September 2014




Natural Resource Inventory

for

Oakland Borough

Bergen County, NJ





Prepared for:

Oakland Borough

Kratzer Environmental Services

Written by:
Deborah J. Kratzer

NATURAL RESOURCE INVENTORY

The Borough of Oakland

Bergen County

New Jersey

Prepared By

Deborah J. Kratzer, Kratzer Environmental Services

For

The Borough of Oakland Environmental Commission

FINAL REPORT

September 2014

This plan was prepared with the assistance of a Smart Growth Planning Grant from the Association of New Jersey Environmental Commissions anjec

Kratzer Environmental Services

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

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Special Acknowledgements:

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Wikipedia – p. 157 (left), 160
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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 Oakland, both affecting and being affected by many physical and biological factors. With Oakland's population of 12,754, or 1,461 persons/mi^2 [1] (US Census, 2010), the cumulative effects of many individual decisions have altered and have the potential to impact the environment and human health.

Nancy Krause

Ramapo River

> "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 Natural Resource Inventory

The goal of the *Natural Resource Inventory (NRI)* is to provide objective, reliable environmental data in one document. This enables Borough officials (the Mayor, Borough Council, Planning Board, Board of Adjustment, Environmental Commission, Shade Tree Advisory Committee and the 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 Bergen County as a whole is 905,116 persons (3,669 persons/mi^2) (the most people for any NJ county) and for the entire State of New Jersey, the population is 8,791,894 (1,008 persons/mi^2) (US Census, 2010).

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 "Natural 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 NRI 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 Oakland. 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 obtained through a grant from the Association of New Jersey Environmental Commissions (ANJEC), with 50% cost share provided by the Borough of Oakland.

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)

An inventory of what is currently known about the physical and biological environment and the human influence on the environment of Oakland 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 110 GIS data layers from 25 sources were used for this report's 58 maps.

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 Oakland 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 Oakland's natural resources, including climate, geology, soils, water, floodplains, wetlands, and forests, and cultural resources such as infrastructure and open space. Environmental concerns in Oakland 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 from NJDEP and Bergen County are used with permission (see the Terms of Agreement in **Appendix A**), with the required "disclaimer" printed on each map which 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 NRI*.

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

B. General Description of the Borough of Oakland

Oakland is located in Bergen County, NJ (see **Figure 1a**) and is bordered by Mahwah Township to the north, Franklin Lakes Borough on the east (both within Bergen County),Wayne Township on the south, Pompton Lakes Borough to the southeast, Wanaque Borough to the west, and Ringwood Borough to the northeast (these five are within Passaic County). The Ramapo River flows from the north to the south, approximately through the center of the borough. The

[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.

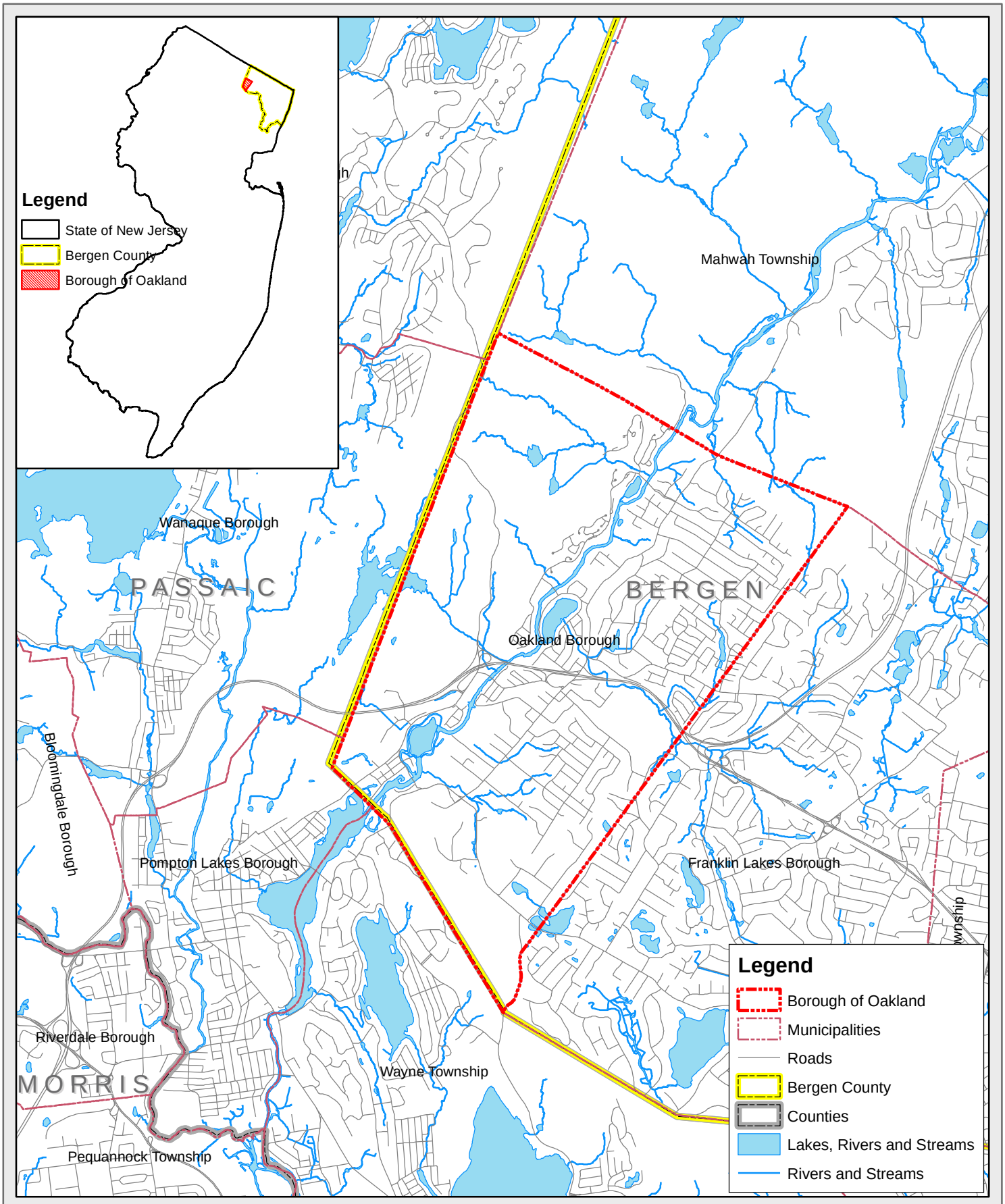

Figure 1a: Location of Oakland Borough

0 0.375 0.75 1.5 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Ramapo River eventually joins the Passaic River, which merges with the Hackensack River before flowing to the Atlantic Ocean.

The Borough was incorporated in 1902. Oakland encompasses 8.45 square miles (5,408 acres) with a population of 12,754 living in 4,470 housing units (US Census, 2010).

C. Land Use and Land Use Change

Figures 1b through 1e show aerial photographs of Oakland and the surrounding areas. In **Figure 1b**, aerial photography taken in 1930, although not very high resolution, and not georeferenced[4], illustrates the prevalence of forests and agriculture and the lack of development at that time. Aerial photographs taken in 1995, 2002, 2007 and 2012 are shown in **Figure 1c, 1d, 1e and 1f** respectively.[5] 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 and 2007 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 Oakland this consists of less than 25 acres which are primarily residences with pastureland or cropland even though they may not be currently used as such. There is also a nursery in town which constitutes an agricultural use.

Forest land is covered by woody vegetation (excluding wooded wetlands, which are included in the wetlands category). 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.

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.

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.

[4] 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.

[5] The 2002, 2007 and 2012 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.

Figure 1b: Aerial Photography 1930

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Figure 1c: Aerial Photography 1995

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

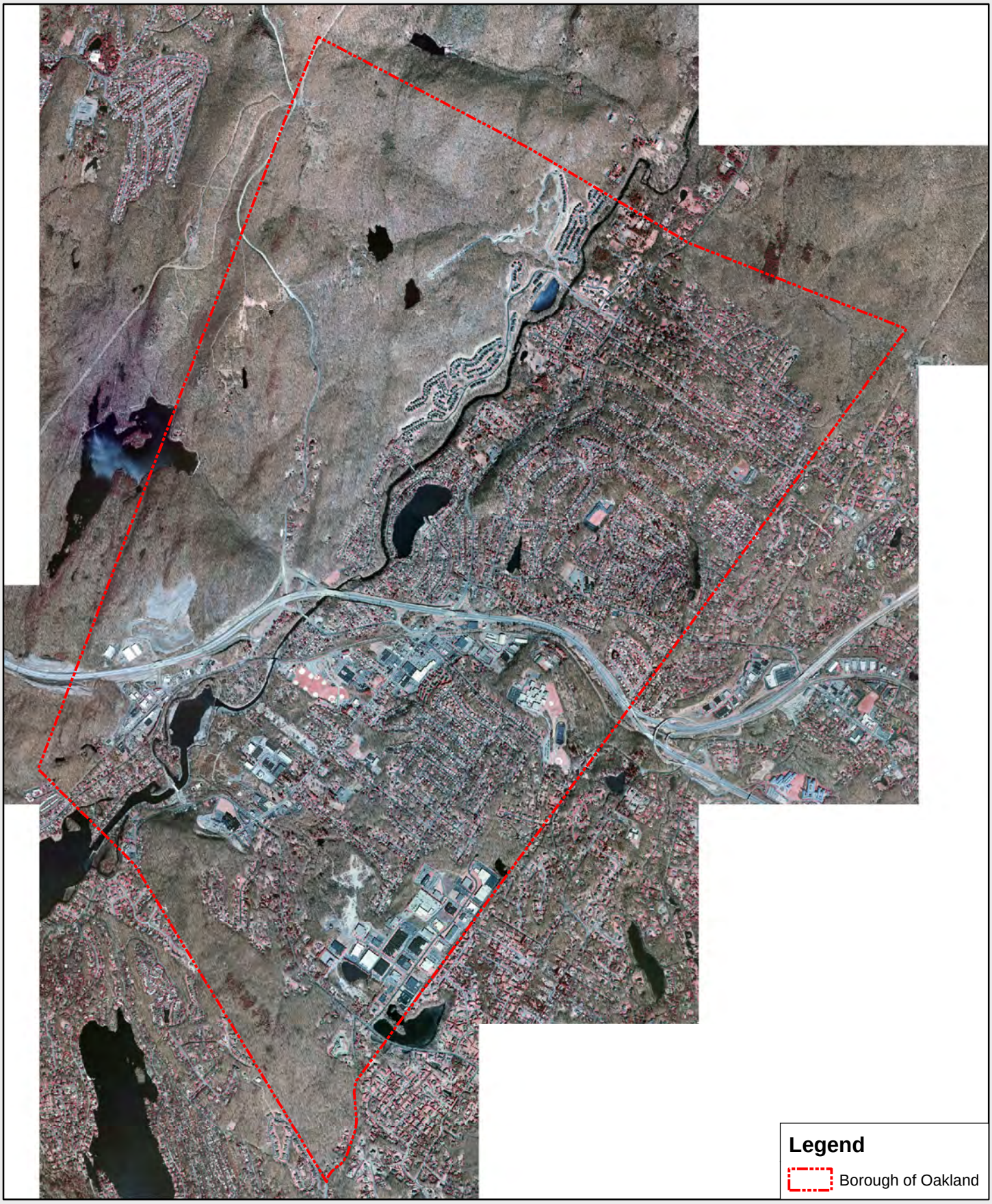

Figure 1d: Aerial Photography 2002

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Figure 1e: Aerial Photography 2007

0 0.25 0.5 1 Miles

N

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

Figure 1f: Aerial Photography 2012

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Land Use Type	Acres	Percent
AGRICULTURE	24.84	0.44
BARREN LAND	46.41	0.83
FOREST	2518.15	44.87
URBAN	2625.30	46.78
WATER	175.41	3.13
WETLANDS	221.62	3.95
Total Acres	**5611.72**	**100.00**

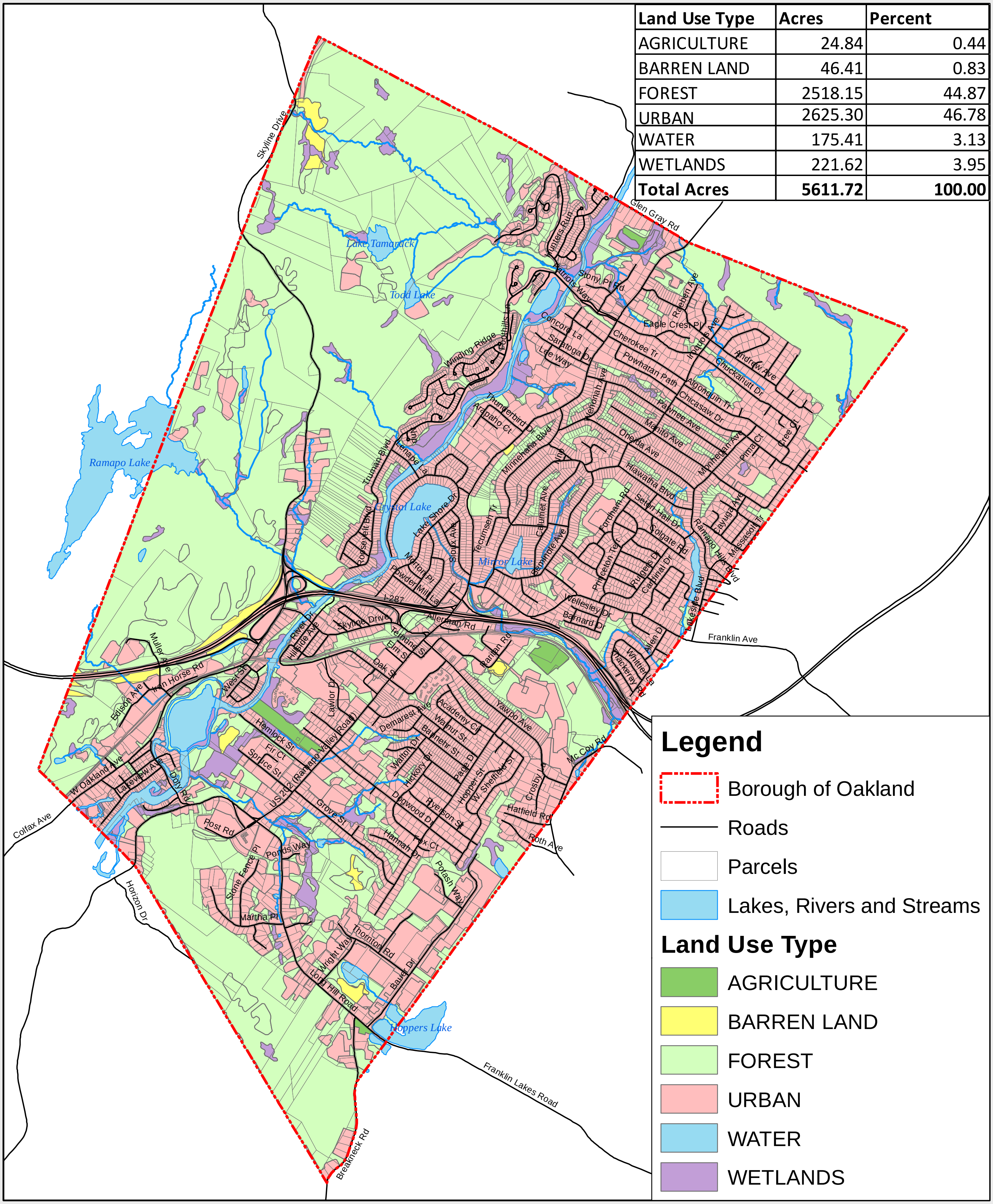

Figure 1g: 2007 Land Use Type

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

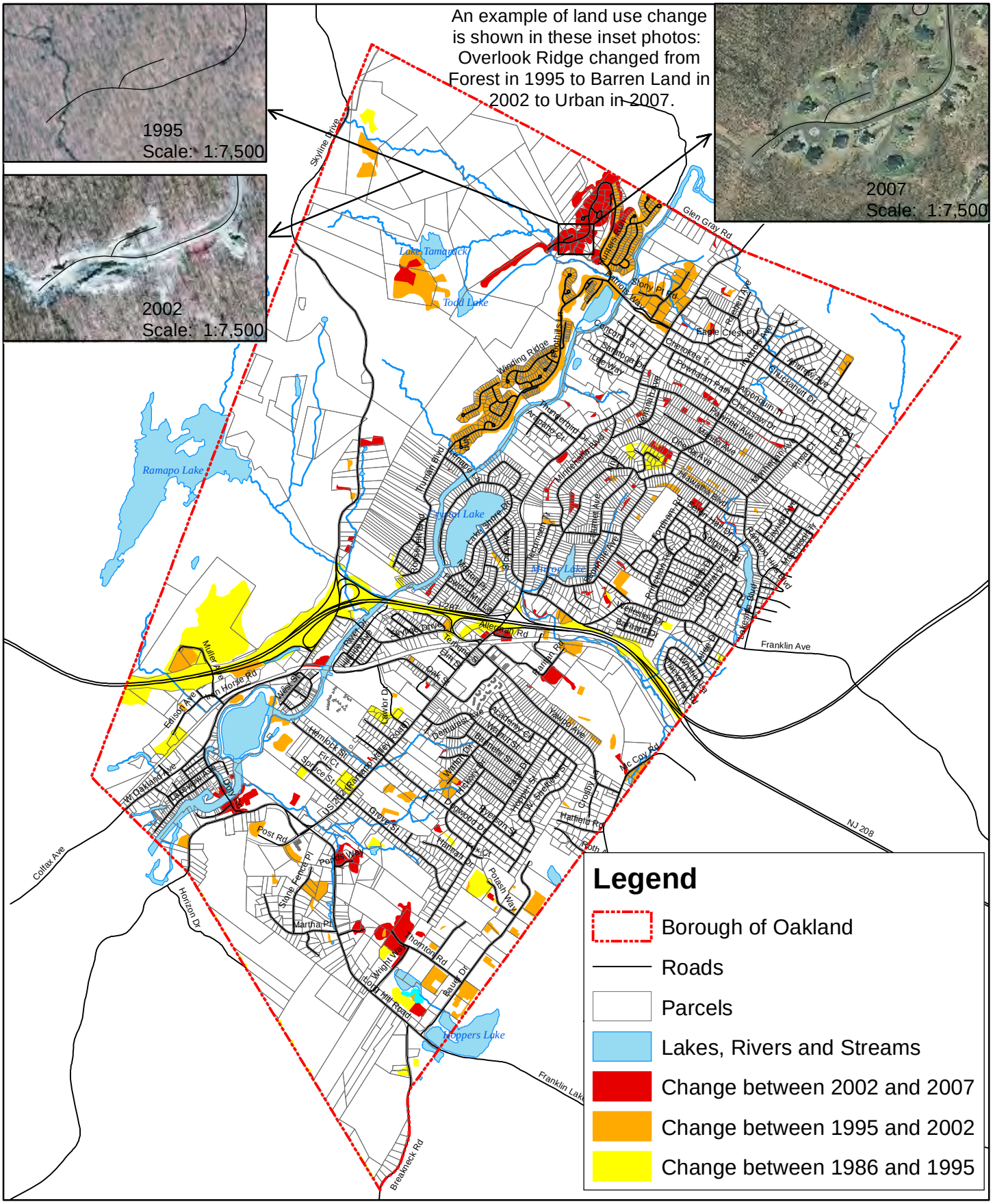

Figure 1h: Change to Urban or Barren Land Use Type

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

The 2007 land use types within the Borough of Oakland are illustrated in **Figure 1e**, and summarized in **Table 1.1**. Oakland is 47% urban and 45% forested. Detailed categories of land use/land cover are shown in **Section 7 (Figures 7a, 7b, 7c and 7d)** of this report.

Table 1.2 shows the percentages of Oakland in each land use type in 1986, 1995, 2002 and 2007 and the changes in percent cover. **Figure 1f** shows the areas that have changed to urban or barren land over this time period.

Table 1.1: 2007 Land Use Type

Land Use Type	Acres	Percent
AGRICULTURE	24.84	0.44
BARREN LAND	46.41	0.83
FOREST	2518.15	44.87
URBAN	2625.30	46.78
WATER	175.41	3.13
WETLANDS	221.62	3.95
Total Acres*	**5611.72**	**100.00**
*Area calculated with GIS differs from area from other sources, such as tax maps.		
Source: NJDEP, 2010		

Table 1.2: Change in Land Use Type*

Land Use Type	1986 Percent	1995 Percent	% Change '86-'95	2002 Percent	% Change '95-'02	2007 Percent	% Change '02-'07
AGRICULTURE	0.12	0.05	-0.06	0.45	0.39	0.44	0.00
BARREN LAND	0.33	1.74	1.41	1.34	-0.40	0.83	-0.52
FOREST	45.03	46.28	1.24	45.82	-0.46	44.87	-0.95
URBAN	46.98	44.22	-2.76	45.31	1.09	46.78	1.47
WATER	3.05	3.01	-0.04	3.02	0.01	3.13	0.11
WETLANDS	4.48	4.70	0.21	4.06	-0.64	3.95	-0.11
*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, 2010; NJDEP, 2007; NJDEP, 2000; NJDEP, 1998							

References: Introduction

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NJ Department of Environmental Protection (NJDEP), Bureau of Geographic Information and Analysis (BGIA). December 1, 2000. NJDEP 1995/97 Land use/Land cover Update, Pompton, Wanaque and Ramapo Watershed Management Area, WMA-3 Edition: 1.3; (FINAL). GIS data. http://www.state.nj.us/dep/gis/digidownload/zips/lulc95/w03lu95.zip

NJDEP, Bureau of Geographic Information and Analysis (BGIA). November 1, 1998. NJDEP 1986 Land Use/Land Cover for Bergen County, New Jersey. GIS Data. http://www.state.nj.us/dep/gis/digidownload/zips/lulc/berlulc.zip

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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 online mapping:

- Google Earth[6]: http://www.google.com/earth/index.html (free download)
- HistoricAerials.com[7]: http://historicaerials.com (free to use, but maps have watermark unless purchased)
- NJ-GeoWeb (NJDEP): http://www.state.nj.us/dep/gis/geowebsplash.htm (free to use, many data layers available)

Bergen County's Official Home Page: http://www.co.bergen.nj.us/

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

Oakland's Official Home Page: http://www.oakland-nj.org/

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

[6] Users of Google Earth may also view several years of historic imagery of Oakland from 1995 through 2012. On the menu bar, click View, then click Historical Imagery and use the slider bar to choose the year.
[7] HistoricAerials.com allows viewing of historic aerial photography between 1931 and 2007.

2: LOCAL & REGIONAL CONDITIONS

A. Climate & Meteorology

Climate

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).

According to the NJ State Climatologist, there is growing evidence that our global climate is changing as a result of human activities. The NJ State Climatologist evaluated data from 19 stations for the NJ Climate Report Card in order to begin to document and understand climate within NJ. While statistical trends were not developed for this study, over 600 time-series graphs were created that chart weather variables over the past century (e.g. min. and max. temperature, precipitation). The weather station nearest to Oakland that was evaluated for this climate study was Charlotteburg Reservoir[8], which has been monitored since 1893 (Robinson, 2010; Hartman, 2002).

According to the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), the temperature trend (annual average) in New Jersey is +0.2 °F per decade, and the precipitation trend is +0.41 inches per decade (for the period of record 1895 to 2012) (NOAA, June 13, 2013).

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

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. Oakland is included in the Northern Zone, which mainly encompasses the Appalachian Highlands portion of the state (ONJSC, No Date).

This region has higher elevations and is more northern than the rest of the state; therefore it experiences colder temperatures – on average 10°F colder than the Coastal Zone in the winter. The Northern Zone receives an average of 40 to 50 inches of snow, compared with an average of 10 to 15 inches in the south. This region is cloudier and wetter, as well. As moist air comes in from the west or off the ocean, it rises when it encounters the mountains, generating clouds and precipitation. During the warm season, thunderstorms are responsible for most of the rainfall, often developing in the evening. About twice as many thunderstorms occur here as in the Coastal Zone, where the Atlantic Ocean helps stabilize the atmosphere (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

[8] The Charlotteburg Reservoir weather monitoring station is located about 8 miles west of Oakland Borough, in West Milford Township, Passaic County near Route 23. See **Figure 2a.**

Charlotteburg Reservoir station[9] is nearest to Oakland. **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).

Measurable precipitation falls in this area on approximately 120 days per year. At the Charlotteburg Reservoir station, annual precipitation has averaged 50.29 inches (for the period 1893-2013), which is at the high end of the range of 40 to 51 inches in New Jersey (see **Table 2.1**) (ONJSC, No Date; ONJSC, May 2013).

Table 2.1: Temperature & Precipitation at Charlotteburg Reservoir, NJ

Month	*Based on data from 1893-2013*		*Based on data from 1893-2013*	*Based on data from 1893-2010*		*Based on data from 1893-2013*
	Temperature (°F)					Mean Precipitation
	Avg. High	Avg. Low	Mean	Record High	Record Low	
January	36.4	17.4	27.0	71°F (1950)	-26°F (1912)	3.70 in.
February	37.7	17.3	27.5	74°F (1985)	-25°F (1943)	3.34 in.
March	47.0	25.8	36.4	85°F (1998)	-10°F (1943)	4.31 in.
April	59.1	35.4	47.2	91°F (1990)	6°F (1923)	4.15 in.
May	70.3	45.0	57.7	96°F (1936)	23°F (1922)	4.27 in.
June	78.3	53.4	65.8	99°F (1934)	29°F (1957)	4.33 in.
July	82.9	58.2	70.5	105°F (1936)	36°F (1945)	4.56 in.
August	81.1	56.4	68.7	100°F (1933)	32°F (1940)	4.63 in.
September	74.7	49.4	62.1	100°F (1953)	23°F (1904)	4.57 in.
October	63.9	38.9	51.4	92°F (1927)	10°F (1936)	4.13 in.
November	51.6	31.1	41.4	81°F (1950)	-1°F (1938)	4.16 in.
December	39.8	21.5	30.7	73°F (1998)	-15°F (1950)	4.15 in.
					Average Annual Precipitation:	50.29 in.
Sources: ONJSC, May 2013 (averages) and ONJSC, 1893-2010 (extremes).						

Rainfall is distributed fairly evenly throughout the year, with February being the driest month. On average, July, August and September have the most precipitation, but appear drier because evapotranspiration exceeds precipitation (ONJSC, May 2013). Record rainfalls are more likely to occur in August and September, due to tropical storms (see **Table 2.2**).

An average of 30 to 40" of snow falls annually in the lower elevations and 40 to 60" falls annually in the northern region (about 10" of snow equals 1" of rain). Each winter, about 11 to 12 days receive snowfall greater than or equal to 0.5" in Oakland. Days with snowfall greater than 4" occur only about 2.1 to 2.5 times per winter in this area (ONJSC, 1971-2000). Measured at Charlotteburg, the earliest snow on record was on October 10 (in 1979, with 1.5"), and the latest was April 29 (in 1909, with 2.0") (ONJSC, 1893-2010).

According to NOAA, Charlotteburg Reservoir has an average of 151 frost-free days. The average date for the last spring frost (32°F) is May 5th (although there is a 10% probability that the last freeze may be May 18th or later). The first frost in fall is usually around October 3rd (although there is a 10% probability that the first frost may be September 19th or earlier). The exact dates vary from place to place as well as from one year to another (NOAA, February 26, 2005).

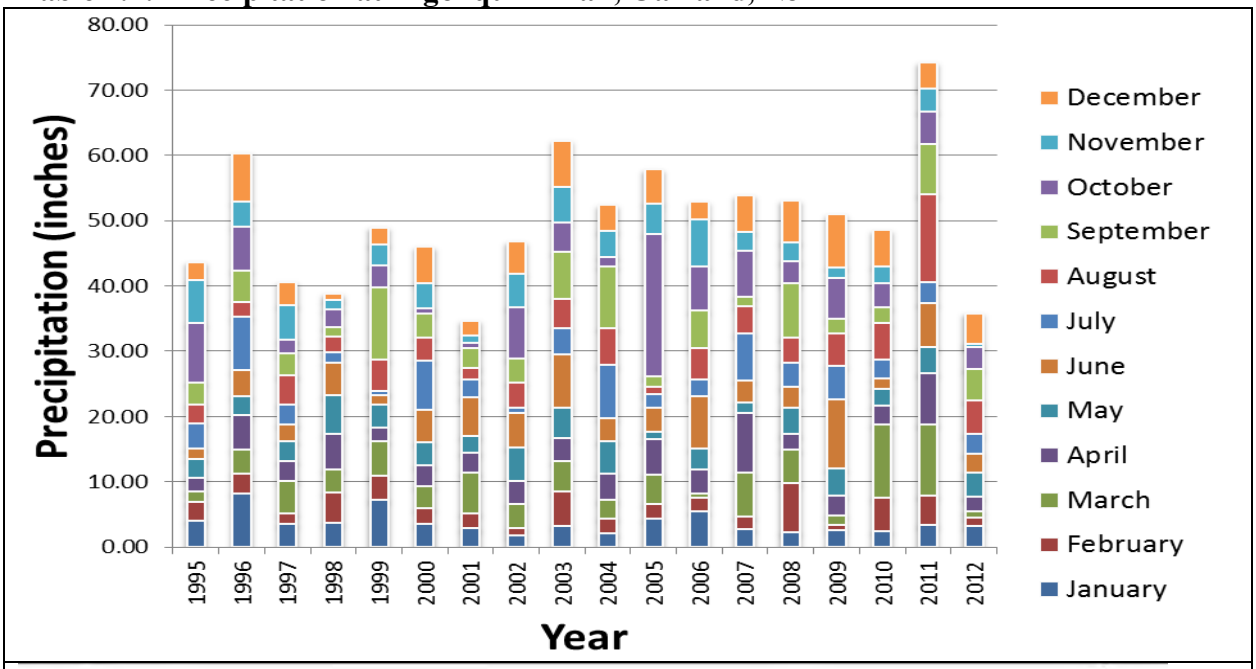
During the winter, temperatures are not generally cold enough to keep the soil frozen for the whole winter. Winter rains are frequently warm enough to thaw the soil. Heavy rain on partly thawed soils is very erosive.

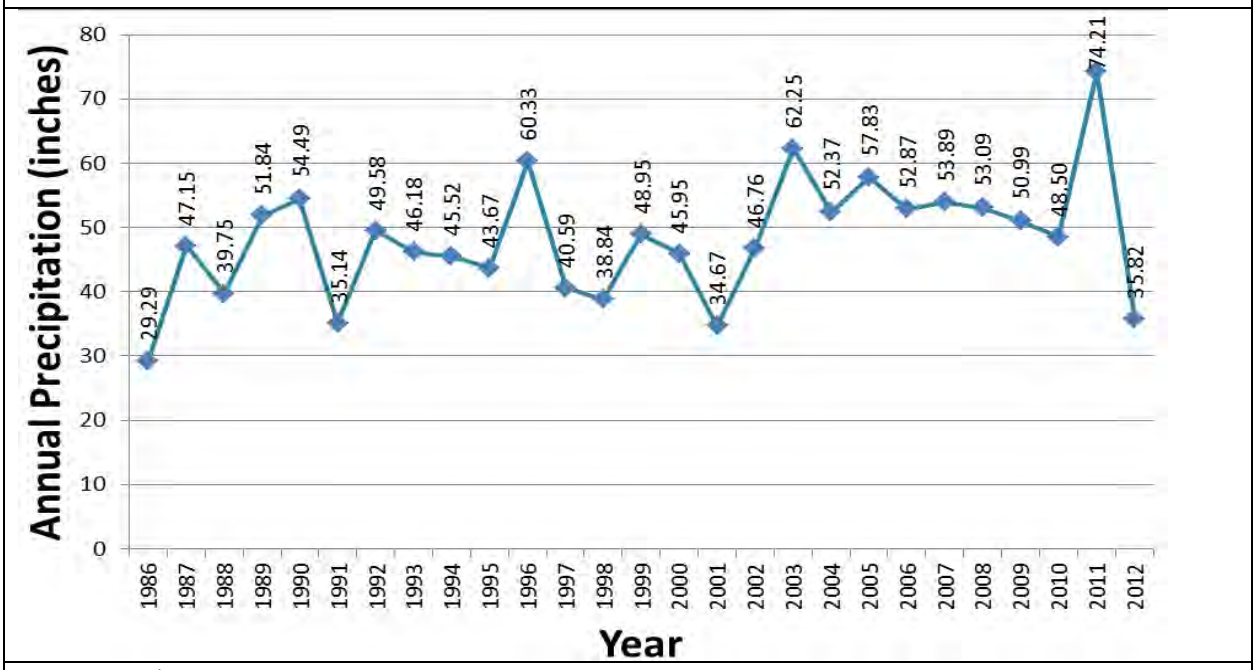
[9] The Haskell and Ramsey Stations are closer, but not currently collecting data.

