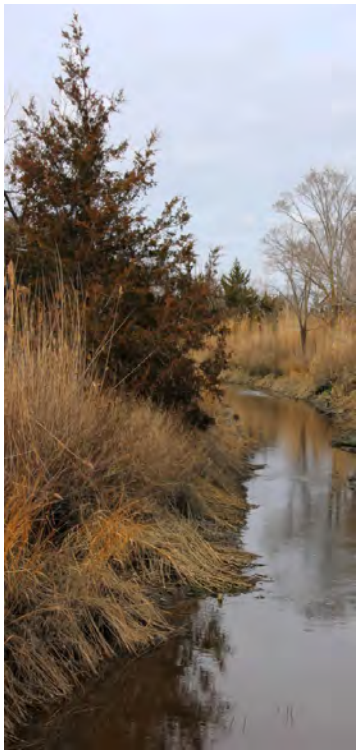
Final May 2018



Environmental Resource Inventory

for

West Cape May Borough

Cape May County, NJ

Prepared for:

West Cape May Borough

Kratzer Environmental Services

ENVIRONMENTAL RESOURCE INVENTORY

The Borough of West Cape May

Cape May County

New Jersey

Prepared By

Kratzer Environmental Services

For

The Borough of West Cape May

May 2018

Kratzer Environmental Services

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"We should act like this is the only planet we have because it is." (Honachevsky, 2000)

ACKNOWLEDGEMENTS

This report was authored by Deborah J. Kratzer, Jill S. Dodds and Elizabeth A. Johnson. Funding for this report was provided by the Borough of West Cape May.

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Table 7.10 (pages 130 to 134): Chuck Bargeron, Univ. of Georgia, Bugwood.org; Ted Bodner at USDA-NRCS PLANTS Database; Britton and Brown, 1913; John D. Byrd, Mississippi State University, Bugwood.org; Steve Dewey, Utah State University, Bugwood.org; Tom Heutte, USDA Forest Service, Bugwood.org; James H. Miller, USDA Forest Service, Bugwood.org; Mohlenbrock , 1995; Jan Samanek, State Phytosanitary Administration, Bugwood.org; Jil M. Swearingen, USDI National Park Service, Bugwood.org; USDA PLANTS Database, Bugwood.org ; Richard Webb, Self-employed horticulurist, Bugwood.org

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1: INTRODUCTION

A. About This Report

Ecologically Based Planning

Ecology is defined as the science of the relationships between organisms and their environments. The relationships between and among the physical factors of the environment, including the air, geology, topography, soils, and water, and the biotic environment, including plants, animals and decomposers, are a complex web. Humans are a significant part of the ecosystem of the Borough of West Cape May, both affecting and being affected by many physical and biological factors. With West Cape May's population of 1,024[1] (US Census, 2010), the cumulative effects of many individual decisions have altered and have the potential to impact the environment and human health.

> "The scientific community needs to articulate more clearly for local decision makers the underlying ecological processes and the consequences resulting from interference or truncation of those processes." (Honachefsky, 2000, p. 32)

Assembling an inventory of the Borough's environmental and biological infrastructure is the first step in a proactive and ecological approach to protecting and preserving human and ecological health. Analyzing the data, gaining an understanding of the ecological processes involved, and considering the consequences of ignoring them, will help local land planners create and maintain an ecologically healthy community.

Goal of the Environmental Resource Inventory

The goal of the *Environmental Resource Inventory (ERI)* is to provide objective, reliable environmental data in one document. This enables Borough officials (the Mayor, Borough Council, Planning Board, Environmental Commission, Shade Tree Commission and Historical Preservation Commission) and the Lower Township Construction Office to make more informed decisions. By taking numerous variables into consideration, they will better protect the Borough's natural resources and the overall health and welfare of the community. Similarly, it is a tool for the public to use.

The Municipal Land Use Law requires municipalities' Master Plans to have a land use plan including, but not necessarily limited to, topography, soil conditions, water supply, flood plains, wetlands, and woodlands (Municipal Land Use Law, 2002).

[1] The population of Cape May County as a whole is estimated to be 94,727 persons and for the entire State of New Jersey, the population estimate is 8,958,013 persons (US Census, July 1, 2015 estimate).

The Environmental Commission Enabling Legislation gives environmental commissions the authority to conduct such research for inclusion in the Master Plan, and then to use this information to help evaluate development applications.

The Association of New Jersey Environmental Commissions (ANJEC) defines "Environmental Resource Inventory" in its Resource Paper, The Environmental Resource Inventory: ERI, as follows:

> "The Environmental Resource Inventory (ERI), or Index of Natural Resources, is a compilation of text, tables, maps and other visual information about the natural resource characteristics and environmentally significant features of an area. Traditionally called "Natural Resources Inventory," the title "Environmental Resources Inventory" is now commonly used, reflecting the addition of manmade features to the inventory, such as historic sites, brownfields and contaminated sites. An ERI provides baseline documentation for measuring and evaluating resource protection issues. It is an objective index and description of features and their functions, rather than an interpretation or recommendation. Identifying significant environmental resources is the first step in their protection and preservation and in assuring that future development or redevelopment protects public health, safety and welfare." (ANJEC, no date).

The ERI will principally be used by the Planning Board and Environmental Commission, but will provide valuable information to anyone interested in the natural resources of the Borough of West Cape May. This objective information may facilitate resource-sensitive development decisions. In addition, familiarity with environmental concerns enables residents to appreciate and to learn how to maintain our valuable natural resources. Areas of specific concern may emerge which require additional protection strategies, such as further research and monitoring, public outreach and education, habitat restoration, easements, volunteer projects, and/or revised or new ordinances.

Methods

Funding for this project was provided by the Borough of West Cape May Environmental Commission.

An inventory of what is currently known about the physical and biological environment and the human influence on the environment of West Cape May has been compiled for this document. The most current GIS data have been obtained from the New Jersey Department of Environmental Protection GIS Data Web Site and other sources (see **Appendix A** and **Appendix B)**. A total of 83 GIS data layers from 30 sources were used for this report's 45 maps.

What is GIS?

"A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts." (GIS.com, 2013)

Further sources include the internet, and federal, state, county and local databases and contacts. All digital inventory data used in this report will be provided to the West Cape May Environmental Commission. The public can also use GIS data by using either the New Jersey Department of Environmental Protection's NJ-GeoWeb website or obtain relevant data layers (most are free on the internet), and download the

free software, ArcExplorer to view the data (see **Internet Resources**, at the end of this section).

When viewing the digital document (as opposed to a printed copy) maps in PDF[2], clicking on the tab "Layers" at the left side of the screen will allow users to turn on or off the various data layers. Viewing the separate layers in this way is often helpful, especially for complex maps[3].

References and related Internet resources (with links) are listed at the end of each section, so that readers may find more information and updates. Please note that Internet sites may change or be temporarily out of service. If an Internet link doesn't work, try using an Internet search engine.

The following chapters present objective information about the Borough of West Cape May's natural resources, including climate, geology, soils, water, floodplains, wetlands, and forests, and cultural resources such as infrastructure and open space. Environmental concerns in West Cape May include air and water pollution, rare, threatened and endangered species and invasive species.

Limitations of the NRI

It should be noted that the NRI is not meant to replace the primary data sources upon which it is based. Details about each data layer, including the date, scale and methods of developing the data, are provided in **Appendix B**. The NRI is intended for preliminary assessments of projects and *cannot substitute for on-site testing and evaluations*. Most maps are presented at a scale of 1:36,000 in order to fit on 8.5 x 11 inch paper. "Zooming in" to better view individual lots is possible, but should not exceed the scale at which the data was created. Most data layers used for this report were created at 1:24,000 scale (with an accuracy of $\pm$ 40 feet). Data mapped at 1:100,000, such as the geology data layer, have an accuracy of $\pm$ 166.7 feet (Garie, 1998).

Sometimes mapped features don't line up exactly, since different data producers may have used different methods of acquiring and analyzing the data, used different scales or coordinate systems, and because of differences or errors in the base data.

GIS data layers from NJDEP are used with permission (see the Terms of Agreement in **Appendix A**), with the required "disclaimer" printed on each map that uses their data.

Some components of the environment may have been studied or presented in detail, while other important factors may have been minimally addressed. When new or updated information becomes available, or new issues emerge, *updates should be appended to the ERI*.

Following the guidelines provided by ANJEC, management recommendations are not included in the ERI.

[2] PDF stands for "Portable Document Format," a digital format which allows the document to appear the same to everyone, requiring only the download of the free Adobe® Reader® at http://www.adobe.com/products/acrobat/readstep2.html.

[3] A few maps are so large in this format that they are included as a simple graphic in the report, but are available separately in PDF.

B. General Description of the Borough of West Cape May

West Cape May is located in Cape May County, NJ (see **Figure 1a**) and is bordered by Lower Township to the north, west, and south and the Cape May City to the east. West Cape May is one of four municipalities that are found south of the Cape May canal, the fourth being Cape May Point.

The Borough was incorporated in 1884. West Cape May encompasses 1.175 square miles (752 acres)[4] with a population of 1,024 living in 1,043 housing units (US Census, 2010).

C. Land Use and Land Use Change

Figures 1b through 1e show aerial photographs of West Cape May and the surrounding areas. In **Figure 1b**, aerial photography taken in 1930, although not very high resolution, and not georeferenced[5], illustrates the prevalence of agriculture and far less development at that time. Aerial photographs taken in 1995, 2002, 2007, 2012 and 2015 are shown in **Figures 1c, 1d, 1e, 1f and 1g** respectively.[6] These aerial photographs are georeferenced. Other options for viewing aerial photos online are listed in **Internet Resources**, at the end of this section.

The New Jersey Department of Environmental Protection (NJDEP) used aerial photography taken in 1986, 1995, 2002, 2007 and 2012 to determine land use and land use change. The Land Use Type is the generalized category of six land uses: agriculture, barren, forest, urban, water and wetlands. Definitions are as follows (USGS, 2010):

Agriculture includes all lands used primarily for the production of food and fiber and associated farm structures. In West Cape May this consists of close to 105 acres, which are primarily pastureland or cropland, with other uses such as orchards, vineyards, nurseries or horticulture.

Forest land is covered by woody vegetation (excluding wooded wetlands, which are included in the wetlands category) and includes overgrown shrubby fields. These areas are capable of producing timber and other wood products, and of supporting many kinds of outdoor recreation. Forests are important environmentally, because they affect air quality, water quality, wildlife habitat and climate.

Any areas periodically covered with water are included in the *water* land use type.

[4] The total acres determined by the ArcGIS coverage differs slightly from the acres provided on tax maps.
[5] Georeferencing involves defining the location of something in physical space using map coordinates and assigning a coordinate system. This is the strength of GIS, because features can be defined in relation to other features.
[6] The 2002, 2007, 2012 and 2015 aerial photography data are high resolution, with pixels of 1 square foot. This is much more detail than can be shown in this report. See NJ-GeoWeb in **Internet Resources**, at the end of this section.

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1a: West Cape May Location

The Borough of West Cape May is located at the southern end of Cape May County. The inset indicates its position relative to the rest of New Jersey.

Legend

- West Cape May
- Roads

0 0.125 0.25 Miles

N

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT

Note: Map accuracy is limited to the accuracy and scale of the original data sets.

Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1b: West Cape May 1930 Aerial Photography

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1c: West Cape May
1995 Aerial Photography

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1d: West Cape May 2002 Aerial Photography

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1e: West Cape May 2007 Aerial Photography

Legend

- West Cape May
- Parcels (2011)
- Roads

0 0.125 0.25 Miles

N

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1f: West Cape May 2012 Aerial Photography

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1g: West Cape May 2015 Aerial Photography

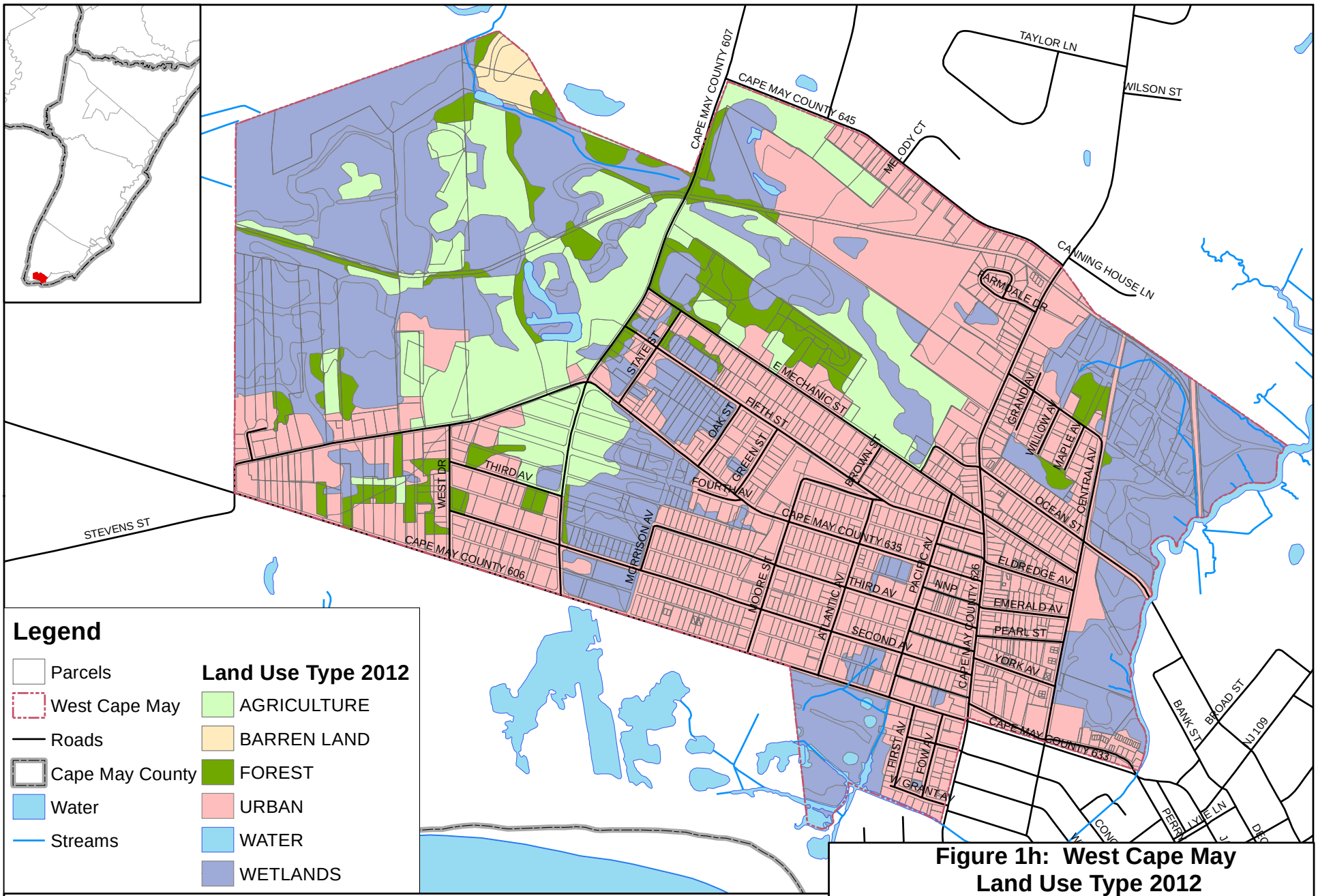


Figure 1h: West Cape May Land Use Type 2012

The predominant land use categories in West Cape May are urban, wetlands and agriculture. Scattered areas of forest are also present, and the remainder is made up of open water or barren land.

Legend

- West Cape May
- Roads
- Changed to Urban or Barren between 2007 and 2012
- Changed to Urban or Barren between 2002 and 2007
- Changed to Urban or Barren between 1995 and 2002
- Changed to Urban or Barren between 1986 and 1995

0 0.125 0.25 Miles

N

Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

Figure 1i: West Cape May Land Use Change to Urban or Barren

Changes in land use between 1986 and 2012 where the type changed to urban or barren are highighted.

Wetlands are those areas that are inundated or saturated by surface or ground waters at a frequency and duration sufficient to support vegetation adapted for life in saturated soil conditions. Included in this category are naturally vegetated swamps, marshes, bogs, etc., as well as formerly natural wetlands that have been altered (sometimes filled) and are now part of a managed recreational area, but which still show signs of soil saturation on the aerial imagery. These areas do not currently support typical wetland vegetation, but are vegetated primarily by grasses and other planted vegetation that may be routinely mowed. Wetlands are further discussed in **Section 6C** of this report.

Table 1.1: 2012 Land Use Type

Land Use Type	Acres*	Percent
AGRICULTURE	104.75	13.88
BARREN LAND	5.06	0.67
FOREST	42.47	5.63
URBAN	329.90	43.72
WATER	6.02	0.80
WETLANDS	266.43	35.31
Total Acres	**754.63**	**100.00**

*Area calculated with GIS differs from area from other sources, such as tax maps.

Source: NJDEP, 2015

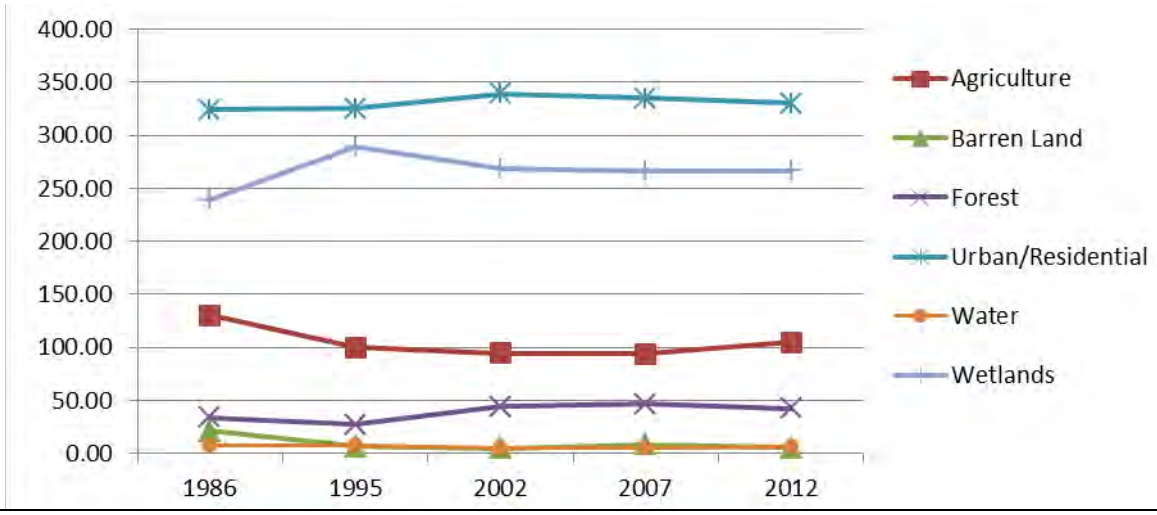
Barren Land includes areas being developed or cleared at the time the photos were taken.

The *Urban Land* type is characterized by intensive land use where the landscape has been altered by human activities. It encompasses various categories of residential, commercial, educational and industrial land.

The 2012 land use types within the Borough of West Cape May are illustrated in **Figure 1h**, and summarized in **Table 1.1**. West Cape May is approximately 44% urban and about 6% forested. Detailed categories of land use/land cover are shown in **Section 7** of this report.

Table 1.2: Change in Land Use Type*

Land Use Type	1986 Percent	1995 Percent	2002 Percent	2007 Percent	2012 Percent	26 year change Acres	26 year change Percent
Agriculture	17%	13%	12%	12%	14%	-25.4	-3%
Barren Land	3%	1%	1%	1%	1%	-15.7	-2%
Forest	4%	4%	6%	6%	6%	8.8	1%
Urban/Residential	43%	43%	45%	44%	44%	5.8	1%
Water	1%	1%	1%	1%	1%	-1.0	0%
Wetlands	32%	38%	36%	35%	35%	27.4	4%
Total:	100%	100%	100%	100%	100%		



*Some changes may be artifacts rather than actual changes, such as due to the increase in resolution in 1995 and 2002 or changes in definitions.

Source: NJDEP, 2015; NJDEP, 2010; NJDEP, 2007; NJDEP, 2000; NJDEP, 1998

Table 1.2 shows the percentages of West Cape May in each land use type in 1986, 1995, 2002, 2007, and 2012 and the changes in percent cover. **Figure 1i** highlights the areas that have changed to urban or barren land from another type (such as agriculture) over this time period. Some land changed within the urban type, such as changing from *other urban or built-up land* to *residential, single unit, low density*; while other areas changed from the urban type to another type, for example changing from *other urban or built-up land* to *cropland and pastureland* and these are not highlighted.

References: Introduction

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NJDEP, Bureau of Geographic Information Systems (BGIS). February 17, 2015. Land Use/Land Cover 2012 Update, Edition 20150217 Subbasin 02040302 - Great Egg Harbor, Subbasin 02040303 - Chincoteague 1:2,400. GIS Data. http://www.nj.gov/dep/gis/listall.html

US Census 2010. http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml; http://quickfacts.census.gov/qfd/states/34/3453850.html https://www.census.gov/quickfacts/table/PST045216/34009,34

US Geological Survey (USGS). 2010. Edited by NJDEP, Bureau of Geographic Information Systems (BGIS) 1998, 2000, 2001, 2002, 2005, 2007, 2010. NJDEP MODIFIED ANDERSON SYSTEM 2007 derived from: A Land Use and Land Cover Classification System for Use with Remote Sensor Data, USGS Professional Paper 964, 1976. 35 pages. http://www.state.nj.us/dep/gis/digidownload/metadata/lulc07/anderson2007.html

Internet Resources: Introduction

Aerial photography and:

Google Earth[7]: http://www.google.com/earth/index.html (free download)

HistoricAerials.com[8]: http://historicaerials.com (free to use, but maps have watermark unless purchased)

Free online mapping:

NJ-GeoWeb (NJDEP): http://www.state.nj.us/dep/gis/geowebsplash.htm

NJ Map: An Interactive Atlas for Ecological Resources, Environmental Education, and Sustainable Communities: http://www.njmap2.com/

[7] Users of Google Earth may also view several years of historic imagery of West Cape May from 1995 through 2012. On the menu bar, click View, then click Historical Imagery and use the slider bar to choose the year.

[8] HistoricAerials.com allows viewing of historic aerial photography between 1931 and 2007.

Cape May County's Official Home Page: http://capemaycountynj.gov/

Environmental Education

NJDEP SEEDS: The State Environmental Education Directory Website: http://www.state.nj.us/dep/seeds/index.html

Free GIS Software

ArcExplorer (free GIS software): http://www.esri.com/software/arcexplorer/explorer.html

GIS Data from New Jersey Department of Environmental Protection
(For a complete list of data sources used in this report, see Appendix B.)

NJ GIS Home Page: http://www.state.nj.us/dep/gis/index.html
Download GIS data: http://www.state.nj.us/dep/gis/downloadintra.html
NJ Geographic Information Network: https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp

West Cape May's Official Home Page: http://www.westcapemay.us/

NJDEP Rules and Regulations (current and proposed): http://www.nj.gov/dep/rules/

2: LOCAL & REGIONAL CONDITIONS

A. Climate & Meteorology

Climate

The American Meteorological Society defines *weather* as atmospheric variations on the short-term (minutes to days), including characteristics such as temperature, precipitation and wind. In contrast, *climate* is defined as the meteorological conditions in terms of long-term averages (a month or more) (American Meteorological Society, 2015).

Climate is a major factor in determining the kinds of plants and animals found in an ecosystem. New Jersey has a temperate climate because it has mild average temperatures, four seasons, and rainfall distributed throughout the year. The dominant atmospheric circulation is the prevailing westerlies, the broad, undulating flow of air from west to east across the middle latitudes of North America. Prevailing winds are from the southwest in summer and from the northwest in winter (ONJSC, No Date).

The NJ State Climatologist has collected and evaluated more than a century of data from 19 stations within NJ in order to chart weather variables over the past century (e.g. min. and max. temperature, precipitation). The weather station nearest to West Cape May that was evaluated for this climate study was Belleplain State Forest[9], which was monitored from April 1922 through January 2008 (Robinson, 2010; Hartman, 2002). According to the NJ State Climatologist, a "Preponderance of evidence suggests climate change is occurring and humans are responsible for a significant portion of recent changes." (Robinson, September 30, 2016).

