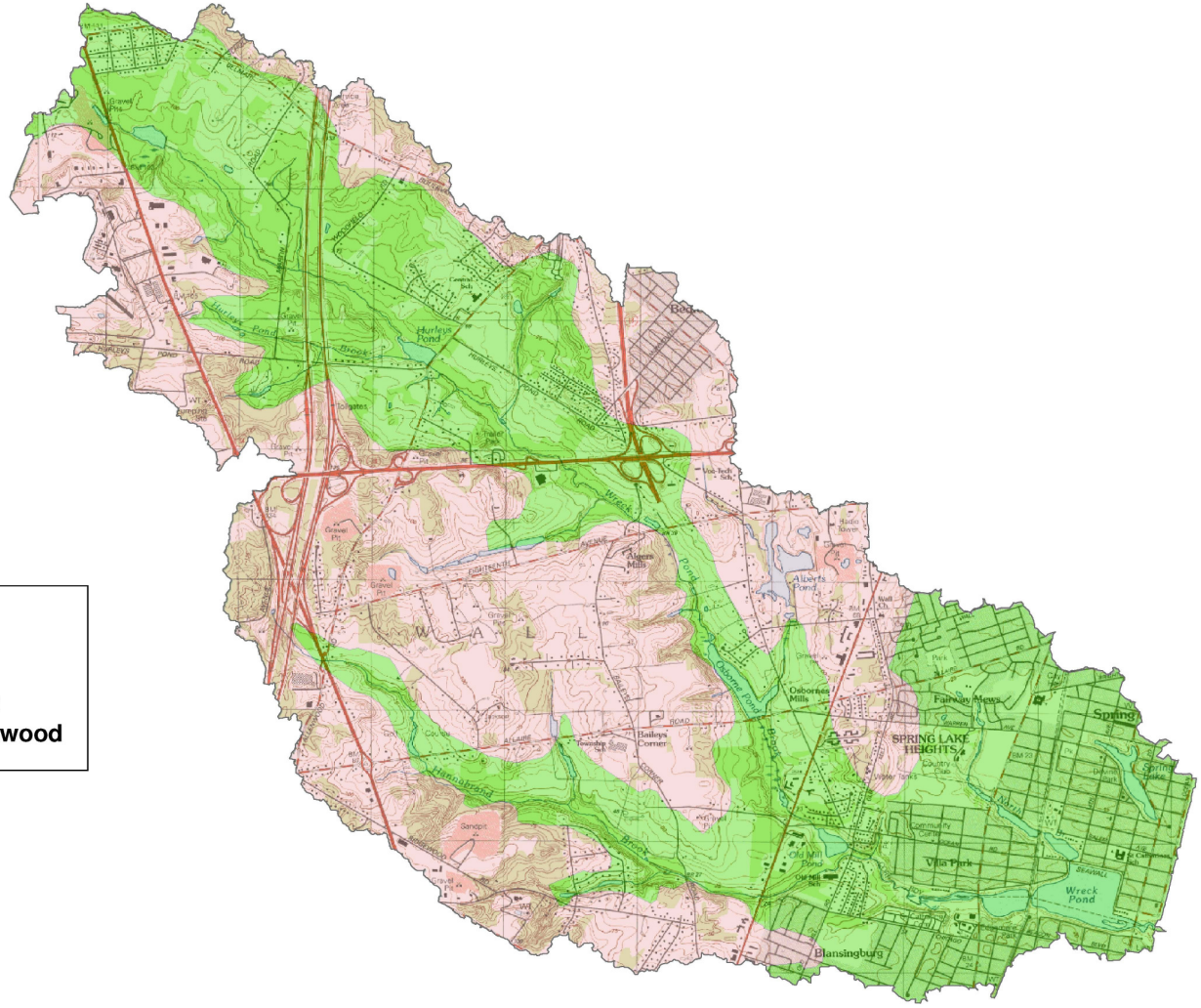
Ground water aquifers are also present at depth in the watershed. The Upper Aquifer of the Potomac-Raritan-Magothy formation is about 1000 feet below sea level in the vicinity of Spring Lake Heights. Overlying this aquifer are the Englishtown Aquifer and the relatively thin Mount Laurel-Wenonah Aquifer. These aquifers are under confined conditions, with various confining beds present.

The deeper aquifers provide water supply within the watershed. Figure 4 provides locations of the public water supply wells within the watershed as provided by NJDEP GIS data. Table 2 summarizes the information on these wells.

According to the GIS layer, most of these wells are within the Englishtown aquifer. The average depth of these wells is about 706 feet. One well is listed as finished in the Mount Laurel-Wenonah Aquifer and is about 564 feet deep. The wells in the Mobile Home park are shallower, at about 75 feet deep, and are in the Kirkwood-Cohansey aquifer. The average pumping rate of the wells are 464 gpm for the Englishtown wells and 12.5 gm for the Kirkwood-Cohansey wells, while the pumping rate for the well in the Mt. Laurel-Wenonah well is 200 gpm.

Each public supply well has a calculated wellhead protection area. Currently, NJDEP regulates certain development within wellhead protection areas. Other wells may be present in the watershed that do not supply public community water.