Precipitation at Oakland

Rain data has also been collected in Oakland by Harvie Klaus, a meteorologist who lives Algonquin Trail. Monthly data from 1995 to 2012 is shown in the top graph in **Table 2.2**. The driest month during this period was March 2006, which had only 0.75 inch of precipitation. The wettest month was October 2005, when Oakland experienced 21.93 inches of rain. The mean for this period is 50.09 inches of precipitation per year (Klaus, 2012), which is 0.2 inches lower than the mean for the Charlotteburg Reservoir site (50.29 inches, based on data from 1893-2013, see **Table 2.1**). The second graph in **Table 2.2** shows annual precipitation for the period 1986 to 2012, and averaged 48.17 inches in the past 27 years (Klaus, 2012). Statistical analysis does not show a clear trend in precipitation.

Table 2.2: Precipitation at Algonquin Trail, Oakland, NJ





Source: Klaus, 2012

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. Although approximately five tornadoes appear each year in New Jersey (usually relatively weak ones) (ONJSC, No Date), there are no records of tornadoes in Bergen County (NOAA, 1996-2013). During the same period, 29 hail events were recorded in Bergen County. Hail which fell specifically in Oakland occurred on April 19, 2002 (hail and flash flooding), May 12, 2004 (0.88", nickel size hail), March 29, 2009 (0.75", penny size hail), June 15, 2009, July 17, 2009 (quarter size hail was reported on I-287 in Oakland and there were downed trees), June 9, 2011 (half-dollar to golf ball size hail, 1.25-1.75" occurred throughout Bergen County) and July 1, 2012 (1" hail) (NOAA, 1996-2013).

Table 2.3 lists some of the highest snow and rainfall received in one day at Charlotteburg Reservoir (*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 2.3: Highest Daily Precipitation Measured at Charlotteburg

Rank	Greatest one-day snowfall		Greatest one-day rainfall	
	Amount	Date	Amount	Date
1st	27.0 in.	Feb. 4, 1926	7.76 in.	Sept. 19, 1894
2nd	26.0 in.	Feb. 12, 1983	7.32 in.	Aug. 28, 1971
3rd	25.0 in.	Jan. 9, 1996	6.89 in.*	Aug. 28, 2011
4th	24.5 in.	Feb. 18, 2003	6.81 in.	Sept. 17, 1999
5th	19.5 in.	Mar. 4, 1960	5.75 in.	Aug. 13, 1955
6th (3 way tie)	18.0 in.	Feb. 19, 1921 Jan. 20, 1961 Mar. 14, 1993	5.66 in.	Aug. 19, 1955
*This data point is from the Ramsey Station, as the Charlotteburg Station was not collecting data during this storm.				
Sources: ONJSC, 1893-2010 and ONJSC, June 13, 2013				

Tropical storms and hurricanes can contribute significant rainfall and can cause flooding. Some of the major storms that have affected Oakland are described here.

The highest one-day precipitation measured at Charlotteburg Reservoir, 7.76 inches, occurred on September 19, 1894 resulted from Hurricane Four (naming began in 1945) (Wikipedia, June 13, 2013). Tropical Storm Doria dropped the second highest one-day rainfall recorded at the Charlotteburg Reservoir Station on August 28, 1971, producing moderate flooding on the Ramapo River. On August 28, 2011, Hurricane Irene was the first hurricane to make landfall in New Jersey since 1903. During Irene, the third highest one-day rainfall (6.89 inches; storm total of 8.18 inches) for the area was recorded at the Ramsey Station (no precipitation data is available for the Charlotteburg Station during this storm) causing record flooding on the Ramapo River. The fourth highest one-day rainfall was the result of Hurricane Floyd, which battered New Jersey on September 16, 1999 and brought with it record breaking amounts of rain and damaging winds. The Charlotteburg Reservoir station recorded 6.81 inches of rain on September 17, resulting in flooding of the Ramapo River. The 1955 Hurricanes Connie and Diane, which occurred on August 12-13 and August 18-19, respectively, each dumped heavy rain on the northern half of New Jersey, the fifth and sixth highest one-day rainfall totals at Charlotteburg. This resulted in major flooding of the Ramapo River (ONJSC, 1893-2010; ONJSC, June 13, 2013; Barry, 2013).

Historical floods are discussed in **Section 6a.** Flood forecasts and gage height of the Ramapo River near Mahwah (upstream of Oakland) and the Ramapo River at Pompton Lakes (downstream of Oakland) are available in real-time on the internet from USGS and NOAA (see **Internet Resources)**.

Hurricane Sandy, which made landfall near Atlantic City on October 29, 2012, was notable not for rain totals, but for sustained wind and wind gusts (48 mph at Charlotteburg, 56 mph at Hawthorne; many sites even higher) and devastating damage to homes, trees and infrastructure (Robinson, November 7, 2012).

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. Oakland lies within the Northeast Drought Region (see **Figure 2a** 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. Significant droughts in recent years included 1997-1999 and 2001-2002. A drought spanning September 1997 through September 1999 included a "snow drought" – one of the least snowy seasons on record. This drought was ended by Tropical Storm Floyd. Another year-long drought occurred between October 2001 and November 2002, when the drought was ended by a series of nor'easters that resulted in a wetter than normal November. The drought of record for the region, however, is considered 1963-1965, when three consecutive years included 3 of the 4 driest years since record-keeping began in 1895 (NJDEP. 2012). The five years with lowest precipitation, based on an average of 10 stations in Northern New Jersey, are shown in **Table 2.4**.

Table 2.4: Lowest Annual Precipitation*

Rank	Year	Amount (inches)	Deviation from Mean
1st	1965	30.46	-19.33
2nd	1963	33.95	-15.84
3rd	1930	34.60	-15.19
4th	1964	34.65	-15.14
5th	1895	35.22	-14.57

*Average of 10 stations in northern NJ from 1895-2012; with a mean of 46.74 inches annually.

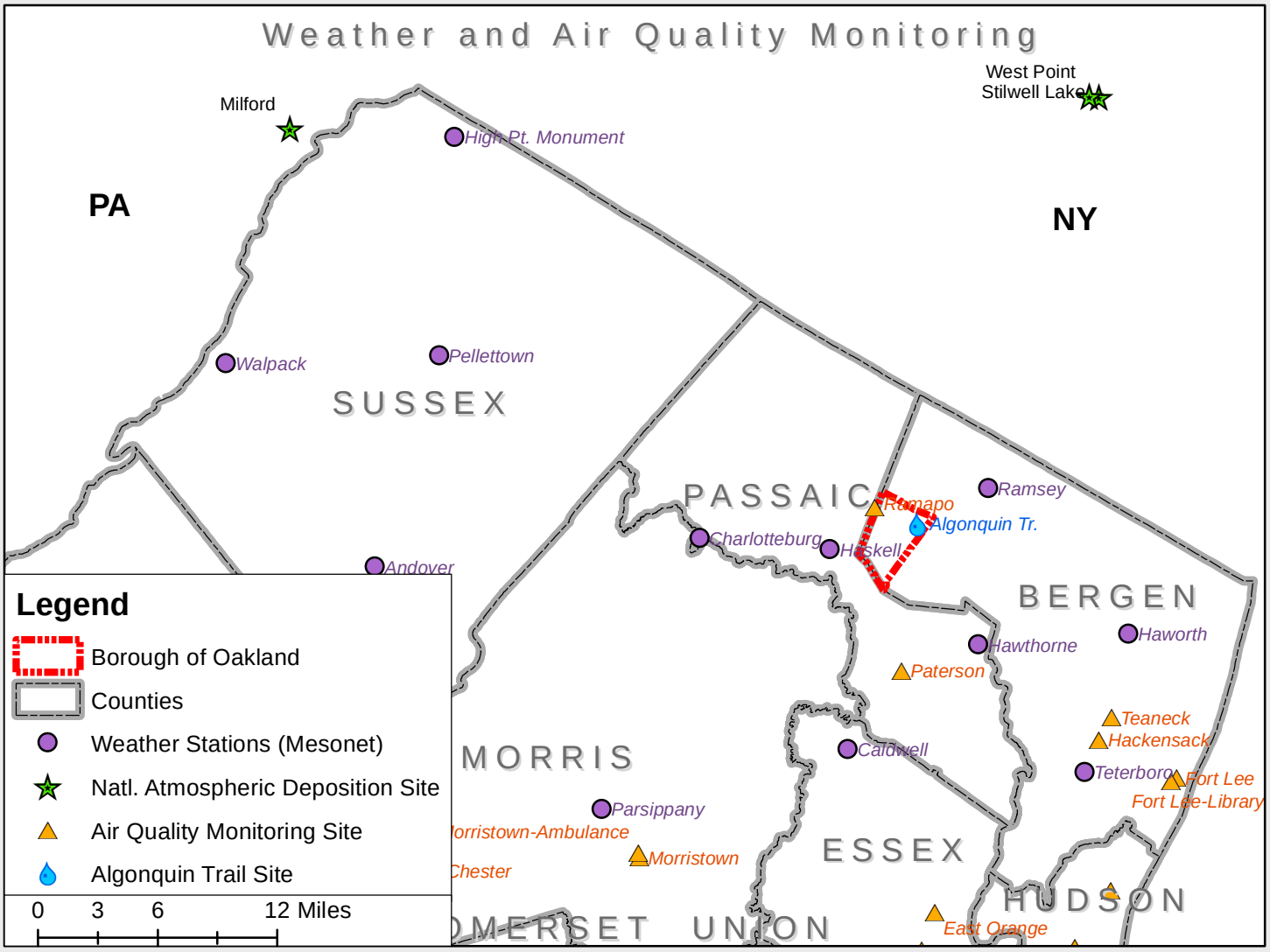
Source: ONJSC, May 2013

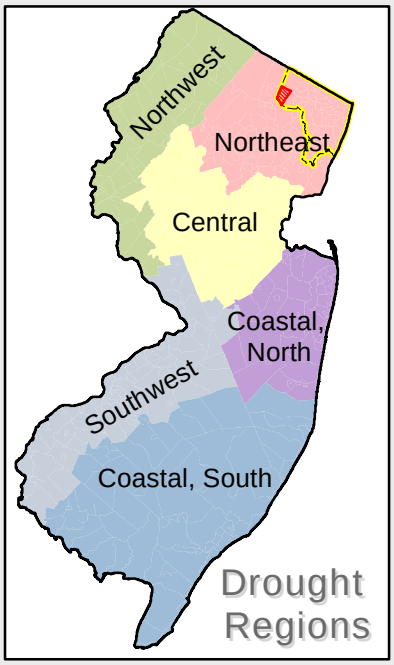
B. Air Quality

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.

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





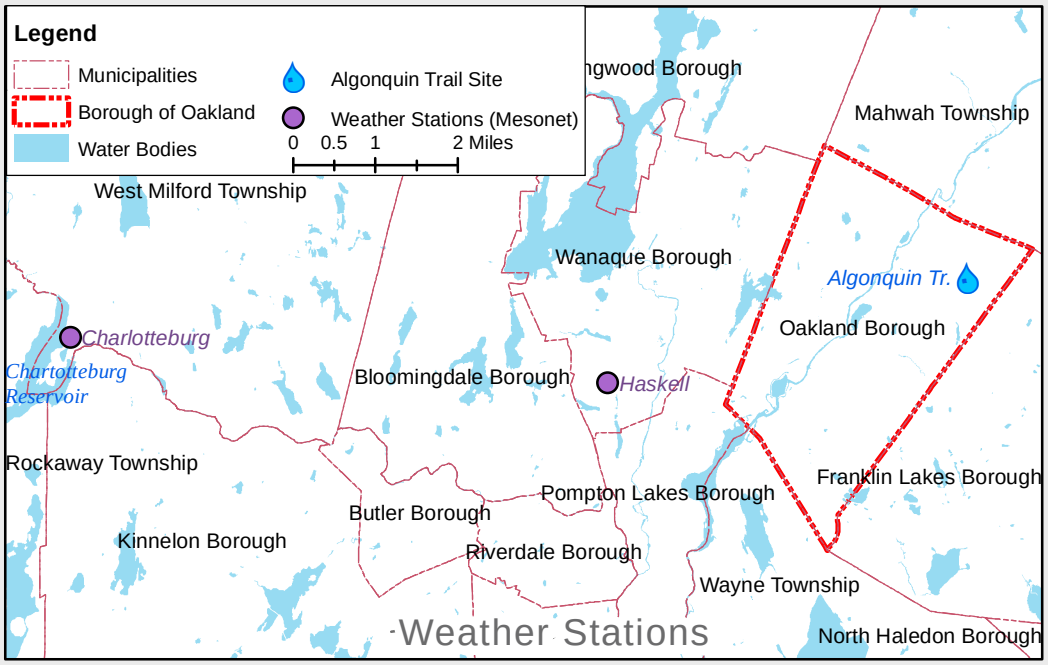


Figure 2a: Weather and Air Quality Monitoring and Drought Regions

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

N

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*.

NJ has never exceeded the NAAQS for nitrogen dioxide (NO_2), and has not exceeded the standard for lead since the early 1970s. Only Warren County exceeds the sulfur dioxide (SO_2) standard. Based on prior violations of the 8-hour carbon monoxide standard, Northeastern New Jersey (including Bergen County) is one of the state's three 8-hour carbon monoxide (CO) maintenance plan areas (see **Table 2.5**). Bergen and Passaic Counties are part of the Northern New Jersey/New York/Connecticut nonattainment area for both the particulate matter ($PM_{2.5}$) annual standard of 15 $\mu g/m^3$, [11,12] as well as for the 24-hour 35 $\mu g/m^3$ standard (see **Table 2.5**). Bergen and Passaic Counties are part of the New York-Northern New Jersey-Long Island (NY-NJ-CT) nonattainment area for the Ozone standard (1997 8-hour ozone standard of 0.08 ppm; revised in 2008 to 0.075 ppm (both primary and secondary); revised in 2012 to 0.075 ppm 8-hour ozone NAAQS (see **Table 2.5**) (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 state is divided into 9 Air Quality Regions. The closest stations for each parameter are as follows: Ozone (O_3) at Ramapo (Ramapo Mountain State Forest, Passaic County); $PM_{2.5}$ was measured at Paterson (Passaic County) until 2012, but currently the closest station is Newark Firehouse (Essex County; where O_3, SO_2 and CO are also measured); and nitrogen dioxide (NO_2) is measured at East Orange (Essex County, also CO) (NJDEP Bureau of Air Monitoring, February 13, 2013; see **Internet Resources** for links to current air quality at these sites; see **Figure 2a** for locations). It should be noted that some of these monitoring sites may receive much higher local air pollution (e.g. from traffic and industry) than Oakland. The following paragraphs provide more information about ground-level ozone, particulates, air toxics and atmospheric deposition.

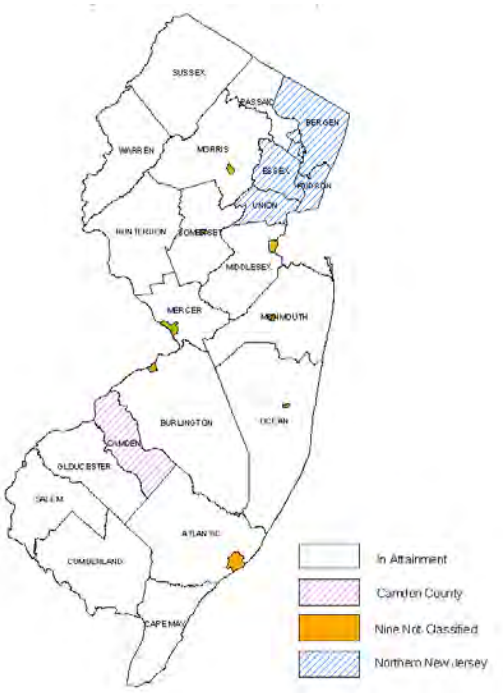
Ground-level Ozone

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. Ozone is monitored at the Ramapo station (in Ramapo Mountain State Forest).

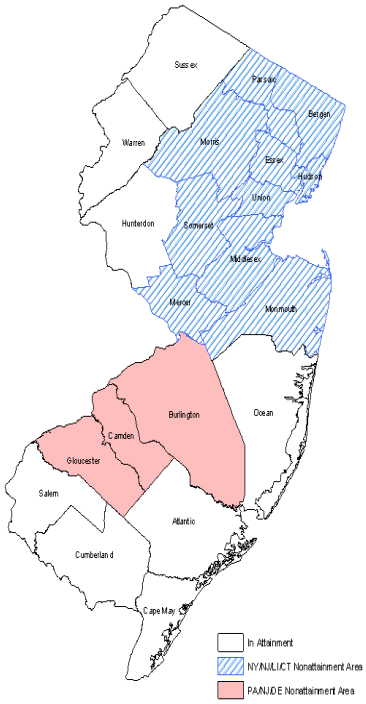
[11] m^3= cubic meters
[12] $\mu g/m^3$ = micrograms per cubic meter of air (a microgram is one millionth (10^{-6}) of a gram).
[13] See Particulates, below in this section, for more information.

Table 2.5: National Ambient Air Quality Standards Nonattainment

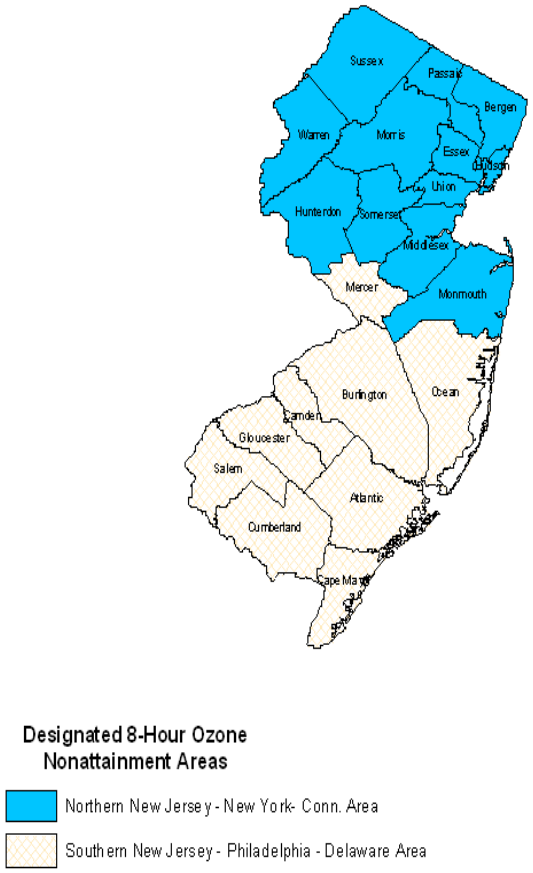
New Jersey Carbon Monoxide (CO) Maintenance Areas



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



New Jersey 8-Hour Ozone Nonattainment Areas



Standards:

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.

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

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 and US EPA, December 14, 2012

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).

According to the most recent three years of monitoring data for the Ramapo site (closest to Oakland, although it's in Passaic County), the 8-hour ozone standard of 0.075 ppm was exceeded 4 times in 2010, 3 times in 2011, and once in 2012. 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. Based on the 3-year period from January 2010 through December 2012, the USEPA has designated all of New Jersey as moderate non-attainment with respect to the 8-hour ozone standard. 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; NJDEP Bureau of Air Monitoring, 2012).

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).

The nearest monitoring site for fine particulates ($PM_{2.5}$) in 2012 was in Paterson[14], but is not being monitored in 2013. The closest current site is at Newark Firehouse (Essex County; although it was not monitored in 2012). The 2012 weighted annual mean[15] at the Paterson station was 9.1$\mu g/m^3$, and the highest 24-hour concentration was 30.7$\mu g/m^3$. The 2012 weighted annual mean at the Newark Firehouse station was 9.0$\mu g/m^3$, and the highest 24-hour concentration was 23.5$\mu g/m^3$. PM_{10} is no longer monitored (NJDEP Bureau of Air Monitoring, February 13, 2013; NJDEP Bureau of Air Monitoring, 2012a).

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

[14] Although the city of Paterson is in Bergen County, the Paterson air monitoring site is in Passaic County (NJDEP Bureau of Air Monitoring, 2012a). See **Figure 2a**.

[15] The *weighted annual mean* is similar to an arithmetic mean, but instead of each data point contributing equally to the final average, some data points contribute more than others.

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.

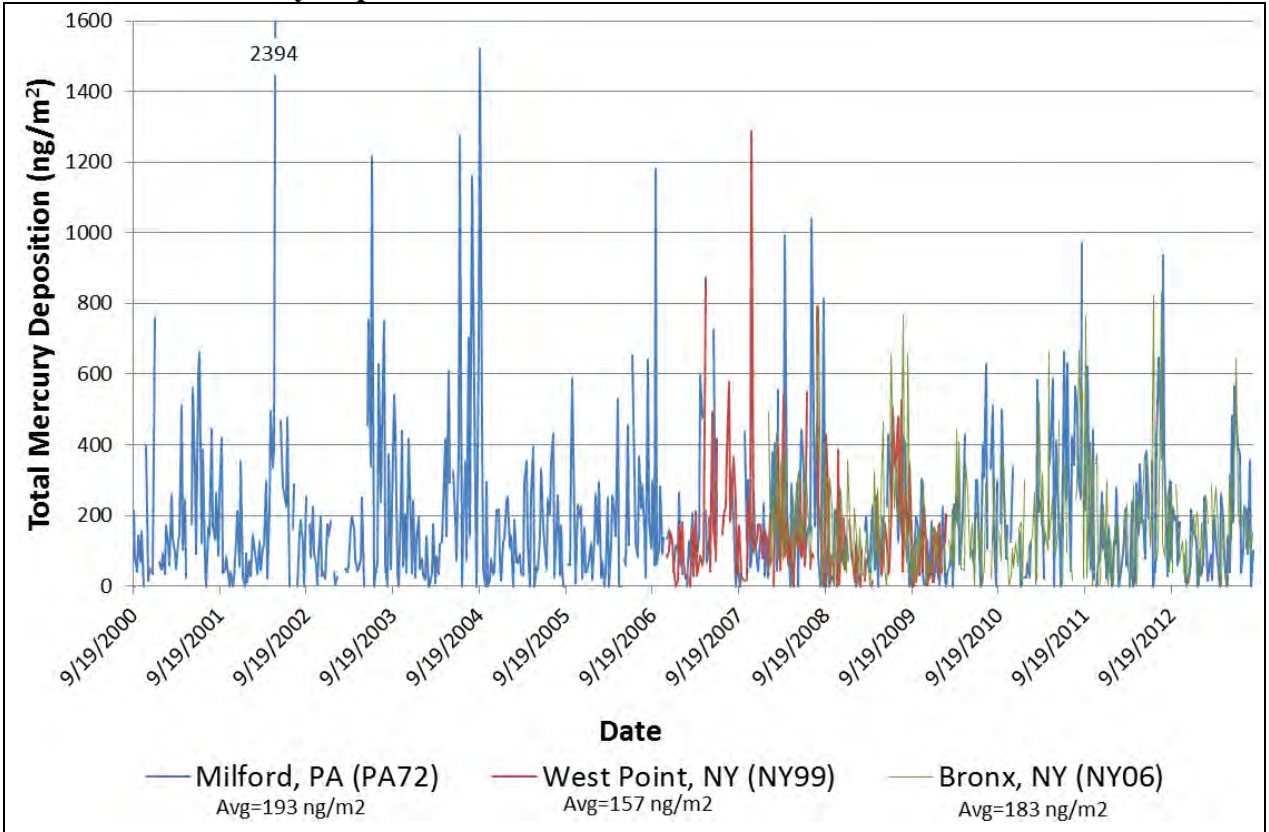
The closest National Atmospheric Deposition Program (NADP) site is located in West Point, NY (Orange County), which has been monitored since 1983. Results for 2012 show a mean pH value of 4.88 (normal rainfall has a pH of about 5.6). This is very acidic, but is an improvement from the 1980s, when pH averaged around 4.2. Trends show decreasing concentrations of SO_4, NO_3, Mg, and N; but no improvement in NH_4, Ca, K, Na and Cl (NADP, 2012a).

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, 2012b).

In New Jersey, three sites are monitored as part of the Atmospheric Mercury Network (AMNet) for mercury: NJ54 Elizabeth Lab, NJ30 New Brunswick and NJ32 Chester, but the data is not publicly available (NADP, 2012c).

The Mercury Deposition Network (MDN) provides a long-term record of total mercury (Hg) deposition in precipitation throughout the United States and Canada. Standard procedures include automated weekly collection modified to preserve mercury. The sites closest to Oakland include Milford, PA (about 35 miles west of the borough), which has been monitored since 2000; West Point, NY (about 25 miles north) which was monitored between November 2006 and January 2010; and Bronx, NY (roughly 25 miles east of Oakland), which has been monitored beginning in January 2008. The Milford, PA site (with an average of 193 mg of Hg per m^2 of precipitation) is relevant to Oakland because the prevailing westerlies cause air to usually flow from west to east in this region. The West Point (average=157 ng/m^2) and Bronx (average=183 ng/m^2) sites are approximately equidistant, however the West Point site is not currently sampled, and the Bronx site would be impacted by higher concentrations of industry than exist in Oakland. Locations of the Milford and West Point sites are shown on **Figure 2a**. Mercury deposition data for these three sites are displayed in **Table 2.6** (NADP, 2012b). Statistical analysis does not show any trends in this data.

Table: 2.6: Mercury Deposition Network Data for Three Sites



Data Summary

MDN Sites	Milford, PA (PA72)	West Point, NY (NY99)	Bronx, NY (NY06)
Date Range Displayed	9/19/2000 to 8/28/2013	11/7/2006 to 2/2/2010	1/15/2008 to 8/28/2013
Average (mean)	192.75	156.57	182.79
Median (middle value)	132.74	110.22	152.80
Minimum	0.00	0.00	0.00
Maximum	2394.37	1287.73	829.79

Source: NADP, 2012b

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.

According to Oakland's 2000 Master Plan, 3,840 of the borough's housing units rely on public water, while 179 units rely on private wells (Oakland Master Plan, 2000). Locations of the Oakland Water Department's seven municipal wells are shown on **Figure 2b.** A discussion of the aquifer that these wells draw from is found in **Section 5B**. **Table 2.7** shows the well withdrawals (combined total of all wells) from 2008 to 2013.

The first graph displays average monthly water use. On average, July has the highest water usage with over 11 million gallons more than any other month, while the February average is over 32 million gallons less than July (Oakland Department of Public Works, February 12, 2014). The higher average water usage during the months of May through September corresponds to the growing season when people are most likely to water their gardens and lawns.

The second graph shows total annual water withdrawals, which has averaged 482 million gallons per year (or 1.32 mgd[16]) (Oakland Department of Public Works, February 12, 2014). Lower water use in 2009 and 2011 corresponds to two years that experienced wet springs and summers. Due to the higher than average spring-summer rainfall, there was a decrease in demand for water during the months that are usually the highest (Klaus, 2012; Oakland Department of Public Works, February 12, 2014). Statistical analysis does not show a trend in water withdrawal.

Water use averages 108 gallons per capita per day, ranging from a low of 84 gallons in January and February to 164 gallons in July (based on 96% of the population using public water (Oakland Master Plan, 2000) and a population of 12,754 (US Census, 2010)).

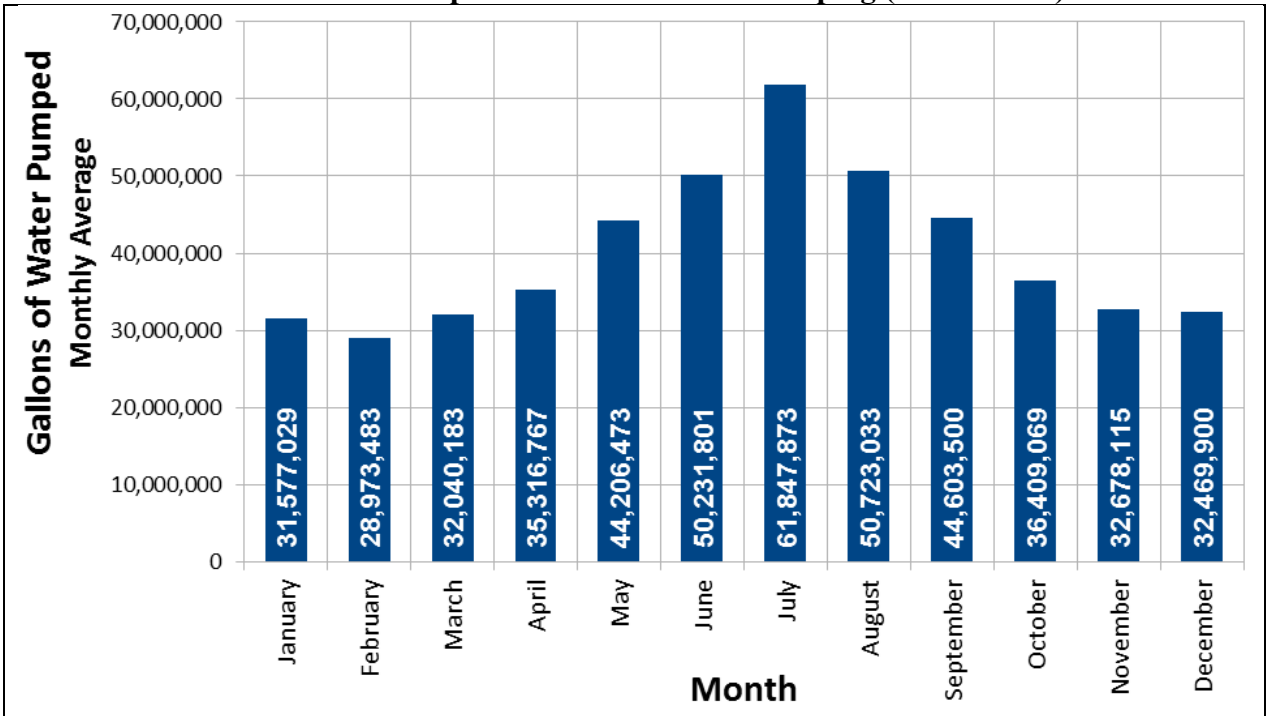
Sewer Service Areas

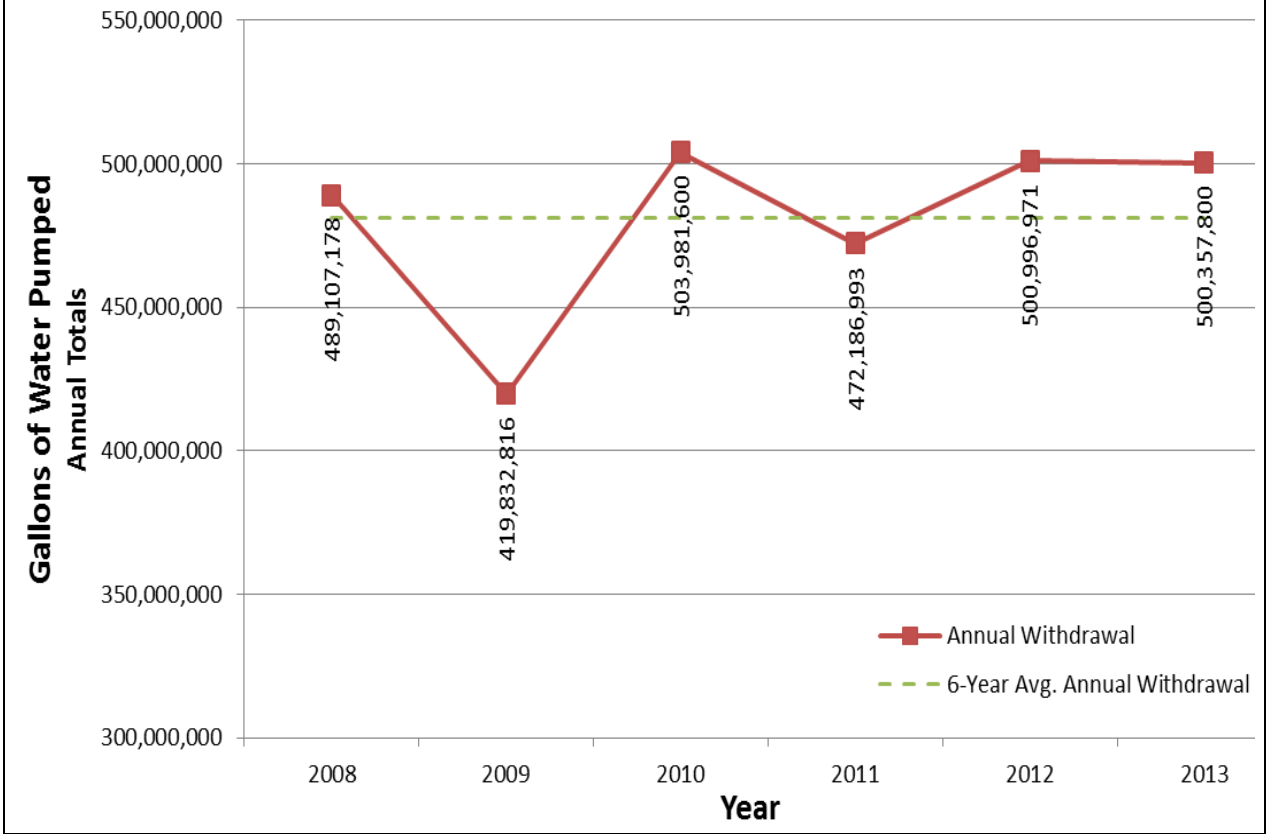
The NJDEP administers the Statewide *Water Quality Management (WQM)* Planning rules found in N.J.A.C. 7:15. The rules establish a mechanism for determining whether proposed projects or activities are consistent with the statewide WQM Plan (see **Internet Resources**). This process includes development and adoption of a *Wastewater Management Plan (WMP)*, a document that provides 20 year planning for wastewater and certain other water quality concerns. While counties are often the responsible agency for WMPs, Oakland Borough is looking to partner with the Northwest Bergen Utilities Authority to complete the WMP. The borough must notify, seek comments from, and offer to confer with all government units that have regulatory or planning jurisdiction over wastewater or land use in the borough, and all government units and public utilities that own, operate, or have contracts or NJDEP permits for sewerage facilities identified in the WMP. A WMP is valid only after submission to NJDEP and

[16] million gallons per day

adoption by the Governor or his designee as a WQM plan amendment (NJDEP Division of Watershed Management, March 2012).