According to the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), the temperature trend (annual average) in coastal New Jersey is +0.3°F per decade, and the precipitation trend is -0.19 inches per decade (for the period of record 1895 to 2016) (NOAA, February 28, 2017). NOAA summarizes New Jersey's climate as follows:

- Average annual temperatures have increased by 3°F over the past century.
- Precipitation has been variable, with wetter than average conditions over the past decade.
- Sea level along the New Jersey coast has risen by more than 16 inches over the past century (Runkle et. al., 2017)

In addition, the NCDC calculates state *normals* (three-decade averages) of climatological variables, including temperature and precipitation. The normal maximum temperature for New

[9] The Belleplain State Forest weather monitoring station was located about 25 miles north of West Cape May Borough, in Dennis (39'15", 74' 51" 30') Township, Cape May County. See **Figure 2a.**

Jersey has increased between 0.5 to 0.7°F for 1981-2010 compared to the 1971-2000 period. Normal minimum temperature for the state has increased 0.3 to 0.5°F (NOAA, May 16, 2011).

The impacts of climate change in New Jersey may include increasing temperature, changing precipitation patterns (more intense river flooding during winter and spring, and drought during summer and fall), rising sea levels, retreating shores, saltwater intrusion, infrastructure damage, challenges for agriculture and fishing, and increased risks to human health (such as increasing respiratory ailments and diseases such as Lyme disease) (USEPA, August, 2016).

Figure 2a illustrates changing shorelines from 1837 to 2007. Online sea level rise and flood mapping tools are listed in **Internet Resources**.

Precipitation and Temperature

As the prevailing westerlies shift north and south and vary in strength, they bring wet, dry, hot, and cold airstreams. These influence the weather throughout New Jersey, resulting in highly variable daily weather. The Office of the New Jersey State Climatologist (ONJSC) divides New Jersey into five distinct climate regions. West Cape May is included in the Coastal Zone, which includes the coastal portions of Monmouth, Ocean, Burlington and Atlantic Counties and nearly all of Cape May County (ONJSC, No Date).

Weather in the coastal zone is determined by both continental and oceanic influences. Proximity to the Atlantic Ocean has a moderating effect on air temperatures, resulting in more gradual changes and less extreme fluctuations than elsewhere in the state. Between October and April, the coastal zone is especially prone to storms that track along the coastal plain or offshore, bringing strong winds and heavy rains to the region. The coastal zone is particularly vulnerable to tropical storms and hurricanes, which may account for a significant amount of the regional precipitation in a given year. In addition to rain and wind, damage from high tides is often associated with severe coastal storms (ONJSC, No Date).

The ONJSC's New Jersey Weather and Climate Network maintains weather stations which transmit real-time data and weather forecasts on the Internet. Of these stations, the Cape May station is nearest long-running station to West Cape May Borough. The Cape May weather station has collected data from 1894 to present, but with gaps in data from 1898-1903, 1914-1925, and 1933-1938. **Table 2.1** displays monthly average highs and lows and mean temperature, average monthly precipitation, and record highs and lows (and the year it occurred in parentheses). In 2008, a weather station was activated at the Rea Farm in West Cape May. Current local conditions and forecasts for the Borough area are available at http://www.njweather.org/station/261.

Measurable precipitation falls in New Jersey on approximately 120 days per year. At the Cape May weather station, annual precipitation has averaged 40.70 inches (for the period 1894-2016), which is at the low end of the range of 40 to 51 inches in New Jersey (see **Table 2.1**) (ONJSC, No Date; ONJSC, February 2017).

Rainfall is distributed fairly evenly throughout the year, with February being the driest month. On average, August has the highest precipitation, but conditions may appear drier because evapotranspiration exceeds precipitation (ONJSC, February 2017). The portion of Cape May County that includes West Cape May Borough averages 10-12 day per year with precipitation one inch or greater, while precipitation levels exceeding two inches are only likely to occur once or twice a year (ONJSC, 2017).

Table 2.1: Temperature & Precipitation at Cape May, NJ

Month	*Based on data from 1894-2016*		*Based on data from 1894-2016*	*Based on data from 1894-2010*		*Based on data from 1894-2016*
	Temperature (°F)					Mean Precipitation
	Avg. High	Avg. Low	Mean	Record High	Record Low	
January	42.0	28.0	35.1	73°F (2002)	-2°F (1982)	3.19 in.
February	43.0	28.5	35.8	74°F (1930)	-1°F (1979)	2.90 in.
March	50.1	35.1	42.6	82°F (1990)	7°F (2007)	3.73 in.
April	59.5	43.4	51.4	91°F (2009)	22°F (1982)	3.29 in.
May	69.0	52.9	60.9	95°F (1991)	33°F (1992)	3.30 in.
June	77.9	62.0	70.0	99°F (1963)	42°F (1956)	3.19 in.
July	82.9	67.4	75.2	106°F (1966)	51°F (1962)	3.46 in.
August	82.1	66.8	74.5	98°F (1912, 2006&7)	45°F (1986)	4.14 in.
September	77.0	61.6	69.3	96°F (1953)	32°F (1967)	3.27 in.
October	66.7	50.9	58.8	89°F (2007)	26°F (1950)	3.38 in.
November	56.2	41.4	48.8	83°F (1950)	14°F (1947)	3.15 in.
December	46.2	32.2	39.3	76°F (1998)	5°F (1942)	3.38 in.
					Average Annual Precipitation:	40.70 in.
Sources: ONJSC, February 2017 (averages) and ONJSC, 1893-2010 (extremes).						

Snow typically contributes little to the total precipitation in West Cape May (about 10" of snow equals 1" of rain). During the average winter, southern Cape May County experiences only four to six days of snowfall greater than or equal to a half inch, while snowfall greater than one inch is likely to occur less than four times per winter (ONJSC, 2017). As measured at the Cape May station, the earliest snow on record was on November 10 (in 1987, with 0.1 inch), and the latest was April 9 (in 1907, with 3.0 inches). Record snowfall for the region was 20 inches on January 24, 1908 (ONJSC, 1893-2010).

The growing season within Cape May County averages about 196 days, although the season is highly variable within the county due to coastal influences. The average date for the last killing spring frost is April 17th, and the first frost of fall occurs around November 3rd; however, the frost-free season is typically 60 days longer on the southern peninsula than it is in the northern part of the county. find and cite county soil survey (Dunlap, D.V. as cited in Markley 1977). Extreme dates for temperatures below freezing recorded in at the Cape May station were October 14 (31°F in 1988) and April 23 (29°F in 1989) (ONJSC, 1893-2010). During the winter, temperatures do not remain low for long periods, and soils do not freeze to a depth of more than six to twelve inches (Dunlap, D.V. as cited in Markley 1977).

Extreme Weather

Most areas of New Jersey receive 25 to 30 thunderstorms per year, with fewer storms near the coast than farther inland. In addition, each year between 1 and 10 nor'easters bring strong winds and heavy rains to the state, particularly in the coastal zone. Approximately five tornadoes appear each year in New Jersey (usually relatively weak ones) (ONJSC, No Date). Eight tornadoes have been recorded in Cape May County since 1950 (occurring in 1952, 1956, 1971, 1979, 1985, 1986, 1989 and 2003) and three funnel clouds have also been documented (in 2006, 2008 and 2012) (NOAA, 1950-2016). During the same period, 18 hail events were recorded in Cape May County. Hail which fell in the immediate vicinity of West Cape May occurred on June 12, 2007 (penny to nickel size hail), June 27, 2008 (nickel size hail), and June 29, 2012 (penny size hail) (NOAA, 1950-2016).

Figure 2a: Historical Coastline Near West Cape May

Selected data from the past 180 years shows a pattern of shifting shorelines at the outer tip of Cape May County.

Table 2.2 lists some of the highest snow and rainfall received in one day at the Cape May weather station (*although multiple day storms can have higher totals*), for the period 1893 to 2010 (the most recent data available on the Internet) (ONJSC, 1893-2010).

Table 2.2: Highest Daily Precipitation Measured at Cape May

Rank	Greatest one-day snowfall		Greatest one-day rainfall	
	Amount	Date	Amount	Date
1st	20.0 in.	Jan. 24, 1908	8.15 in.	Aug. 14, 1953
2nd	18.8 in.	Feb. 16, 2003	6.35 in.	Sep. 12, 1960
3rd	17.5 in.	Feb. 6, 2010	4.89 in.	Jun. 19, 1967
4th	16.8 in.	Feb. 19, 1979	4.60 in.	Aug. 4, 1967
5th	16.0 in.	Jan. 25, 1905	4.31 in.	May 21, 1894
6th	14.4 in.	Feb. 24, 1989	4.30 in.	Aug. 25, 1958
Source: ONJSC, 1893-2010				

Tropical storms and hurricanes can contribute significant rainfall and can cause flooding. Some of the major storms that have affected West Cape May are described here. Hurricane Floyd battered New Jersey on September 16, 1999, although the toll was greatest in the northern and central regions of the state. Damage in the Cape May area was limited to back bay flooding and minor beach erosion. Other noteworthy tropical storms affecting Cape May since 1950 include Bertha (July 13, 1996), Isabel September 18-19, 2003), Hanna (September 6, 2008) and Irene (August 27, 2011). Although post-tropical, Superstorm Sandy (October 28-30, 2012) was the costliest natural disaster in New Jersey, and nearly every municipality in Cape May County experienced widespread damage (NOAA 1950-2016). Precipitation levels were highest in Cape May County, and the storm delivered 8.97 inches of rain to West Cape May (Robinson, 2012).

Cape May County is also susceptible to non-tropical coastal flooding, which occur fairly frequently in the region. In addition to Superstorm Sandy, 62 coastal flooding events have been recorded in the region from 1996-2016 (NOAA, 1950-2016). Seven of these events resulted in extensive property damage within the county (**Table 2.3**).

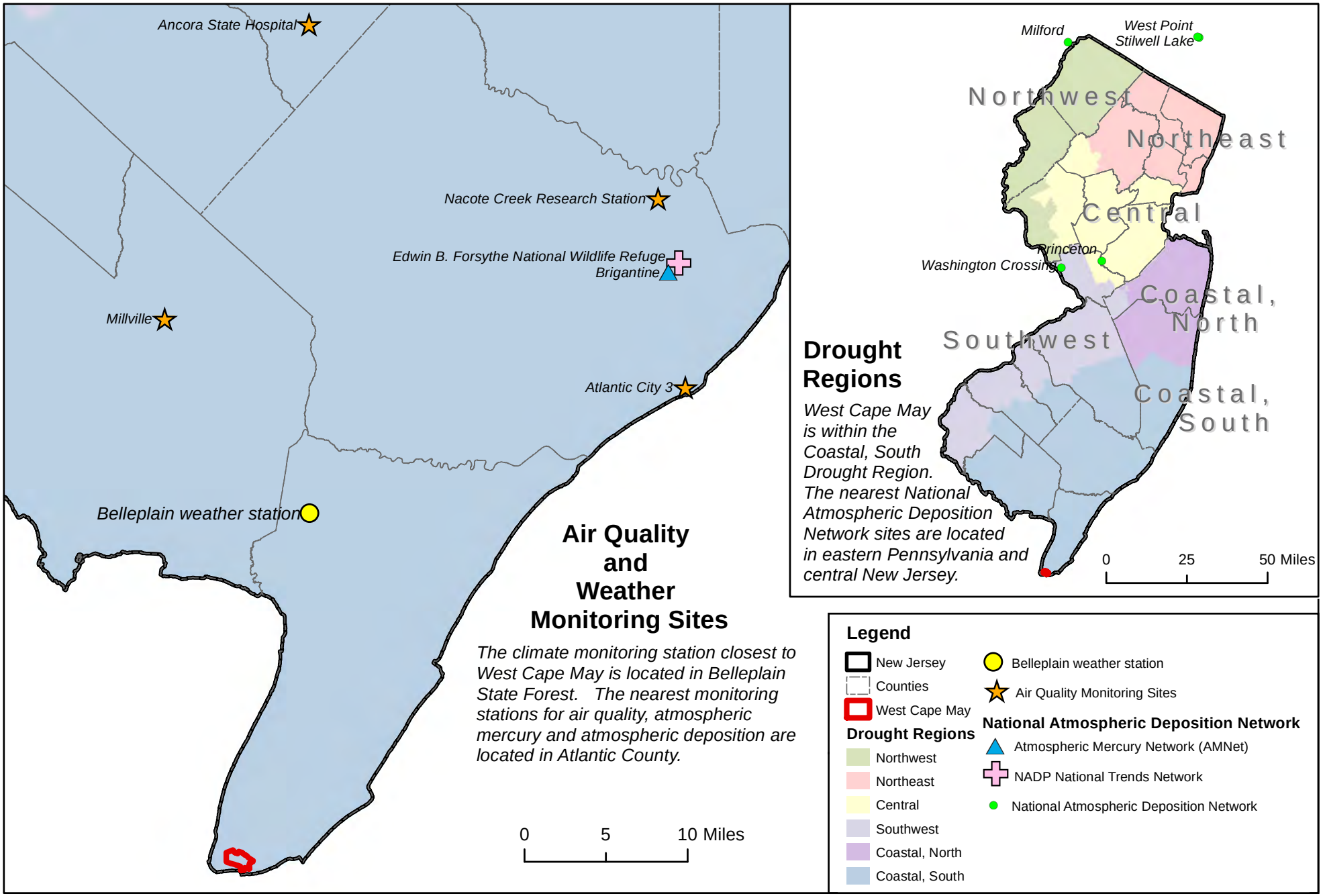
At the other extreme, extended periods of time with less than normal amounts of precipitation result in drought; agriculture suffers, wells can fail, reservoir levels fall and water supplies can be threatened.