Figure 3: Wreck Pond Brook Watershed Geology



Legend

Geology

- Cohansey Formation
- Lower Member - Kirkwood

Map Author: Najarian Associates
11.09.2007

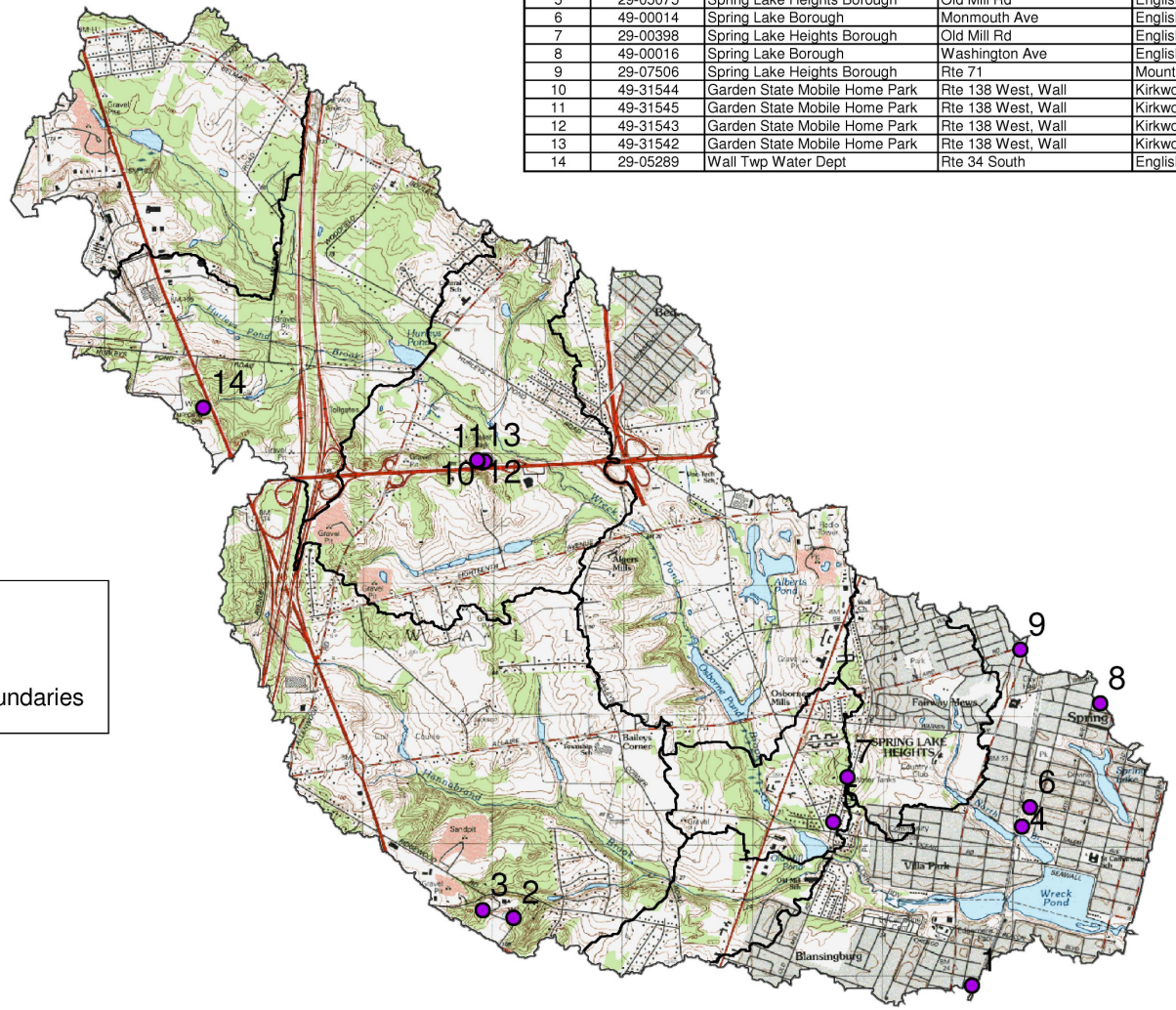
0 0.25 0.5 1 1.5 2 Miles

Table 2: PUBLIC WELL INFORMATION						
Well #	**Well Permit**	**OWNER - Municipality**	**Address**	**Depth**	**Pumping Rate**	**Aquifer**
1	29-04102	Sea Girt Water Dept	Philadelphia & Bell Pl	715	420	Englishtown aquifer
2	29-02869	Wall Twp Water Dept	Atlantic Ave	757.42	400	Englishtown aquifer
3	29-02870	Wall Twp Water Dept	Tilton Corner Rd	728	400	Englishtown aquifer
4	49-00015	Spring Lake Borough	Monmouth Ave	707	500	Englishtown aquifer
5	29-05075	Spring Lake Hts Borough	Old Mill Rd	685	450	Englishtown aquifer
6	49-00014	Spring Lake Borough	Monmouth Ave	698	550	Englishtown aquifer
7	29-00398	Spring Lake Hts Borough	Old Mill Rd	713.5	510	Englishtown aquifer
8	49-00016	Spring Lake Borough	Washington Ave	705	500	Englishtown aquifer
9	29-07506	Spring Lake Hts Borough	Rte 71	564	200	Mt Laurel-Wenonah aquifer
10	49-31544	Garden State Mobile Home Park	Rte 138 West, Wall	75	12.5	Kirkwood-Cohansey aquifer
11	49-31545	Garden State Mobile Home Park	Rte 138 West, Wall	75	12.5	Kirkwood-Cohansey aquifer
12	49-31543	Garden State Mobile Home Park	Rte 138 West, Wall	75	12.5	Kirkwood-Cohansey aquifer
13	49-31542	Garden State Mobile Home Park	Rte 138 West, Wall	75	12.5	Kirkwood-Cohansey aquifer
14	29-05289	Wall Twp Water Dept	Rte 34 South	654	450	Englishtown aquifer

As part of the management of stormwater, protection of aquifer recharge and ground water quality are essential factors. In the coastal area, overuse of groundwater can cause intrusion of saline water into the near-shore aquifers.

Figure 4: Public Water Supply Wells

PUBLIC WELL INFORMATION				
Well #	Well Permit	OWNER - Municipality	Address	Aquifer
1	29-04102	Sea Girt Water Dept	Phildelphia & Bell Place	Englishtown aquifer system
2	29-02869	Wall Twp Water Dept	Atlantic Ave	Englishtown aquifer system
3	29-02870	Wall Twp Water Dept	Tilton Corner Rd	Englishtown aquifer system
4	49-00015	Spring Lake Borough	Monmouth Ave	Englishtown aquifer system
5	29-05075	Spring Lake Heights Borough	Old Mill Rd	Englishtown aquifer system
6	49-00014	Spring Lake Borough	Monmouth Ave	Englishtown aquifer system
7	29-00398	Spring Lake Heights Borough	Old Mill Rd	Englishtown aquifer system
8	49-00016	Spring Lake Borough	Washington Ave	Englishtown aquifer system
9	29-07506	Spring Lake Heights Borough	Rte 71	Mount Laurel-Wenonah aquifer
10	49-31544	Garden State Mobile Home Park	Rte 138 West, Wall	Kirkwood-Cohansey water-table aquifer system
11	49-31545	Garden State Mobile Home Park	Rte 138 West, Wall	Kirkwood-Cohansey water-table aquifer system
12	49-31543	Garden State Mobile Home Park	Rte 138 West, Wall	Kirkwood-Cohansey water-table aquifer system
13	49-31542	Garden State Mobile Home Park	Rte 138 West, Wall	Kirkwood-Cohansey water-table aquifer system
14	29-05289	Wall Twp Water Dept	Rte 34 South	Englishtown aquifer system



Legend

- Public Wells
- Sub-Watershed Boundaries

Map Author: Najarian Assoc.
11.09.2007

0 0.25 0.5 1 1.5 2 Miles

2.4 Soils

Soils are classified as to hydrologic groups and type. Figure 5 provides a map by hydrologic soil group and Figure 6 provides a soil map for the watershed. A variety of soils are present. Table 3 provides a summary of the soil types in the Watershed.