Table: 2.7: Oakland Water Department Well Water Pumping (2008 – 2013)





Source: Oakland Department of Public Works, February 12, 2014

According to the 2000 Master Plan, only 253 (6.6%) of the borough's housing units are served by public sewer. The remaining units are served by septic systems, package plants and

private systems. The public *Sewer Service Areas* (SSA) mapped on **Figure 2c** show these areas. 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 BWR, 2012).

Brownfields

The New Jersey Department of Community Affairs (DCA) Office of Smart Growth defines *brownfields* as any former or current commercial or industrial site, currently vacant or underutilized, on which there has been, or there is suspected to have been, a discharge of a contaminant[17]. The purpose of the Brownfields and Contaminated Site Remediation Act (N.J.A.C. 58:10) is to develop strict remediation standards in order to protect public health and safety and the environment. In order to encourage clean-up of contaminated sites, NJDEP provides financial incentives, liability protection, cleanup procedures that are cost effective and regulatory action that is timely and efficient (NJDEP Site Remediation Program, 2011).

The Brownfields SiteMart was developed to highlight and denote locations of brownfield sites in order to promote the redevelopment of brownfields throughout the State. The 11 brownfield sites currently located within Oakland are listed in **Table 2.8** and shown on **Figure 2d**.

Table 2.8: Brownfields

Site ID❖	PI Number*	Site Name	Address	Current Site Name/ Status
4453	018094	Astro Plastics Inc	37 Edison Ave	
4455	018634	Brown Chemical Co	302 W Oakland Ave	
4456	014982	Clad Metal Industries, Inc.	40 Edison Ave	
4451	255206	Dewey Electronics Corporation	27 Muller Rd	
4454	006943	Engineering Laboratories, Inc.	360 W Oakland Ave.	
4450	008942	Exxon Store 3-2238	160 Ramapo Valley Rd	
4458	G000011603	Oakland Borough Water Department Well 5	Ramapo Valley Rd & Oak St	
4457	022535	Ramapo Valley Council 5846 KOFC	7 Courthouse Plaza	
4449	G000003081	Silicon Technology Corporation	48 Spruce St	
4448	192097	Titan Tools Inc.	12 Wright Way	
4452	G000003960	Vinyl Building Products Inc.	1 Raritan Rd	
❖Identification number used on NJ SiteMart. *Program Interest ID used by NJDEP.				
Sources: NJ Department of Community Affairs, Office of Smart Growth, January 2013; NJ Office for Planning Advocacy, June 2013				

[17] Sites remain on the list, even if cleanup has occurred and the site is not vacant, until the landowner has applied for and the NJDEP has issued a No Further Action letter.

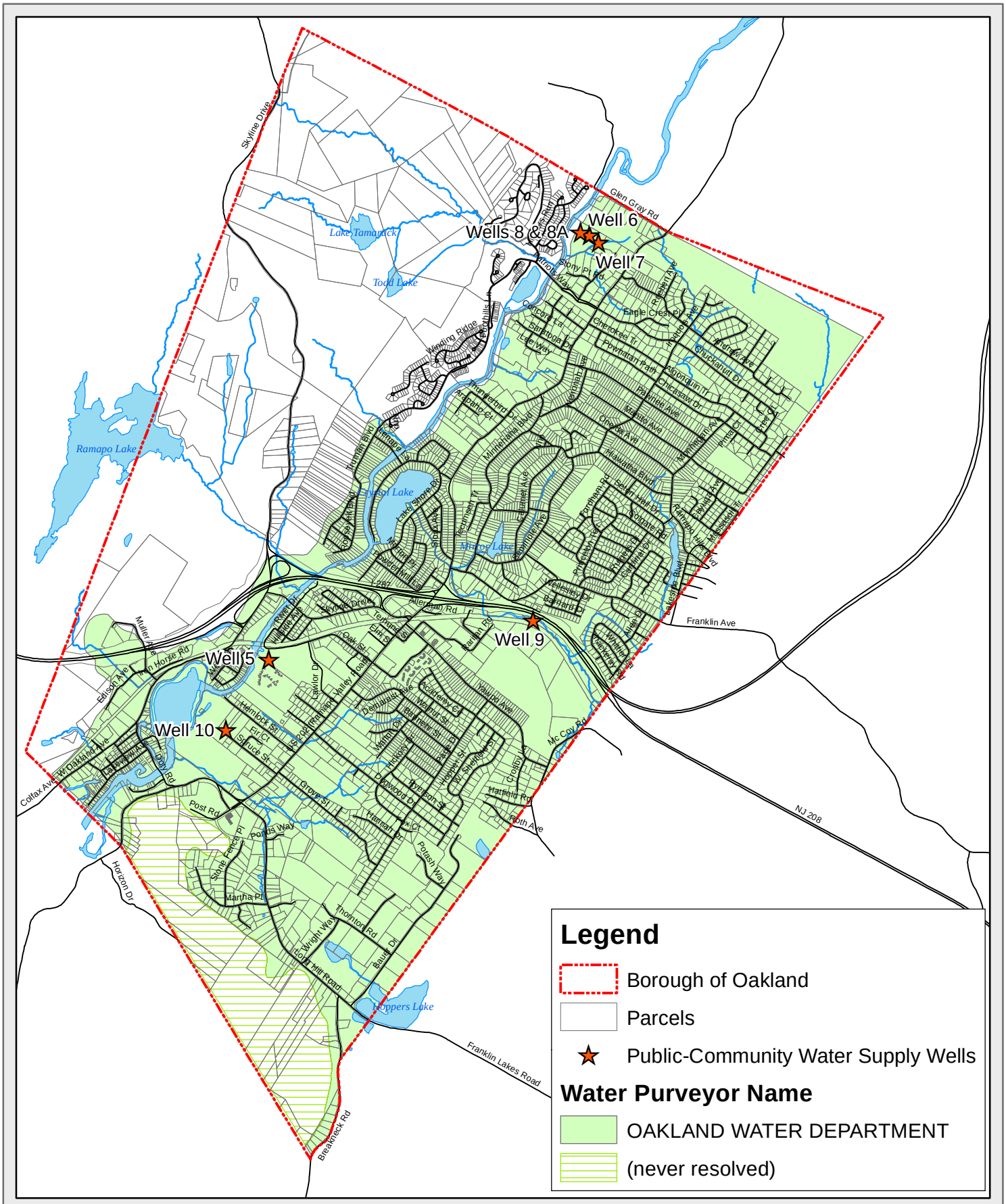


Figure 2b: Public Water

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

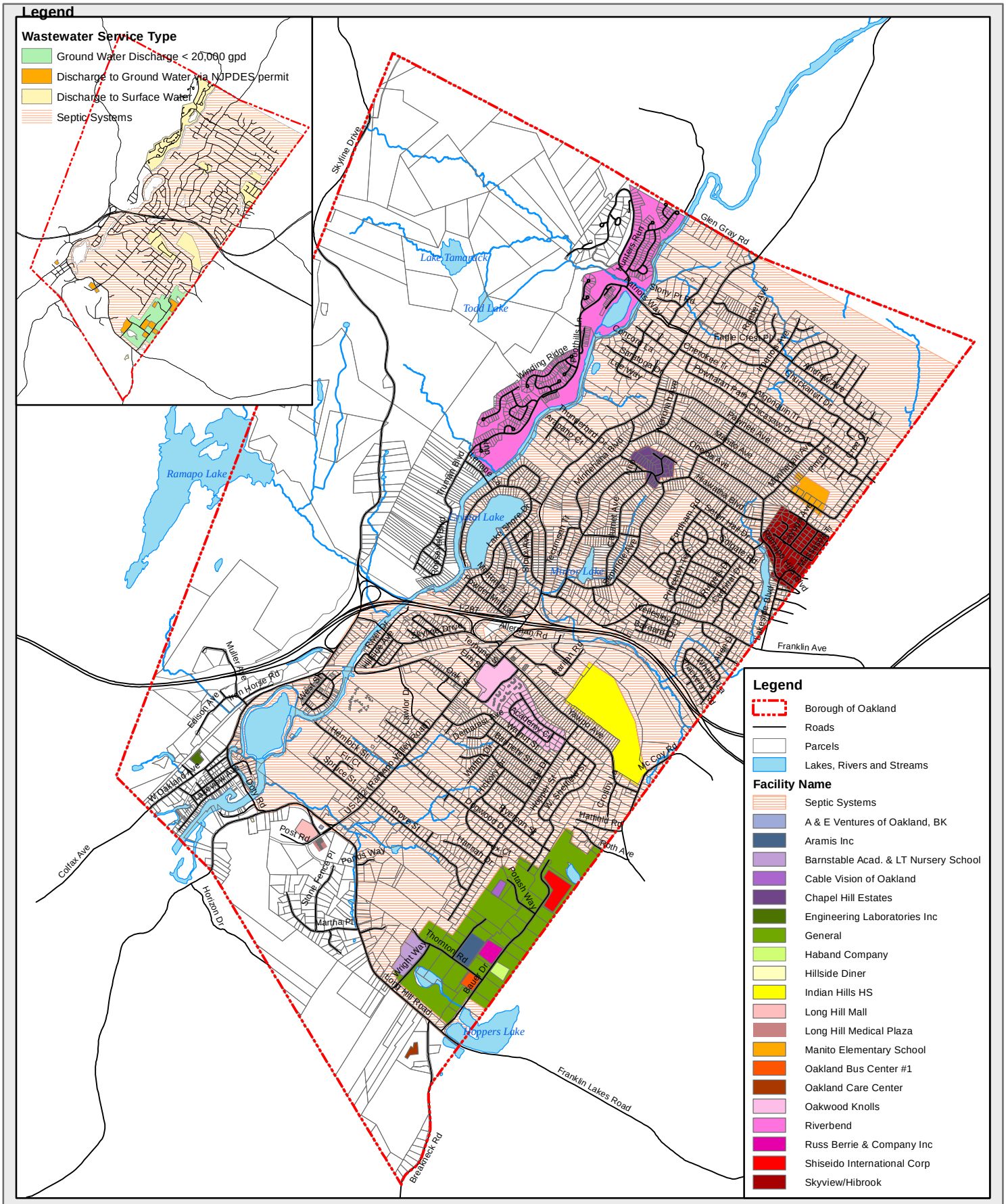


Figure 2c: Sewer Service Areas (October 2013)

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

Data Sources: NJDEP
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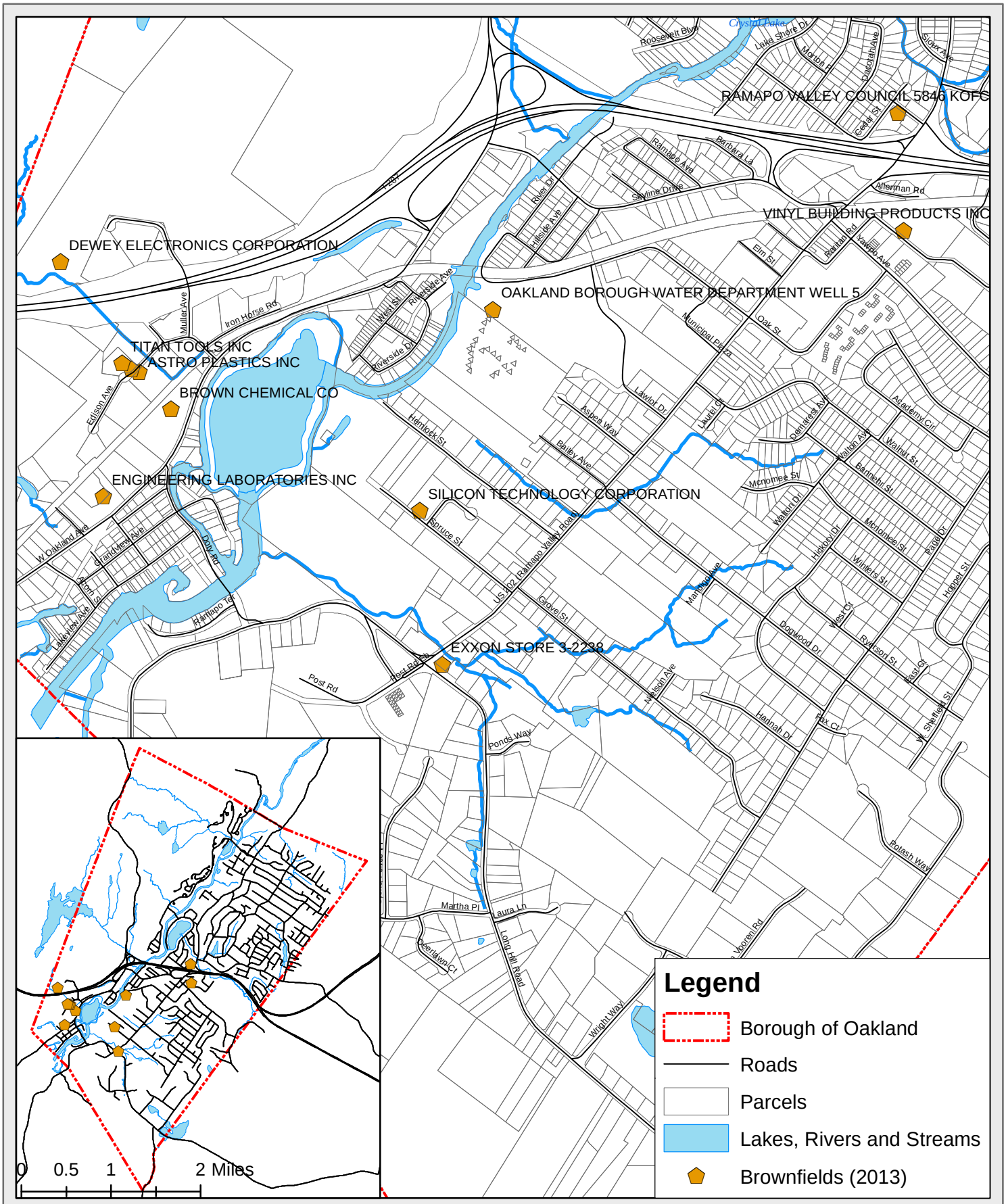

Figure 2d: Brownfields

0 0.1 0.2 0.4 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

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Internet Resources: Local & Regional Conditions

Climate and Meteorology

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 Northeast Region: http://www.njdrought.org/status.html#northeast
- Weather and Climate Network Index: http://climate.rutgers.edu/njwxnet
- Weather and Climate Network, Ramsey Station: http://climate.rutgers.edu/njwxnet/station.php?s=450
- Weather and Climate Network, Hawthorne Station: http://climate.rutgers.edu/njwxnet/station.php?s=30
- Weather and Climate Network, Charlotteburg Station: http://climate.rutgers.edu/njwxnet/station.php?s=471

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions):

- Ramapo River at Mahwah (upstream of Oakland): http://water.weather.gov/ahps2/hydrograph.php?wfo=okx&gage=MAWN4
- Ramapo River at Pompton Lakes (downstream of Oakland): http://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=pptn4

National Weather Service Forecast Oakland, NJ: http://forecast.weather.gov/MapClick.php?lat=41.0322496&lon=-74.23554039999999&site=all&smap=1&searchresult=Oakland%2C%20NJ%2007436%2C%20USA

USGS Real-Time Stream Flow Stations:

- 01387500 Ramapo River Near Mahwah (upstream of Oakland): http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01387500&PARAmeter_cd=00065,00060
- 01388000 Ramapo River at Pompton Lakes (downstream of Oakland): http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01388000&PARAmeter_cd=00065,00060
- Index of NJ sites: http://waterdata.usgs.gov/nj/nwis/current/?type=flow

Air Quality

Current Air Quality: Closest Stations for the following parameters:

- O_3: Ramapo (Ramapo Mountain State Forest) http://www.njaqinow.net/StationInfo.aspx?ST_ID=23
- CO, NO_2, Temperature, RH%: East Orange (~16 miles from Oakland) http://www.njaqinow.net/StationInfo.aspx?ST_ID=9

$PM_{2.5}$, winddir, windsp, wd, ws, SO_2-Tr, CO-Tr (also $O_{3)}$: Newark Firehouse (~18 Miles from Oakland)
http://www.njaqinow.net/StationInfo.aspx?ST_ID=34
SO_2, CO, smoke: Jersey City (~21 miles from Oakland)
http://www.njaqinow.net/StationInfo.aspx?ST_ID=16

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

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

Existing Infrastructure
Brownfields SiteMart Search: http://www.njbrownfieldsproperties.com/Search.aspx

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**.

Deborah J. Kratzer

A bedrock outcrop of Horneblende granite can be seen on Overlook Ridge.

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, one of which is Ramapo Mountain. 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. Ramapo Mountain is the highest point (1,171 feet) on the southeastern side of the Highlands Province. The Highlands Province is also characterized by deep, steep-sided valleys carved by streams (NJGS, 2006).

Roughly the western half of the Borough of Oakland lies in the Highlands Province (see **Figure 3a**).

The Highlands Province is separated from the *Piedmont Province* by a series of major faults, including the Ramapo Fault, 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). The specific rock formations in Oakland are discussed in **Section 3C**.

Approximately half of Oakland lies within the Piedmont Physiographic Province (NJGS, 2007) (see **Figure 3a**).

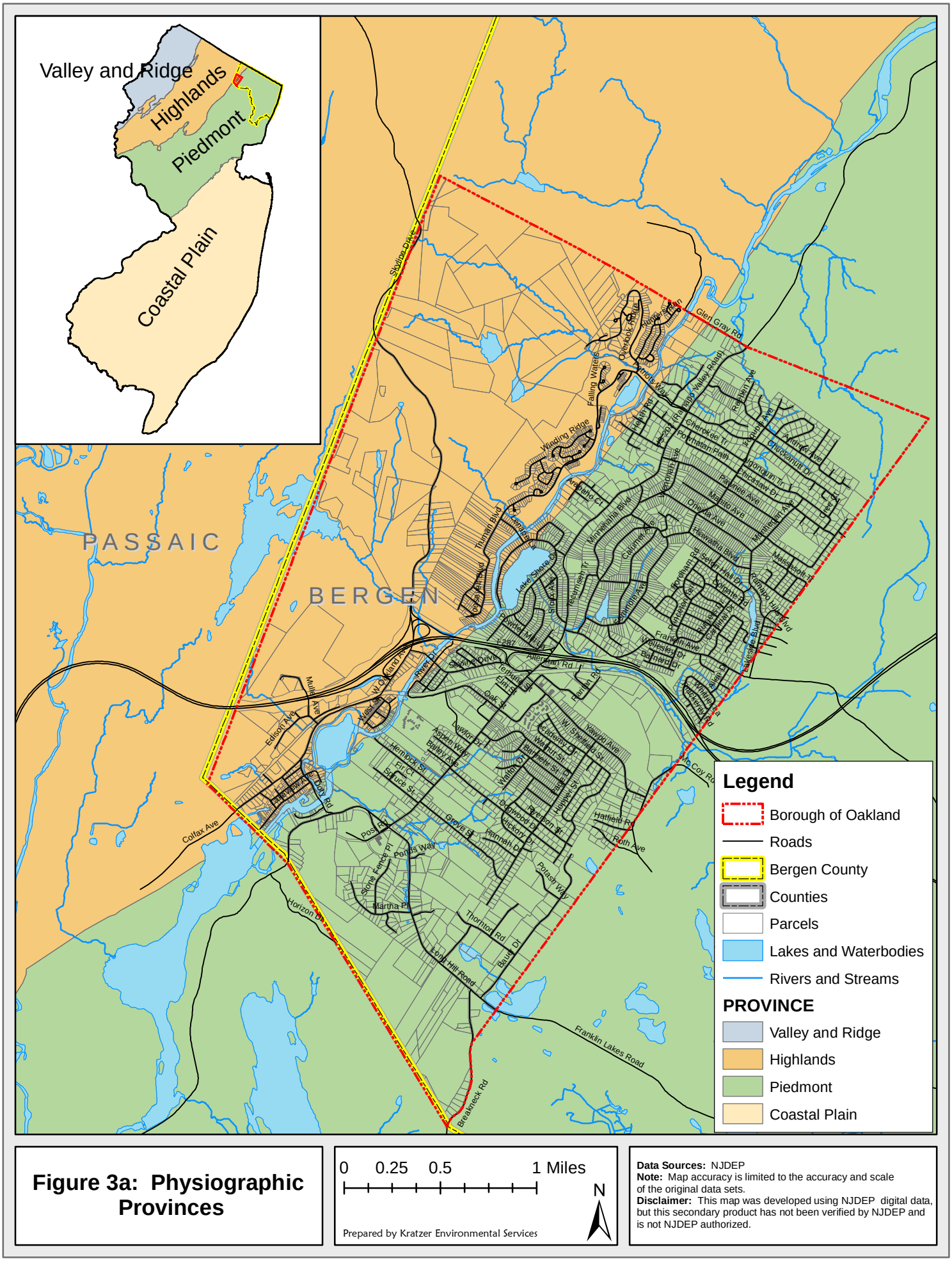

Figure 3a: Physiographic Provinces

0 0.25 0.5 1 Miles

N

Prepared by Kratzer Environmental Services

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

Overlapping the Piedmont Province approximately 30 miles south of Oakland, 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).

Within the past two million years, the climate alternated between cool and warm. During periods of glaciation, the glaciers covered Oakland 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). The impact of glaciation on Oakland is discussed in **Section 3F.**

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, ornithopods (forerunner of hadrosaurus), tenontosaurus (relative of the

Period	Million Years Ago	Description of Climate and Fossils Found in Corresponding Bedrock
		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. The elevation in Oakland ranges from about 280 meters (918 feet) (at the northwestern edge of the Borough, in Ramapo Mountain County Park and Ramapo Mountain State Forest) to 80 meters (262 feet) above mean sea level (along the Ramapo River) (NJGS, 1999a) (see **Figure 3b**). In **Figure 3b**, each line represents 20 meters of elevation, and is drawn to follow the contour of the land. **Figure 3c** uses shaded colors to illustrate elevation in Oakland (NJGS, 1999b).

Steep slopes present difficulties for driveway construction and for usable areas around a house. In addition, steeper slopes are more vulnerable to erosion. As the gradient or percent of slope increases, the velocity of runoff water increases, which increases its erosive power. A doubling of velocity of runoff water increases the erosive power fourfold and causes 32 times the amount of material of a given particle size that can be carried (Foth, 1978).

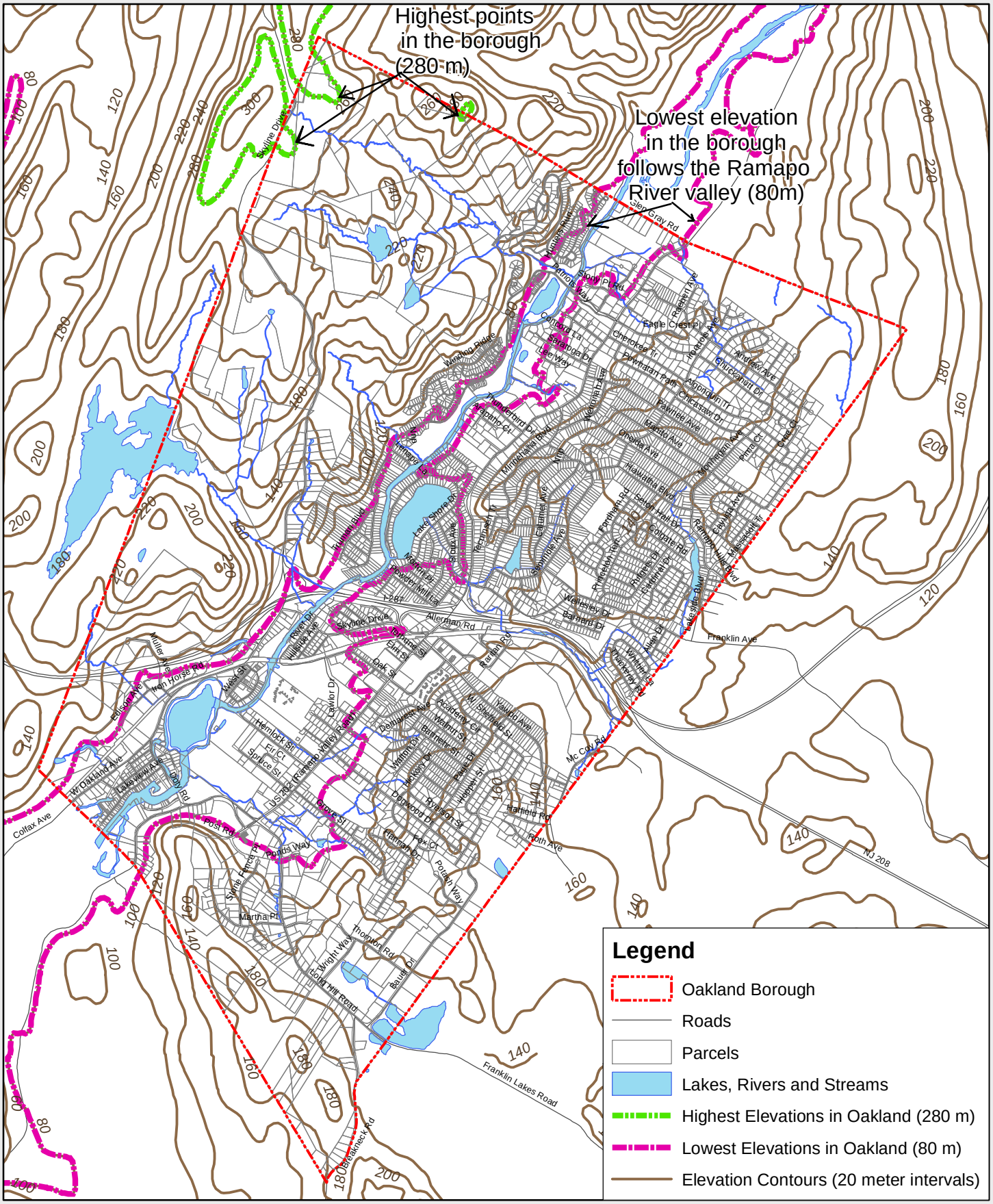

Figure 3b: Elevation Contours

0 0.25 0.5 1 Miles

N

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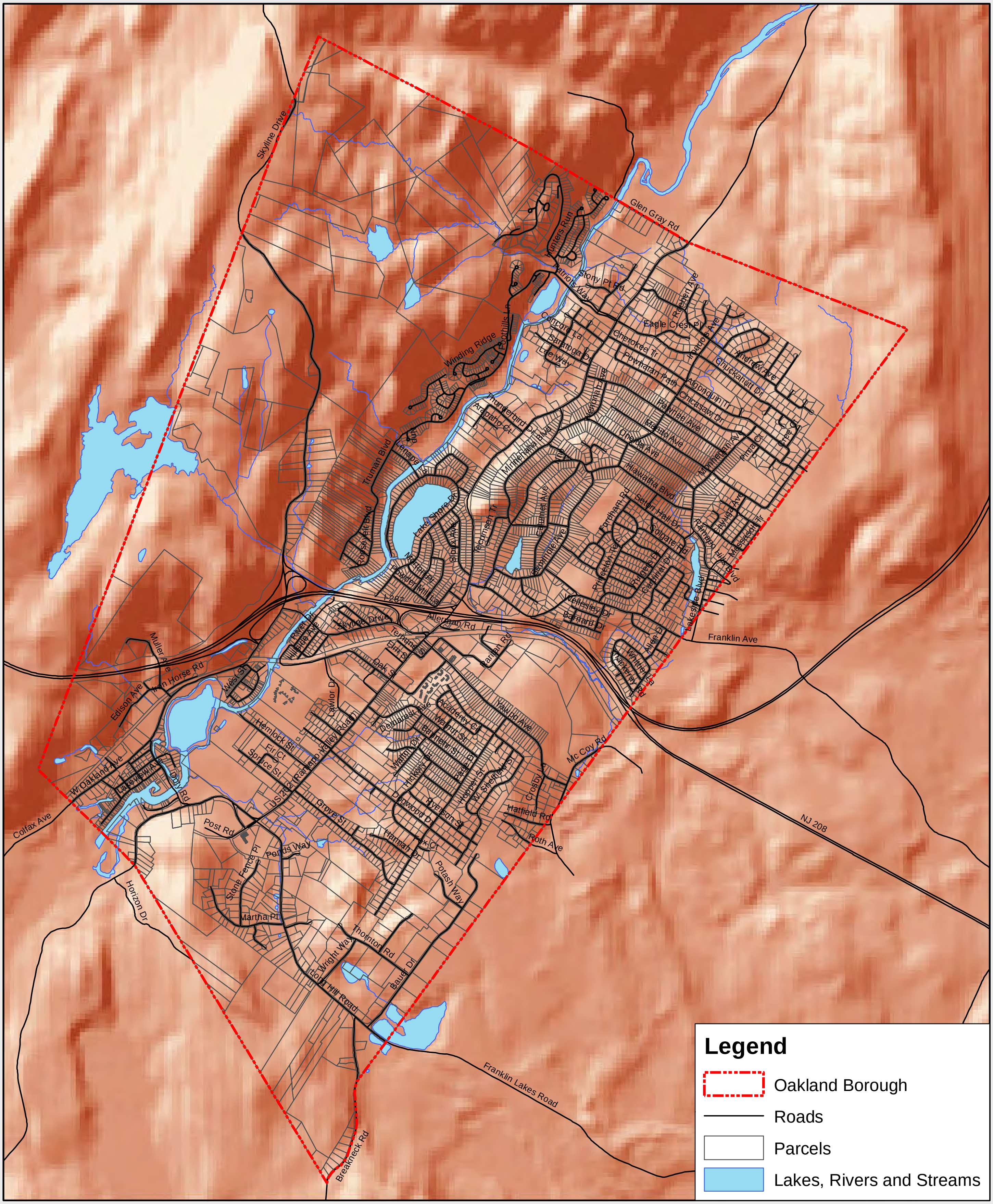

Figure 3c: Shaded Topography (Hillshade)

0 0.25 0.5 1 Miles

N

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Erosion causes a number of harmful effects on the environment: loss of soil upon which plants and wildlife depend; loss of soil fertility, because the nutrients and organic material are more easily eroded; gully formation; loss of water that might have been useful for plant growth or ground water recharge; sedimentation of streams; and deposition of soil in navigable waters, creating the need for dredging to maintain navigability. Eroded sediment, and the nutrients, pesticides, and other chemicals carried with it, affects aquatic life in many ways. The sediments may bury fish eggs, reduce light available to aquatic plants, and reduce recreational quality and aesthetics.