NJDEP provides information about droughts according to Drought Region, using indicators of 90-day precipitation, 90-day stream flow, reservoir levels and ground water levels for each region. West Cape May lies within the Coastal South Drought Region (see **Figure 2b** and **Internet Resources**).

During a *drought watch*, voluntary water conservation measures are encouraged. During a *drought warning*, measures are taken to manage water supplies in order to avert a *drought emergency*. A water supply emergency results in mandatory restrictions on water use in order to curtail water demand. New Jersey's worst drought occurred in the 1960s, and included three consecutive years (1963-1965) that were among the four driest years since record-keeping began in 1985 (NJDEP, 2012). The full span of the drought ranged from June 1961 through August

Table 2.3: Cape May County Losses from Recent Coastal Flooding Events

Date	Estimated Cost	Cause
October 28, 2012	$ 175,000,000	Sandy
November 13, 2009	$ 122,000,000	northeaster
January 28, 1998	$ 14,500,000	northeaster
January 7, 1996	$ 3,900,000	coastal flood
February 4, 1998	$ 3,630,000	northeaster
October 2, 2015	$ 2,000,000	persistent onshore flow
February 12, 2006	$ 200,000	winter storm
March 7, 2013	$ 20,000	northeaster
Source: NOAA, 1950-2016.		



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Data Sources: NJDEP, NJDOT, NADP
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.

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Figure 2b: Air Quality and Weather Monitoring Sites and Drought Regions

1966 (Bauersfeld et. al., 1989), and resulted in a major disaster declaration for the state (FEMA, 2017). FEMA (2017) also lists an emergency declaration for the state during the drought of June 1980 to April 1981. The most recent long-term drought of significance began in October 2001, was declared an emergency in March 2002, and ended in January 2003 for north and central New Jersey but extended into March 2003 in the southern part of the state (NJDEP, 2017). The five years with lowest precipitation, based on long-term data from Cape May, New Jersey, are shown in **Table 2.4**.

Table 2.4: Lowest Annual Precipitation*

Rank	Year	Amount (inches)	Deviation from Mean
1st	1930	26.12	-14.58
2nd	1943	27.10	-13.60
3rd	1947	29.35	-11.35
4th	1929	29.85	-10.85
5th	1931	31.64	-9.06
*Cape May 1894-2016; mean = 40.70 inches			
Source: ONJSC, February 2017			

B. Air Quality

The New Jersey Comparative Risk Project (March 2003), funded by the United States Environmental Protection Agency (USEPA) and the NJDEP, combined the efforts of 73 experts to analyze and rank 88 chemical, physical and biological factors ("stressors") according to their relative negative impacts on human health, ecological quality, and socioeconomic conditions (monetary cost). The study ranked several air pollutants among the highest risks to human health, including ground-level ozone, particulate matter, radon[10], secondhand tobacco smoke, and volatile organic compounds (VOCs). Air pollution is estimated to have medium to medium-high socioeconomic impact, and lesser impacts to ecological quality (Steering Committee of the NJ Comparative Risk Project, 2003).

Exposure to air pollution is a widespread problem that occurs throughout the entire state. Airborne pollutants come from a wide variety of sources, including industry, utilities, manufacturing and commercial sources, vehicles and residential activities (such as oil burning for home heating, and painting houses). On hot summer days, when pollutant levels are worst, winds in New Jersey are usually blowing from the southwest, carrying air pollution from the Washington, Baltimore and Philadelphia metropolitan areas to New Jersey. In turn, these winds carry the pollution created here to New York, Connecticut and further to the northeast.

After the passage of the Clean Air Act in 1970, the USEPA set National Ambient Air Quality Standards (NAAQS) for six pollutants, known as the *Criteria Pollutants:* nitrogen dioxide, lead, sulfur dioxide, ozone, carbon monoxide, and particulate matter. These pollutants are addressed throughout the country through a planning process and the concentrations of these pollutants in air have been monitored for compliance with the air quality standards. Since 1970, concentrations of these six pollutants have been significantly reduced throughout the country (USEPA, July 24, 2012; USEPA, February 14, 2012). Areas of the country where air pollution levels persistently exceed the NAAQS are designated *nonattainment*.

New Jersey has never exceeded the NAAQS for nitrogen dioxide (NO_2), and has not exceeded the standard for lead since the early 1970s. As of 2014, Warren County was the only county to exceed the sulfur dioxide (SO_2) standard, but since Pennsylvania's Portland Power Plant shut down its coal-fired units all of New Jersey is in attainment of the SO_2 standard. Five New Jersey counties, and selected urban areas in ten additional counties, are included in the state's three 8-hour carbon monoxide (CO) maintenance plan areas (see **Figure 2c**). All of Cape May County is currently in attainment of the standard for CO. Thirteen New Jersey counties are presently designated as nonattainment areas for both the particulate matter ($PM_{2.5}$) annual

[10] Radon is discussed in **Section 3D** and Radon in ground water is discussed in **Section 5F**.

standard of 15 μg/m^3, [11,12] and for the 24-hour 35 μg/m^3 standard (see **Figure 2c**). Cape May County is in attainment with this standard, as are the two adjacent counties. However, Cape May County is part of the Southern New Jersey-Philadelphia-Delaware nonattainment area for the Ozone standard (1997 8-hour ozone standard of 0.08 ppm; revised in 2008 to 0.075 ppm (see **Figure 2c**) (NJDEP Bureau of Air Quality Planning, January 25, 2013).

The USEPA requires New Jersey to report the emissions from major sources annually. To accomplish this, the Emission Statement Rule (N.J.A.C. 7:27-21) requires the annual reporting of emissions from stationary sources for the following air contaminants; carbon monoxide (CO), sulfur dioxide (SO_2), ammonia (NH_3), total suspended particulate matter (TSP), respirable particulate[13] matter (PM_{10} and $PM_{2.5}$), lead (Pb), volatile organic compounds (VOC), oxides of nitrogen (NO_x), carbon dioxide (CO_2), methane (CH_4) and the 36 toxic air pollutants (TAPs).

NJDEP developed the Air Quality Index (AQI) to provide a descriptive rating and a color code (e.g. green=good) in real-time on the internet for many sites. The closest station to West Cape May that monitors Ozone (O_3) is located northeast of Millville in Cumberland County. Particulate matter ($PM_{2.5}$) and Nitrogen Dioxide/Nitric Oxide (NO_x) are also monitored at the site (NJDEP Bureau of Air Monitoring, February 13, 2013). See **Internet Resources** for a link to current air quality at the site; see **Figure 2b** for the location). The following paragraphs provide more information about ground-level ozone, particulates, air toxics and atmospheric deposition.

Ground-level Ozone

Ground-level ozone (O_3) causes serious adverse health and environmental effects. It forms in the air from volatile organic compounds (VOCs) and nitrogen oxides (NO_x) under conditions of high temperature and bright sunlight. Sources include vehicles, power plants and factories. The hottest days of summer can yield unhealthy levels of ozone.

The National Ambient Air Quality Standards (NAAQS) for ozone were revised in 2008 because the USEPA determined that the 1997 standard was inadequate to protect public health. The standard of 0.075 ppm is calculated as an average over 3 years of the annual fourth-highest daily maximum 8-hour concentration. The 1-hour ozone standard was revoked June 15, 2005 (USEPA, December 14, 2012).

During 2016, monitoring data for the Millville site indicated that the 8-hour ozone standard of 0.075 ppm was exceeded once, on the 25th of May. The 2013-2015 average of 4th-Highest Daily Maximum was 0.065 ppm at Millville, which is below the standard.

The Clean Air Act requires that all areas of the country be evaluated and then classified as attainment or non-attainment areas for each of the National Ambient Air Quality Standards. Using the most recent data throughout the state, the USEPA has classified northern New Jersey as being "moderate" and southern New Jersey as "marginal" for non-attainment of the 8-hour ozone NAAQS, as illustrated in **Figure 2c**. A "marginal" area has a design value of 0.076 up to but not including 0.086 ppm. New Jersey's 2012 Ozone Summary states that significant further improvements will require reductions in both VOCs and NOx, which will have to be achieved over a large region because levels in New Jersey are impacted by emissions from upwind sources (US EPA, May 3, 2013; US EPA, September 30, 2017; NJDEP Bureau of Air Monitoring, 2015; NJDEP Bureau of Air Monitoring, 2012).

[11] m^3= cubic meters
[12] μg/m^3 = micrograms per cubic meter of air (a microgram is one millionth (10^{-6}) of a gram).
[13] See Particulates, below in this section, for more information.

12 **Figure 2c: National Ambient Air Quality Standards Nonattainment**

Cape May County is currently in attainment of the standards for carbon monoxide emissions and particulate matter. All of southern New Jersey is classified as marginally unhealthy for non-attainment of ground-level ozone standards.

New Jersey Carbon Monoxide (CO) Maintenance Areas

Carbon Monoxide [76 FR 54294, Aug 31, 2011]
Primary Standard:
8-hour average = 9 ppm not to be exceeded more than once per year.
1-hour standard = 35 ppm not to be exceeded more than once per year.

New Jersey Annual Fine Particulate Matter ($PM_{2.5}$) Nonattainment Areas

***Particle Pollution*, $PM_{2.5}$** [as of Dec 14, 2012]
Primary:
Annual mean, averaged over 3 years=12 µg/m^3; Secondary:
Annual mean, averaged over 3 years=15 µg/m^3;
Primary & Secondary:
24-hour 98th percentile, averaged over 3 years=35 µg/m^3

New Jersey 8-Hour Ozone Nonattainment Areas(2008 standard)

Ozone*, *8-hour [73 FR 16436, Mar 27, 2008]
Primary & secondary:
Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years = 0.075 ppm

Sources: NJDEP Bureau of Air Quality Planning, January 25, 2013; USEPA, September 30, 2017

Particulates

Particulate air pollution consists of both solid particles and liquid droplets suspended in the atmosphere, usually less than 70 microns in diameter. In addition to human health and environmental effects, particulate matter is a major cause of reduced visibility. Particulate matter smaller than 2.5μ (μ=microns, equal to 0.001 millimeter) diameter ($PM_{2.5}$) are considered *Fine Particulates*, while larger particles are considered *Coarse Particulates*. Coarse Particulates are made up of Total Suspended Particulates (TSP) and Inhalable Particulates (PM_{10}). All sizes are harmful to the environment, but coarse particles smaller than 10 microns (PM_{10}) are inhalable, therefore are considered harmful to human health, while fine particles less than 2.5 microns ($PM_{2.5}$) are even more detrimental to human health. Coarse particle sources include windblown dust and industrial sources, while fine particles come from combustion sources or are formed in the atmosphere from gaseous emissions. In December 2012, the EPA revised the standard from 15.0 $\mu g/m^3$ to 12.0 $\mu g/m^3$. An area will meet the standard if the three-year average of its annual average $PM_{2.5}$ concentration (at each monitoring site in the area) is less than or equal to 12.0 $\mu g/m^3$ (US EPA, December 14, 2012).