Hydrologic soils group classifies soils as to runoff potential. The properties of a soil that influence infiltration of precipitation control the hydrologic soil group. Soils are grouped from A (low runoff potential) to D (high runoff potential). This property is important in modeling runoff from a watershed.

Table 3: Summary of Soils

Soil Name	Approx. Area (Acres)	Hydrologic Soil Group	Hydric?
ATSION	219	C/D	Y
DOWNER	3268	B	N
EVESBORO	647	A	N
FALLSINGTON	198	B/D	Y
FREEHOLD	104	B	N
HAMMONTON	181	B	N
HOLMDEL	24	C	N
HOOKSAN	9	A	N
HUMAQUEPTS	491	D	Y
KLEJ	204	B/D	Y
LAKEHURST	61	A	N
LAKEWOOD	220	A	N
PITS	443	A	N
SASSAFRAS	1482	B	N
SULFAQUENTS	6	D	Y
UDORTHENTS	299	Varies	
WATER	166	N/A	
WOODSTOWN	151	C	N

2.5 Climate

The watershed is located within the New Jersey Coastal Zone. Climate in New Jersey varies by location, but some general observations about Stat climate can be made. The following information is taken from the New Jersey Climate Overview (Office of NJ Climatologist, 2007). Average precipitation along the southeast coast is about: 40 inches, with about 25 thunderstorms. Snow may fall from around November 15 to April 15.

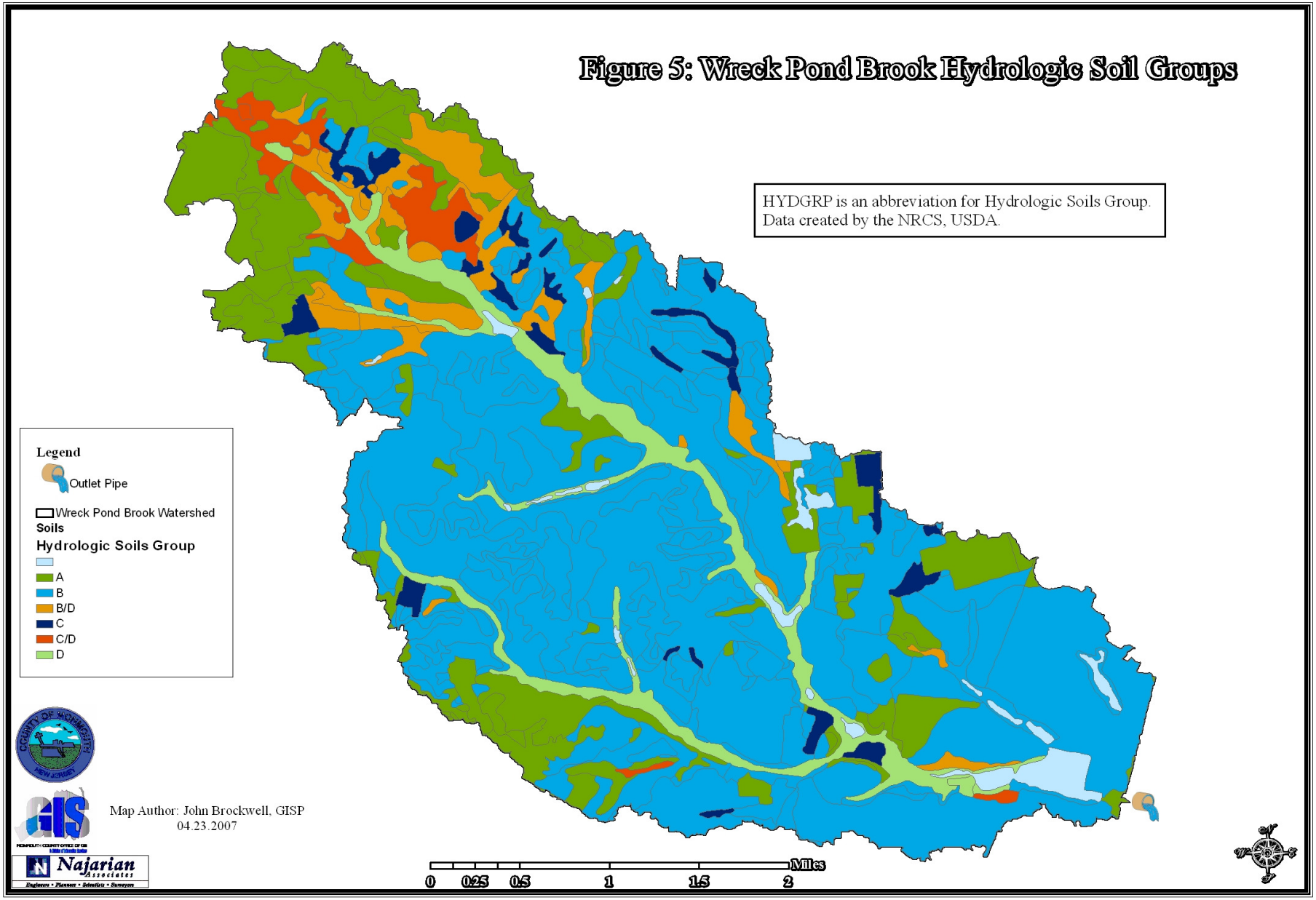


Figure 5: Wreck Pond Brook Hydrologic Soil Groups
HYDGRP is an abbreviation for Hydrologic Soils Group.
Data created by the NRCS, USDA.
Legend
Outlet Pipe
Wreck Pond Brook Watershed
Soils
Hydrologic Soils Group
A
B
B/D
C
C/D
D
Map Author: John Brockwell, GISP
04.23.2007
Najarian Associates
Miles
0
0.25
0.5
1
1.5
2