Slopes greater than 10 or 15% are generally considered "steep slopes." Steep topography can be seen in **Figure 3d** and **Table 3.2**. Information from the Highlands Region Steep Slope Protection Area is depicted in this map, which emphasizes the greater sensitivity of steep slopes adjacent to streams. Additional data concerning steep slopes greater than 30% is from the NJDEP (see **Figure 3d**). In Oakland, most of the area west of the Ramapo River consists of moderately to severely steep slopes. This corresponds to the Highlands portion of the borough. Other concentrations of steep slopes occur in the areas underlain with erosion-resistant basalt (see **Section 3C**, below). Additional steep slopes are scattered throughout the borough, many associated with steam corridors (NJ Highlands Council, 2012; NJDEP NJFFS, April 17, 2009).

Table 3.2: Steep Slopes

Slope Category	Acres*	Percent
Constrained and Limited Slopes: Non-riparian non-forested lands 15% to 20% slope	94.04	1.68%
Moderately Constrained Slopes: Non-riparian forested lands 15% to 20% slope	217.12	3.87%
Severely Constrained Slopes Non-riparian areas > 20% slope or riparian areas > 10% (> 30% slope (374.79 acres, or 6.68%; included in Severely Constrained Category)	1835.63	32.71%
Total Steep Slopes in Oakland	**2146.79**	**38.26%**
*Area calculated with GIS differs from area from other sources, such as tax		
Sources: NJ Highlands Council, 2012a, b and c; NJDEP NJFFS, April 17, 2009		

C. Bedrock Geology of Oakland

Bedrock is the solid rock beneath the soil and surficial rock. Fourteen different types of bedrock are found underneath the Borough of Oakland. The western half of Oakland is underlain with rocks of the New Jersey Highlands, which consist of a series of ridges, one of which is Ramapo Mountain. The mountains are composed of hard, crystalline, erosion-resistant Precambrian igneous and metamorphic rocks (1.2 billion to 900 million years old). A small area of bedrock of Middle Ordovician age (544 to 440 million years old) is found in central Oakland. In the eastern half of Oakland, areas within the Piedmont Province are underlain by soft shales and sandstone and hard basalt of the Newark Basin Supergroup, which were formed in the Late Triassic to Early Jurassic Periods (240 to 140 million years old) (**Table 3.3** and **Figure 3e**).

Precambrian Bedrock of the Highlands (1.2 billion to 900 million years old)

During the Precambrian Period (also called the Proterozoic), thousands of feet of sediments were deposited, while Bergen County was the bottom of the sea. Over time, these deeply buried sediments were subjected to folding, faulting, pressure and heat, which metamorphosed the rocks. Molten igneous rock intruded, further modifying the rocks, and resulting in metamorphic gneiss, a coarsely grained rock in which light and dark colored bands can be seen (Lucey, 1971).

The oldest rocks are plagioclase-rich gneiss and amphibolite of the *Losee Metamorphic Suite* (see photo on next page), which consists of volcanic rocks that underwent metamorphism.

Two rock types of the Losee Metamorphic Suite are found within Oakland. The *Quartz-oligoclase gneiss (Ylo)* is a white to light colored, medium- to coarse-grained, moderately layered gneiss underlaying about 13% of the borough. *Biotite-quartz-oligoclase gneiss (Ylb)* is white- to gray found beneath about 4% of Oakland (Drake et al, 1996; NJGS, 2007).

An unconformity (a period of erosion; or where deposition was not continuous) separates the Losee Metamorphic from the *Metasedimentary Rocks* (metamorphosed sedimentary rocks), that, in total, underlay about 8% of the borough. *Microcline gneiss (Ym)* is light-colored, fine- to medium grained, well-layered gneiss beneath less than 1% of Oakland. About 4% of the bedrock in Oakland is *Biotite-quartz-feldspar gneiss (Yb)*, a grayish, variable gneiss. *Hornblende-quartz-feldspar gneiss (Ymh)* is a pinkish fine- to medium-grained gneiss under about 3% of Oakland. Less than 0.1% of the borough has *Pyroxene gneiss (Yp),* a whitish, fine- to medium-grained, well-layered gneiss (Drake et al, 1996; NJGS, 2007).

Rocks of the *Byram Intrusive Suites*, including the *Hornblende granite (Ybh),* intruded the other formations. Hornblende granite is light colored medium to coarse grained granite and granite gneiss. These rocks are approximately 1.1 million years old and underlay about 14% of Oakland (Drake et al, 1996; NJGS, 2007). Gray- to grayish-black, medium-grained *Amphibolite (Ya)* is a metamorphic rock of varying origin, underlying about 2% of the borough (Drake et al, 1996).

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Pictured above is a road-cut outcrop looking north at the Skyline Drive exit ramp from Route 287 South. This is a close-up view of an offset potion of the Ramapo Fault. The highly fractured type of bedrock pictured is part of the Losee Metamorphic Suite (Middle Proterozoic in age; ~1.3 billion years old).

Middle Ordovician Bedrock (544 to 440 million years old)

The *Bushkill Member (Omb)* is part of the Kittatinny Valley Sequence, rocks of Cambrian through Ordovician age within the Kittatinny Valley and valleys infaulted into the Highlands. The Kittatinny Valley sequence includes the carbonate and silica-rich sedimentary rocks. A small area, less than 1% of the borough, of the Bushkill Member is located near the Ramapo River, north of Crystal Lake near Rock Ledge Road and Boulder Run Road (Drake et al, 1996; NJGS, 2007).

Late Triassic and Early Jurassic Bedrock of the Piedmont (240 to 140 million years old)

During the late Triassic Period, the supercontinent Pangaea began to break apart. The Highlands were uplifted, while the area to the east of these faults shifted downward. The climate was arid, and sediments from the mountains were eroded during seasonal torrential rains and deposited in broad alluvial fans over the plains. These sediments are known as the Newark Supergroup, a northeast-trending lens shape bounded on the northwest by faults. The composite thickness of the layers of the Newark basin total approximately 7,500 meters (24,600 feet) (Lucey, 1971; Drake et al, 1996).

Streams laden with sediments flowed down from the Highlands at high velocities, where they spread out on a low, flat plain. These layers of sediment accumulated to form the Stockton

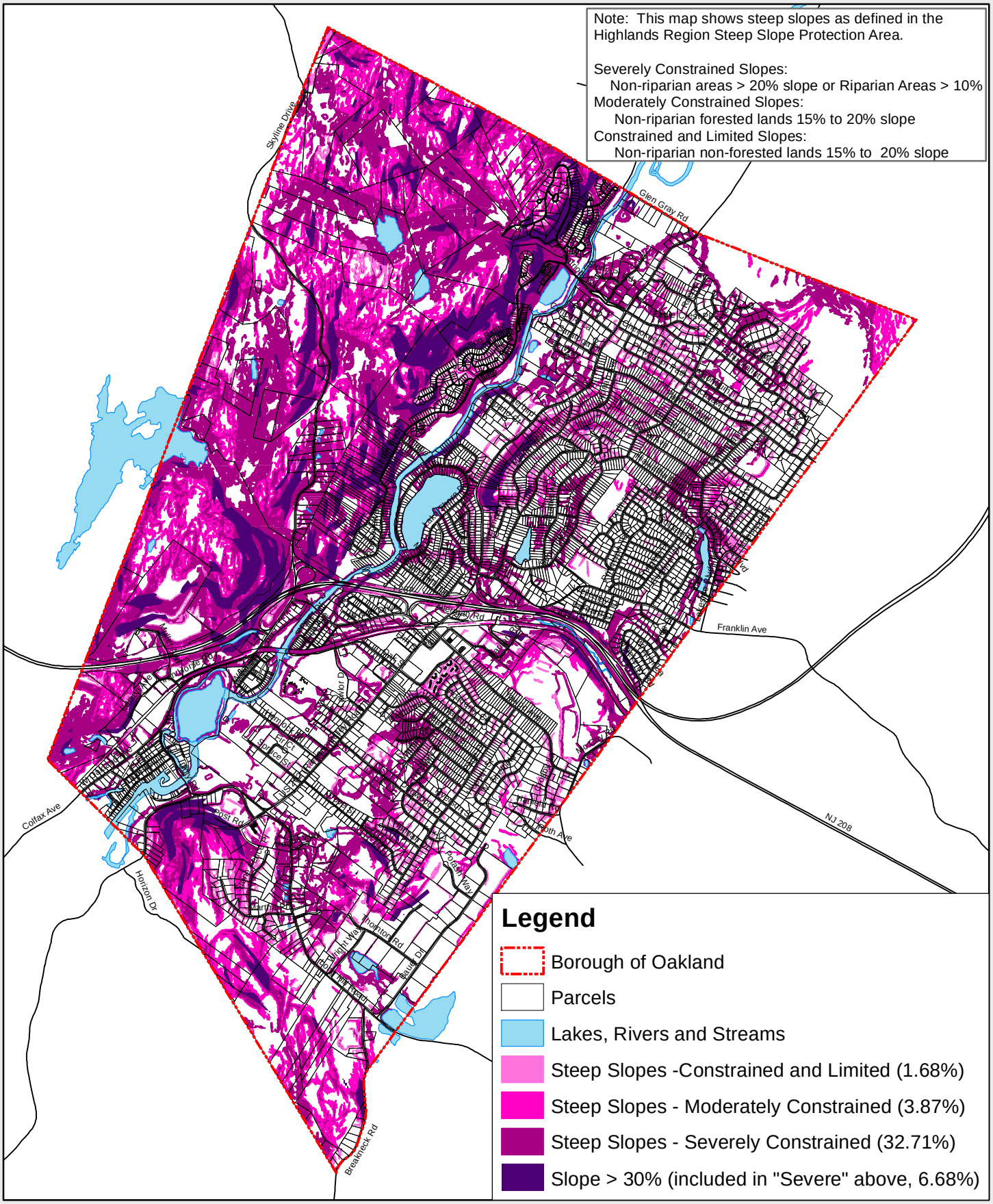

Figure 3d: Steep Slopes

0 0.25 0.5 1 Miles

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Formation and then the Brunswick Formation[18] on top of the Stockton. In Oakland, the sedimentary layers of the Brunswick Formation are mostly coarse-grained sandstone with some conglomerate, including the *Towaco Formation, Feltville Formation* and the *Feltville Formation Conglomerate and Sandstone.* The absence of gneissic materials indicates that there were Paleozoic sediments covering the Highlands gneiss during the time of erosion and deposition of the Newark sediments (Lucey, 1971). The *Feltville Formation* underlies 19% of Oakland, the 2nd most prevalent bedrock type in Oakland, while the *Feltville Formation Conglomerate and Sandstone* accounts for only about 1% of the borough. About 1% of Oakland is underlain by the *Towaco Formation*, in north-central Oakland, where it borders Mahwah Township (Drake et al, 1996; NJGS, 2007).

These Triassic-Jurassic sedimentary rocks exhibit two types of fracturing. Bedding fractures resulted from changes in the characteristics of the sediments at the time of deposition. In addition, fracturing occurred when weak sedimentary layers were pulled apart as the continents separated. Often these fractures have a vertical or near vertical orientation and extend a few inches to a few feet across (Van Houten, 1969).

During the Triassic-Jurassic Periods, there were three or more periods of volcanic activity as Pangaea continued to break apart, forming the Atlantic Ocean. Two types of igneous rock occur in this region; basalt and diabase, together commonly known as traprock. Lava that came to the surface and solidified formed *basalt*, a hard, fine grained, dense textured, extrusive igneous rock. The bottom of the lava flows cooled quickly, with little time to form crystals, therefore the rock is fine grained and dense, while the top of the flow is porous and spongy due to escaping bubbles of steam and other gasses as the lava cooled and solidified. The basalts are more erosion-resistant than the sandstones and shales, forming the ridges and hills of the Piedmont (Lucey, 1971). The *Preakness Basalt (Jp)*, very fine grained and dense, is the most prevalent bedrock (25%) beneath the Borough of Oakland. *Orange Mountain Basalt (Jo)*, under 12% of Oakland, is also fine-grained, has columnar jointing, pillow structures, and pahoehoe (Drake et al, 1996; NJGS, 2007).

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This picture is from the top ShopRite parking lot (looking north) over Oakland. The yellow line in photo shows the trace (scarp) of the Ramapo Fault, trending northeast to southwest. The Ramapo Fault is a major boarder fault dividing two physiographic provinces; yellow arrows indicate the respective motion of the fault: upside (Ramapo Mountains and NJ Highlands) and downside (Piedmont, Jurassic-age Newark Basin) of the fault.

[18] Olson (1980) divides the Brunswick Formation (also known as the Passaic Formation) into three major basalt formations (Hook Mountain, Preakness, and Orange Mountain) and three interbedded sedimentary units (Boonton, Towaco, and Feltville), which differs from older references.

Table 3.3: Characteristics of Bedrock Types Found in Oakland

Geologic Formation	Lithology (physical character of the rocks)		Area (acres) in Oakland	Percent of Oakland
	General	Detailed		
Jf Feltville Formation	sandstone, siltstone, silty mudstone, fine- to coarse-grained, and less abundant calcareous siltstone and mudstone, carbonaceous limestone	interbedded brownish-red to light-grayish red, fine- to coarse-grained sandstone, gray and black, coarse siltstone, and silty mudstone, with a maximum thickness about 155 meters (510 feet). Where the formation came in contact with the Preakness Basalt, the rocks metamorphosed into hornfels. Near the base are layers that contain abundant fish, reptile, invertebrate, and plant fossils.	1075.46	19.16
Jfc Feltville Formation Conglomerate and Sandstone facies	quartzite and quartz in sandstone and siltstone; conglomerate and conglomeratic sandstone	contains subrounded pebbles to cobbles of quartzite and quartz in a red siltstone and sandstone matrix, which interfingers with the sandstone and siltstone of the Feltville Formation.	55.64	0.99
Jo Orange Mountain Basalt	basalt, fine- to medium-grained	dark-greenish-gray to greenish-black basalt composed mostly of calcic plagioclase and clinopyroxene (augite and pigeonite); crystals are generally less than 1 mm (0.04 in) long. Lower and middle flows are generally massive or have columnar jointing. Uppermost flow has pillow structures and pahoehoe (lava with smooth ropy surface, formed from fluid, fast-moving lava). Tops and bottoms of flow layers are pitted. Maximum thickness is about 182 meters (597 feet).	691.47	12.32
Jp Preakness Basalt	basalt, fine- to coarse-grained	dark-greenish-gray to black, very-fine grained, dense, hard basalt composed mostly of intergrown calcic plagioclase and clinopyroxene (pigeonite and augite). Crystals are generally less than 1 mm (0.04 in) long, but locally feldspar crystals are larger than 1.3 cm (0.5 in.). Small spherical to tubular cavities (gas-escape vesicles) may be filled by zeolite minerals or calcite. Thickness ranges from 250 meters (820 feet) to 320 meters (1,050 feet).	1422.16	25.34
Jt Towaco Formation	sandstone, siltstone, silty mudstone, fine- to medium-grained; less abundant calcareous siltstone and mudstone	reddish-brown to brownish-purple, fine- to medium-grained micaceous sandstone, siltstone, and silty mudstone. Distributed throughout formation are eight or more sequences of gray to greenish- or brownish-gray, fine-grained sandstone, siltstone and calcareous siltstone and black, calcareous siltstone and mudstone containing fossil pollen, fish and dinosaur tracks. Maximum thickness of this formation is about 380 meters (1,250 feet).	77.68	1.38
Omb Bushkill Member	shale, slate, less abundant siltstone, and minor dolomite lenses	interbedded medium- to dark gray, thinly laminated to thick-bedded shale and slate and less abundant medium-gray to brownish-gray, laminated to thin-bedded siltstone. It is thickest to the southwest, near the Delaware River, and thins to approximately 457 meters (1,500 feet) at the New York State line.	11.44	0.20
Ya Amphibolite	amphibolite, fine- to medium-grained	gray- to grayish-black, medium-grained amphibolite composed of hornblende and andesine. Some phases contain biotite and/or clinopyroxene. Ubiquitous and associated with almost all other Middle Proterozoic units. Some amphibolite is clearly metavolcanic in	134.10	2.39

		origin, some is metasedimentary, and some appears to be metagabbro (similar to basalt).		
Yb Biotite-Quartz-Feldspar Gneiss	gneiss, fine- to coarse-grained	gray-weathering, locally rusty, gray to tan or greenish-gray, fine- to medium-coarse- grained, moderately layered and foliated gneiss that is variable in texture and composition. Composed of oligoclase, microcline microperthite, quartz, and biotite. Locally contains garnet, graphite, sillimanite, and opaque minerals.	249.21	4.44
Ybh Hornblende Granite	granite, medium- to coarse-grained	pinkish-gray- to medium-buff-weathering, pinkish-white or light-pinkish-gray, medium- to coarse-grained, gneissoid to indistinctly foliated granite and sparse granite gneiss composed principally of microcline microperthite, quartz, oligoclase, and hornblende. Some phases are quartz syenite or quartz monzonite. Includes small bodies of pegmatite and amphibolite not shown on the map. Approximately 1.1 million years old.	772.63	13.77
Ylb Biotite-Quartz-Oligoclase Gneiss	gneiss, fine- to coarse-grained	White- to light-gray-weathering, light- to medium-gray or greenish-gray, fine- to coarse-grained, massive to moderately well layered, foliated gneiss composed of oligoclase or andesine, quartz, biotite, and, locally, garnet. Commonly interlayered with amphibolite.	211.66	3.77
Ylo Quartz-Oligoclase Gneiss	gneiss, medium- to coarse-grained	white-weathering, light-greenish-gray, medium- to coarse-grained, moderately layered to indistinctly foliated gneiss and lesser amounts of granofels composed of quartz, oligoclase or andesine, and, locally, biotite, hornblende and (or) clinopyroxene. Contains thin amphibolite layers.	750.87	13.38
Ym Microcline Gneiss	gneiss, fine- to medium-grained	Light-gray- to pinkish-white-weathering, tan to pinkish-white, fine- to medium grained, well-layered gneiss composed principally of quartz, microcline, and lesser amounts of oligoclase. Common accessory minerals include biotite, garnet, magnetite, and, locally, sillimanite.	12.26	0.22
Ymh Hornblende-Quartz-Feldspar Gneiss	gneiss,fine- to medium-grained	Pinkish-gray- to buff-weathering, light- pinkish-white to pinkish-gray, fine- to medium-grained, massive to moderately well layered gneiss containing microcline, quartz, oligoclase, hornblende, and magnetite. Locally contains garnet and biotite.	142.12	2.53
Yp Pyroxene Gneiss	gneiss, fine- to medium-grained	White- to tan-weathering, greenish-gray, fine- to medium-grained, well-layered gneiss containing oligoclase, clinopyroxene, variable amounts of quartz, and trace amounts of opaque minerals and titanite. Some phases contain scapolite and calcite. Commonly interlayered with pyroxene amphibolite or marble.	5.02	0.09
		Total:	**5611.72**	**100.00**
Source: NJGS, 2007; Drake et al, 1996				

D. Earthquakes

Damaging earthquakes are rare in Oakland, but possible. Soils influence the potential for damage from earthquakes. Many areas of Oakland have relatively shallow depth to bedrock, which dampens the movement of earthquakes (NRCS, November 21, 2012). However, soft soils (e.g. silt, clay, and fine sand) amplify the motion of earthquake waves, increasing ground

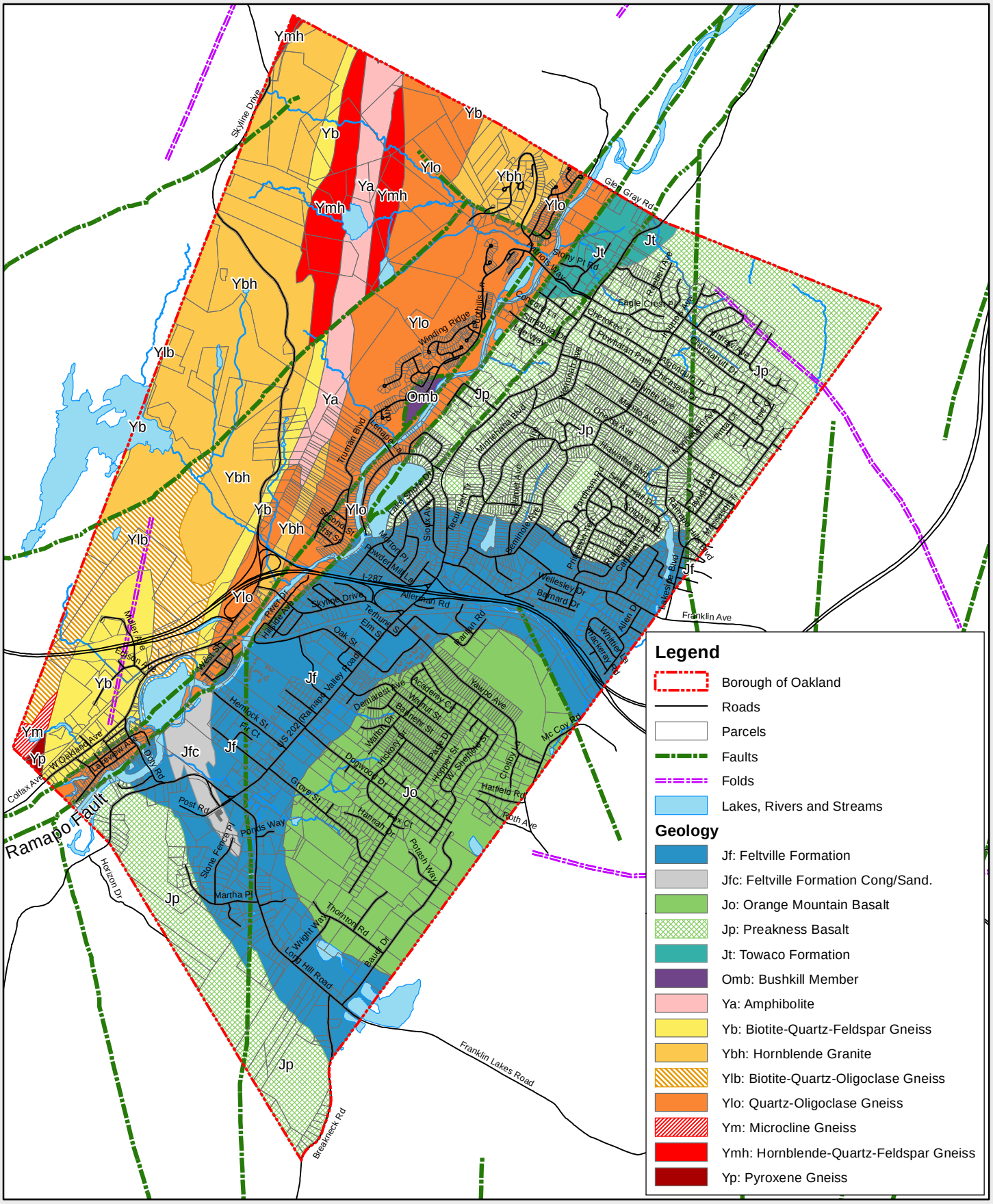

Figure 3e: Geology

0 0.25 0.5 1 Miles

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shaking, while wet sandy soils can liquefy (Stanford, 2003).

No recorded earthquakes have had their epicenter in Oakland; while 18 have occurred within 5 miles (see **Figure 3f** and **Table 3.4**). The earthquake with an epicenter closest to Oakland (approximately 1.4 miles away) was also the most recent: A magnitude 2.0 earthquake occurred on November 5, 2012 in Mahwah Township. The strongest earthquake (a mild 2.9) within 5 miles occurred in 1978 in Mahwah Township (NJDEP NJGS, 2012).

Table 3.4: Earthquakes within 5 miles of Oakland

Date	Magnitude	Location (NJGS database)	Municipality	Comments
4/1/1947	2.7	Pompton Lakes NJ	Wanaque Borough	
10/13/1962	2.2	Pompton Lakes, NJ	Riverdale Borough	1 aftershock on 12/20/1962
11/27/1977	1.8	Oakland, NJ	Franklin Lakes Borough	
5/18/1978	1.5	Bloomingdale, NJ	Riverdale Borough	
6/30/1978	2.9	Mahwah-Oakland, NJ	Mahwah Township	1 aftershock on same day
5/18/1981	2.1	Ramsey, NJ	Mahwah Township	
12/22/1988	1	Wanaque, NJ	Ringwood Borough	
8/21/1990	0.7	Wanaque, NJ	Ringwood Borough	
5/12/1991	1.3	Wanaque, NJ	Wanaque Borough	
5/26/1995	1.5	Kinnelon, NJ	Butler Borough	
2/18/1996	1.5	Ringwood	Ringwood Borough	
2/19/1996	1.7	Ringwood, NJ	Wanaque Borough	1 aftershock 22 minutes later
2/19/1996	0.8	5 km W Ringwood, NJ	Ringwood Borough	
6/20/1998	1.2	2 km SE Kinnelon, NJ	Kinnelon Borough	
6/30/1998	1.9	3 km S Butler, NJ	Kinnelon Borough	
02/10/2010	2.2	1 km W of Wanaque	Wanaque Borough	
08/23/2012	1.2	1.4 km E of Ringwood, NJ	Ringwood Borough	
11/05/2012	2	3 km SW of Mahwah, NJ	Mahwah Township	
Source: NJDEP NJGS, 2012				

Michael DaSilva

This Fanglomerate rock (above left, and close-up above right) is an interesting formation in Oakland and is geologically present due to mountain building and motion of the Ramapo Fault. This picture is of the conglomerate alluvial rock formation seen above the upper parking lot of ShopRite in Oakland. The significance and occurrence of this rock unit is related to (re-activated) motion of the Ramapo Fault, which indicates a rapid re-growth event (Faust, 1908) of the paleo-Ramapo Mountains. The rapid uplift (re-growth) event was accompanied by a period of significant erosion and deposition. The Fanglomerate rock formation is a large-scale conglomerate alluvial fan deposit consisting of sediments that were eroded and deposited from the ancient mountain range. This rock formation lies stratigraphically above the uppermost lava flow of the Preakness basalt.

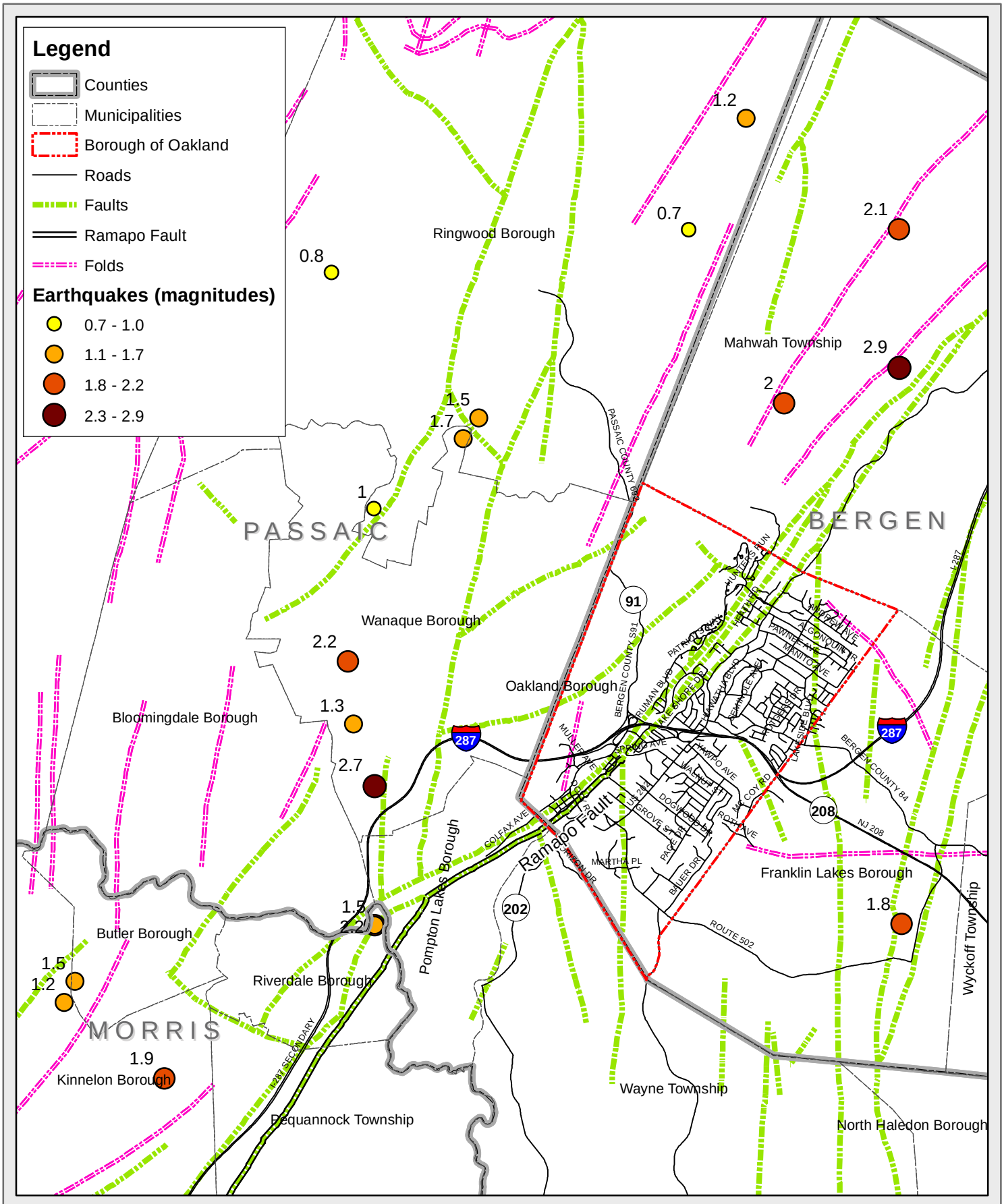

Figure 3f: Earthquakes, Faults and Folds

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E. Radon

The natural decay of uranium and thorium produce *radon gas*, which has been shown to cause lung cancer. Radon can accumulate in enclosed spaces, such as homes, to unhealthy levels. Considering the potentially serious health risk, the U.S. Environmental Protection Agency (EPA) and the NJDEP recommend mitigation if radon levels are ≥4 pCi/L (picocuries per liter) (NJDEP, 2013).

Proterozoic rocks of the New Jersey Highlands, which are geologically continuous with rocks of the Reading Prong in Pennsylvania, contain uranium. It was also discovered that the Triassic-Jurassic rocks of the Piedmont Province also can be high in radon. Radioactive minerals are more concentrated in granite, near faults, and in lake-bed formations.