Air Toxics

In 1979, NJDEP adopted a regulation that specifically addressed air toxics emissions. This rule (Control and Prohibition of Air Pollution by Toxic Substances, N.J.A.C. 7:27-17) listed 11 Toxic Volatile Organic Substances (TVOS) and required that sources emitting those TVOS to the air should register with the Department and demonstrate that they were using state-of-the-art controls to limit their emissions (NJDEP Air Toxics in NJ, July 24, 2012). Under the Clean Air Act Amendments of 1990, USEPA is required to begin to address a list of 188 of these air toxics (known as Hazardous Air Pollutants, or HAPs). NJDEP works with USEPA to implement these various strategies to reduce air toxics throughout the state

The USEPA prepared a comprehensive inventory of air toxics emissions for the entire country as part of the National-Scale Air Toxics Assessment (NATA) in 1996, and updated in 1999, 2002 and 2005. The 2005 study update determined that, in New Jersey, on-road mobile sources are responsible for 33% of the toxic emissions; nonpoint/area sources contribute 31% (residential, commercial, and small industrial sources); non-road mobile sources (airplanes, trains, construction equipment, lawnmowers, boats, dirt bikes, etc.) account for 29%; and point sources account for the remaining 7%.

The NJDEP has established four comprehensive air toxics monitoring sites. They are located in Elizabeth, New Brunswick, Chester and Camden. Pollutant concentrations are trending downward, but many of them still exceed the NJDEP health benchmarks (NJDEP Air Toxics in NJ, 2005).

Atmospheric Deposition

Pollution that is deposited on land or water from the air is called *atmospheric deposition.* Wet deposition is washed from the air by precipitation, while dry deposition refers to particulates that settle out of the atmosphere during dry weather. Sources include motor vehicles, power plants, and incinerators. The major pollutants of concern are sulfur dioxide (SO_2), nitrogen oxides (NO_x), mercury (Hg), and volatile organic compounds (VOCs). In addition, the presence of these pollutants changes the pH of the precipitation which can harm plants and aquatic life (trout are particularly sensitive) and deplete nutrients from soils.

The closest National Atmospheric Deposition Program (NADP) site is located in Edwin B. Forsythe National Wildlife Refuge, which has been monitored since 1998. Results for 2016 show a mean pH value of 5.12 (normal rainfall has a pH of about 5.6). This is acidic, but is an

improvement from 1999, when pH averaged 4.35 at this site. Trends show decreasing concentrations of SO_4 and NO_3; but no improvement in NH_4, Ca, Mg, K, Na, Cl and N (NADP, 2017a).

Mercury (Hg) is a highly toxic heavy metal. Human health concerns of mercury include neurotoxicity (low-level exposure is linked to learning disabilities in children) and interference in reproduction, while both methyl mercury and mercuric chloride are listed by EPA as possible human carcinogens. Environmental effects have not been adequately studied, but animals, especially fish-eaters, experience effects similar to humans. The exposure to mercury is not from ambient air, but from deposition of airborne mercury onto surface water, vegetation and soil, which can then enter the food and water supply. On the basis of preliminary data from the New Jersey Air Deposition Network, the deposition of mercury from the air is higher than the national average of 10 $\mu g/m^2$/year. In NJ, the major sources of mercury are steel and iron manufacturing, coal combustion, products (such as broken fluorescent tubes), and municipal and sludge incineration. Mercury persists in the atmosphere up to two years and reaches the surface through atmospheric deposition, where it may persist as methyl mercury in the soil for decades. Mercury is never removed from the environment, but accumulates in biological tissue (bioaccumulation) (see **Section 6.I for Fish Consumption Advisories**) (NJDEP New Jersey Mercury Task Force, December 2001; NADP, 2017b).

In New Jersey, three sites are monitored as part of the Atmospheric Mercury Network (AMNet) for mercury: NJ54 Elizabeth Lab, NJ30 New Brunswick and NJ05 Brigantine The Brigantine site was initiated in 2015, replacing the Chester site. The data from this program is not publicly available (NADP, 2017c).

The Mercury Deposition Network (MDN) provides a long-term record of total mercury (Hg) deposition in precipitation throughout the United States and Canada, including one site in New Jersey (see **Figure 2d**). Standard procedures include automated weekly collection modified to preserve mercury. Ten years of data show a gradually decreasing trend in mercury deposition at the New Brunswick site (NADP, 2017b).

In addition to directly measuring mercury in precipitation, a study of mercury in lake sediment cores can be representative of atmospheric deposition over long periods of time. A 2003 study by the NJDEP Division of Science, Research and Technology, with sites throughout New Jersey, demonstrated that, while mercury levels have decreased, they are still present at levels far higher than natural levels (Kroenke et al, 2003; Schuster et al, 2004).

C. Existing Infrastructure

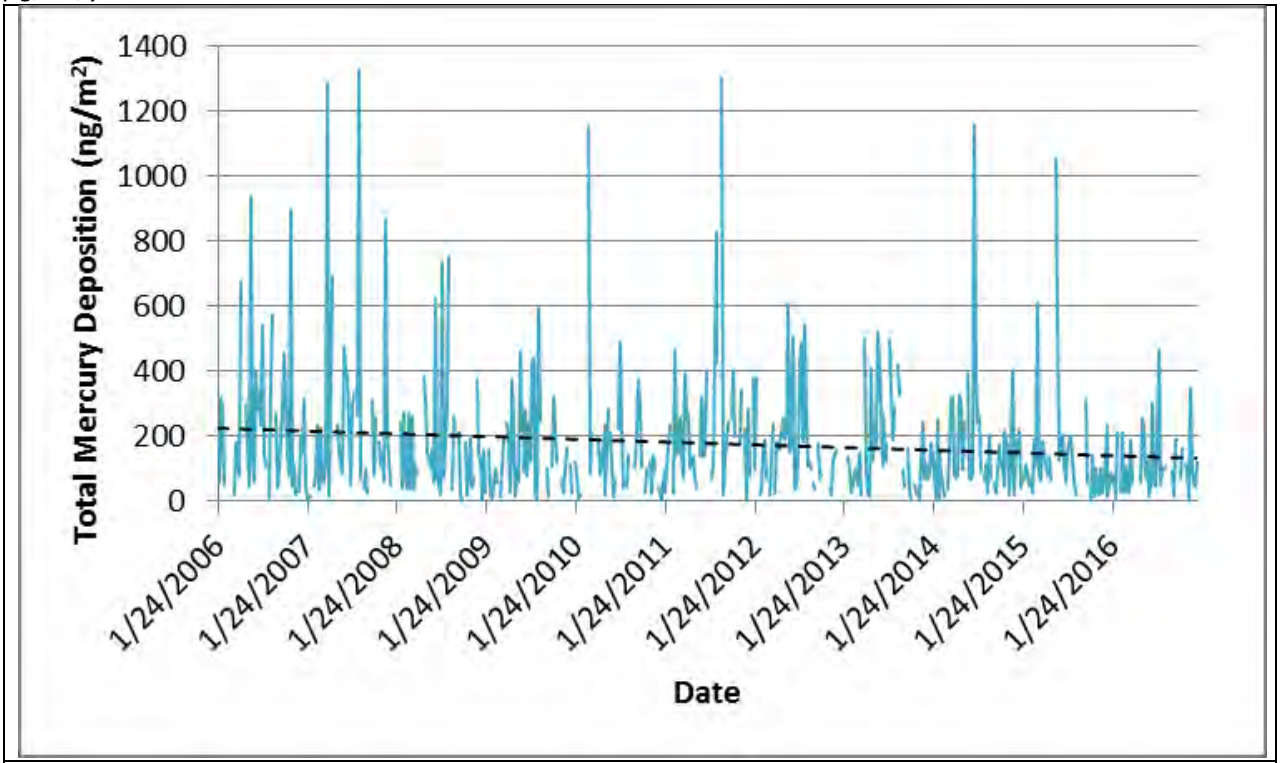
Public Water

Public water purveyors may be government agencies, private companies, or quasi-government groups. Water purveyors are regulated by the NJDEP Bureau of Safe Drinking Water, under the Safe Drinking Water Act. *Public Community Water Supply* (PCWS) wells are wells that supply potable water to public communities, and serve at least 15 connections used by year-round residents or which serve at least 25 year-round residents.

The West Cape May Water Department obtains the borough's water from Cape May City Water Department from the wells shown in **Figure 2e,** which draw from the Atlantic City 800-foot sand aquifer and the 560-foot-deep Cohansey aquifer, and blended with the clean water from the desalination plant. The water purveyor areas are shown on **Figure 2e.** Roughly the northwestern quadrant of the borough (east of route 607 and south of Stevens Street) relies on private wells (NJDEP Bureau of Environmental Assessment, 2004). A discussion of the aquifers that these wells draw from is found in **Section 5C** while **Section 5.E** addresses water quality.

13 **Figure 2d: Mercury Deposition Network (MDN) at New Brunswick (2006 to 2016)**

Mercury levels in New Jersey show a decreasing trend, but still greatly exceed the national average of 10 µg/m²/year.



MDN Site NJ30 (New Brunswick)
Latitude: 40.4728 Longitude: -74.4226
Date Range Displayed: 01/17/2006 to present
Average (mean) = 178.2 ng/m2
Median (middle value) = 115.43
Minimum = 2.48 collected on 10/20/2015
Maximum = 1326.41 collected on 8/14/2007

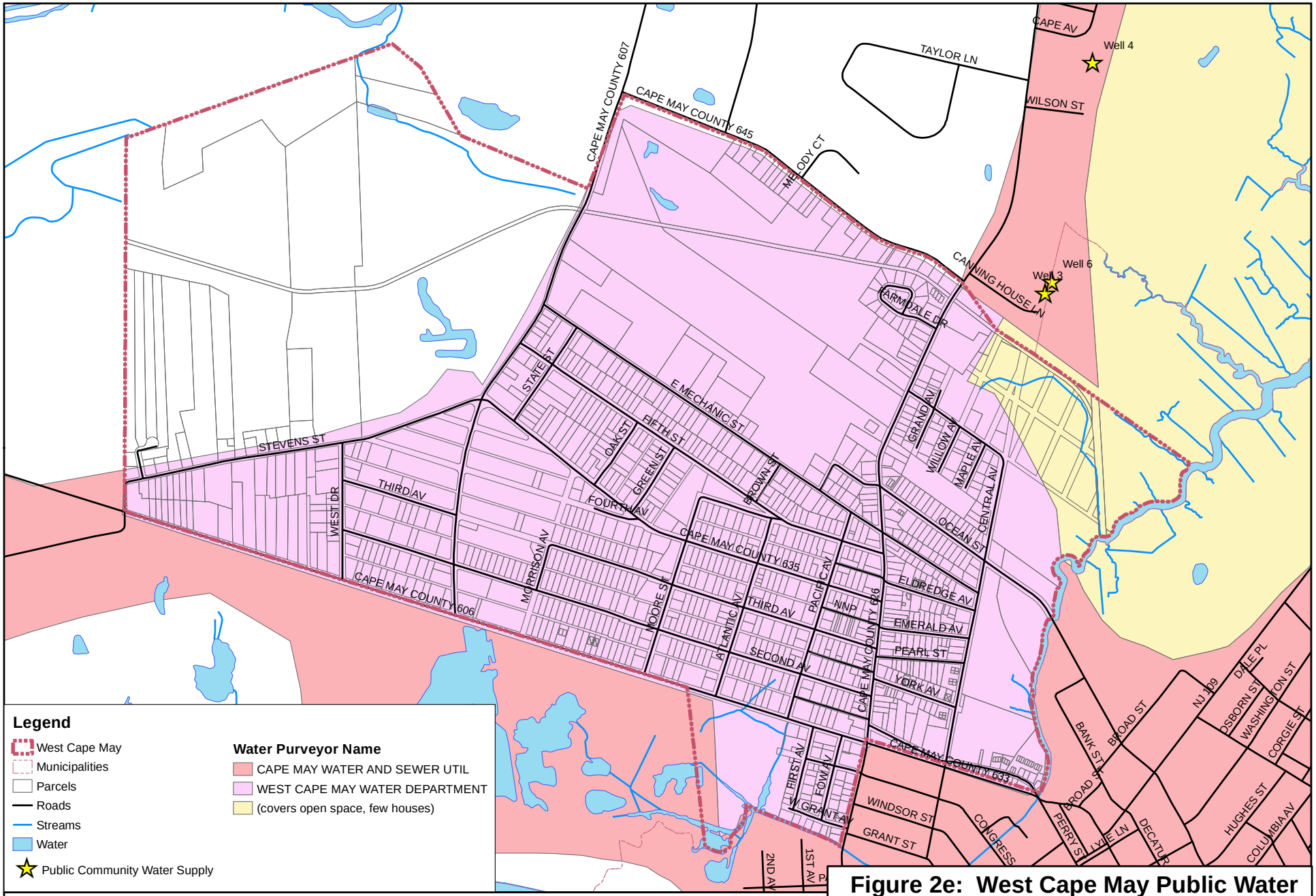
Source: NADP, 2017b

Sewer Service Areas

The NJDEP administers the Statewide *Water Quality Management (WQM)* Planning rules found in N.J.A.C. 7:15. The rules establish a mechanism for determining whether proposed projects or activities are consistent with the statewide WQM Plan (see **Internet Resources and Section 10C**). This process includes development and adoption of a *Wastewater Management Plan (WMP)*, a document that provides 20 year planning (or to build-out for non-urban communities) for wastewater and certain other water quality concerns.