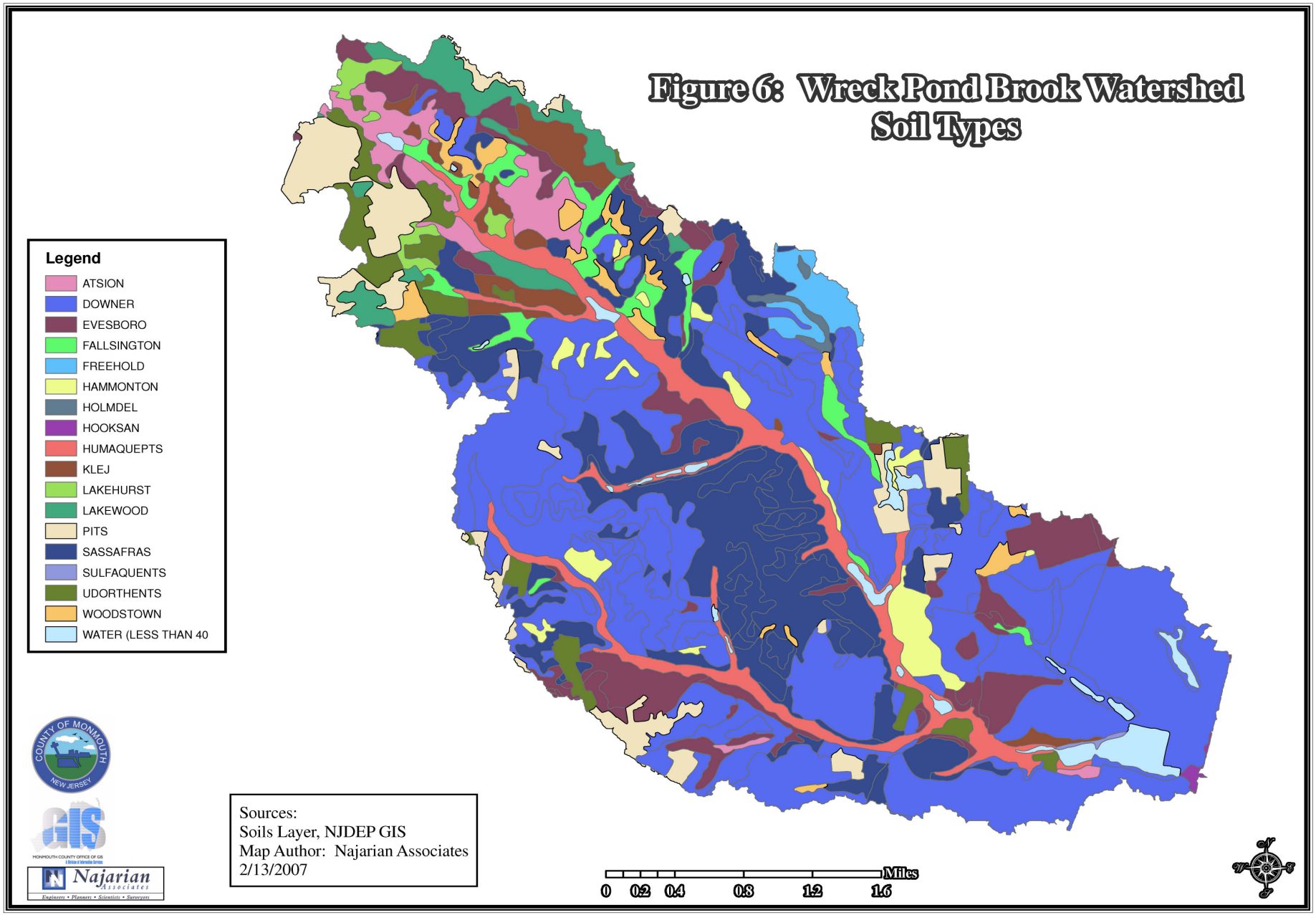


Figure 6: Wreck Pond Brook Watershed
Soil Types
Legend
ATSION
DOWNER
EVESBORO
FALLSINGTON
FREEHOLD
HAMMONTON
HOLMDEL
HOOKSAN
HUMAQUEPTS
KLEJ
LAKEHURST
LAKEWOOD
PITS
SASSAFRAS
SULFAQUENTS
UDORTHENTS
WOODSTOWN
WATER (LESS THAN 40
Sources:
Soils Layer, NJDEP GIS
Map Author: Najarian Associates
2/13/2007
Miles
0
0.2
0.4
0.8
1.2
1.6
COUNTY OF MONMOUTH
NEW JERSEY
GIS
Najarian
Associates

In the Coastal areas, the climate is influenced by the interaction of oceanic and continental influences. The Ocean tends to keep temperature fluctuations less extreme than in the interior and seasonal changes are more gradual.

In the fall and early winter, the ocean is warmer than the land meaning the coastal zone is typically warmer than the interior areas. However, in the spring the ocean winds keep temperatures cooler along the Coast.

Sea breezes strongly influence the coastal climate. As noted in the State climate summary:

> When the land is warmed by the sun, heated air rises, allowing cooler air at the ocean surface to spread inland. Sea breezes often penetrate 5-10 miles inland, but under more favorable conditions, can affect locations 25-40 miles inland. They are most common in spring and summer.

Coastal storms, often called as nor'easters, occur commonly from October to April. These storms bring strong winds and heavy rains and at least one such event occurs each winter and some years can bring five to ten. Tropical storms and hurricanes are potential concerns for coastal areas. These storms can bring substantial rain as well as severe high tides and coastal erosion. Flooding and other damage can occur in the coastal zone due to such storms.

2.6 Hydrology

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. Numerous ponds and small lakes are also found in the watershed. Figure 7 shows the major hydrologic features within the watershed and the subwatershed boundaries. Table 4 provides data on the subwatershed areas.