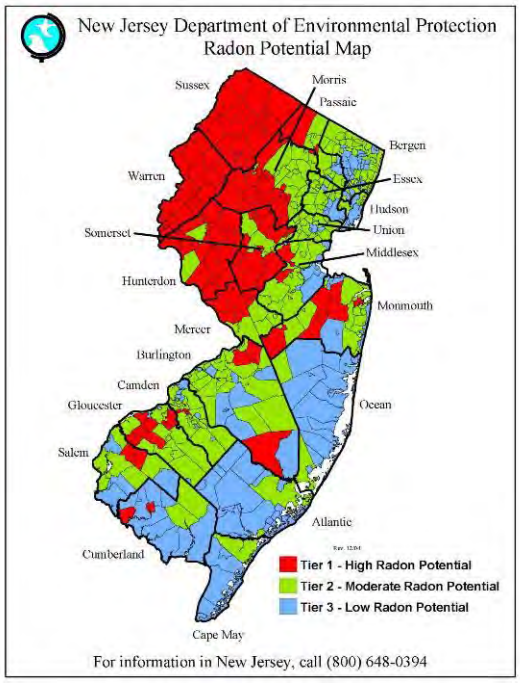

Figure 3g: Radon Potential Map

http://www.njradon.org/radonin.htm

Cambrian and Ordovician rocks are the source of the highest radon levels in New Jersey, with over 50% of homes having radon above 4 pCi/L. The southern Piedmont Province also has elevated radon, with 32% over this level. In contrast, only 6% of homes in the northern Piedmont exceed the recommended radon limit, partly because glacial materials cover the bedrock (Muessig et al, 1992). Therefore, the Borough of Oakland is considered to be *Tier 2 - Moderate Radon Potential* (see **Figure 3g**) (NJDEP, 2012).

Radon in drinking water is discussed in **Section 5f**.

F. The Surficial Geology of Oakland

Surficial materials are the unconsolidated sediments that overlie bedrock formations, and that are the parent material for soils. Surficial geology deposits in Oakland consist of materials deposited by glaciers, including glacial-stream sand and gravel deposits, typically less than 40 feet thick; and artificial till, alluvial and swamp deposits of post-glacial age, generally less than 20 feet deep (Stanford, 2004). The characteristics of surficial geology types found in Oakland are provided in **Table 3.5** and illustrated in **Figure 3h,** with the types of glacial sediments illustrated in **Figure 3i**.

Glacial Deposits

During the last 1.5 million years of the Pleistocene epoch, the climate of what is now New Jersey varied from arctic in glacial periods to temperate or subtropical during periods between the glaciers. Continental ice sheets up to 10,000 feet thick advanced and retreated in what is now New Jersey at least three times. The pre-Illinoisan (800,000 years ago) and the Illinoisan (150,000 years ago) glaciers probably covered what is now Bergen County, but traces have been wiped out by the most recent glaciation, the Wisconsinan, which occurred about 21,000 years ago (White, 1998).

Glacial deposits include till and stratified sediments. *Till* is poorly sorted (particles are different sizes), non-stratified (not layered) sediment deposited directly by glacial ice or by

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The "sand pit" is representative of the glacial deposits found in Oakland.

sediment flows from glacial ice. The *stratified* sediments are usually well sorted (particles have uniform size). They include sand and gravel laid down by glacial melt water in river plains and in glacial lake deltas and fans. The stratified sediments also include silt, clay and fine sand deposited on the bottoms of glacial lakes and moderately to poorly sorted sand and gravel deposited in ice-walled basins and ponds (Stanford, 2004).

The orientation of striations created by the ice movement and distribution of till indicates that late Wisconsinan ice advanced in two lobes across this area. One lobe moved south across the Hudson Highlands from the Wallkill Valley in New York State, then across Ramapo Mountain. Simultaneously, another lobe of the glacier flowed southwest from the Hudson and Hackensack Valleys across the east of Ramapo Mountain. During the advance of ice, glaciers eroded over 130 feet of material, including older glacial deposits, soils and the underlying sandstone, basalt and gneiss bedrock (Stanford, 2004).

The two types of till (Netcong and Rahway) found within Oakland were deposited directly by glacial ice or by sediment flows from glacial ice. The till is compacted below the soil zone due to the weight of overlying ice. Till was deposited unevenly on the bedrock surface; thickest on the north- and northwest-facing slopes of Ramapo Mountain and east-facing slope of Campgaw Mountain, and thin and irregular over the majority of Ramapo Mountain and on the top and western slope of Campgaw Mountain. South of Campgaw Mountain in Oakland, till is less than 20 feet thick over the basalt bedrock, although outcrops of bedrock are sparse in that area (Stanford, 2004). Areas of continuous and discontinuous till and bedrock outcrops are shown in **Figure 3i**.

Netcong Till (Qwtn) is found in most of the borough west of the Ramapo River, and roughly half of the area to the east of the river (see Figure 3g). It consists of yellow, yellowish brown, reddish-yellow, very pale brown (oxidized) to grayish brown and brown (unoxidized) silty sand to sandy silt with 10-40% pebbles and cobbles, and less than 10% boulders. Gravel is mainly gray to white gneiss and grey mudstone and sandstone with some red sandstone and conglomerate, basalt, and purple-to-gray quartzite, while boulders are primarily gneiss. Southeast of the Ramapo River valley, a few boulders are basalt and red sandstone. The composition of rock fragments reflects southerly glacial transport from the Wallkill and Hudson Valleys (underlain by Paleozoic sedimentary rock) and from the Hudson Highlands and Ramapo Mountain (underlain by even older Precambrian gneiss). In this area, the Netcong Till can be as much as 80 feet thick. The Netcong till overlies the Rahway till (described below), in some places only 1-3 feet thick over the Rahway till (Stanford, 2004).

The *Rahway Till (Qwtr)*, found in the southeastern section of the borough, is reddish-brown, light reddish-brown, reddish-yellow silty sand to sandy silt derived mostly from local red sandstone bedrock. Gravel-size rocks include mostly red and gray sandstone and siltstone, red-purple conglomerate, gray gneiss, white quartz and a little purple quartzite and basalt, while boulders are primarily gneiss. Rahway till is typically less than 40 feet thick (Stanford, 2004).

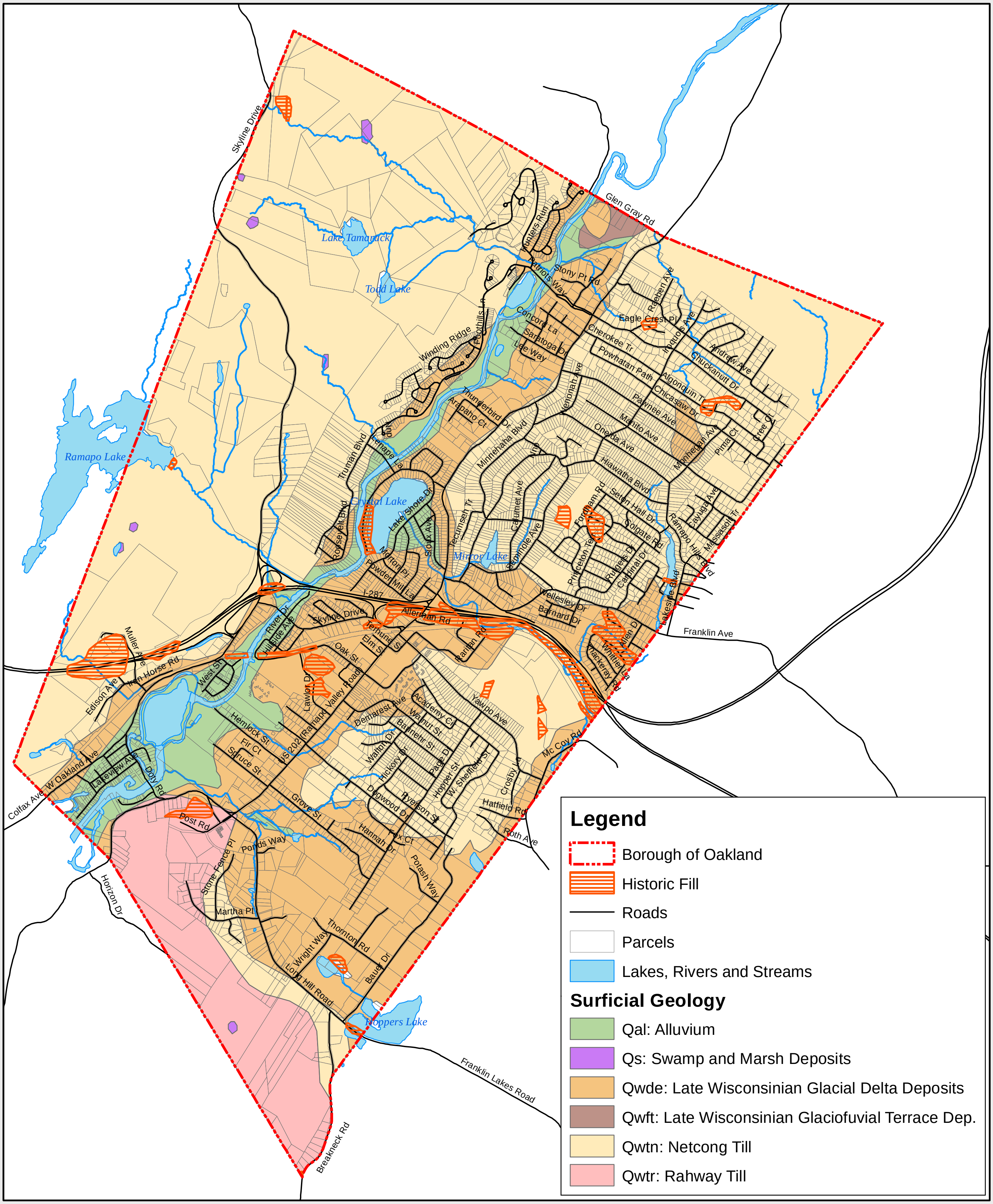

Figure 3h: Surficial Geology

0 0.25 0.5 1 Miles

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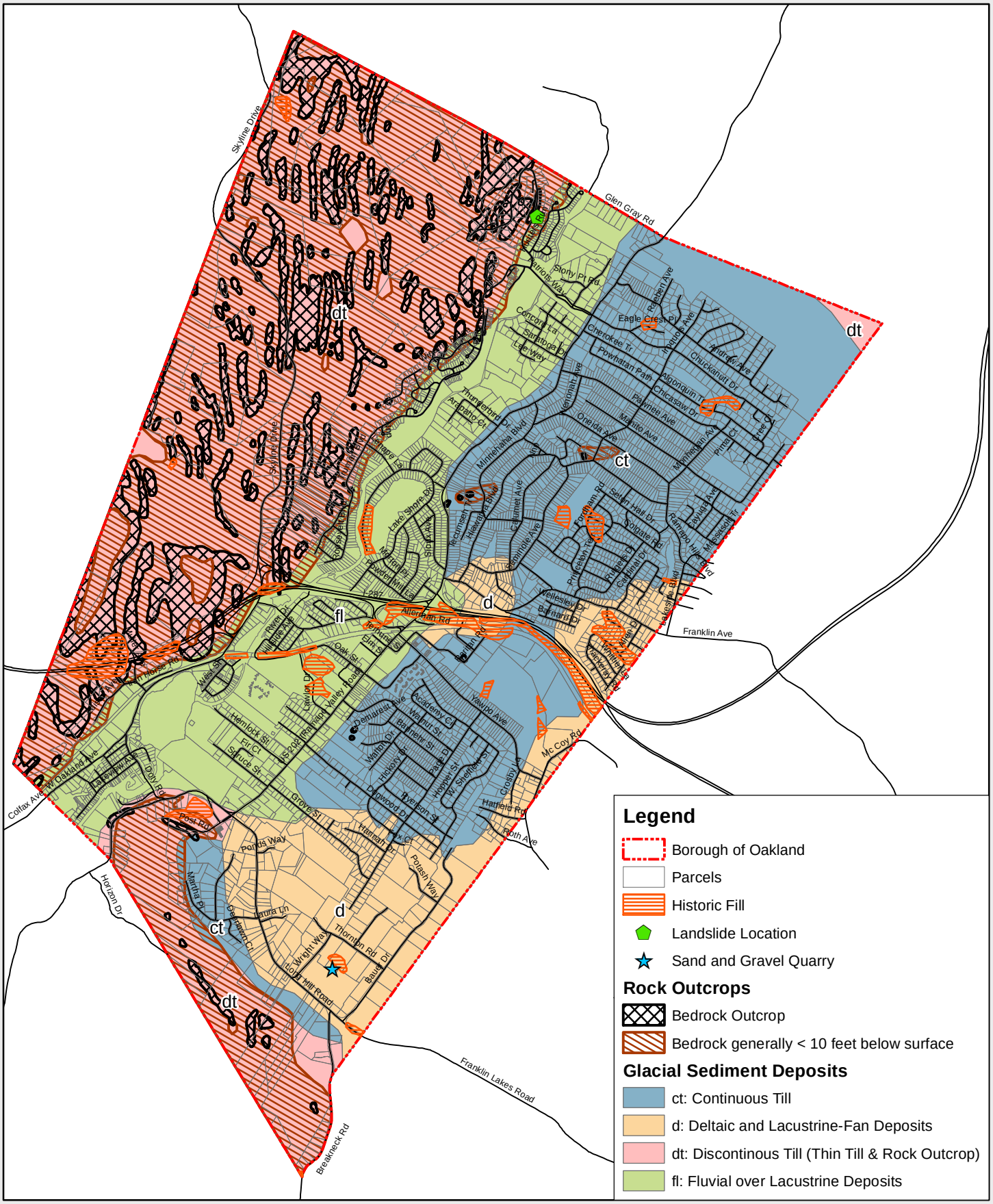

Figure 3i: Rock Outcrops, Glacial Sediments and Fill

0 0.25 0.5 1 Miles

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Oakland Borough Natural Resource Inventory

Prepared by Kratzer Environmental Services

Data Sources: NJDEP

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

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

Late Wisconsinan ice advanced another 40 miles south of Oakland before the ice began to retreat about 20,000 years ago. Ice no longer covered this area by about 18,000 years ago. The retreating ice margin left behind rocks and materials which had been mixed in with the ice, damming east or north draining valleys and forming glacial lakes through the valleys of what is now central and eastern Oakland. *Late Wisconsinan Glacial Delta Deposits (Qwde)* mostly consist of steeply to gently dipping layers of fine gravel, sand and silt that were laid down in these glacial lakes (White, 1998).

Table: 3.5: Characteristics of Surficial Geology Found in Oakland

Abbre-viation	Deposit Type	Lithology	Geologic Age*	Notes	Area
Qwde	Late Wisconsinan Glacial Delta Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown, reddish brown, light gray. As much as 150 feet thick.	late Pleistocene, late Wisconsinan	Deposited in deltas and other ice-contact landforms in glacial lakes during the late Wisconsinan glaciation.	
Qwft	Late Wisconsinan Glaciofluvial Terrace Deposits	Sand, pebble-to-cobble gravel, minor silt; yellowish brown to reddish brown. As much as 40 feet thick.	late Pleistocene, late Wisconsinan	Form terraces deposited by glacial streams during the late Wisconsinan glaciation.	
Qwtn	Netcong Till	Silty sand to sandy silt with some to many pebbles and cobbles and some to many boulders; pale brown, yellowish brown, light gray. As much as 200 feet thick, generally less than 30 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice during the late Wisconsinan glaciation.	
Qwtr	Rahway Till	Clayey silt to sandy silt with some to many pebbles and cobbles and few boulders; reddish brown, reddish yellow, yellowish brown, brown. As much as 100 feet thick, generally less than 40 feet thick.	late Pleistocene, late Wisconsinan	Deposited directly from glacial ice during the late Wisconsinan glaciation.	
Qal	Alluvium	Sand, gravel, silt, minor clay and peat; reddish brown, yellowish brown, brown, gray. As much as 20 feet thick.	Holocene and late Pleistocene	Contains variable amounts of organic matter. Deposited in modern floodplains and channels.	
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.	
				Sum AREA	

*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

Source: NJGS, 2006

The glacial stream deposits that were laid down in valleys that drained away from the melting glaciers are called *Late Wisconsinan Glaciofluvial Terrace Deposits (Qwft)*, found only in a small area on the north-central border of Oakland. These are chiefly made up of horizontal to gently dipping layers of fine gravel and sand (White, 1998).

Post-glacial Deposits

Post-glacial deposits have been deposited since the retreat of the Wisconsinan glacier, about 18,000 years ago.

Found in the Ramapo River valley, *Alluvium (Qal)* consists of sand, silt, pebble-to-cobble gravel, a small amount of clay, and, in spots, includes boulder gravel. Alluvium is dark brown, brown, yellowish-brown, or gray in color, and moderately to well sorted. It contains variable amounts of organic matter, demolition debris, and trash and can be as much as 20 feet thick (Stanford, 2004).

Swamp And Marsh Deposits (Qs) are found in small patches on the Netcong and Rahway till deposits. Swamp and Marsh deposits are recent in origin and are comprised of peat and organic silt, and fine sand. Color ranges from black, dark brown, to gray. While some deposits can be as much as 20 feet thick, some of the small swamps on Ramapo Mountain are only seasonally wet and have less than 1-2 feet of organic sediment covering the till (Stanford, 2004).

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).

In this area, artificial fill includes sand, gravel, silt, clay, rock fragments and man-made materials including cinders, ash, brick, concrete, wood, slag, asphalt, metal, glass and trash. The color is variable depending on its composition, but is generally dark brown, gray or black. Fill can be as much as 40 feet thick, but is generally less than 20 feet thick. Areas of historic fill in Oakland are shown on **Figure 3h** (NJGS, 2009; Stanford, 2004).

Landslide

A landslide is a natural geologic process in which earth materials (including rock, earth, debris) move down a slope under the influence of gravity. A landslide can occur rapidly or slowly, and can involve large or small amounts of material. Triggers for landslides include a heavy rainfall event, earthquakes or human activity. One landslide, which occurred on September 16, 1999, has been recorded in the Borough of Oakland. This debris flow was triggered by heavy rain due to Hurricane Floyd. Three houses were damaged, and 100 people were evacuated. It occurred on the steep slopes (>30% slope) of the Overlook Ridge area, and its location is shown of **Figure 3i** (NJGS, 2012).

Mining & Quarrying

According to the New Jersey Geological Survey, there is one sand and gravel quarrying operation and no records of mining within Oakland (NJGS, 2005). It is owned by Oakland Industries, and is located in the stratified drift formation (see **Figure 3i**).

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4: SOILS

A. Soil Survey Maps

The *soil* is the unconsolidated mineral material on the immediate surface of the earth and which serves as the medium for growth of land plants. The characteristics of each soil type have developed over time (usually many thousands of years) under the influence of the parent material (the bedrock that has broken down into small fragments to form the soil), climate (including moisture and temperature regimes), macro- and microorganisms, and topography. Soil is a basic resource for food production, in addition to its essential role in collecting and purifying water before it enters the ground water (Soil Science Society of America, 2011). However, soil itself can be a pollutant as dust in the air or as sediment in water.

The US Department of Agriculture Natural Resources Conservation Service (USDA NRCS) is the science-based agency which provides technical assistance based on sound science in the conservation and management of soil, water, and other natural resources to private land owners and local, state, and federal agencies and policy-makers (USDA NRCS, February 10, 2011).

One of these technical services is the soil survey. A *soil survey* is an inventory of the country's soil resources to determine soil characteristics and capabilities and to help people understand soils and their uses. Soil surveys help identify the best way to protect soil and water quality through the use of conservation practices and to identify which sites are suitable (and the degree of suitability) for various land uses (e.g. septic systems, roads, agriculture).

The objective of soil mapping is to separate the landscape into segments that have similar use and management requirements. Therefore, this data set is not designed for use as a primary regulatory or management tool, but may be used as a broad scale reference source. According to the Soil Survey Geographic Database (also known as SSURGO) information, field investigations and data collection were carried out in sufficient detail to name map units and to identify accurately and consistently areas of about 5 acres. As with other GIS data sets, enlargement of the maps to a scale greater than the accuracy of the data can cause misinterpretation of the data. Onsite sampling, testing, and detailed study of specific sites is essential for determining intensive uses, and managing farms and wetlands (USDA NRCS, February 17, 2012).

Beginning in 2005, the NRCS made its soil surveys available online (USDA NRCS, February 17, 2012). This provides the means for keeping the information current and available to the public. Users specify a geographic "area of interest" (must be less than 10,000 acres) and then may view a wide variety of tables of soil properties and soil interpretations. For this report, the entire SSURGO (Soil Survey Geographic Database) spatial data and tabular data for Bergen County were downloaded for use in the GIS (USDA NRCS, August 18, 2008) [19].

B. Soil Series and Map Units

Soil characteristics vary from place to place in slope, depth, drainage, erodibility and other characteristics that affect management. A *soil series* is a basic unit of soil classification consisting of soils that are essentially alike, except that they may differ in surface texture, stoniness, slope or some other attribute. A *map unit* is the area delineated on a soil map,

[19] The maps in this report use the most recent data available (Bergen County, NJ; Tabular Data Version 8, 8/18/2008; Spatial Data Version 2, 6/25/2008; Spatial Format=ArcView Shapefile; Coordinate System=UTM Zone 18, Northern Hemisphere (NAD 83)).

representing an area dominated by one major kind of soil, and is named according to the classification of the dominant soil or soils. However, soils are natural systems, with natural variability, and the range of some observed properties may extend beyond the limits defined for the class. In addition, small areas of contrasting soils may not be visible on the maps. The databases included with the soils data describe the characteristics of each soil map unit. The NRCS has included both estimated and measured data on the physical and chemical soil properties and soil interpretations for engineering, water management, recreation, agronomic, woodland, range and wildlife uses of the soil.

There are 16 soil series' found in the Borough of Oakland, such as Boonton, Dunellen and Rockaway. A total of 44 different map units are present in Oakland. These map units are described below and listed in **Table 4.2**, along with several important properties of these soils, and shown on **Figure 4a**. **Figures 4b** through **4g** illustrate the distribution of some soil characteristics (descriptions, tabular data and GIS data are from USDA NRCS, August 18, 2008).

Map Unit Descriptions[20]

AdrAt - Adrian muck, 0 to 2 percent slopes, frequently flooded
The Adrian series consists of very poorly drained soils formed in deposits of organic material over sandy sediments in depressional areas within lake plains, till plains and moraines. The surface soil is black muck 34 inches thick. The substratum is gray mottled sand. Slopes are 0 to 2 percent. Most areas are in native vegetation.

BohB - Boonton moderately well drained gravelly loam, 3 to 8 percent Slopes
The Boonton series consists of coarse-loamy basal till derived from basalt. The surface layer is gravelly loam and fine sandy loam 30 inches thick. Moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 3 to 8 percent.

BohBb - Boonton moderately well drained gravelly loam, 0 to 8 percent slopes, very stony
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 26 inches. Very stony, moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 0 to 8 percent.

BohC - Boonton moderately well drained gravelly loam, 8 to 15 percent slopes
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 23 inches. Moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 8 to 15 percent.

BohCb - Boonton moderately well drained gravelly loam, 8 to 15 percent slopes, very stony
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 23 inches. Very stony, moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 8 to 15 percent.

BohD - Boonton moderately well drained gravelly loam, 15 to 25 percent slopes
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 22 inches. Moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 15 to 25 percent.

BohDb - Boonton moderately well drained gravelly loam, 15 to 25 percent slopes, very stony
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 22 inches. Very stony, moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 15 to 25 percent.

BohE - Boonton moderately well drained gravelly loam, 25 to 45 percent slopes
The Boonton series consists of coarse-loamy basal till derived from basalt. Gravelly loam is found in the top 20

[20] Nontechnical description/SOI-5 Report, Survey Area Version: 9, Survey Area Version Date: 10/22/2008

inches. Moderately well drained soil has a seasonal high water table 24 inches deep. Slopes range from 15 to 25 percent.

BorB - Boonton moderately well drained-Rock outcrop complex, 3 to 8 percent slopes
Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but include some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

BorC - Boonton moderately well drained-Rock outcrop complex, 8 to 15 percent slopes
Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but includes some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

BorD - Boonton moderately well drained-Rock outcrop complex, 15 to 25 percent slopes
Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but includes some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

BorE - Boonton moderately well drained-Rock outcrop complex, 25 to 45 percent slopes
Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but includes some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

BouB - Boonton-Urban land complex, 0 to 8 percent slopes
BouC - Boonton-Urban land complex, 8 to 15 percent slopes
BouD - Boonton-Urban land complex, 15 to 25 percent slopes
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent.

CarAt - Carlisle muck, 0 to 2 percent slopes, frequently flooded
The Carlisle series, flooded, consists of very deep, very poorly drained soils formed in woody organic deposits along streams and in bogs other depressional areas. The surface layer is black muck 8 inches thick. The underlying material is black and dark reddish brown muck. Slopes are 0 to 2 percent. Areas are used for cropland and wetland wildlife habitat.

DuoB - Dunellen loam, 3 to 8 percent slopes
The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8 inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

DuoC - Dunellen loam, 8 to 15 percent slopes
The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8 inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

DuoD - Dunellen loam, 15 to 25 percent slopes
The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8 inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

DuuB - Dunellen-Urban land complex, 3 to 8 percent slopes
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent. The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8

inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

DuuC - Dunellen-Urban land complex, 8 to 15 percent slopes
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent. The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8 inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

DuuD - Dunellen-Urban land complex, 15 to 25 percent slopes
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent. The Dunellen series consists of deep, well drained soils on outwash plains and terraces. They formed in water-deposited material. Typically, these soils have a dark brown sandy loam surface layer, 8 inches thick. A subsurface layer from 8 to 14 inches is brown sandy loam. The subsoil layers from 14 to 32 inches are reddish-brown and dark reddish-brown sandy loam. The dark reddish-brown substratum from 32 to 42 inches is sandy loam and from 42 to 70 inches is loamy sand. Slopes range from 0 to 35 percent.

FmhAt - Fluvaquents, loamy, 0 to 3 percent slopes, frequently flooded
Fluvaquents, loamy consist of very deep, poorly and somewhat poorly drained soils on flood plains. They formed in alluvium. Typically these soils have a reddish brown silt loam surface layer 7 inches thick. The mottled silt loam subsoil is reddish brown from 7 to 16 inches and pinkish gray from 16 to 35 inches. The substratum from 35 to 52 inches is pinkish gray sandy loam and below 52 inches is varigated pinkish gray stratified sand and gravel. Slopes range from 0 to 8 percent.

HamBb - Haledon gravelly loam, 0 to 8 percent slopes, very stony
The Haledon series consists of deep, somewhat poorly drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown, very stony or extremely stony loam surface layer, 8 inches thick. The mottled subsoil from 8 to 30 inches is yellowish-brown cobbly loam. A very firm and brittle mottled fragipan from 30 to 45 inches is dark brown gravelly sandy loam. The substratum from 45 to 72 inches is dark brown very firm gravelly sandy loam. Slopes range from 0 to 15 percent.

HasB - Haledon-Urban land complex, 3 to 8 percent slopes
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent.

HcsAb - Hasbrouck loam, 0 to 3 percent slopes, very stony
The Hasbrouck series consists of fine-loamy eroded and redeposited glacial material over glacial till. Seasonal high water table is 5 inches deep, and this soil is hydric, poorly drained and very stony, with occasional ponding. Two inches of moderately to highly decomposed plant material cover silt loam and gravelly loam with a fragipan at 16 to 34 inches. Slopes range from 0 to 3 percent.

HhmBb - Hibernia loam, 0 to 8 percent slopes, very stony
The Hibernia series is coarse-loamy colluvium and/or till. Very stony, somewhat poorly drained soils have a seasonal high water table at 12 inches. Surface material is loam to a depth of 30 inches, with gravelly, sandy loam beneath. Slopes range from 0 to 8 percent.

OtsD - Otisville gravelly loamy sand, 15 to 25 percent slopes
The Otisville series consists of glaciofluvial deposits derived from sandstone and shale. Excessively drained soils have a seasonal high water table greater than 60 inches deep. Surface material is gravelly, sandy loam to 14 inches. Substratum is composed of very gravelly sand. Slopes range from 15 to 25 percent.

OtsE - Otisville gravelly loamy sand, 25 to 35 percent slopes
The Otisville series consists of glaciofluvial deposits derived from sandstone and shale. Excessively drained soils have a seasonal high water table greater than 60 inches deep. Surface material is gravelly, sandy loam to 24 inches. Substratum is composed of extremely gravelly sand. Slopes range from 25 to 35 percent.

PbuA - Pascack silt loam, 0 to 3 percent slopes
The Pascack series consists of coarse-loamy outwash. Somewhat poorly drained soils have a seasonal high water table at approximately 18 inches. The top 5 inches are silt loam, with fine sandy loam beneath it. Stratified sand and gravelly loamy sand exists from 52 to 72 inches. Slopes range from 0 to 3 percent.

PHG - Pits, sand and gravel
Pits, sand and gravel are comprised of sandy material disturbed by human activity. They are well drained with a seasonal high water table greater than 60 inches.

PrnAt - Preakness silt loam, 0 to 3 percent slopes, frequently flooded
The Preakness series consists of deep, poorly and very poorly drained soils on outwash plains and outwash terraces. They formed in water-sorted material. Typically, these soils have a very dark gray sandy loam surface layer, 12 inches thick. The mottled subsoil from 12 to 30 inches is grayish-brown sandy loam. The substratum from 30 to 60 inches is grayish brown gravelly loamy sand. Slopes range from 0 to 4 percent.

RkrB - Riverhead sandy loam, 3 to 8 percent slopes
The Riverhead series consists of deep, well drained soils on outwash plains and valley trains. They formed in relatively gravel free deposits overlying stratified sand and gravel. Typically these soils have brown to dark brown sandy loam surface layers 12 inches thick. The subsoil from 12 to 27 inches is strong brown sandy loam and from 27 to 35 inches it is yellowish brown loamy sand that is gravelly below 32 inches. The substratum from 35 to 65 inches is brown and very pale brown stratified sand containing thin gravel layers. Slopes range from 0 to 50 percent.

RkrC - Riverhead sandy loam, 8 to 15 percent slopes
The Riverhead series consists of deep, well drained soils on outwash plains and valley trains. They formed in relatively gravel free deposits overlying stratified sand and gravel. Typically these soils have brown to dark brown sandy loam surface layers 12 inches thick. The subsoil from 12 to 27 inches is strong brown sandy loam and from 27 to 35 inches it is yellowish brown loamy sand that is gravelly below 32 inches. The substratum from 35 to 65 inches is brown and very pale brown stratified sand containing thin gravel layers. Slopes range from 0 to 50 percent.

RofCb - Rockaway gravelly loam, 8 to 15 percent slopes, very stony
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to 50 percent.

RofDb - Rockaway gravelly loam, 15 to 25 percent slopes, very stony
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to 50 percent.

RofEb - Rockaway gravelly loam, 25 to 35 percent slopes, very stony
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to 50 percent.

RomC - Rockaway-Rock outcrop complex, 8 to 15 percent slopes
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to

50 percent. Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but include some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

RomD - Rockaway-Rock outcrop complex, 15 to 25 percent slopes
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to 50 percent. Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but include some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

RomE - Rockaway-Rock outcrop complex, 25 to 45 percent slopes
The Rockaway series consists of deep, moderately well-drained and well-drained soils on uplands. They formed in glacial till. Typically, these soils have a very dark grayish-brown very stony or extremely stony sandy loam surface layer 4 inches thick. The subsoil from 4 to 22 inches is yellowish brown gravelly sandy loam. A mottled, very firm and brittle fragipan, from 22 to 38 inches, is gravelly sandy loam. The substratum, from 38 to 72 inch is variegated stony sandy loam and gravelly loamy sand that is weakly brittle, when dry, in the upper part. Slopes range from 3 to 50 percent. Rock outcrop consists of exposures of bare, hard bedrock other than lava flows and rock-lined pits. They consist mainly of unweathered volcanic and metamorphic rock, but include some sedimentary rock such as consolidated limestone and conglomerate. Slopes range from 0 to 100 percent.