Cape May County is the responsible agency for WMPs in the area including the borough of West Cape May (NJDEP Office of Water Resources Management Coordination, November 14, 2017).

The public *Sewer Service Areas* (SSA) mapped on **Figure 2f** show the areas served by the Cape May Regional Wastewater Treatment Plant. A separate SSA covers Westwood Mobile Estates Depot Travel Park. Areas not designated as SSAs are planned for service by individual subsurface disposal system (septic systems) discharging less than 2,000 gallons per day (gpd) (where the site conditions and existing regulations allow) (NJDEP, January 24, 2017).

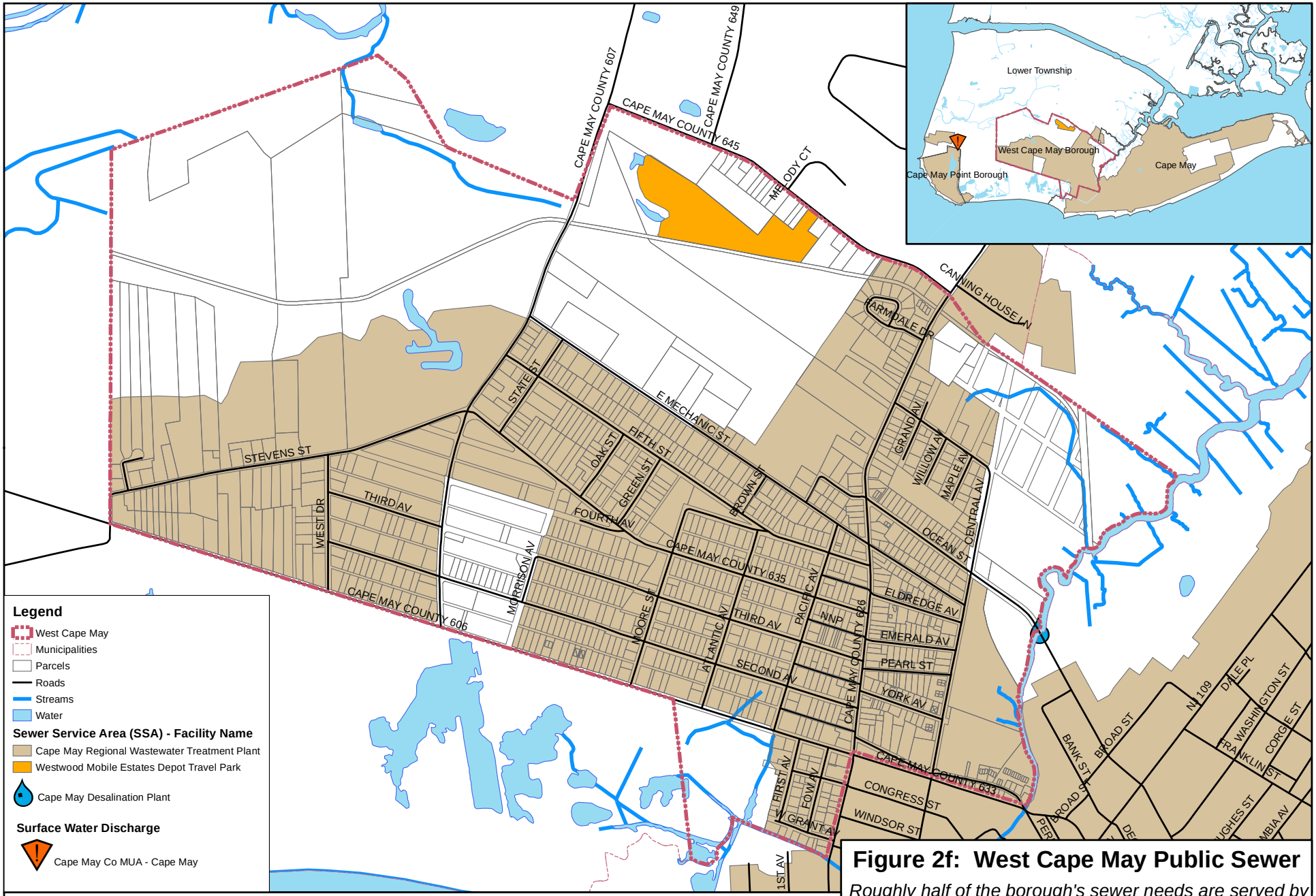


Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized

Figure 2e: West Cape May Public Water

The West Cape May Water Department obtains much of the borough's water from wells managed by the Cape May City Water Department. Water in the northwestern section of the borough is provided via private wells.



Prepared by Kratzer Environmental Services

Data Sources: NJDEP, NJDOT
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Figure 2f: West Cape May Public Sewer

Roughly half of the borough's sewer needs are served by the Cape May Regional Wastewater Treatment Plant. A separate Sewer Service Area covers Westwood Mobile Estates Depot Travel Park. The remaining areas are planned for service by individual septic systems.

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Internet Resources: Local & Regional Conditions

Climate and Meteorology
NJ Weather and Climate Network: West Cape May, NJ, Rea Farm. Current local conditions and forecasts for the Borough area are available at http://www.njweather.org/station/261

Office of the New Jersey State Climatologist (ONJSC)
- ONJSC Home Page: http://climate.rutgers.edu/stateclim/
- NJ Drought Watch: http://www.njdrought.org/
- Drought Status of Northwest Region: http://www.njdrought.org/current.html#coastalsouth
- Weather and Climate Network Index: http://climate.rutgers.edu/njwxnet

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions):
Delaware Bay at Cape May: http://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=cman4
Cape May Harbor at Cape May Harbor: http://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=capn4

National Weather Service Forecast West Cape May, NJ:
http://forecast.weather.gov/MapClick.php?CityName=Cape+May&state=NJ&site=PHI&textField1=38.9401&textField2=-74.9055&e=1#.WfZAaluPLb0

Sea Level Rise
- Climate Central Surging Seas Risk Finder: https://riskfinder.climatecentral.org/
  - Directly to West Cape May https://riskfinder.climatecentral.org/place/west-cape-may.nj.us
- NJ Coastal Communities Initiative: http://www.prepareyourcommunitynj.org/
- NJ Flood Mapper (an interactive mapping website to visualize coastal flooding hazards and sea level rise): http://www.njfloodmapper.org/slr/

Air Quality
Current Air Quality: http://www.njaqinow.net/

Daily Air Quality Index Forecast: http://www.airnow.gov/index.cfm?action=airnow.local_state&stateid=31&tab=0

What you can do to reduce air toxics? http://www.state.nj.us/dep/airmon/airtoxics/youcan.htm

NJDEP Radon Information: http://njradon.org or call 1-800-648-0394 609-984-5425

NJDEP Rules and Regulations (current and proposed): http://www.nj.gov/dep/rules/

United States Environmental Protection Agency Air Topics: http://www.epa.gov/agriculture/air.html

3: PHYSIOGRAPHY, TOPOGRAPHY & GEOLOGY

A. Physiography

New Jersey can be divided into four regions, known as *physiographic provinces*, which are areas with a common geologic history and similar sequences of rock types and geologic structures (see **Figure 3a**). The geologic history of New Jersey is summarized in **Table 3.1**.

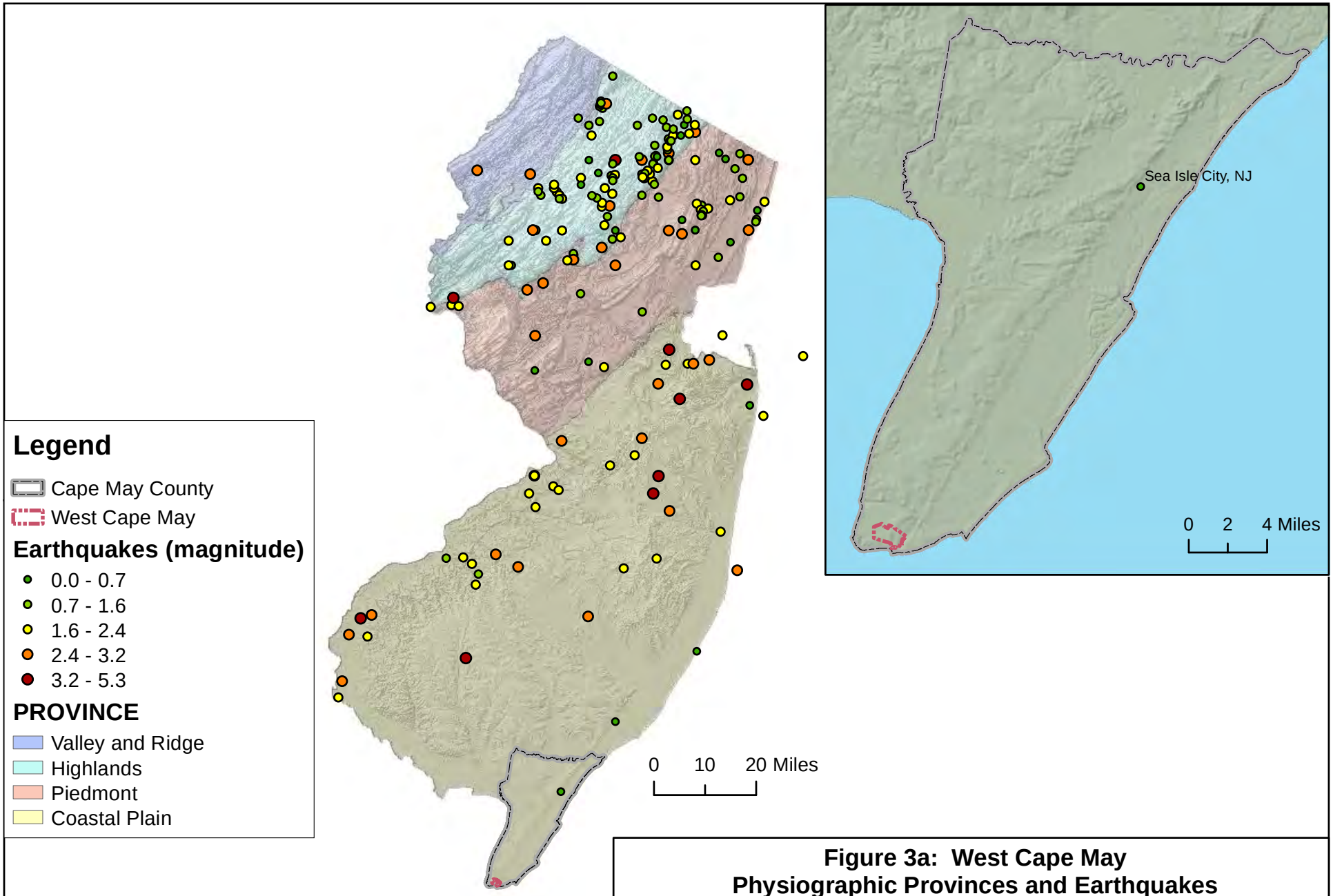
During the Precambrian and Paleozoic Eras, the land that is now New Jersey was at the bottom of the sea, close to the equator. About 400 million years ago, the continents Europe and North America collided; forming the Appalachian Mountains, which at that time reached far higher and were more rugged than the Rocky Mountains are now (Gallagher, 1997).

In New Jersey, the Appalachian Mountains are known as the *Valley and Ridge Province.* This Province is characterized by long, parallel ridges and valleys, and encompasses the northwestern section of New Jersey. High Point, with an elevation of 1,803 feet and the highest point in New Jersey, is located in this Province (NJGS, 2006).