All of the streams within the watershed are classified as FW2-NT (FW2 Non-trout) in the New Jersey Surface Water Quality Standards. None of the streams are Category 1 (C1). 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;

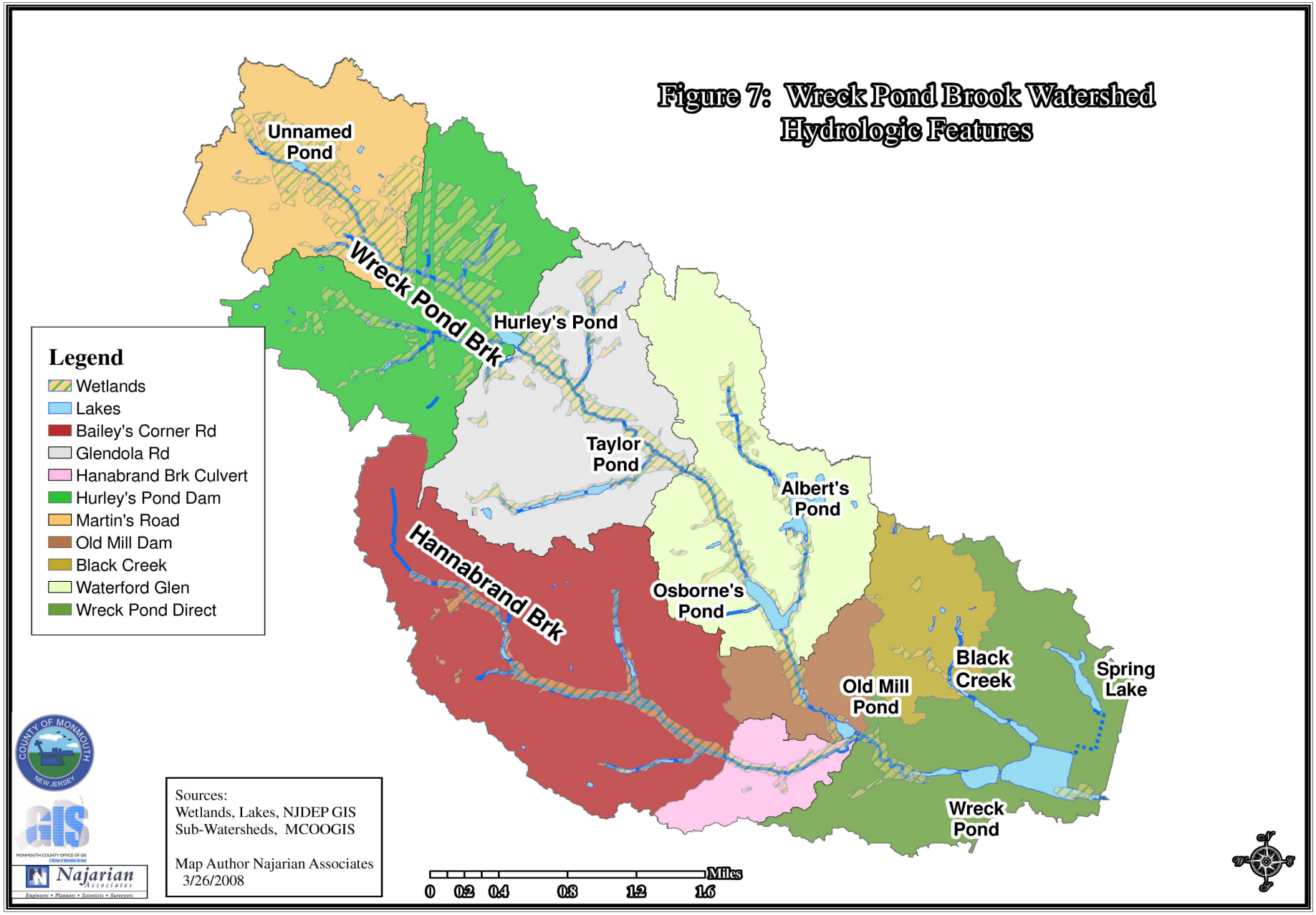


Figure 7: Wreck Pond Brook Watershed
Hydrologic Features
Unnamed Pond
Wreck Pond Brk
Hurley's Pond
Taylor Pond
Albert's Pond
Hannabrand Brk
Osborne's Pond
Old Mill Pond
Black Creek
Spring Lake
Wreck Pond
Legend
Wetlands
Lakes
Bailey's Corner Rd
Glendola Rd
Hanabrand Brk Culvert
Hurley's Pond Dam
Martin's 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
Miles
0 0.2 0.4 0.8 1.2 1.6
COUNTY OF MONMOUTH NEW JERSEY
GIS
Najarian Associates

4. Public potable water supply after conventional filtration treatment and disinfection; and
5. Any other reasonable uses.

Table 4: Subwatershed Areas		
Stream	**Subwatershed**	**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**

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 is about 4,640 acres. 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 subwatershed includes the largest watershed area at about 4,641 acres, which is more than half of the watershed area.

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 an unnamed pond with 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 19th century through the 1950s. The timber dam and berm have been breached and the impoundment drained (WMAC, 1996).

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 Osborn's Pond (sometimes called Trimmers Pond) which is controlled by a dam under Allaire Road.

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 a 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 Osborn's 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 Wreck 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 7 shows the ponds within the watershed, which are summarized in Table 5. Other unnamed small ponds are also found throughout the watershed, included some impounded areas along the streams.

Table 5: Lakes and Ponds

Name	Area (ac)
Unnamed Pond	2.72
Hurley's Pond	6.46
Taylor Pond	0.71
Albert's Pond	25.75
Osborne's 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. 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.

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 acre 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.

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 it widest expanse and is 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. The northwestern shoreline, along Shore Road in Spring Lake Heights, is not bulkheaded but contains a more natural 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 west. It is somewhat narrower and generally has only limited tidal exchange. This portion of the Pond is about 14.2 acres. The northern shoreline contains park right along the shore, with grassed and some treed and shrub areas. The southern shoreline contains a wooded area 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 north of Wreck Pond. Although this pond is separate from Wreck Pond, it is connected to Wreck Pond via stormwater infrastructure piping, shown as a dotted line on Figure 7. 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.

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.

2.7 Flooding

Flooding is a concern within certain parts of the watershed. Figure 8 presents the US FEMA flood hazard area map for the watershed. Within the watershed about 651 acres are within Zone AE. This zone corresponds to "the 1-percent annual chance floodplains that are determine in the Flood Insurance Study by detailed methods of analysis"