UdkttB - Udorthents, loamy, 0 to 8 percent slopes, frequently flooded
Udorthents are made of loamy material transported by human activities and found low hills on uplands, fills, and cuts (road, railroad, etc.). They are well drained with a seasonal high water table at approximately 72 inches. Twelve inches of loam cover 48 inches of silty clay. Slopes range from 0 to 8 percent.

UdwB - Udorthents, wet substratum, 0 to 8 percent slopes
Udorthents consist of loamy lateral spread deposits. They are moderately well drained with seasonal high water table greater than 60 inches. Slopes range from 0 to 8 percent.

UdwuB - Udorthents, wet substratum-Urban land complex
Udorthents consist of loamy lateral spread deposits. They are moderately well drained with seasonal high water table greater than 60 inches. Slopes range from 0 to 8 percent. Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent.

UR - Urban land
Urban land is land mostly covered by streets, parking lots, buildings, and other structures of urban areas. Slopes range from 0 to 45 percent.

C. Soil Quality

Soil is arranged in horizontal layers called horizons. These horizons have technical designations largely useful for soil scientists to distinguish one soil series from another. The descriptions in the NRCS soil survey are done using soil in its native state where possible, so a soil profile which has been disturbed may not match the written description for the series. This is the way the degree of disturbance is assessed—by comparing the soil in its native condition to the profile observed at a specific site. For example, the upper horizon is often an *A horizon*, commonly known as "*topsoil*." An A horizon typically exhibits increased organic matter, reduced clay percentage, a more granular structure of the soil aggregates, and a lower bulk density than the *B horizon* below it. If the A horizon is removed (a common practice in construction), this is evident to a trained observer and the soil would be described as having the A horizon missing. The material on the new surface does not automatically become an A horizon merely as a result of its position. It is possible over time for the newly exposed surface

to acquire the characteristics of an A horizon, however this is not automatic and is highly management dependent. In technical writing, in particular guidance documents intended for post-construction remediation, the use of the term "topsoil" should be used with caution if at all because there is no legal definition of topsoil and the materials available in commerce are highly variable in quality (Muldowney, 2011).

Soils vary naturally in their capacity to function. *Soil quality* is defined as the capacity of a specific kind of soil to function to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. *Inherent* or *intrinsic soil qualities* or characteristics of the soil are determined by factors of soil formation (climate, parent material, topography, time and biota). These are properties which cannot be altered by management except by actually replacing the present material with a different material altogether. An example is the soil's percent sand. The inherent soil quality is used to evaluate the suitability of soils for specific uses (buildings, roads, agriculture, septic systems, etc.). An example is soil particle size: A loam soil will have higher water holding capacity than a sandy soil, therefore will have a higher inherent quality for storing water (USDA NRCS, November 2010).

Contrasting with intrinsic soil properties are management-dependent soil properties, also known as *dynamic soil qualities*. As the term suggests, these can be altered significantly (for better or for worse) by the management of a specific parcel of land and they can have significant consequences for overall environmental quality. Dynamic quality is determined by soil characteristics that are affected by human use and management practices, including physical, chemical and biological properties. Soil quality or health may be evaluated by either comparing to a reference condition that represents full capacity of a soil for a specific function, or to a baseline for the management-dependent soils properties (such as before and after a land use change) (USDA NRCS, November 2010).

Degradation of soil quality occurs in many forms. Significant issues are cutting and filling, compaction, excess salt content and organic matter content. *Cutting and filling* operations actually remove, bury, or invert existing horizons such that they no longer behave in a hydrologically coherent way, with precipitation and gases readily able to enter the soil surface and transmit to horizons lower in the profile. *Compaction*, the increase of bulk density as a result of compression from the surface, is another common form of soil degradation. Compaction can be avoided by not working soil at too high a moisture content. Even foot traffic on a near saturated soil can result in lasting damage which does not resolve itself naturally. A compacted soil can have runoff characteristics more similar to pavement than to the soil in good condition (Muldowney, 2011).

Excess salt content often results from deicing salts but sometimes from fertilizer preparations. It is especially common on roadside verges. The remedy is to either prevent or to wash the salt from the profile with excess water. Sodium salts are especially damaging because sodium causes the clays to disperse. Calcium chloride is relatively harmless to plants and soil (Muldowney, 2011; Wikepedia, May 30, 2013).

Organic matter content is another dynamic soil property. Rutgers New Jersey Agricultural Experiment Station (see **Internet Resources**) provides a chart for interpretation of organic matter percentages in New Jersey soils. Soils with a high organic content are better able to resist other forms of degradation than soils with depleted organic matter. Organic matter in the upper horizons of soil is a measure of carbon storage in soil. Soil is the largest terrestrial reservoir of carbon and has the greatest potential for long term storage if degraded soils are managed in a way that builds up carbon. Silt loams, like the Preakness, are able to store more carbon in the form of organic matter than sandier soil. Keeping soil in good condition reduces runoff, produces cleaner runoff, requires less irrigation, grows more robust plantings, and sequesters more atmospheric carbon than a damaged soil (Muldowney, 2011).

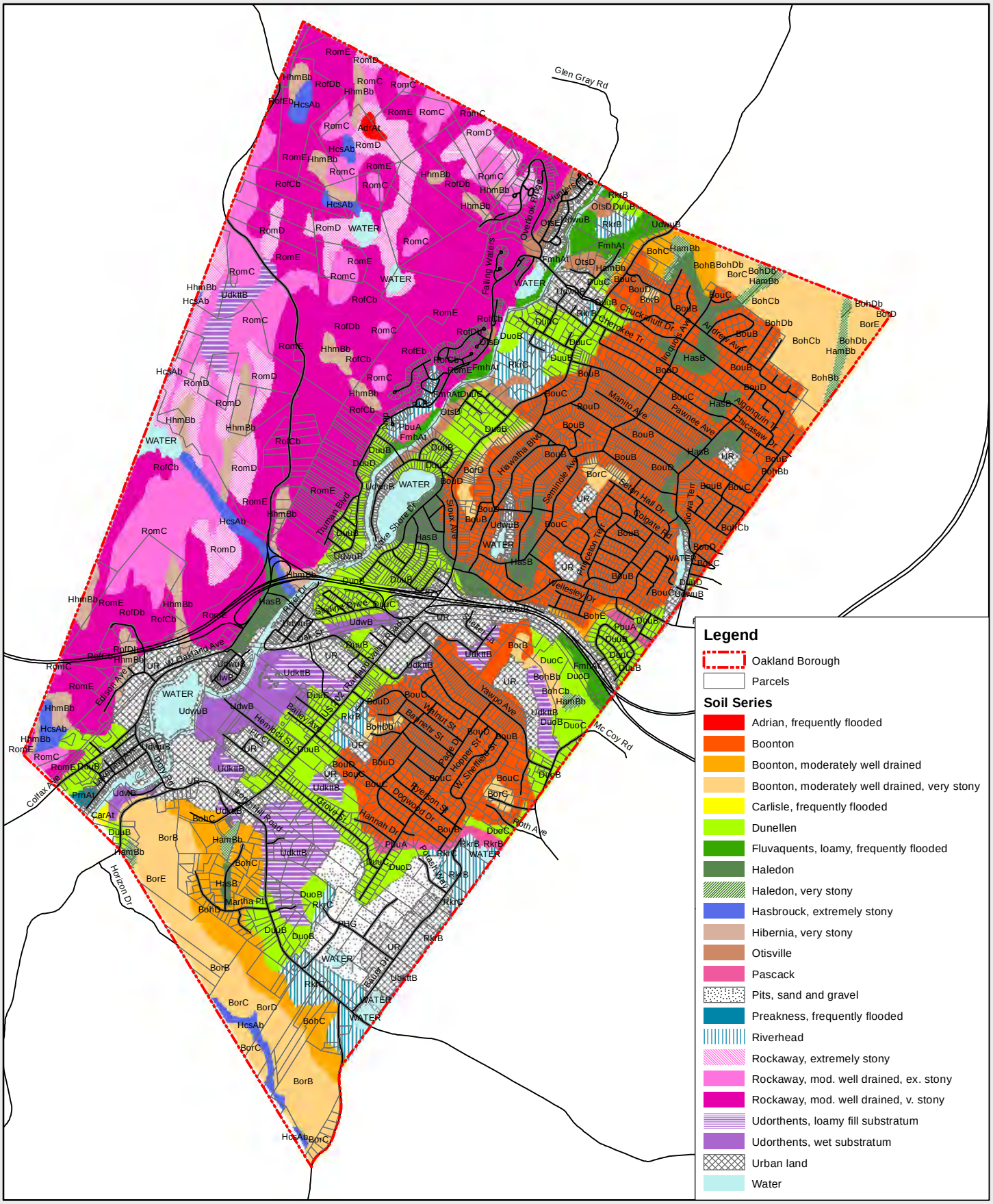

Figure 4a: Soils

D. Characteristics of Oakland Soils

Soil properties contained in the NRCS soil survey and mapped in **Figures 4b through 4g** are *intrinsic* soil properties. These are properties which cannot be altered by management except by actually replacing the present material with a different material altogether.

Depth to Bedrock (Figure 4b)

According to NJDEP (1999), *bedrock* is defined as "any solid body of rock, with or without fractures, which is not underlain by soil or unconsolidated rock material."

The *depth to bedrock* is the distance from the land surface to bedrock. Each soil map unit is characterized by a range of depths to bedrock that is typical for the majority of that soil type. Depth to bedrock is an important factor when determining the suitability of land for building roads, foundations and septic systems.

Bedrock outcrops (depth to bedrock equals zero inches) are common in the Borough of Oakland, on the Rockaway and Boonton soils. Elsewhere, depth to bedrock is very deep, due to glacial deposits. Depth to bedrock is not rated in developed areas. **Figure 4b** shows the range of depths to bedrock for the majority of each soil unit (see **Table 4.2** and **Figure 4b**).

Depth to Seasonal High Water Table (Figure 4c)

The *depth to seasonal high water table* (SHWT) is the distance between the ground surface and the top of the water surface in the saturated part of a water bearing zone. A SHWT of less than one foot severely constrains development, while SHWT between 1 and 3 feet also provides obstacles to development. On-site investigation will often reveal that these areas are actually wetlands or floodplains. High water tables impact the effectiveness of septic systems, and the freeze/thaw cycles cause frost heaving, which damages structures and roads.

The majority of Oakland has SHWT exceeding 3 feet. Adrian, Carlisle and Preakness soils have a SHWT at the surface (i.e., they are frequently flooded). Hasbrouck and Haledon-Urban Land both have a SHWT of 20 inches, while Haledon and Hibernia soils have a SHWT of 31 inches (see **Figure 4c**; see **Figure 6c for floodplains**).

Hydrologic Soil Group (Figure 4d)

The *hydrologic soil grouping* describes a group of soils having similar runoff potential under similar storm and cover conditions (how much water would runoff compared to the rate that water would infiltrate into the ground). Most of Oakland has slow or very slow infiltration rates, primarily corresponding to areas underlain with Highlands bedrock or Triassic-Jurassic basalt. Other areas of the borough have high or moderate infiltration rates (see **Figure 4d**). The definitions of the hydrologic soil groups are shown in **Table 4.1**.

Table 4.1: Hydrologic Soil Grouping

Class	Definition
A	High infiltration rates. Soils are deep, Wto excessively drained sands and gravels.
B	Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils that have moderately course textures.
C	Slow infiltration rates. Soils with layers impeding downward movement of water, or soils that have moderately fine or fine textures.
D	Very slow infiltration rates. Soils are clayey, have a high water table, or are shallow to an impervious layer.
Source: USDA NRCS, 2008	

Table 4.2: Characteristics of Soil Types Found in Oakland

Map Unit Symbol	Map Unit Name	Depth to Restrictive Layer (kind, inches)	Seasonal High Water Table Depth (feet)	Flooding	Ponding	Potential Frost Action	Hydrologic Group*	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Disposal Field Rating Class (NJ)	Septic Limiting Features (NJ) ◆
AdrAt	Adrian muck, 0 to 2 percent slopes, frequently flooded	---	0.0	Frequent	Frequent	High	A/D	Very poorly drained	Yes	Unique	Very limited	DAZS; NP-Flooding; NP-Hydric
BohB	Boonton moderately well drained gravelly loam, 3 to 8 percent slopes	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BohBb	Boonton moderately well drained gravelly loam, 0 to 8 percent slopes, very stony	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BohC	Boonton moderately well drained gravelly loam, 8 to 15 percent slopes	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Statewide importance	Very limited	RS; RH; DPZS
BohCb	Boonton moderately well drained gravelly loam, 8 to 15 percent slopes, very stony	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BohD	Boonton moderately well drained gravelly loam, 15 to 25 percent slopes	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BohDb	Boonton moderately well drained gravelly loam, 15 to 25 percent slopes, very stony	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BohE	Boonton moderately well drained gravelly loam, 25 to 45 percent slopes	Fragipan, --	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; NP-Steep; DPZS
BorB	Boonton moderately well drained-Rock outcrop complex, 3 to 8 percent slopes	Fragipan, -- Lithic Bedrock, 0	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BorC	Boonton moderately well drained-Rock outcrop complex, 8 to 15 percent slopes	Fragipan, – Lithic Bedrock, 0	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS
BorD	Boonton moderately well drained-Rock outcrop complex, 15 to 25 percent slopes	Fragipan, – Lithic Bedrock, 0	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS

Map Unit Symbol	Map Unit Name	Depth to Restrictive Layer (kind, inches)	Seasonal High Water Table Depth (feet)	Flooding	Ponding	Potential Frost Action	Hydrologic Group*	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Disposal Field Rating Class (NJ)	Septic Limiting Features (NJ) ◆
BorE	Boonton moderately well drained-Rock outcrop complex, 25 to 45 percent slopes	Fragipan, -- Lithic Bedrock, 0	1.5-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; NP-Steep; DPZS
BouB	Boonton-Urban land complex, 0 to 8 percent slopes	Fragipan, 20-36	---	None	None	Moderate	C	Well drained	No	Prime	Very limited	RS; RH
BouC	Boonton-Urban land complex, 8 to 15 percent slopes	Fragipan, 20-36	---	None	None	Moderate	C	Well drained	No	Prime	Very limited	RS; RH
BouD	Boonton-Urban land complex, 15 to 25 percent slopes	Fragipan, 20-36	---	None	None	Moderate	C	Well drained	No	Prime	Very limited	RS; RH
CarAt	Carlisle muck, 0 to 2 percent slopes, frequently flooded	---	0.0	Frequent	Frequent	High	A/D	Very poorly drained	Yes	Unique	Very limited	DAZS; NP-Flooding; NP=Hydric
DuoB	Dunellen loam, 3 to 8 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Prime	Not limited	---
DuoC	Dunellen loam, 8 to 15 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Statewide importance	Not limited	---
DuoD	Dunellen loam, 15 to 25 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Prime	Not limited	---
DuuB	Dunellen-Urban land complex, 3 to 8 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Prime	Not limited	---
DuuC	Dunellen-Urban land complex, 8 to 15 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Prime	Not limited	---
DuuD	Dunellen-Urban land complex, 15 to 25 percent slopes	---	---	None	None	Moderate	A	Well drained	No	Prime	Not limited	---
FmhAt	Fluvaquents, loamy, 0 to 3 percent slopes, frequently flooded	---	0.5-1.5	Frequent	Frequent	High	B/D	Somewhat poorly drained	No	Prime	Very limited	DAZS; NP-Flooding
HamBb	Haledon gravelly loam, 0 to 8 percent slopes, very stony	Fragipan, 24-35	0.5-1.5	None	None	High	C	Somewhat poorly drained	No	Prime	Very limited	RS; RH; DPZS
HasB	Haledon-Urban land complex, 3 to 8 percent slopes	Fragipan, 24-36	0.6-1.5	None	None	High	C	Somewhat poorly drained	No	Prime	Very limited	RS; RH; DAZS

Map Unit Symbol	Map Unit Name	Depth to Restrictive Layer (kind, inches)	Seasonal High Water Table Depth (feet)	Flooding	Ponding	Potential Frost Action	Hydrologic Group*	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Disposal Field Rating Class (NJ)	Septic Limiting Features (NJ) ◆
HcsAb	Hasbrouck loam, 0 to 3 percent slopes, very stony	Fragipan, 16-34	0.0-0.5	None	Occasional	High	D	Poorly drained	Yes	Prime	Very limited	RS; RH; DAZS; NP-Hydric
HhmBb	Hibernia loam, 0 to 8 percent slopes, very stony	Fragipan, --	0.5-1.5	None	None	High	C	Somewhat poorly drained	No	Prime	Very limited	RS; RH; DPZS
OtsD	Otisville gravelly loamy sand, 15 to 25 percent slopes	---	---	None	None	Low	A	Excessively drained	No	Prime	Not limited	---
OtsE	Otisville gravelly loamy sand, 25 to 35 percent slopes	---	---	None	None	Low	A	Excessively drained	No	Prime	Very limited	NP-Steep
PbuA	Pascack silt loam, 0 to 3 percent slopes	---	---	None	None	High	C	Somewhat poorly drained	No	Prime	Very limited	DAZS
PHG	Pits, sand and gravel	---	---	---	---	---	---	Well drained	No	---	---	---
PrnAt	Preakness silt loam, 0 to 3 percent slopes, frequently flooded	---	0.0	Frequent	Occasional	High	D	Very poorly drained	Yes	Prime	Very limited	DAZS; NP-Flooding; NP-Hydric
RkrB	Riverhead sandy loam, 3 to 8 percent slopes	---	2.4-3.4	None	None	Moderate	B	Well drained	No	Prime	Somewhat limited	ECH; ECS; DAZS
RkrC	Riverhead sandy loam, 8 to 15 percent slopes	---	---	None	None	Moderate	B	Well drained	No	Statewide importance	Somewhat limited	ECH; ECS
RofCb	Rockaway gravelly loam, 8 to 15 percent slopes, very stony	Fragipan, 16-20 Lithic Bedrock, 48-72	2.0-3.0	None	None	Moderate	C	Mod. well drained	No	Statewide importance	Very limited	RS; RH; DPZS; MB
RofDb	Rockaway gravelly loam, 15 to 25 percent slopes, very stony	Fragipan, 24-40 Lithic Bedrock, 48-72	2.0-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS; MB
RofEb	Rockaway gravelly loam, 25 to 35 percent slopes, very stony	Fragipan, 24-39 Lithic Bedrock, 48-72	2.0-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; NP-Steep; DPZS; MB
RomC	Rockaway-Rock outcrop complex, 8 to 15 percent slopes	Fragipan, 18-30 Lithic Bedrock, 72-99 Lithic Bedrock, 0	2.0-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; DPZS; MB

Map Unit Symbol	Map Unit Name	Depth to Restrictive Layer (kind, inches)	Seasonal High Water Table Depth (feet)	Flooding	Ponding	Potential Frost Action	Hydrologic Group✳	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Disposal Field Rating Class (NJ)	Septic Limiting Features (NJ) ◆
RomD	Rockaway-Rock outcrop complex, 15 to 25 percent slopes	Fragipan, 18-30 Lithic Bedrock, 0	2.0-3.0	None	None	Moderate	C	Well drained	No	Prime	Very limited	RS; RH; DPZS
RomE	Rockaway-Rock outcrop complex, 25 to 45 percent slopes	Fragipan, 16-39 Lithic Bedrock, 48-72 Lithic Bedrock, 0	2.0-3.0	None	None	Moderate	C	Mod. well drained	No	Prime	Very limited	RS; RH; NP-Steep; DPZS; MB
UdkttB	Udorthents, loamy, 0 to 8 percent slopes, frequently flooded	---	4.0->6.0	None	None	High	D	Well drained	No	Prime	Very limited	RS
UdwB	Udorthents, wet substratum, 0 to 8 percent slopes	---	---	---	---	---	D	Mod. well drained	No	---	---	---
UdwuB	Udorthents, wet substratum-Urban land complex (SSURGO1)	---	---	---	---	---	D	Mod. well drained	No	---	---	---
UR	Urban land	---	---	---	---	---	---	---	---	---	---	---
WATER	WATER	---	---	---	---	---	---	---	---	---	---	---

Notes:

-- = data not provided

✳**Hydrologic Group:** see **Table 4.1** for definitions

◆ **Septic System Limitation Interpretation (NJ):**

DAZS= Depth to apparent zone of saturation; **DPZS**= Depth to perched zone of saturation; **ECH**=Excessively coarse horizon; **ECS**=Excessively coarse substratum; **MB**=Depth to massive bedrock ; **NP-Flooding**=Not Permitted – Flooding; **NP-Hydric**=Not Permitted - Hydric Soil **; NP-Steep**= Not Permitted Too Steep ; **RH**= Restrictive horizon; **RS**= Restrictive substratum

Source: USDA NRCS, August 18, 2008

The information in this map is from the SSURGO soils data Soil Service Area (SSA) Bergen County, New Jersey

SSA Version 8 (8/18/2008), indicating the dominant soil condition but does not eliminate the need for onsite investigation

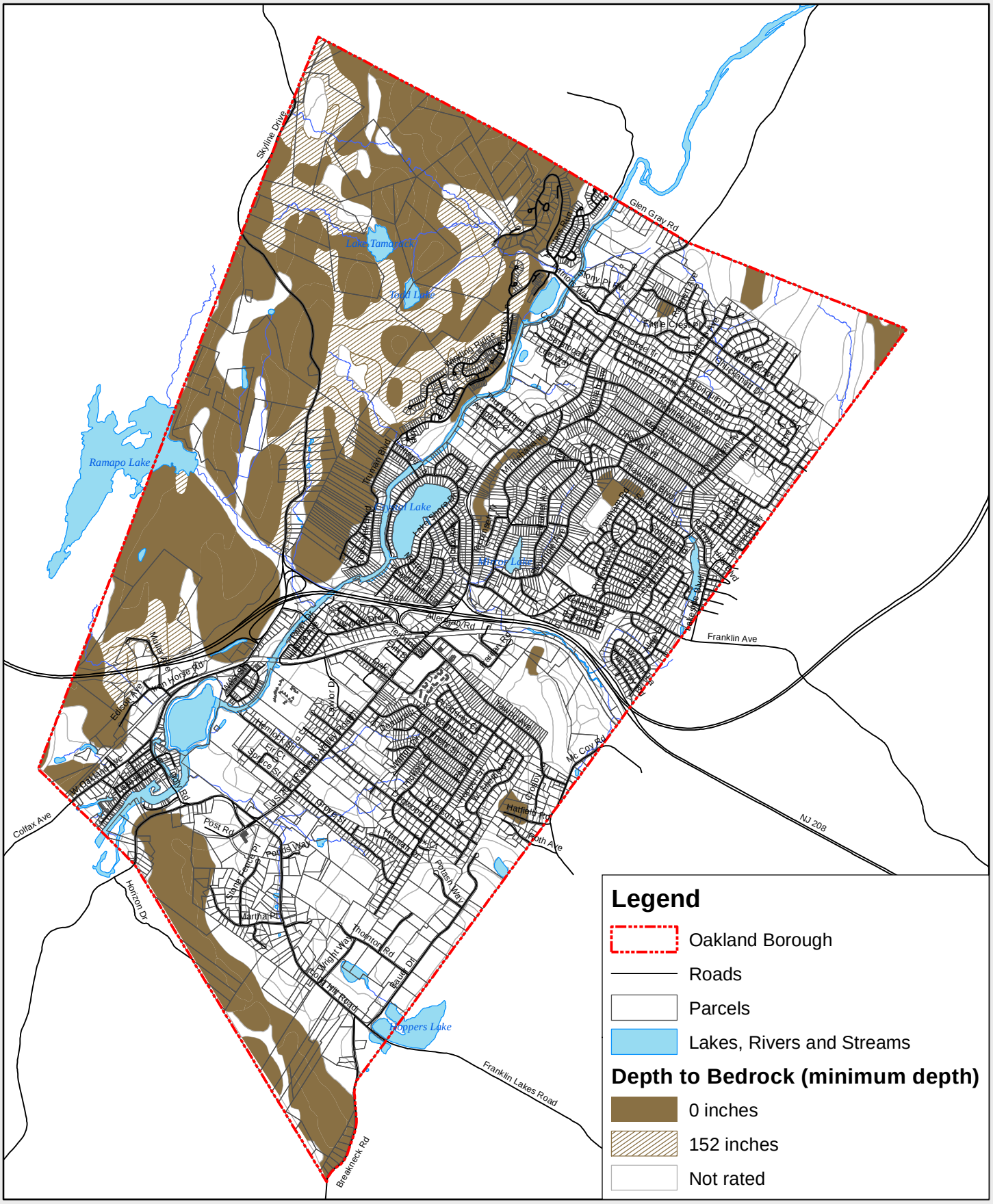

Figure 4b: Soils - Depth to Bedrock

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

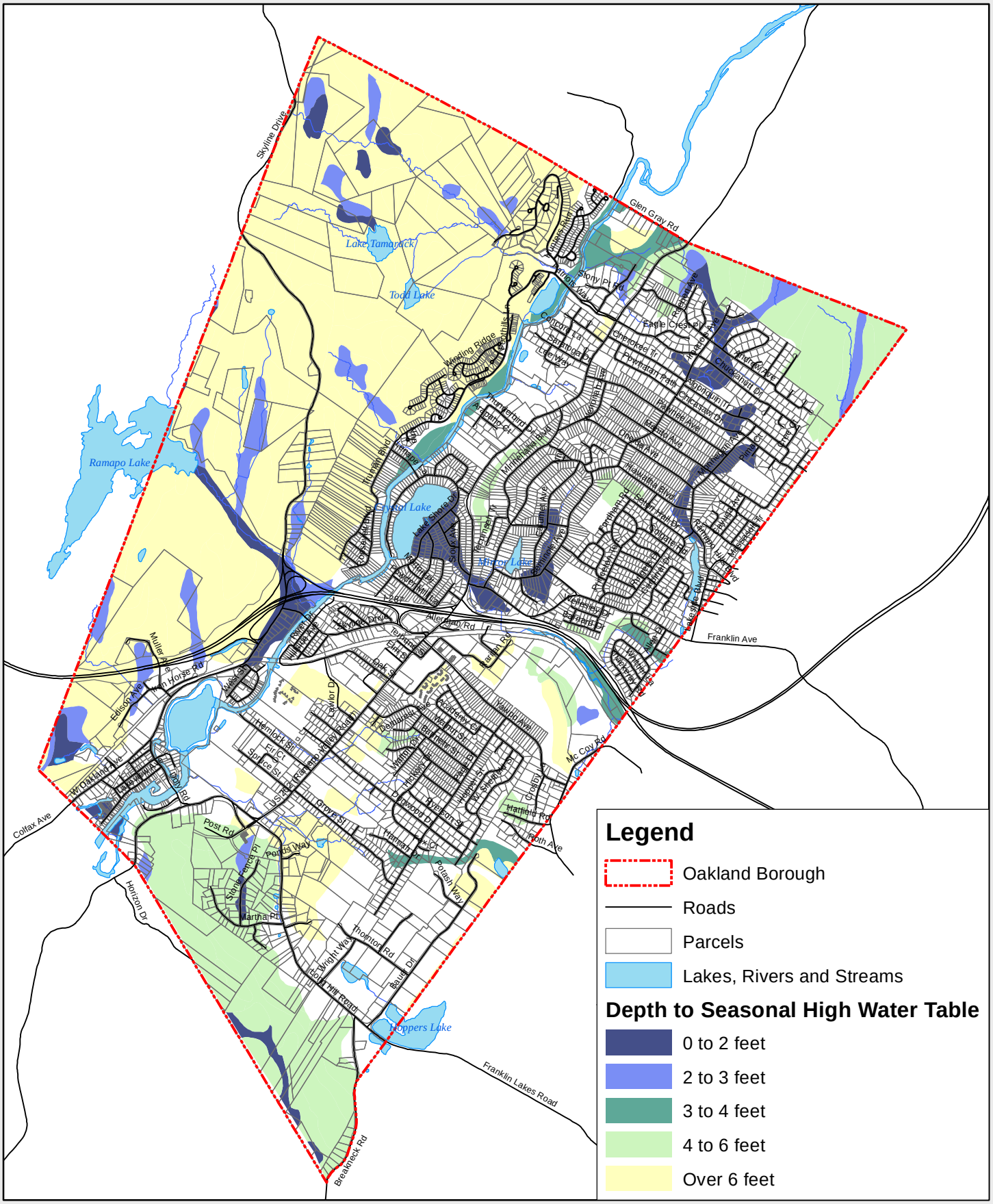

Figure 4c: Soils - Depth to Seasonal High Water Table

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

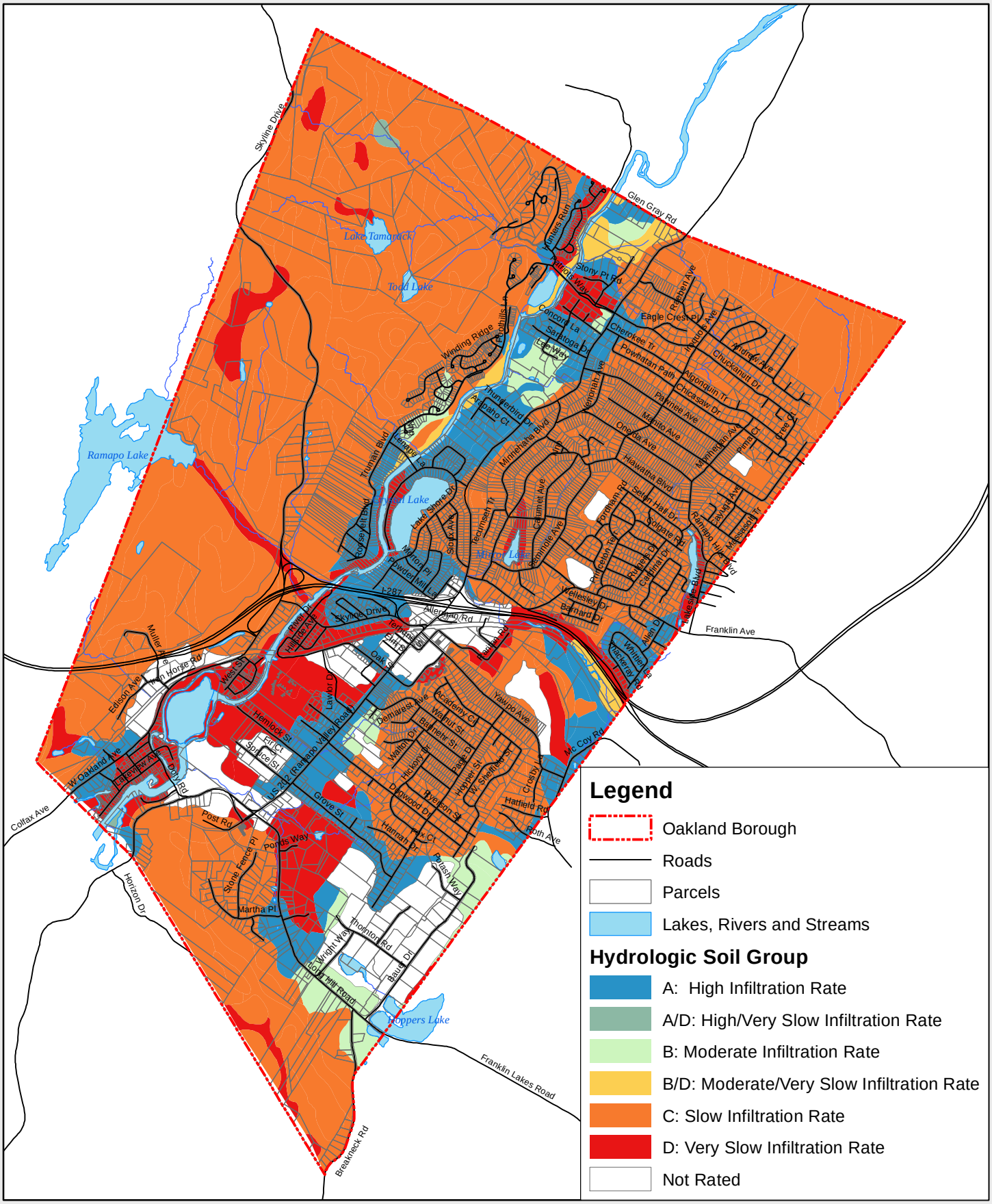

Figure 4d: Soils - Hydrologic Soil Group

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Septic Suitability (Figure 4e)

The NRCS SSURGO database provides an interpretation of limitations of each soil for *septic suitability*. The interpretation shown in **Figure 4e** is based on the N.J.A.C. 7:9A Standards for Individual Subsurface Sewage Disposal Systems, Subchapter 10 Disposal Fields. Factors which may affect the functioning of the system, and therefore limit septic suitability, are excessively coarse substratum or excessively coarse horizon (which allow effluent to percolate to ground water too rapidly); presence of water (including depth to perched zone of saturation; depth to apparent zone of saturation;, flooding, and hydric soils); depth to restrictive layer (bedrock, restrictive horizon or restrictive substratum) and steep grades over 25%. N.J.A.C 7:9A prohibits septic systems in soils subject to flooding. In addition, septic disposal fields are prohibited in locations with the combination of slope greater than 10% and less than 50 feet upslope of any bedrock outcrop where signs of ground water seepage can be detected (NJDEP, 1999).