Bordering the Valley and Ridge Province to the southeast, the *Highlands Province* consists of a series of ridges. Metamorphic granite and gneiss rocks 1.2 billion to 900 million years old (the oldest rocks in the state) are resistant to erosion and create a hilly upland. Wawayanda Mountain is the highest point (1,496 feet) in the Highlands. Elevations decrease to the southeast and southwest. The Highlands Province is also characterized by deep, steep-sided valleys carved by streams (NJGS, 2006).

The Highlands Province is separated from the *Piedmont Province* by a series of major faults, where the crystalline rocks of the Highlands touch the much younger sedimentary and igneous rocks of the Piedmont. The Piedmont Province is characterized by gently rolling hills. The rocks of the Piedmont are of Late Triassic and Early Jurassic age, 240 to 140 million years old (NJGS, 2006).

Sediments that eroded from adjacent uplands were deposited along rivers and lakes within the basin, and they became compacted and cemented to form conglomerate, sandstone, siltstone and shale bedrock. Roughly 200 million years ago, the supercontinent Pangaea broke apart, and the Atlantic Ocean was born. This was accompanied by volcanic activity, which resulted in magma flowing at the surface (forming basalt) or near the surface (forming diabase) (Lucey, 1971).



Data Sources: NJDEP, NJDOT
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
Disclaimer: This map was developed using NJDEP GIS digital data, but this secondary product has not been verified by NJDEP and is not NJDEP authorized.
Prepared by Kratzer Environmental Services

Figure 3a: West Cape May Physiographic Provinces and Earthquakes

West Cape May is located within the Coastal Plain province, which consists of unconsolidated sedimentary formations such as sands, clays and marls. Earthquakes are rare in the southern part of the state--the nearest record is from Sea Isle City in 1910.

Overlapping the Piedmont Province, the relatively flat terrain of the *Coastal Plain Province* consists of unconsolidated sedimentary formations, such as sands, clays, and marls. These range in age from 90 to 10 million years old (NJGS, 2006). The Coastal Plain Province is sometimes divided into the Inner and Outer Coastal Plains with West Cape May located in the latter.

Within the past two million years, the climate alternated between cool and warm. During periods of glaciation, the glaciers covered northern New Jersey and extended as far south as Perth Amboy, NJ, while the area below that became cold tundra. At times, the Coastal Plain was under the Atlantic Ocean, although at other times, the shore may have extended a hundred miles beyond the present shore (White, 1998).

Table 3.1: Summary of New Jersey's Geologic History

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
Precambrian Era		
	Up to 544	**Climate:** New Jersey was under the sea. **Fossils:** stromatolites; most life forms were soft bodied and left no fossils
Paleozoic Era		
Cambrian Period	544 – 505	**Climate:** New Jersey was close to the equator, covered by warm tropical seas. **Fossils:** trilobites, brachiopods, stromatolites, worm burrows
Ordovician Period	505 – 440	**Climate:** New Jersey continued to be underwater, as the sea above deepened to oceanic depths. **Fossils:** trilobites, brachiopods, coral, nautiloids, clams, crinoids, and snails
Silurian Period	440 – 410	**Climate:** The sea level rose and fell, with New Jersey remaining at the sea floor. **Fossils:** coral, brachiopods, clams, brine shrimp, primitive fish, eurypterids (sea scorpions), arthrophycus (fossilized feeding burrow made by a worm-like animal)
Devonian Period	410 – 360	**Climate:** Europe collided with North America, forming the mountains which are now the Ridge and Valley and Highlands provinces of New Jersey. The fossils found continued to be aquatic life forms. **Fossils:** brachiopods, clams, trilobites, nautiloids, crinoids, coral, snails, stromatoporoids, ostracodes, bryozoa
Mississippian, Pennsylvanian & Permian Periods	360-248	**Climate:** No geologic record of these time periods is present in New Jersey. At some point, the sea subsided, and New Jersey became dry land, at least in part. **Fossils:** none
Mesozoic Era		
Triassic Period	248 – 200	**Climate:** New Jersey was next to Morocco, part of the supercontinent Pangaea. In the dry interior of the continent, the area experienced greater daily and seasonal fluctuations than the coasts. The rugged landscape consisted of high young mountains and deep valleys formed by faults. The brief rainy seasons' flashfloods dropped mud and silt in low areas, where playa lakes formed. In the end of the Triassic the climate became desert-like. The lakes began to dry up and became salty, resulting in an environment where brine shrimp flourished. When a lake went dry, some fish and other aquatic life became fossils. **Fossils:** dinosaur footprints, thecodonts, fish (including coelacanths), phytosaurs, amphibians, insects, plants
Jurassic Period	200 – 145	**Climate:** The breakup of Pangaea resulted in the beginning of the Atlantic Ocean. Igneous intrusions (molten rock forced into earlier rock formations) formed diabase and basalt bedrock. Because the terrain was mountainous, the net geologic action was erosion, not deposition. **Fossils:** There are no late Jurassic deposits in New Jersey; therefore no fossils exist from this period. However, the fauna probably consisted of the same dinosaurs as the American West, including sauropods, armored dinosaurs,

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
		ornithopods (forerunner of hadrosaurus), tenontosaurus (relative of the iguanadon). True flowering plants (angiosperms) appeared at this time.
Cretaceous Period	145 – 65	**Climate:** Northern New Jersey was above sea level, while southern New Jersey experienced flooding and ebbing. The sea level changed cyclically from deeper to shallower water in this tropical environment. During flooding, greensand marl (glauconite) was formed. During ebbing, clay and sand were deposited. **Fossils:** Fossil phytoplankton, clams, snails, crustaceans, ammonites, oysters, reptiles, sharks, burrows, worm tubes and vertebrates such as mosasaurs have been found in New Jersey's coastal plain. The fossil dinosaurs found include hadrosaurus (which probably washed downstream during a flood), ornithomimus, *Dryptosaurus aquilunguis* (a 17' predator with a great hand claw), *Hadrosaurus foulkii*, and *Hadrosaurus minor*.
Cenozoic Era		
Tertiary Period	65 – 1.8	**Climate:** The climate was warm, and the sea level was higher, covering the much of the Coastal Plain (see **Figure 3a**). **Fossils:** Fossils of land animals include birds, such as the diatryma (a giant flightless bird), tillodont (an extinct mammal the size of a bear, but with rodent-like teeth) and possibly others similar to those found in the South Dakota badlands, such as brontotherium, ancestral horses, entelodonts (resembled giant warthogs), diceratherium (semi-aquatic rhinoceros), peccary, prosynthetoceras (a camal), anchitherium (horse), and a primitive doglike carnivore. Fossils found in the Outer Coastal Plain include brachiopods, corals, sponges, clams, sharks, mollusks, crinoids, mammals (probably washed to the sea in floods), crocodiles, snakes, and early whales.
Quaternary Period	1.8 - present	**Climate:** The climate alternated between cool and warm, resulting in four intervals of glaciation. The glaciers covered northern New Jersey, reaching as far south as Belvidere on the Delaware River. South of the glacial ice, treeless, frozen tundra existed. When water was frozen in glaciers, the sea level was lower, resulting in a shoreline over a hundred miles east of the present coast. **Fossils:** Fossils of many familiar and some extinct animals have been found in nearby areas. There were insects, turtles, and snakes. Herbivores included squirrels, groundhogs, porcupines, beaver, muskrats, voles, mice, eastern cottontail rabbits, white-tailed deer, peccaries, tapirs, giant ground sloth, the elk-moose, giant beaver, American mastodon, and mammoth. Carnivores included otters, skunks, bobcats, foxes, black bears, coyotes, jaguars, jaguarundi, short-faced bear and a saber-toothed cat.
Sources: Gallagher, 1997; University of California Museum of Paleontology et al., 2003; USGS, 2002		

B. Topography

Topography depicts the relief features of an area. More than half of West Cape May's land area is less than ten feet above the ocean at mid-tide. The elevation in West Cape May ranges from about sea level at Cape Island Creek and Pond Creek to 20 feet above sea level east of S. Bayshore Rd. and north of Sixth Avenue, with the average elevation being 9.843 feet (NJGS, 1999a) (see **Figure 3b**). **Figure 3b** uses shaded colors to illustrate elevation in West Cape May (NJGS, 1999b).

Although steep slopes are of concern in many localities in New Jersey, there are no steep slopes present in West Cape May.

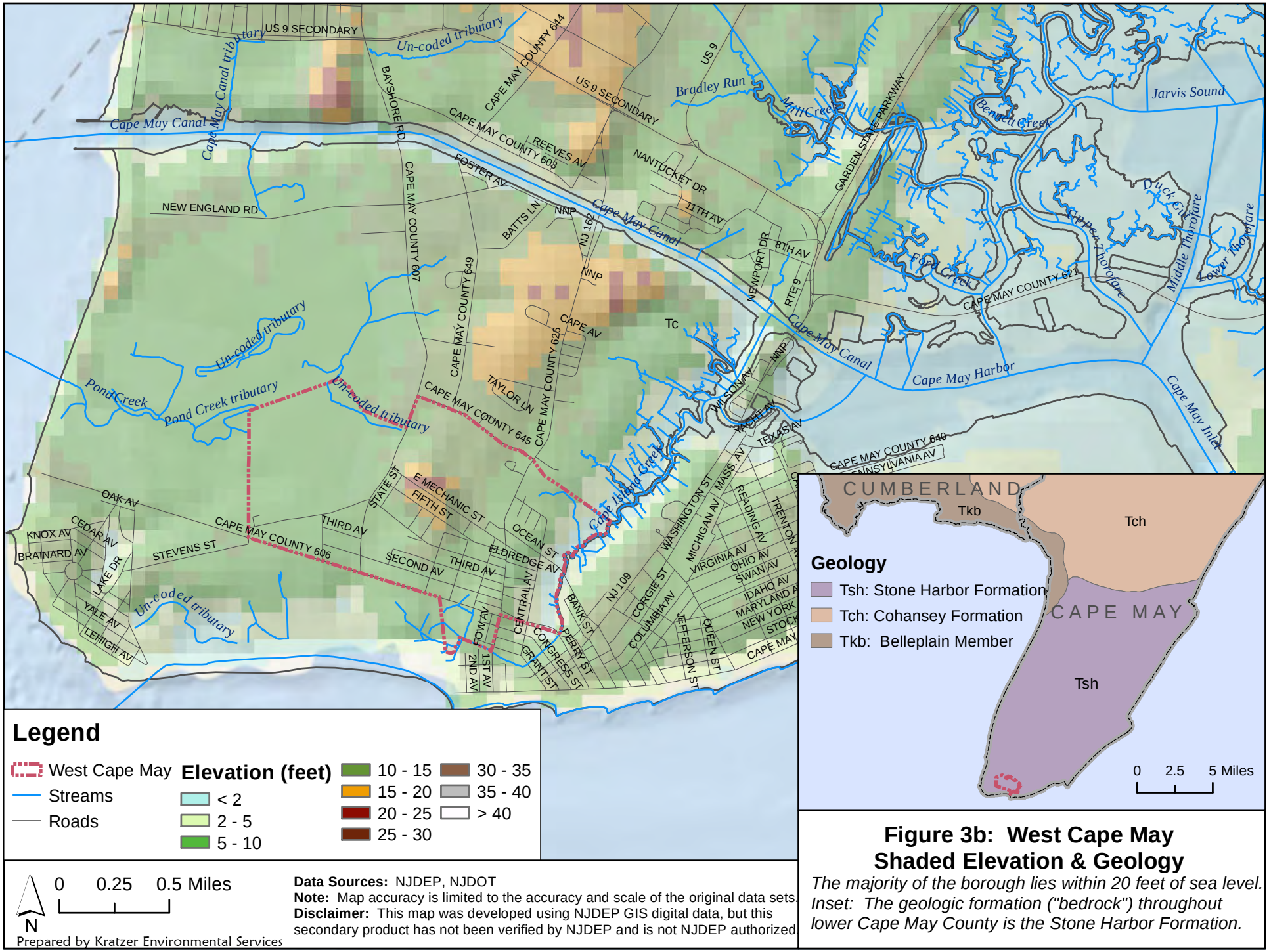


Figure 3b: West Cape May Shaded Elevation & Geology

The majority of the borough lies within 20 feet of sea level. Inset: The geologic formation ("bedrock") throughout lower Cape May County is the Stone Harbor Formation.