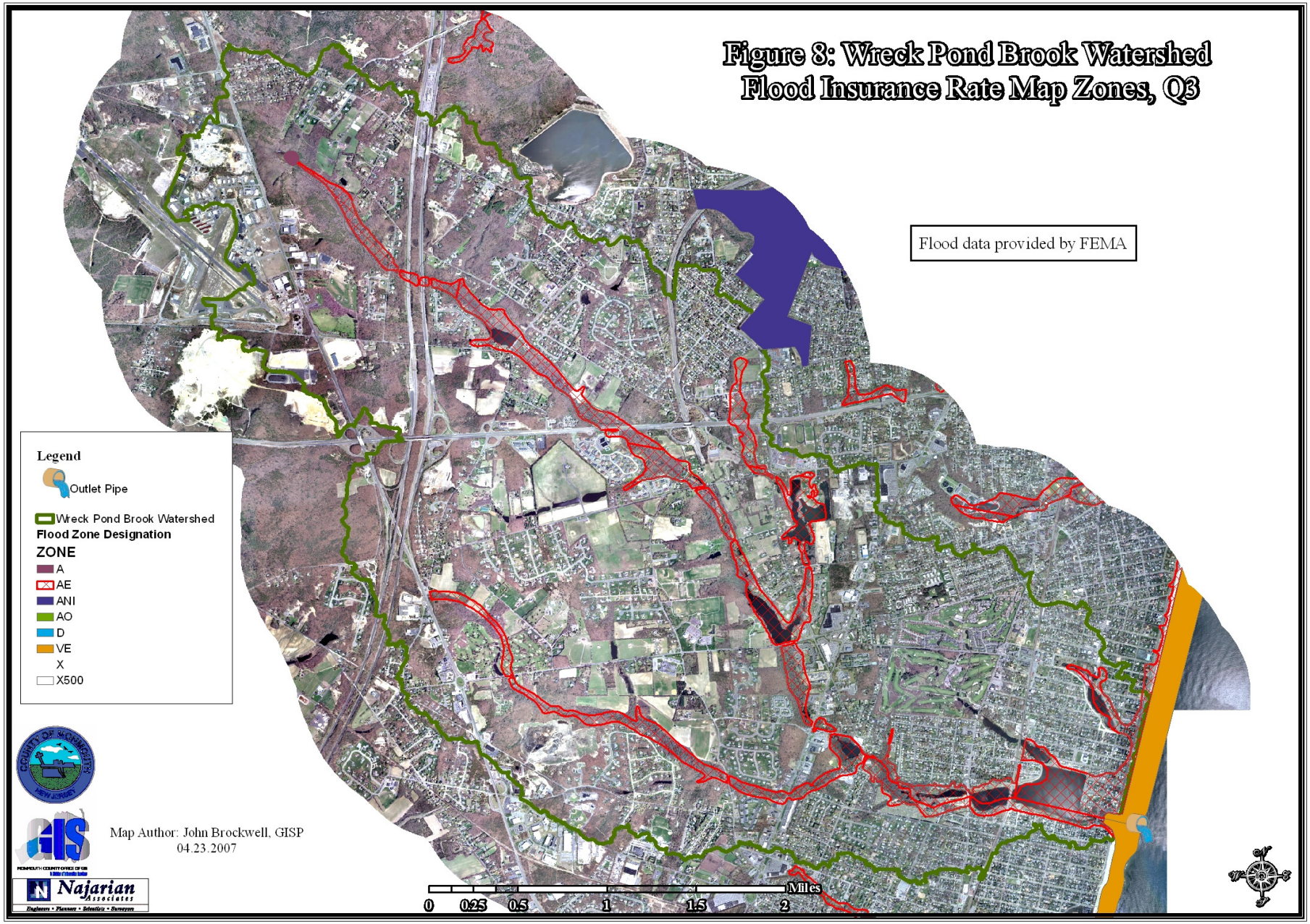


Figure 8: Wreck Pond Brook Watershed
Flood Insurance Rate Map Zones, Q3
Flood data provided by FEMA
Legend
Outlet Pipe
Wreck Pond Brook Watershed
Flood Zone Designation
ZONE
A
AE
ANI
AO
D
VE
X
X500
Map Author: John Brockwell, GISP
04.23.2007
Najarian Associates
Miles
0
0.25
0.5
1
1.5
2

(FEMA, 2007). The 1-precent 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 noted as an area in which the 1-percent annual chance flood is estimated.

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" (FEMA, 2007).

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 rain of 11.58 inches over a period of 3 days. The actual flooding occurred rapidly, during an over night period surprising residents. On the evening of October 14, 2005, a flood elevation of 10.55 (NGVD 1929 Datum) 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.

2.8 Ecology

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. Figure 7 shows the overall wetland locations.

Table 6 summarizes the wetlands types within the watershed based on analysis of the land use GIS layer.

Table 6: Summary of Wetlands

WETLAND TYPE	ACRES
Agricultural Wetlands (Modified)	24.1
Deciduous Scrub/Shrub Wetlands	79.5
Deciduous Wooded Wetlands	295.1
Disturbed Wetlands (Modified)	0.7
Freshwater Tidal Marshes	4.8
Herbaceous Wetlands	46.0
Managed Wetlands (Modified)	69.1
Mixed Forested Wetlands (Coniferous Dom.)	24.6
Mixed Forested Wetlands (Deciduous Dom.)	502.8
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	45.8
Saline Marshes	10.0
Total Wetland Area	**1102.5**

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 a very small area of freshwater (±4.81 acres) or saline (±9.98 acres) tidal marsh is noted.

Endangered or threatened animal species or habitat for such species are reported only in a few small patches within the watershed. NJDEP provides mapping that ranks areas of the state as to endangered species occurrence and habitat. NJDEP describes the ranks as follows:

- **Rank 5** is assigned to patches containing one or more occurrences of at least one wildlife species listed as endangered or threatened on the Federal list of endangered and threatened species.
- **Rank 4** is assigned to patches with one or more occurrences of at least one State endangered species.
- **Rank 3** is assigned to patches containing one or more occurrences of at least one State threatened species.
- **Rank 2** is assigned to patches containing one or more occurrences of at least one non-listed State priority species.
- **Rank 1** is assigned to patches that meet habitat-specific suitability requirements such as minimum size criteria for endangered, threatened or priority wildlife species, but that do not intersect with any confirmed occurrences of such species.

Thus, only Rank 3 or higher have occurrences of threatened or endangered species.

A few endangered or threatened species are noted in the vicinity of Wreck Pond. The federally listed Least Tern nests in the dunes along the beach adjacent to the eastern portion of Wreck Pond. The Piping Plover, federally listed as threatened, nests in the dunes adjacent to the outlet. A colony of Least Terns, State listed as threatened, nest on the beach seaward of the Pond outlet structure. The plant, Seabeach Amaranth, a federally listed threatened plant has been identified along “an approximately 900’ of beach between the Spring Lake and Sea Girt boardwalks”. Another plant, the state-listed endangered awl-leaf mudwort (*Limosella subulata*) has “been known to occur along the southern shoreline of Wreck Pond” according to NJDEP.