The majority of Oakland has very limited suitability for septic systems, primarily corresponding to areas underlain with Highlands bedrock or Triassic-Jurassic basalt. Other areas of the borough have high or moderate infiltration rates **Figure 4e**.

Soil Drainage Class (Figure 4f)

Soil Drainage Class is a code identifying the natural drainage condition of the soil and refers to the frequency and duration of periods when the soil is free of saturation or partial saturation during soil formation, and does not refer to saturation due to recently altered drainage (manmade or natural). The categories are as follows: well drained, moderately well drained, excessively drained, somewhat excessively drained, poorly drained, and somewhat poorly drained. For the most part, Oakland has moderately well drained and well drained soils. Otisville (OtsD) is an excessively drained soil, found in the Ramapo River valley. Adrian (AdrAt), Carlisle (CarAt) and Preakness (PrnAt) are very poorly drained, and make up a very small portion of the borough's soils. Some of the poorly drained and very poorly drained soils are wetlands (see **Figure 4f).**

Potential Frost Action (Figure 4g)

Potential Frost Action is an interpretation rating of the susceptibility of the soil to frost heaving. Most soils within Oakland have moderate potential frost action. The Adrian, Carlisle, Fluvaquents, Haledon, Hasbrouck, Hibernia, Pascack, Preakness and Urdothents soils have high potential frost action. In contrast, the excessively drained Otisville soils have low potential frost action (see **Figure 4g)**.

Flooded and Hydric Soils

Annual flood frequency is a descriptive term used to describe the frequency of flooding that is likely to occur in a year. **Frequent** is > 50% chance of flooding in a given year; **occasional** is 5 to 50%; **rare** is 0 to 5% chance of flooding. In Oakland, the Adrian, Carlisle, Fluvaquents and Preakness soils bordering the Ramapo River and Pond Brook frequently experiences flooding (see **Table 4.2**; **Figure 6c** shows floodplains, which encompass the frequently flooded soils).

Hydric soils are those soils that are wet long enough to periodically produce anaerobic conditions, thereby influencing the growth of plants. For delineation of hydric soils the ponding event must last greater than seven days. Adrian, Carlisle, Hasbrouck and Preakness soils are the hydric soils found within Oakland (see **Table 4.2**; **Figure 6d** shows wetlands and hydric soils).

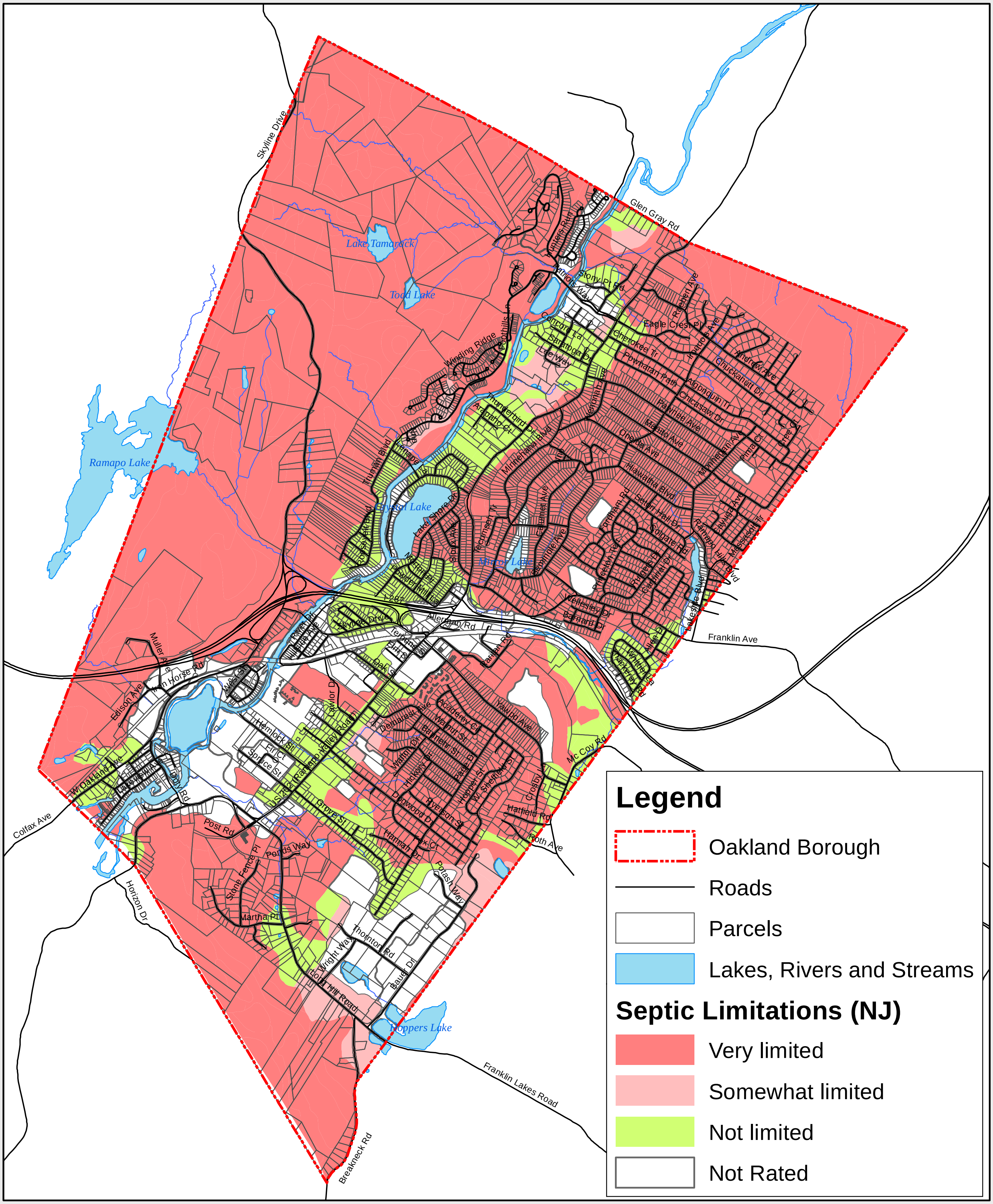

Figure 4e: Soils - Septic System Limitations (NJ interpretation)

0 0.25 0.5 1 Miles

N

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Data Sources: NJDEP
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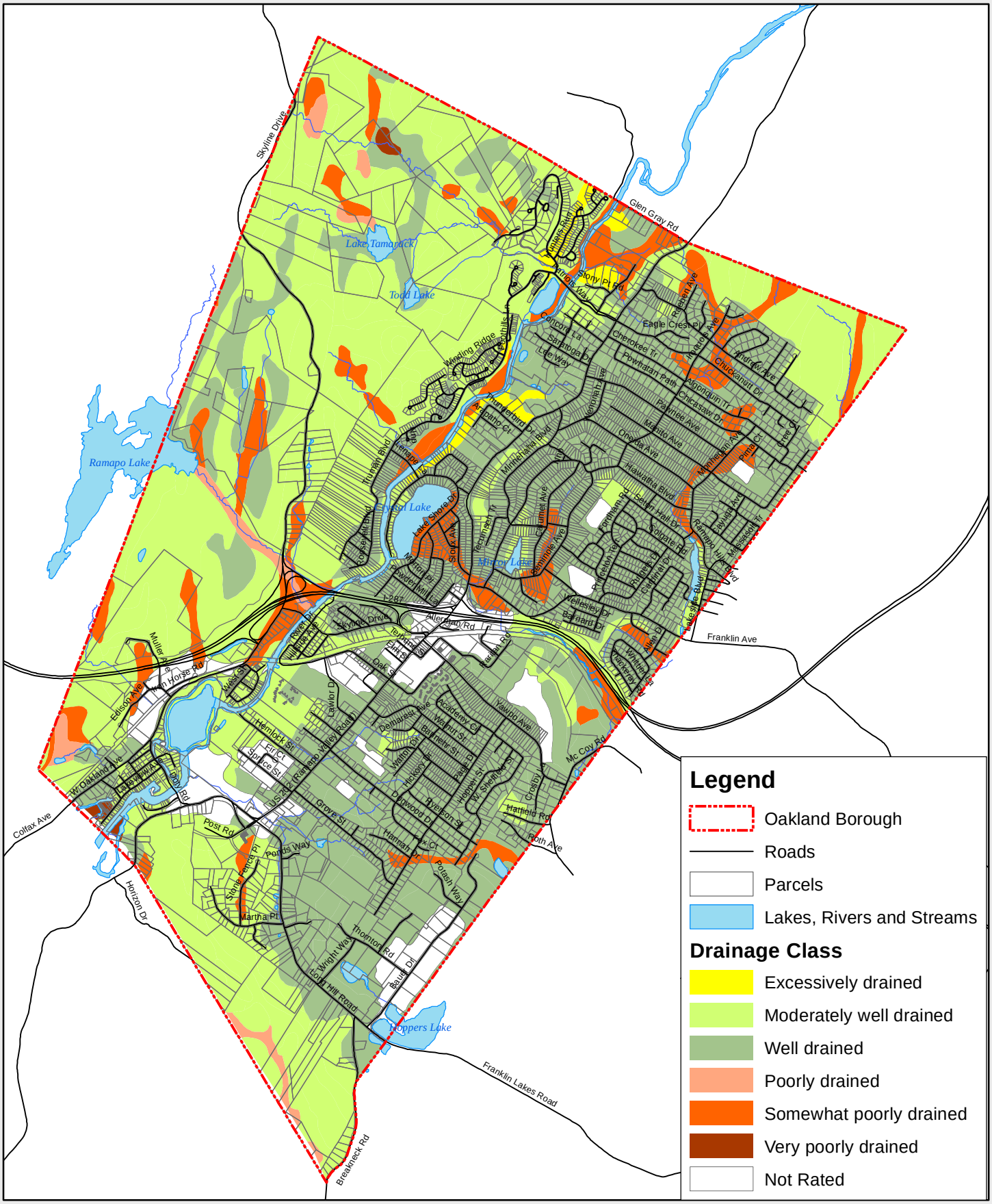

Figure 4f: Soils - Drainage Class

0 0.25 0.5 1 Miles

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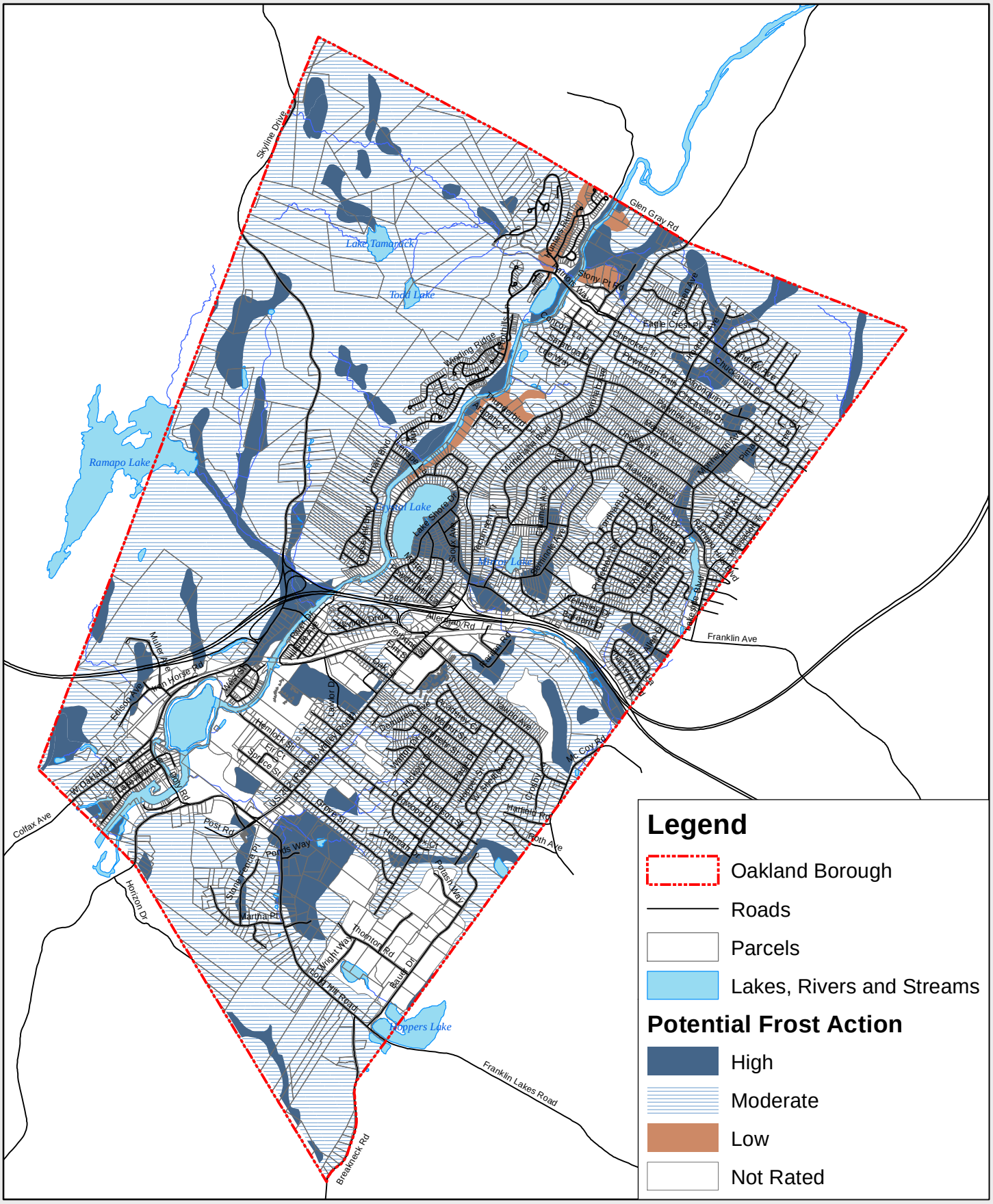

Figure 4g: Soils - Potential Frost Action

0 0.25 0.5 1 Miles

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References: Soils

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Wikipedia. Accessed May 30, 2013. Calcium chloride. http://en.wikipedia.org/wiki/Calcium_chloride

Internet Resources: Soils

NRCS New Jersey Office: http://www.nj.nrcs.usda.gov/

NRCS Soils Website: Helping People Understand Soils: http://soils.usda.gov/

NRCS Soil Data Mart (download soils data for GIS): http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

NRCS Soils Online Study Guide: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/home/?cid=nrcs141p2_018928

Rutgers New Jersey Agricultural Experiment Station Soil Testing Laboratory Interpretation of Organic Matter Levels in New Jersey Soils: http://njaes.rutgers.edu/soiltestinglab/pdfs/nj-om-interpret.pdf

Web Soil Survey: Instructions: ftp://ftp-fc.sc.egov.usda.gov/NSSC/pub/WSS_brochure.pdf
Web Soil Survey Site (online soils mapping): http://websoilsurvey.nrcs.usda.gov/app/

5: GROUND WATER & DRINKING WATER

A. Water Cycle

Even though the quantity of water on the earth is great, only a small portion can be used for drinking water and other human needs. Ninety-seven percent of the world's water supply is saltwater stored in the oceans. The remaining 3% is fresh water. However, most of this is unavailable for human use because it is frozen in the polar ice caps, glaciers, and icebergs; too difficult to tap (below 1.6 miles depth); or too polluted. This leaves 0.003% of water that is available as fresh surface or ground water that humans can use (Miller, 1988).

Surface water is water that is visible above the ground surface, such as creeks, rivers, ponds, lakes, and wetlands. *Ground water* is that portion of water beneath the land surface that is within the zone of saturation (below the water table) where pore spaces are filled with water. An *aquifer* is a water-bearing rock or rock formation where water is present in usable quantities. Water is constantly recycled through the *hydrologic cycle*, also known as the *water cycle* (see **Figure 5a***)*. Precipitation falls on the ground and some travels on the surface of the land (called *surface runoff*), entering streams (where it can be seen as high flows after rain events), and eventually making its way back to the ocean. Some of the water from precipitation enters the ground but remains in the shallow layers where it is available for use by plants, where it returns to the atmosphere through *transpiration* by plants, while some water re-enters the atmosphere directly through *evaporation* from surface water. Evaporation and transpiration combined are known as *evapotranspiration*. The water that migrates below the root zone travels underground and exits the system as stream flow, known as *ground water baseflow* or *ground water recharge*. Ground-water baseflow can be calculated by measuring stream flow during dry weather conditions. A smaller portion of the water penetrates deeper into the ground and enters (or recharges) the saturated zone of the fractured bedrock, called the *aquifer,* where most wells obtain their water.

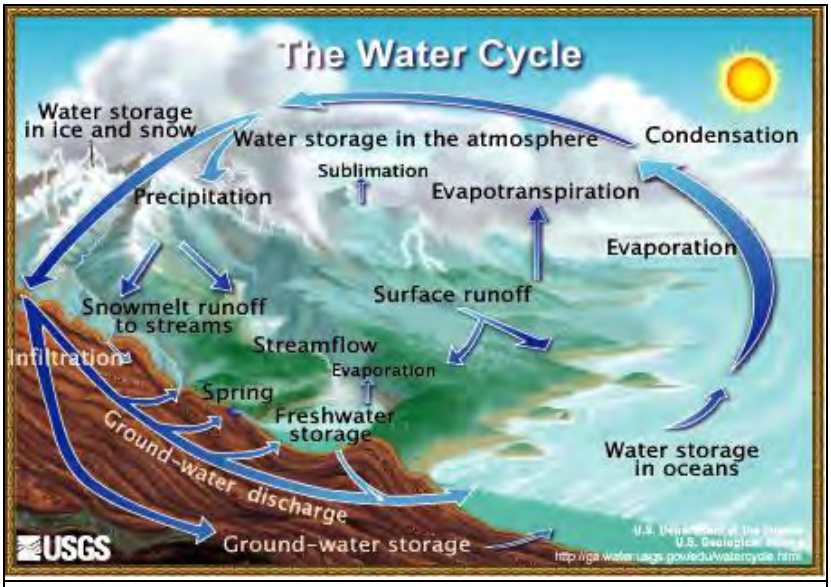

Figure 5a: The Water Cycle

Source: USGS, no date

Pollutants can enter water as it travels the water cycle. Surface runoff can pick up chemicals and soil on its way, depositing these pollutants in waterways. This is especially true of "uncontrolled runoff" on soils that are vulnerable to erosion. Water seeping into the soil can be cleansed of many pollutants by natural soil processes. However, if the pollutant is one that is resistant to break-down, or if the pollutant doesn't get exposed to the soil long enough (such as by entering a bedrock fracture or by entering the ground water through sub-surface disposal), pollutants can spread underground and pollute sources of drinking water.

Movement of ground water is usually quite slow, on average, ranging from about one foot per day to perhaps ½ inch per month. Therefore, in some areas, it might take days for water to travel from the point where it enters the ground, to a point of discharge into a stream, or it might take millennia (Heath, 1983). However, ground water in fractured rock aquifers can potentially move much more quickly. The rates of movement in large fractures may approach those observed in surface streams (Heath, 1983; Freeze and Cherry, 1979). A contaminant could also travel quickly through fractures, with little soil contact to allow for filtration or degradation of pollutants. Thus, a well located on a large fracture might have a very good yield, but may be highly susceptible to contamination.

An understanding of the water cycle emphasizes the connections between surface and ground water. While the Borough of Oakland relies primarily on water from public wells (not individual wells) fed by ground water, the water is no less part of the natural water cycle, and is susceptible to human impacts and the influence of climate and geology.

B. The Aquifers in Oakland

Almost half of New Jersey's drinking water comes from ground water. In the northern half of New Jersey, aquifer boundaries roughly correspond to physiographic province boundaries (discussed in **Section 3a** and **Figure 3a**).

The hydrogeologic characteristics of an aquifer are dependent on the type of bedrock. The report Geology as a Guide to Regional Estimates of Water Resources states:

> "The six guiding principles in the application of geology to rock country [bedrock aquifer] wells are: (1) there is no correlation between depth and yield, (2) each drainage basin, no matter how minor, is a surface and ground water entity, (3) water is usable only from fractures, fissures and solution openings, (4) successful industrial wells are completed in the first 200 to 500 feet of rock, (5) porous and permeable Pleistocene or deep weathered rock regolith zones [such as are found in portions of Oakland] above the rock will usually act as a built-in reservoir to increase well capacity and (6) glacial till, heavy clay soil, or bedrock close to the surface will decrease well yields." (Widmer, 1968, p. 11)

Essentially all the ground water in the region originates as local precipitation. The ground water moves through the aquifers, eventually discharging into streams or directly into the Ramapo River Basin Aquifer Systems and distributed by wells (USEPA, August 1992).

The density of housing and impervious surfaces can impact aquifers and may result in reduced recharge, lowered yields, increased interference (wells interfering with each other), and degradation of ground water quality. In any aquifer, if the rate of water use exceeds the recharge rate, well yields will decrease (see **Section 5D**). Furthermore, these changes can alter stream flow dynamics resulting in higher flows after storm events and lowered flows between events.

The Borough of Oakland is underlain by two types of aquifers; glacial sediment and bedrock. The glacial sediment aquifers lie on top of bedrock, therefore the percentages will add to more than 100%.

Oakland rests within two physiographic geologic provinces (NJ Highlands and Piedmont), therefore, Oakland's bedrock aquifers consist of three different types of bedrock (basalt, metamorphic, and sedimentary); 41% of the borough in underlain by igneous-metamorphic rocks, 38% underlain by basalt rocks, and 21% sedimentary rocks that are characterized as the Passaic and Brunswick aquifers.

Glacial aquifers of Sand and Gravel cover 54% of the borough, while till is only found in 2%. The aquifers are discussed in the paragraphs below and shown in Figure 5b, while the aquifers' characteristics are detailed in **Table 5.1.**

Bedrock Aquifers

Passaic

In bedrock aquifers such as the Passaic, which is in the Late Triassic Newark Group, sedimentary rocks near the land surface experience weathering, caused by freezing and thawing of water, which has widened fractures and dissolved some of the intergranular cement in the sedimentary rocks. This type of bedrock yields water mostly from *secondary porosity*[21] and permeability provided by fractures. Rocks below the weathered zone, which is usually about 75 feet thick, have no *primary porosity* (Lewis-Brown and Jacobsen, 1995). Therefore, the distribution and orientation of these fractures control the rates and directions of ground water flow. The water bearing structures underground may bear little resemblance to the overlying topography.

Unconfined[22] conditions commonly exist above this level of about 75 feet because pores and fractures in this material are usually well-connected. Below this level, *confined* conditions are caused by the presence of low-permeability layers containing relatively few fractures (Lewis-Brown and Jacobsen, 1995).

The Passaic formations are characterized by several layers of extensively fractured rocks (water-bearing units) that typically are 1 to 10 feet thick interbedded with layers of sparsely fractured rocks (confining units) that typically are 30 to 100 feet thick. These geologic formations extend thousands of feet below ground, but the density of fractures decreases with depth. Water-bearing, interconnected fractures are present only from the land surface to a depth of about 300-500 feet in the Piedmont (Houghton, 1990). In the Triassic-Jurassic Passaic Formation, wells are drilled to these deep depths because there is a good potential to encounter additional water-bearing fractures and therefore, to increase the yield. For this reason, wells extended beyond this depth usually do not increase well productivity (the extra storage provided by the greater length of the well bore-hole may be necessary, however, to supply enough water for the well's intended use). The extensive fracturing and interconnection of these fractures results in most wells in the Passaic Formation being capable of transmitting and storing sufficient volumes of water to meet most needs.

Wells near surface water bodies can also derive a significant amount of water from the surface water body by *induced infiltration* (Lewis-Brown and Jacobsen, 1995). These wells located near surface water often have higher yields (Vecchioli and Palmer, 1962 in Lewis-Brown and Jacobsen, 1995), but can be vulnerable to pollution if the surface water carries pollutants.

In general, the yield of a well is primarily dependent on the number and size of fractures directly intersected by the well bore, although some water comes from other water-bearing units leaking through confining units. Kasabach (1966) indicates that initial yields in the Passaic Formation are high and that these yields decrease with time as fractures are dewatered.

Highlands Precambrian Igneous and Metamorphic Aquifer

The Precambrian igneous and metamorphic rocks of the Highlands have a low primary porosity and, therefore, are relatively impermeable. Secondary porosity and permeability

[21] *Porosity* is the measure of voids in soil or rock, which are available to hold water (like holes in a sponge). *Primary porosity* is due to spaces between the soil or rock particles or within porous rock particles. *Secondary porosity* is found in fractures in bedrock. Aquifers with primary porosity store far more water than those with only secondary porosity.

[22] *Unconfined aquifers* (also called water table aquifers) occur where water only partly fills an aquifer, therefore the upper surface of the saturated zone is free to rise and decline. Where an aquifer is overlain by a confining bed, and water completely fills an aquifer, it is known as a *confined aquifer* (also called an artesian aquifer)(Heath, 1983).

develop as a result of fracturing and weathering (e.g. frost action, plant roots, and the dissolving action of water). Therefore, nearly all the ground water is in the weathered zone within 200 to 300 feet of the land surface. The water-bearing fractures decrease in size and number with depth. High yields can occur near major fault zones and this aquifer can be an excellent source of water for domestic use in some areas (USGS, January 14, 2013a; USEPA, August 1992).

Within the Ramapo River basin, the rugged topography indicates that the rock is resistant to erosion, and suggests that the depth to which water-bearing fractures occur may be even shallower than in other areas. In addition, the geologically recent glaciation scoured away most of the severely weathered rocks, leaving only fresh or only slightly weathered rock. While high yields are not to be expected from this aquifer, wells drilled in the valleys would likely have better yields, because the valleys usually have formed along fault zones or where the rock is more extensively jointed (USEPA, August 1992).

Basalt

Basalt is one of the least productive aquifers. Ground water occurs mainly in fractures, but some occurs in vesicular zones (rock that is pitted with cavities). The vesicular zones are found mainly at the bases of the flows where the basalt is in contact with the Brunswick Formation, and also in the upper parts of the sheets. Where the basalt formed in multiple flows, there may be vesicular zones between each sheet. Weathering associated with ground water movement at the contact zones between the basalt and the Brunswick Formation can enlarge fractures or increase the interconnection of vesicles (USEPA, August 1992).

Glacial Valley-Fill Aquifer

When the Wisconsinan glacier retreated 20,000 years ago, it left behind rocks, gravel, sand and silt that had been mixed in with the ice (as described in **Section 3E**). This stratified drift forms the glacial valley-fill aquifers. The aquifers are generally not more than 30 to 40 feet thick. However, where there were stream valleys before glaciation, the aquifers may be up to 300 feet thick (USGS, January 14, 2013b).

Glacial valley-fill aquifers are the most productive source of ground water in parts of northeastern New Jersey, yielding as much as 2,000 gallons per minute (gpm) to public supply and industrial wells (USGS, January 14, 2013a & b).

Substantial amounts of precipitation are retained by the stratified drift, which can also increase yields in the underlying bedrock aquifers. Because water is stored in primary porosity, the stratified drift can yield water to wells more easily than fractured bedrock aquifers. The aquifer is generally unconfined except where overlain by a layer of till (silt, clay, sand and gravel) 10 to 30 feet thick, which acts as a confining unit because of its poor permeability (USGS, January 14, 2013b).

Ground water from the valley-fill aquifer in the Ramapo River Valley has supplied the Borough of Oakland and Mahwah Township with more than 3 million gallons per day (gpd) for public water supply and has served as a reliable source of water for industrial use. During drought, the Ramapo River recharges the valley-fill deposits, particularly in the vicinity of municipal wells. In Oakland, the unconsolidated deposits of the valley-fill range from a few feet thick to as much as 212 feet thick. A maximum saturated thickness of 160 feet was reported for Oakland (Canace and Hutchinson, 1988).

All seven of the Oakland Borough Water Department's wells are located in the glacial valley-fill aquifer (Herman et al., 1998).