C. Geology of West Cape May

Bedrock is the solid rock beneath the soil and surficial rock. However, per convention by the USGS, coastal plain bedrock in New Jersey is considered to be unconsolidated sediments deposited from roughly the time of Cohansey Formation deposition and older (Scott Stanford, personal communication, March 7, 2017). The geologic formation that outcrops at the surface for the entire peninsula, including West Cape May, is mapped as the recently named Stone Harbor Formation (see **Table 3.2**) (Dalton et al., 2014).

Solid crystalline bedrock of Middle Proterozoic to Mesozoic age can be found approximately 6,300 feet below the land surface, covered with layers of sands and gravels deposited by repeated inundations of the sea (Volkert et al., 1996). These beds of deposited sediments gently slope from northwest to southeast, being thicker at the eastern edge (Cape May).

Table 3.2: Characteristics of Geologic Formation Found in West Cape May

Geologic Formation	Lithology (physical character of the rocks)		Percent of West Cape May
	General	Age	
Tsh Stone Harbor Formation	Interbedded gravel, sand, and clay	upper Miocene	100 %
Source: Sugarman et al. 2016			

Tsh – The entire Cape May peninsula is covered by the newly named Stone Harbor Formation. In the southern part of the peninsula, it consists predominantly of sand, with layers of medium/coarse sand with organically rich materials, fine micaceous sand, and thinly laminated clay to sandy clay and silty sandy clay, clayey silt, and clay. Lignite[14] is generally common and there are scattered granuliferous and pebbly beds. At the well cores, it is overlain by the Cape May formation (see surficial geology) and underlain by the Cohansey Formation. The maximum thickness is 180 feet (Sugarman et al., 2016).

D. Earthquakes

The likelihood of an earthquake occurring in West Cape May is very low. The nearest reported quake occurred in Sea Isle City on April 23, 1910 (NJGS, November 7, 2016).

E. The Surficial Geology of West Cape May

Surficial materials are the recent unconsolidated sediments that overlie bedrock formations, and that are the parent material for soils. Surficial geology deposits in West Cape May consist of materials deposited by oceans over many millions of years. The characteristics of surficial geology types found in West Cape May are provided in **Table 3.3** and illustrated in **Figure 3c.** In West Cape May, sea level fluctuations over "recent" millennia were caused by the cycle of glacial/interglacial periods. However, there are no glacial deposits evident in this part of the coastal plain.

[14] Lignite is a soft coal, also called brown coal, in which vegetable matter has altered more than in peat but not as far as in bituminous coal.

Table: 3.3: Characteristics of Surficial Geology Found in West Cape May

Geologic Abbreviation & Name	LITHOLOGY	GEOAGE	GEONOTES	AREA (acres)	Percent
Qcm2 CAPE MAY FORMATION, UNIT 2	Sand, pebble gravel, minor silt, clay, peat, and cobble gravel; very pale brown, yellow, reddish yellow, white, olive yellow, gray. As much as 200 feet thick on the Cape May peninsula, generally less than 50 feet thick elsewhere.	late Pleistocene (Sangamonian stage)	Silt and clay are thicker and more continuous in subsurface parts of the formation on the Cape May peninsula and along the Delaware bayshore. Forms a marine terrace with surface altitude up to 40 feet.	340.8	45.2%
Qcm3 CAPE MAY FORMATION, UNIT 3	Sand, pebble gravel, minor silt, clay, and peat; yellow, reddish yellow, white, gray. As much as 20 feet thick.	late Pleistocene (Late Sangamonian or middle Wisconsinan stages) age	Forms a marine terrace with surface altitude up to 15 feet. Equivalent to Cape May Formation, unit 1 of Newell and others (2000).	333.5	44.2%
Qmm SALT-MARSH AND ESTUARINE DEPOSITS	Silt, sand, peat, clay, minor pebble gravel; brown, dark-brown, gray, black. 100 feet thick	Holocene	Contain abundant organic matter. Deposited in salt marshes, estuaries, and tidal channels during Holocene sea-level rise.	38.7	5.1%
Qs SWAMP AND MARSH DEPOSITS	Peat and organic clay, silt, and minor sand; gray, brown, black. As much as 40 feet thick.	late Pleistocene and Holocene	Deposited in modern freshwater wetlands.	41.6	5.5%
Total				754.6	100.0%
*Note on Geologic time periods: Pleistocene: 2.6 million years ago – 117,000 years ago Holocene: 117,000 years ago – present Wisconsinan glaciation: 21,000 years ago (Wikipedia, 2013) http://en.wikipedia.org/wiki/Pleistocene					
Sources: NJGS, 2006; Newell and others, 1995; O'Neal and Dunn, 2003					

Qm - Salt-marsh deposits (Holocene)

Organic muck and peat, silt, clay, and sand. Black, brown, and gray organic muck includes remains of salt-tolerant grasses, especially *Spartina* (sp.). Silt and sand occur as levee and crevasse splay deposits along tidal creek margins. Transported largely as suspended sediments in turbid bays or rivers during high tides. Generally 1 to 2 m thick; up to 6 m thick along shorelines.

Qcm3 - Cape May Formation Unit 3 (early Sangamonian)

Sand, clayey silt, pebble gravel, and peat; wide variety of oxidized colors including gray and brownish gray. Primarily consists of quartz-rich estuarine and fluvial deposits with variable amounts of heavy minerals and chert. Thickness is highly variable, ranging from 1 to 47 m; thicker deposits fill deep channels cut as much as 55 m below present sea level by paleorivers, including a proto-Delaware River channel described by Knebel and Circe (1988) and Knebel (1992). Channels formed when sea level dropped as much as 60 m below present sea level.

Paleochannel shown in cross section C-C' on southern sheet has been informally known as the Rio Grande paleochannel (Gill, 1959; Gill, 1962).

Qcm2 - Cape May Formation Unit 2 (late Sangamonian)

Sand, pebble gravel, clayey silt, peat, silty sand, and cobble gravel. Variety of oxidized colors including gray, greenish gray, and brownish gray. Deposits include facies of several depositional environments. Beach facies consists of quartz-rich sand to pebble gravel with variable mix of heavy minerals and chert; characterized by well rounded, disc- and rod-shaped pebbles scattered in well-sorted, low-angle, planar beds which dip seaward and are interleaved with sets of lunate megaripples and trough crossbeds; axes of troughs parallel beach; locally includes leached, oxidized molds and casts of surf clams **(***Spisula***,** sp.); burrows common; top 1 to 2 m is deeply weathered and locally includes frost wedges and blanket of windblown sand; thickness varies from one to several meters; unconformably overlies open-bay to inner-shelf facies and largely is restricted to top 3 to 5 m of Cape May Peninsula south of Swainton in southern New Jersey. Shallow marine facies consists of fine to medium sand and silty sand; includes scattered thin, shelly sand beds; patchy distribution, thin layers, and lack of good subsurface data makes separation of this facies from estuarine-fluvial facies difficult. Estuarine-fluvial facies consists of sand, pebble to cobble gravel, silt and clay, and peat; deposits localized along tributary rivers entrenched primarily into Cohansey and Kirkwood Formations in southern New Jersey.

Historic Fill

Historic fill is defined by NJDEP as non-indigenous material placed on a site in order to raise the topographic elevation of the site. Large areas (over 5 acres) of historic fill have been mapped by NJDEP, as required by the Brownfield and Contaminated Site Remediation Act (N.J.S.A. 58:10B-1 et seq.). Some areas of fill are inferred by comparing the extent of swamps and alluvial deposits shown on historical geologic and topographic maps to current maps. Small areas of fill are not mapped. While most urban and suburban areas are underlain by an irregular layer of excavated indigenous soil mixed with various amounts of non-indigenous material, this material generally does not meet the definition of historic fill. Also, there may be historic fill areas that were not detectable on aerial photography or by archival map interpretation, particularly along streams in urban and suburban areas (NJGS, 2009)**.** Areas of historic fill in West Cape May are shown on **Figure 3c** (NJGS, 2009).

Mining & Quarrying

According to the New Jersey Geological Survey, there are no current sand and gravel quarrying operations and no records of mining within West Cape May (NJGS, 2005). Sand, gravel, and topsoil have been excavated out of local "borrow pits" (open mines) in past years. These mined areas are shown on County Soil survey maps. Small fresh water ponds were sometimes created in the process of mining. Most of these have been taken over by reed grass (Phragmites) or have become swamp forest (West Cape May ERI, 2003)

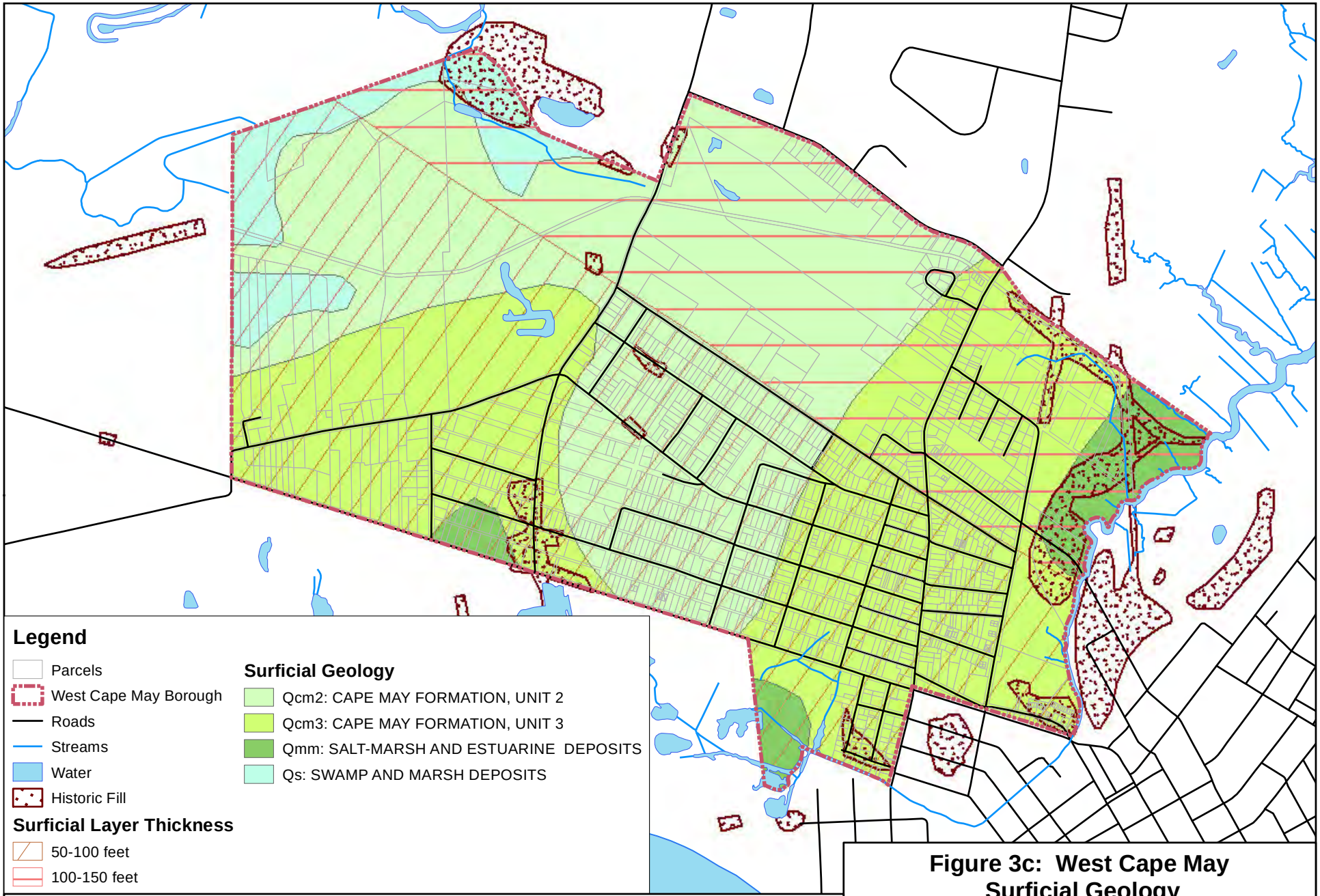


Figure 3c: West Cape May Surficial Geology

Prevalent surface materials are from the Cape May Formation Units 2 and 3, with sand and pebble gravel dominating the mix. Nonindigenous materials are mapped as Historic Fill.

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