Within the watershed, the Northern Pine Snake is listed as a species of concerns in the wooded and grassed lands in the far northwestern portion of the watershed, near Allaire Airport. Otherwise, the woodlands and emergent wetlands are generally categorized as Rank 2, which is “Priority Concern”. This indicates that no endangered species or habitat for such species have been found in, or in the vicinity of, these habitats.

2.9 Critical Habitat and Environmentally Constrained Land

The Wreck Pond Brook watershed includes some environmentally sensitive lands. Most of these lands are the wetlands and streams within the watershed. As noted in Section 2.2, the watershed does not include significant steep slope areas. There are only limited areas with habitat for threatened or endangered species, including the dunes along Wreck Pond and a small portion on the southwestern edge of the watershed near Allaire airport which is potential habitat for the Northern pine snake.

No waters in the watershed are Category 1 waters.

The ponds and streams within the watershed and the accompanying wetlands and buffers provide environmental benefits to the wildlife and people in the watershed. These may be considered environmentally sensitive lands.

2.10 Land Use

The Wreck Pond watershed, like much of Coastal Monmouth County, includes a mix of land uses, primarily residential and commercial.

The eastern portion of the watershed has been developed in residential uses for many years. The 1930 aerial from the NJDEP GIS system reveals that the watershed was extensively developed for agriculture, with a few pockets of residential development or areas with housing, for example in the area called “New Bedford”. Much of the Borough of Spring Lake was already developed. The golf course in Spring Lake Heights also is visible. Over time, the agricultural lands gave way to suburban development, with some areas reverting to woodlands. Over time, suburban development moved west within the watershed. Historically, there were a few sand and gravel mines within the watershed.

The areas surrounding Wreck Pond are generally fully developed with suburban/urban uses, primarily homes with some commercial uses. This includes the communities of Spring Lake, Spring Lake Heights and Sea Girt. Moving further upstream within the watershed are less developed lands including woodlands, agricultural lands and brush areas along with suburban land uses. Wall Township contains most of the undeveloped area in the watershed. Table 7 summarizes the land use in the watershed. This information was taken from the Monmouth County GIS system, updated to 2006. The land use categories provided in Table 7 are from the NCRS (formerly the Soil Conservation Service) and are relatively broad categories.

Table 7: Land Use		
Land Use/Land Cover	**Watershed**	
	Acres	**Percentage**
Agricultural Land	39.6	0.5
Agricultural Land (Cropland)	741.6	9.1
Brush	289.8	3.6
Landscaped Commercial/Industrial/Institutional	109.5	1.3
Landscaped Commercial/Industrial/Institutional/Mixed-use	448.1	5.5
Landscaped Open Space	359.3	4.4
Landscaped Open Space (Golf Course)	261.2	3.2
Landscaped Open Space/detention basin	1.3	0.0
Orchards/Tree Nurseries	37.3	0.5
Permanently Unvegetated/Sparsely Vegetated	311.5	3.8
Residential (17% impervious)	748.1	9.1
Residential (23% impervious)	592.3	7.2
Residential (33% impervious)	1247.1	15.3
Residential (65% impervious)	239.5	2.9
Unlandscaped Commercial/Industrial/Institutional	61.8	0.8
Unlandscaped Commercial/Industrial/Institutional/Mixed-use	199.8	2.4
Water	205.6	2.5
Water Feature (Retention Basin)	10.3	0.1
Wooded Area	2270.3	27.8
TOTAL	***8174***	***100***

The land use categories in Table 7 are one way to categorize land use. However, some of the land use categories were not optimal for this study. Thus, additional analysis of land use was conducted.

Description of land use depends on the level of detail of available information as well as decisions as to how to categorize the land use. 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 more generally applied. For example, wooded lands are subdivided in that system to categories such as “Deciduous forest (>50% crown closure)” or “Mixed forest (>50% deciduous with >50% crown closure)”. The decision as to how to categorize land use depends on both the needs of the study and the need to display the land uses in an understandable format.

For the purposes of this study, land use is of concern for generation of stormwater and impacts to water quality. In addition, for the build-out analyses discussed later herein, the land use categories must be comparable to zoning classes. For example, the forested areas are all considered similar for generation of stormwater and the potential for future development, thus there is no need to further subdivide those classes. Alternatively, the potential for water quality impacts and the development of best management practices likely will differ for institutional lands, industry or a mining operation. The broad commercial/industrial/institutional categories contained uses ranging from schools to industrial lands. This was subdivided into commercial, industrial, cemetery, and mining using the Anderson Codes for 1995 and if necessary, the aerial photographs.

Finally, the landscaped open space category included a variety of uses including athletic fields, parks, planting strips at commercial or industrial buildings, and open areas adjacent to schools or businesses. In addition, the NRCS (SCS) code classified athletic fields in some locations as landscaped open space and in others as landscaped commercial/industrial/institutional, likely depending on whether the field was associated with a school. Thus, the Anderson codes and aerial photographs were used to identify the athletic fields and parks.

Table 8 provides the revised Land Use classifications. This provides 24 different land use categories. While descriptive, these are not easy to understand on a map. Further, the data will also be used in water quality modeling and compared to future zoning for the build-out analysis. Water pollutant generation data is not available for all of these land uses. Thus, fourteen general land use categories were developed and these are summarized in Table 9 and shown on Figure 9. These categories also were used to evaluate future build-out in Book 2 of the RSWMP. Note that wetlands are not one of these categories as this was not consistently reported in the land use GIS files. As noted later, wetlands were overlain on land use using the NJDEP GIS wetland layer.

The land uses in Table 9 can be subdivided into developed and undeveloped areas. Developed areas include residential, commercial, industrial and institutional lands as well as landscaped open space. Agricultural lands, while an active land use, are considered to be available for future development. Table 10 provides a broad summary of land uses as to currently developed or future developable lands.

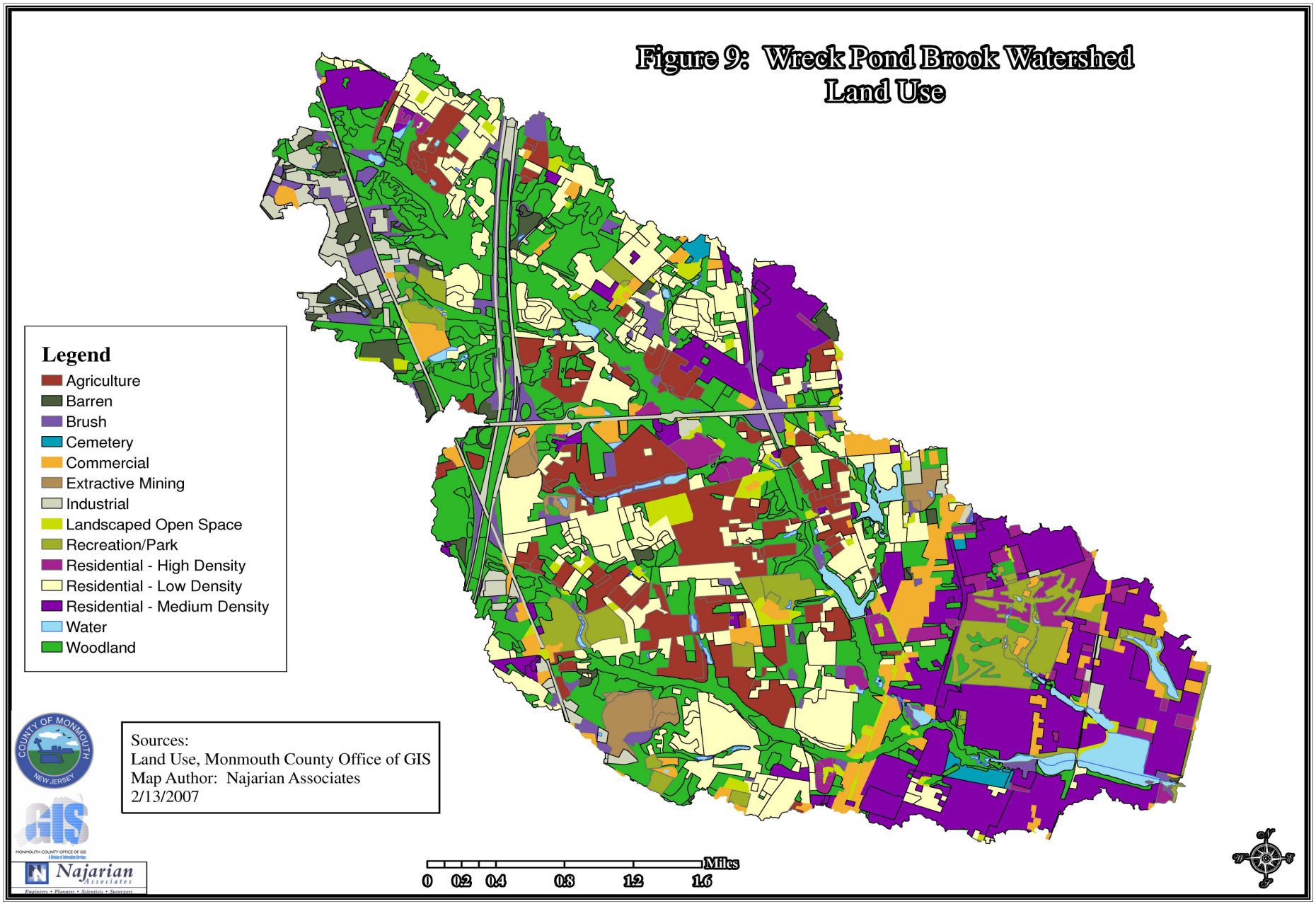


Figure 9: Wreck Pond Brook Watershed
Land Use
Legend
Agriculture
Barren
Brush
Cemetery
Commercial
Extractive Mining
Industrial
Landscaped Open Space
Recreation/Park
Residential - High Density
Residential - Low Density
Residential - Medium Density
Water
Woodland
Sources:
Land Use, Monmouth County Office of GIS
Map Author: Najarian Associates
2/13/2007
COUNTY OF MONMOUTH
NEW JERSEY
GIS
MONMOUTH COUNTY OFFICE OF GIS
Najarian
Associates
Engineers • Planners • Scientists • Surveyors
0 0.2 0.4 0.8 1.2 1.6
Miles

Table 8: Updated Land Use Summary		
Land Use Category	**Area (Acres)**	**Percent of Watershed**
Agricultural Land	41.4	0.5%
Agricultural Land (Cropland)	741.6	9.1%
Orchards/Tree Nurseries	37.3	0.5%
Permanently Unvegetated/Sparsely Vegetated	165.5	2.0%
Cemetery	38.4	0.5%
Brush	283.7	3.5%
Landscaped Commercial	302.6	3.7%
Unlandscaped Commercial	102.8	1.2%
Extractive Mining	120.9	1.5%
Landscaped Industrial	106.3	1.3%
Landscaped Transportation	160.4	2.0%
Unlandscaped Industrial	66.0	0.8%
Unlandscaped Transportation	95.3	1.2%
Landscaped Open Space	163.4	2.0%
Landscaped Open Space (Golf Course)	265.8	3.3%
Landscaped Open Space (Park)	30.9	0.4%
Recreational (Beach)	3.1	0.0%
Athletic Field	103.7	1.3%
Residential (65% impervious)	239.5	2.9%
Residential (17% impervious)	773.5	9.5%
Residential (23% impervious)	639.8	7.8%
Residential (33% impervious)	1247.1	15.3%
Water	215.9	2.6%
Wooded Area	2229.9	27.3%

Thus, of the approximately 8,174 acres in the watershed, a little less than half (about 45%) or ±3,733 acres are developed in residential, commercial, industrial or institutional lands. An additional ±442 acres (5.4%) is recreational, park or cemetery land and ±163 acres (2%) is landscaped open space. About 45% (±3,690 acres) of the watershed is agricultural, fields, barren, mining or wooded lands that may be subject to future development. Current environmental regulations, including NJDEP CAFRA, Stormwater Management and Wetland Rules will govern the nature and extent of some future development. In addition, local zoning requirements will dictate how development occurs. Book 2 of this report discusses future zoning and development.

Table 9: 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 10: Land Use of Developable and Undevelopable Lands		
	Acres	**Percent**
Future Developable Lands	**3690.1**	**45.1%**
Agricultural Use	818.5	10.0%
Brush	289.8	3.3%
Unvegetated	311.5	3.8%
Woods	2270.3	27.8%
Developed or Undevelopable Lands	**4483.9**	**54.9%**
Landscaped Open Space	621.8	7.6%
Water	215.9	2.6%
Commercial/Industrial/Institutional	819.2	10.0%
Residential	2827.0	34.6%