Table 5.1: Characteristics of Oakland Aquifers

Aquifer Unit	Aquifer Rank▪	Characteristics	Common Range*		Percent of Oakland
			Depth (ft)	Yield (gpm)	
FRACTURED-ROCK AQUIFERS					
Passaic aquifer (ba)	C	Sandstone, siltstone, and shale of the Newark Group. Ground water stored and transmitted in fractures. Unconfined to partially confined in upper 200 ft; confined at greater depth. Water is normally fresh, slightly alkaline, non-corrosive and hard; may have large concentrations of iron and sulfate. Calcium-bicarbonate type waters dominate. Subordinate calcium-sulfate waters are associated with high total dissolved solids. Includes conglomerate facies (bac) along the northwest margin of the basin.	30-1,500	10-500	20.55
Brunswick aquifer conglomerate (bac)	C				0.99
Basalt (bs)	D	Hard, dense, and highly-fractured igneous rocks. Ground water stored and transmitted in fractures. Few high capacity wells. Water is normally fresh, slightly to highly alkaline, moderately hard, and of the calcium-bicarbonate type.			37.71
Igneous and metamorphic rocks (imr)	D	Highlands crystalline units: including gneiss, granite, schist, and marble. Ground water stored and transmitted in fractures. Confined and unconfined. Most water obtained from weathered and fractured zone in upper 300 ft; high yields in or near major fault zones. Fractures in marble are locally enlarged by chemical weathering. Average water from non-marble units is fresh, slightly acidic, corrosive and moderately hard. Water from marble has higher TDS, alkalinity, pH, hardness, and is less corrosive. Calcium-bicarbonate type waters dominate. Chemical treatment may be locally required for hardness, iron, and manganese.	35-800	5-50	40.75
GLACIAL AQUIFERS AND CONFINING UNITS					
Sand and Gravel (sg)	B	Glacial deposits of boulders, gravel, sand, silt, and clay, where thicker than 50 ft. Generally unconfined except where overlain by lake silt and clay or till. Aquifers composed of stratified sand and gravel [Rank B] are confined in the subsurface by lake-bottom silt and clay (E], till [D], and morainic deposits [D]. Sand and gravel includes glacial fans or deltas, fluvial outwash, and ice-contact deposits. Till and morainic deposits locally form aquifers where thick and sandy. Aquifers have primary intergranular porosity and permeability. Ground-water quality varies with the sedimentary texture and mineral content. Water is fresh, slightly alkaline, moderately-hard to hard, and of the calcium-bicarbonate type.	10-300	100-1,000	53.91
Till (t)	D				1.62

▪**Aquifer Rank** is from NJGS GIS data. It is based on High Capacity Wells (such as water-supply, irrigation, and industrial-supply wells sited and tested for maximum yield. Many of the wells have boreholes exceeding the standard six-inch diameter for domestic wells. State Rank is best viewed on a relative basis, with "A" yielding the most water, and "E" the least. Median High Capacity Wells Yield (in gpm): [A] > 500; [B] 251 to 500; [C] 101 to 250; [D] 25 to 100; [E] <25

Sources: Herman et al, 1998; *USGS, January 14, 2013a

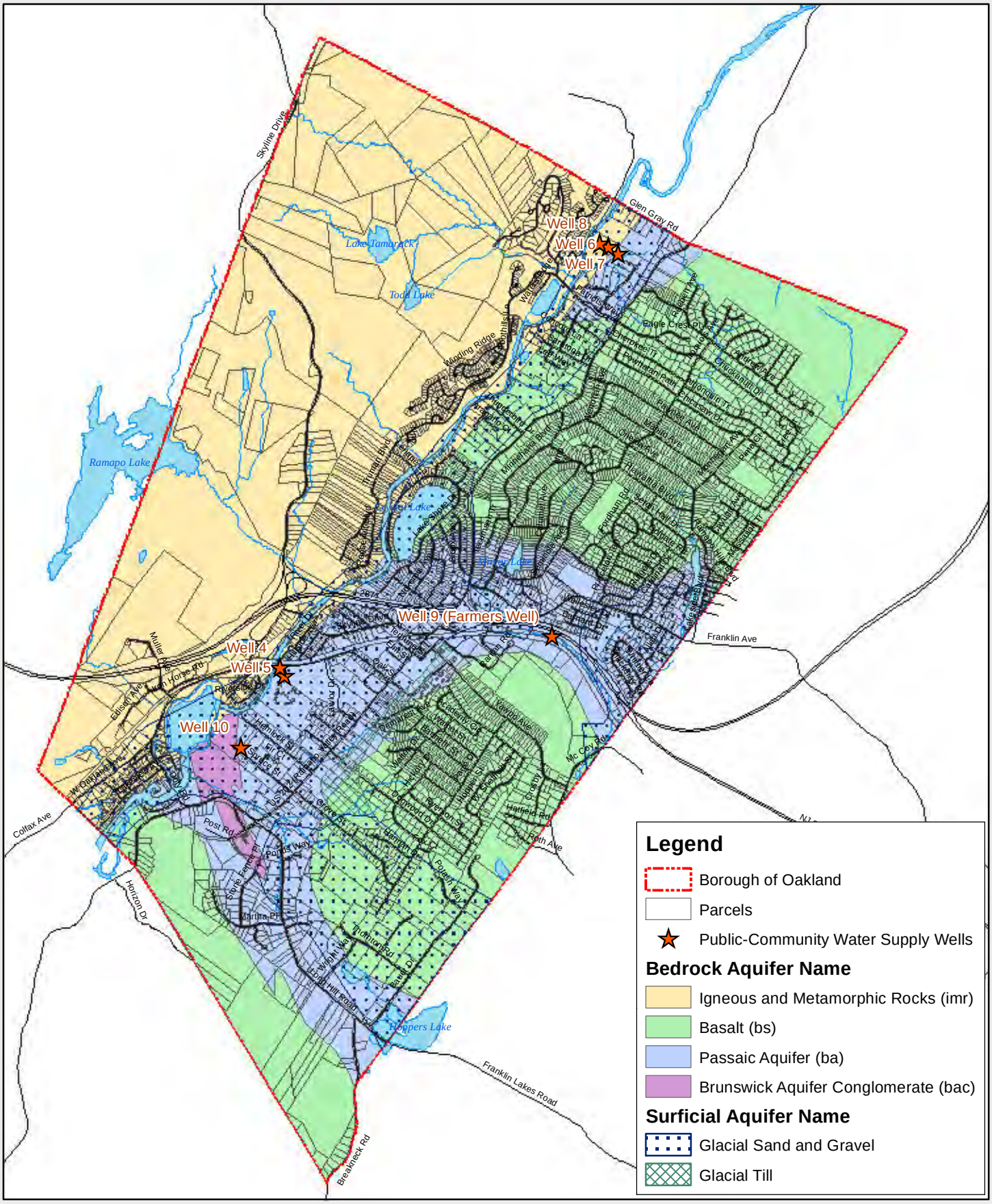

Figure 5b: Aquifers & Water Supply Wells

0 0.25 0.5 1 Miles

N

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C. Sole-Source Aquifers

The Safe Drinking Water Act (SDWA) of 1974 contains a provision in Section 1424(e) that provides for designating an aquifer that is the sole or principal drinking water source for an area and that, if contaminated, would create significant hazard to public health. As defined by the U.S. Environmental Protection Agency (EPA), s*ole-source aquifers* (SSA) are those aquifers that contribute more than 50% of the drinking water to a specific area and the water would be impossible to replace if the aquifer were contaminated. Once designated, no Federal financial assistance may be approved for any project that may contaminate the aquifer through a recharge zone so as to create a significant hazard to public health (US EPA, August 1992). Therefore, the EPA must review any federally-funded project in an area that could affect ground water in a sole-source aquifer, including the *aquifer's recharge zone* (the area through which water recharges the aquifer) and its *stream-flow source zone* (the upstream area that contributes recharge water to the aquifer).

The Ramapo River Basin Aquifer System met the technical requirements for SSA designation, and Notice of approval was published in the Federal Register 57 FR 39201, August 28, 1992. It includes the entire Ramapo River watershed in New Jersey and New York (USEPA Region 2, August 1992; NJDEP NJGS, May 19, 1998). The portion of the Ramapo SSA within New Jersey is shown in **Figure 5c**.

D. Recharge

Ground water recharge is defined as water added to an aquifer (for example, precipitation that seeps into the ground deep enough to enter the saturated zone of the fractured bedrock). A g*round water recharge area* is the land area that allows precipitation to seep into the saturated zone. These areas are generally at topographically high areas with discharge areas at lower elevations, commonly at streams or other water bodies (i.e. the ground water returns to surface water). In general, ground water divides[23] coincide with, or are slightly offset from, surface water divides (Lewis-Brown and Jacobsen, 1995) (watersheds are described in **Section 6A** and shown in **Figure 6a**). Most ground water flows through the shallow layers of soil and weathered bedrock to the nearest stream. A smaller percentage penetrates deeper and recharges the aquifer.

Recharge rates are expressed in terms of the amount of precipitation that reaches the aquifer per unit of time (e.g. inches/year during a drought year is used in **Figure 5d**). New Jersey receives an average of about 40 to 51 inches of precipitation per year (lowest along the southeast coast, highest in the north-central parts of the state, including Oakland) (ONJSC, no date), and references vary widely about how much reaches the aquifer (Lewis-Brown and Jacobsen, 1996; Kasabach, 1966; USGS, 2013) in areas like Oakland. This is because, while precipitation can be accurately measured, recharge cannot be directly measured. Many factors affect the amount of recharge that will occur in a given area, including climate (e.g. the amount, intensity, and form of precipitation, and the effect of wind, humidity and air temperature on evapotranspiration), soil, surficial geology, and vegetation factors. In addition, recharge of ground water varies seasonally. During the growing season, precipitation is intercepted by plants and returned to the atmosphere through transpiration (part of the hydrologic cycle, see **Section 5A**). Likewise, evaporation is higher during the warmer months. Together, these are known as

[23] A ground water divide is a line on a water table where on either side of which the water table slopes downward. It is analogous to a drainage divide between two drainage basins on a land surface. http://www.srh.noaa.gov/jetstream/append/glossary_g.htm

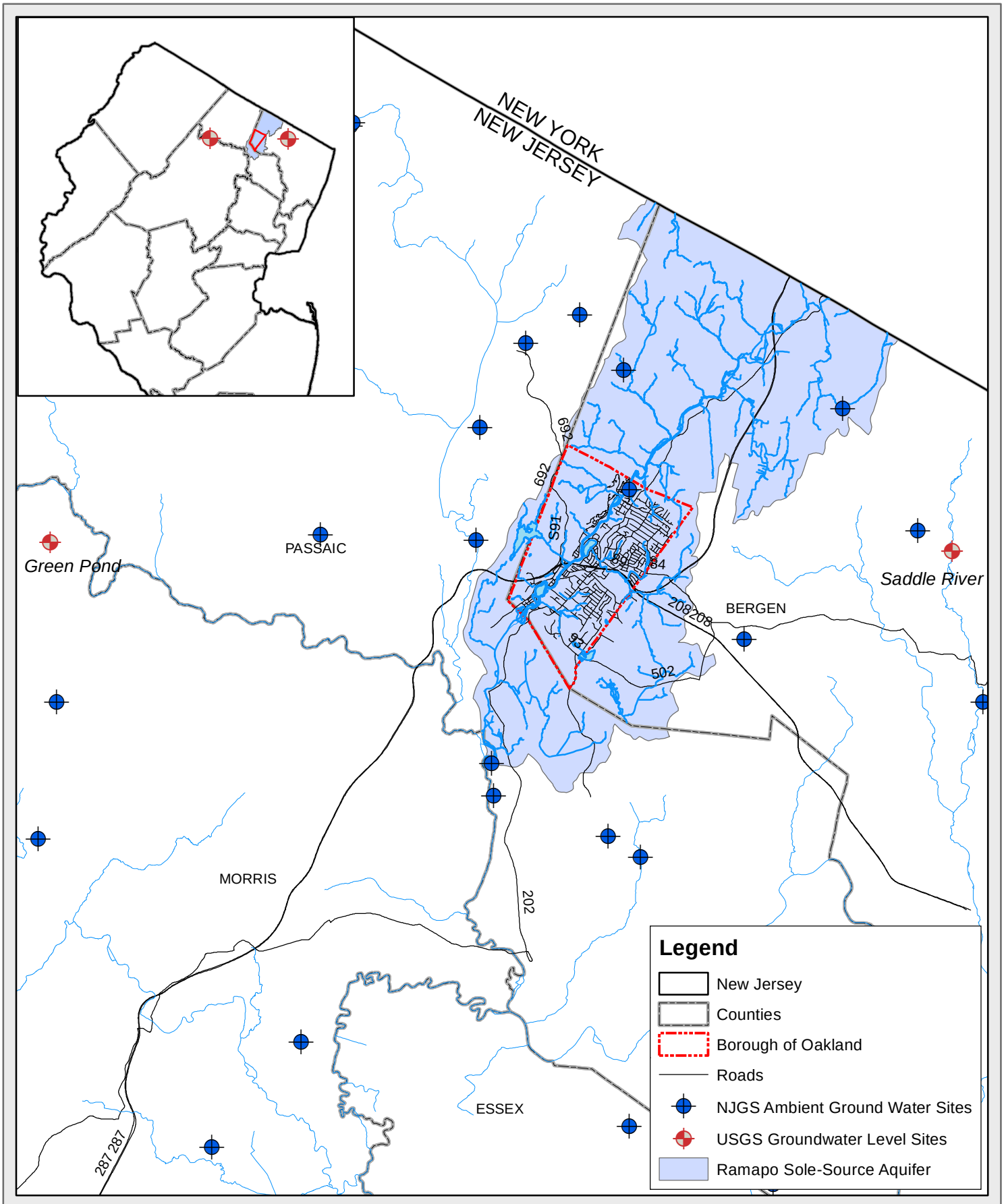

Figure 5c: Sole Source Aquifer & Ground Water Monitoring Sites

0 1.25 2.5 5 Miles

N

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evapotranspiration. Therefore, most recharge occurs during late fall, winter, and early spring, when plants are dormant and evaporation rates are minimal (Heath, 1983). Relative to land use, recharge rates in forests are much higher than those in urban areas (Heath, 1983). This is because urban areas have large areas covered with impermeable surfaces, hastening runoff to surface water, instead of allowing precipitation to percolate into the ground.

To ensure that water is available during all weather conditions for human consumption as well as ecosystems dependent on water, the NJDEP established the Planning Threshold, or *dependable yield,* to be used for planning purposes. *Dependable yield* is defined as "the water yield maintainable by a ground-water system during projected future conditions, including both a repetition of the most severe drought of record and long-term withdrawal rates without creating undesirable effects." The most severe drought on record was in the early 1960's (see **Section 2A**), and this is used in the Statewide Water Supply Plan. However, the Plan acknowledges that there is insufficient long-term precipitation data to prove that this is the worst drought that could occur in the future, in duration or severity, and recommends re-evaluation of safe-yield estimates and development of optimal strategies for severe droughts (NJDEP OEP, 1996). Robert Canace, of the NJ Geological Survey, suggested that 20% of the estimated recharge should be used for planning purposes, representing the portion of recharge actually available for use during drought conditions (Canace, 1995).

In view of the importance of not exceeding the aquifers' safe yield, the New Jersey Geological Survey has completed studies quantifying recharge, as discussed in the following sections.

New Jersey Geological Survey Recharge Method GSR-32

N.J.S.A. 58:11A, 12-16 required the NJDEP to publish a methodology to map and rank aquifer-recharge areas. In addition, the legislation required the development of ground water protection practices designed to encourage ecologically sound development in aquifer-recharge areas (Charles et. al., 1993). To fulfill the requirements of this legislation, the NJ Geological Survey developed GSR-32, which estimates ground water recharge (but not aquifer recharge), and is useful for evaluating the relative effect of present and future land uses on recharge areas (Charles et. al., 1993). For this method, recharge was calculated based on data for precipitation, soil, land-use/land-cover[24], surface runoff, and evapotranspiration. This method was then applied by NJGS to create a GIS coverage (see **Figure 5d**). There were a number of assumptions made for the calculations and model inputs that limit the accuracy of the method: 1) the calculated ground water recharge includes any water entering the ground (in actuality, lesser amounts enter the aquifer); 2) assumes that all water that migrates below the root zone recharges the aquifer (which does not happen); 3) addresses only natural ground water recharge, and does not include artificial recharge, withdrawals or natural discharge; 4) wetlands and water bodies were eliminated from analysis, because the direction of flow between ground water and surface water is site-specific and also varies seasonally, and this level of detail was beyond the scope of the study (these areas were assumed to provide no recharge or discharge); 5) stream baseflows used may not be representative of local streams (Charles et. al., 1993) and 6) does not consider topography, depth to bedrock, presence of impervious surfaces, and/or type of bedrock underlying soils. An additional limitation of the data is that they estimate long-term average annual recharge, which does not represent the reduced recharge during critical summertime conditions (NJ Water Supply Authority, 2002).

[24] Land use/land cover data from 1995-1997 were used for this study. Changes in land use/land cover and impervious surfaces affect recharge, but are not shown on **Figures 5d** or **5e**, because this involves complex calculations, and NJGS has not updated this GIS data layer.

Applying the GSR-32 method to Oakland, the estimated average annual subsurface recharge rates range from 0 to 21 inches per year (excluding surface water, wetlands and hydric soils) and 0 to 15 inches per year during drought (shown on **Figure 5d**). Applying the 20% consumptive use limit to these figures results in usable recharge from 0 to 3 inches per year. As previously mentioned, only a portion of water entering the ground actually recharges the aquifer, but since GSR-32 did not attempt to quantify this amount, this method would be better described as *soil recharge*.

New Jersey Geological Survey Ground Water Potential

In 2005, also in response to N.J.S.A. 58:11A, 12-16, the NJ Geological Survey developed a qualitative representation of the potential for aquifer recharge. This was created by combining ground water recharge rankings and aquifer rankings.

NJGS assigned a relative rank based on the inches of ground-water recharge per year (mapped in **Figure 5d**), from A (highest recharge) to E (lowest recharge). Relative values of aquifer yield (based on high yield industrial wells and described in **Table 5.1**) were assigned to each aquifer, from A (highest yield) to E (lowest yield). The State Ranks for the aquifers underlying Oakland are B, C and D. For both data sets, areas of wetlands, open water and hydric soils were not ranked, since individual areas differ in whether they increase or decrease recharge, which varies seasonally. These two ranks are combined in the format "ground water recharge rank/aquifer recharge rank" and illustrated in **Figure 5e**. For example, A/A would be an area with the highest relative recharge and highest yield, and an area designated E/E would have the lowest recharge and lowest yield, while other combinations would lie somewhere in between (French, 2004).

E. Ground Water Quality

Pollution, such as nitrates, bacteria, metals, pesticides and antibiotics, can enter ground water via non-point sources (including septic systems and runoff from fields and roads), point sources, and rain. The New Jersey Comparative Risk Project (2003) identified a number of possible human health risks from drinking water, including lead (which, when present, is usually from the plumbing)(NJDEP, 2004), radon, arsenic, MTBE (methyl-t-butyl ether, which is a fuel oxygenate), nitrates, and waterborne pathogens.

In addition, radioactive substances (including uranium, thorium, radium, and radon) from natural sources (see **Section 3D)** are frequently found in ground water in New Jersey. Almost all rocks and soil contain at least some radioactive substances, which can sometimes exceed safe levels in drinking water (no data was found specific to Oakland, but background information may be found in **Internet Resources**).

NJGS Studies

The NJ Geological Survey studied ground water quality in the Newark Basin in 1994 and in the Highlands aquifer in 2004. NJGS ground water monitoring sites are shown in **Figure 5c** (NJGS, August 15, 2013).

The NJ Geological Survey analyzed data from 150 wells in the Newark Basin (including the Brunswick Aquifer) in order to characterize the natural range of ground water quality parameters (Serfes, 1994; Serfes and Herman, 1995). While no sites were located within Oakland, a number of sites were situated in neighboring municipalities (sites 7 and 10 were the nearest). Results showed that ground water in the Newark Basin, including the Passaic Formation, is normally fresh (total dissolved solids less than 1,000 mg/l), somewhat oxidizing,

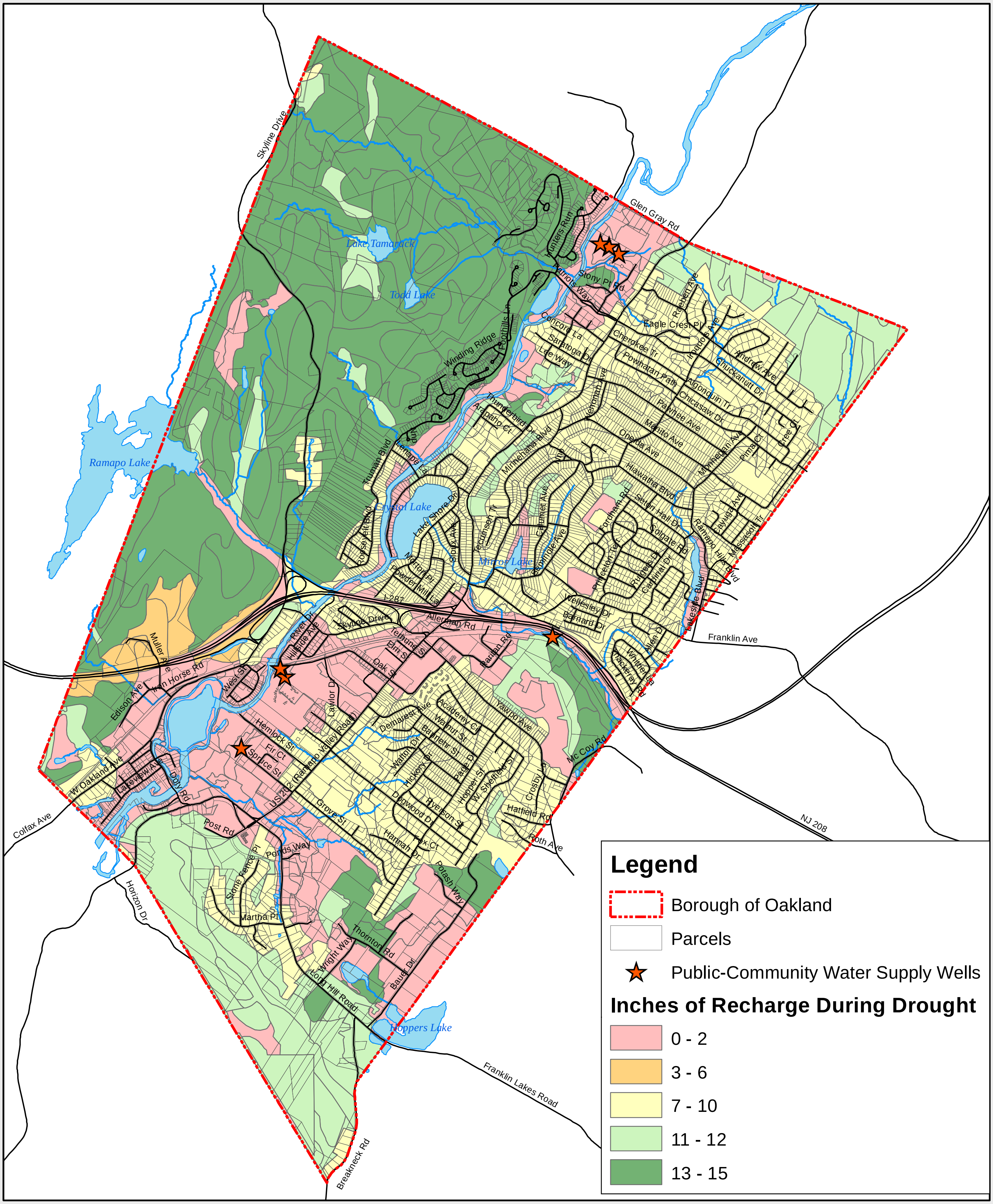


Figure 5d: Recharge

0 | 0.25 | 0.5 | 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

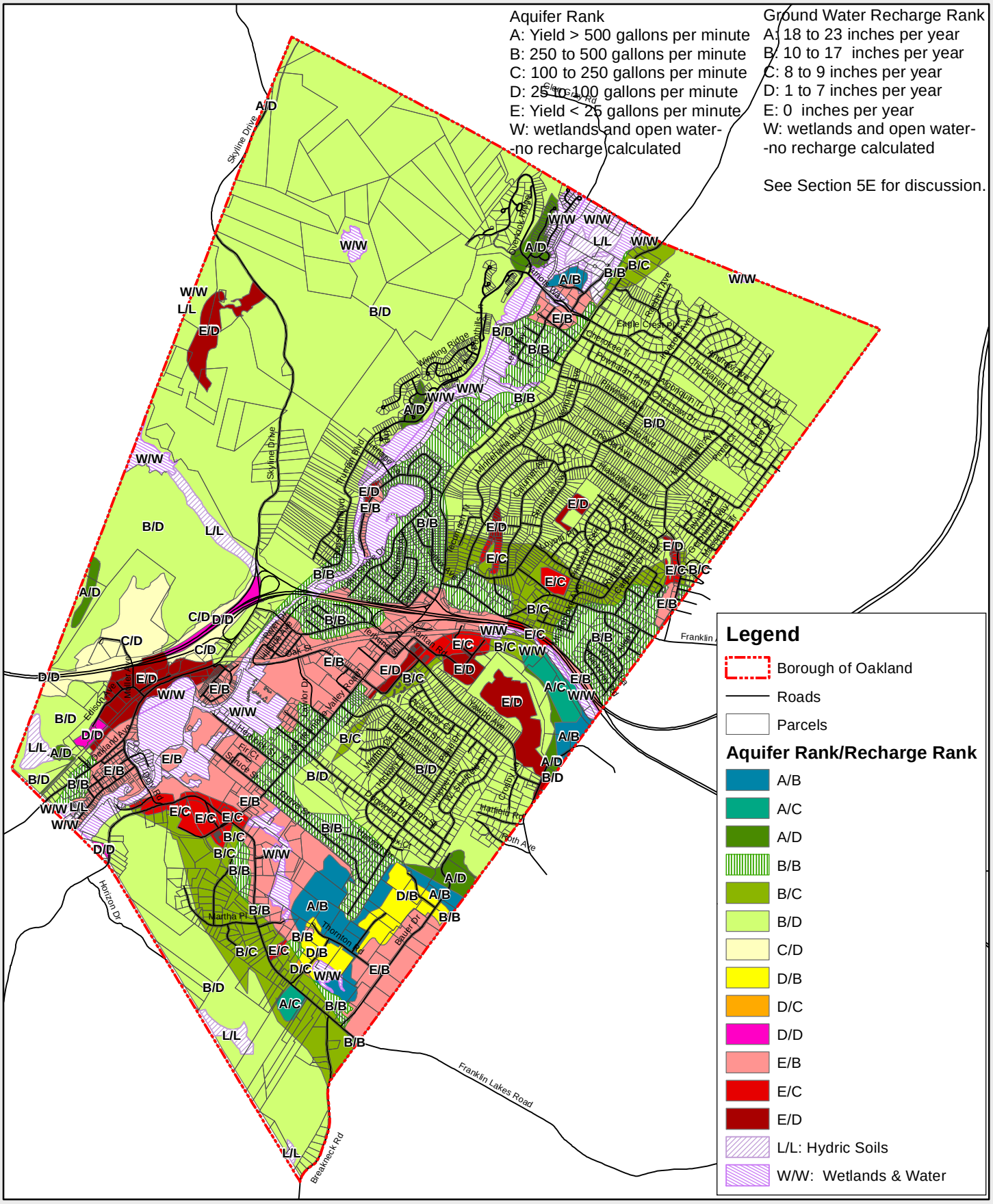


Figure 5e: Aquifer Potential

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

slightly alkaline, non-corrosive, hard and of good natural quality. Calcium bicarbonate waters dominate, but calcium-sulfate waters exist and are associated with high total dissolved solids. Standards were exceeded for manganese in 27% of samples, maximum hardness in 21%, corrosivity 31% of the time, total dissolved solids 14%, sodium 8% and sulfate 8% of the time. The primary drinking water standard for gross alpha particle activity (radon and progeny) was exceeded in 6% of the samples, for radium in 3%, and for lead 1% of the time (Herman et al., 1998; Serfes, 1994). In addition, the water may have large concentrations of iron and sulfate (USGS, January 14, 2013a; Serfes, 1994).

In 2004, the NJGS analyzed data from 105 wells in the Highlands and Valley and Ridge Physiographic Provinces. No sites were located in Oakland, but one site was in Mahwah, and a total of 45 sites were in the same bedrock formation. The study confirmed that the ground water quality is very good for most purposes. The most frequent problems were with secondary drinking water standards[25]: 30% of the samples exceeded the standard for pH (<6.5), 4.5% exceeded for hardness (>250 mg/l), 6.7% exceeded for iron (>0.3mg/l), 16.3% exceeded for manganese (0.05 mg/l). In addition, 19% exceeded the primary drinking water standard for gross alpha particle activity (>15 picocuries/l) (Serfes, 2004).

Water from the glacial valley-fill sand and gravel deposits contains moderate amounts of dissolved solids (113-215 mg/l), is generally moderately hard (75-155 mg/l), and is neutral to slightly alkaline (pH ranging from 6.8 to 7.7) (US EPA, August 1992).

Public Water Wells

The Oakland Water Department serves 12,000 people from the wells shown in **Figure 5b**. These wells are all located in the glacial valley-fill sand and gravel surficial aquifer. Between 2000 and 2012, the system experienced only one violation of the Safe Drinking Water Act. In that instance, which occurred in 2004, the standard for Total Coliform was exceeded (NJDEP Division of Water Supply and Geoscience, July 9, 2013). Water quality testing results are available online (see **Internet Resources**).

Private Wells

The New Jersey Private Well Testing Act (N.J.S.A. 58:12A-26 et seq.) became effective in September 2002, mandating private well testing upon the sale of a house. The number of wells tested in a municipality reflects the number of real estate transactions involving homes with private wells. Since Oakland is served primarily by public water systems, just 29 private wells have been tested pursuant to this regulation. Of these 29 wells tested, one well (3.5% of those tested) exceeded the arsenic[26] Maximum Contaminant Level (MCL) of 5 µg/l (result was 5.9 µg/l); 0 exceeded the nitrate MCL of 10 mg/l; and 0 exceeded the Volatile Organic Compounds (VOCs) standards. Wells in Bergen County are not required to test for gross alpha particle activity (NJDEP Office of Science, December 21, 2012; NJDEP Division of Water Supply and Geoscience, June 4, 2013).

F. Ground Water Quality Standards

The New Jersey Ground Water Quality Standards (GWQS; N.J.A.C. 7:9C) (last amended July 22, 2010) specify the quality criteria and designated uses for ground water, and serve as the

[25] *Secondary drinking water standards* are those that affect the aesthetics of water; *Primary drinking water standards* are those that affect human health.

[26] Wells drilled in northern NJ can contain high levels of naturally occurring arsenic (from bedrock). Other sources include past use of pesticides and waste from glass or electronics production.

basis for setting ground water discharge standards under the New Jersey Pollutant Discharge Elimination System program (see **Section 5H**), as well as for establishing standards for ground water cleanups and other relevant laws. The criteria are numerical values assigned to each constituent (pollutant). The GWQS also contain technical and general policies to ensure that the designated uses can be adequately protected.

Ground water within watersheds of FW1 surface waters (see **section 6D** for surface water classifications), state-owned Natural Areas, and the major aquifers of the Pinelands Area are designated *Class I*. The designated use for Class I ground water is the maintenance of special ecological resources, with secondary uses being potable, agricultural and industrial water. *Class II* waters are those not specifically designated Class I or Class III. The designated use of Class II ground waters is to provide potable water using conventional treatment. Class II criteria specify the levels of constituents above which the water would pose an unacceptable risk for drinking water. *Class III* ground waters can be used for anything other than for potable water (NJDEP Bureau of Water Quality Standards and Assessment, December 5, 2011).

Oakland's waters are designated Class II (to provide potable water with conventional treatment). It should not be assumed that ground water quality everywhere meets the criteria for each classification area in view of natural variability and the possibility of localized pollution. In fact, NJDEP has designated 3 areas within the Borough where ground water contamination has been identified (Dewey Electronics, Silicon Technology Corp., and Exxon Service Station #3-2238; see **Section 5I** and **Figure 5f**).

G. Ground Water Discharges

New Jersey regulates the discharge of pollutants to ground water under the authority of the New Jersey Water Pollution Control Act (WPCA) N.J.S.A. 58:10A. The New Jersey Pollutant Discharge Elimination System (NJPDES) permit program regulations are contained in N.J.A.C. 7:14A (NJDEP, January 5, 2009).

NJPDES permits are required for discharges to ground water of both sanitary and industrial wastes. These permits, which limit the mass and/or concentration of pollutants discharged, are issued to sanitary and industrial facilities that have ongoing, operational discharges of wastewater to ground water. The purpose is to restrict the discharge of pollutants to the ground waters of the state and protect the public health and the environment. Discharges from past activities may continue to be regulated under the Site Remediation Program or the Division of Solid and Hazardous waste.

There are 4 ground water discharges within Oakland, described below in **Table 5.2** and shown on **Figure 5.f** (NJDEP DWQ BNPC, 2007).

Table 5.2: NJPDESGW in Oakland

Map ID	FACILITY	PI #	NJPDES #	DISCHARGE TYPE
0	Aramis Inc. 5 Thornton Rd	47347	NJ0086797	GW
1	Russ Berrie & Company Inc. BD Oakland Owner LLC BD 111 Bauer Dr	47154	NJ0078565	GW
2	Cable Vision of Oakland 40 Potash Rd	47209	NJ0083038	GW
3	Engineering Laboratories, Inc. 360 W Oakland Ave.	46307	NJ0051471	GW
Source: NJDEP, Division of Water Quality (DWQ), Bureau of Nonpoint Pollution Control (BNPC), 2007				

H. Contaminated Sites

On May 7, 2012, NJDEP adopted amendments, repeals, and new rules to implement site remediations through the *Site Remediation Reform Act (SRRA)*, N.J.S.A. 58:10C-1 et seq., and related amendments to the *Brownfield and Contaminated Sites Act (Brownfield Act)* N.J.S.A. 58:10B-1 et seq., the *Spill Compensation and Control Act (Spill Act),* N.J.S.A. 58:23-11 35 seq., the *Industrial Site Recovery Act (ISRA)*, N.J.S.A. 13:1K-6 et seq., and the *Underground Storage of Hazardous Substances Act (UST Act)*, N.J.S.A. 58:10A-21 et seq. This major shift requires remediations of contaminated sites to proceed under the supervision of a *Licensed Site Remediation Professional (LSRP)* (hired by the property owner) instead of NJDEP (NJDEP Site Remediation Program, May 7, 2012).

The goal of these changes is to increase the pace of remediation, in order to decrease the threat of contamination to public health and safety and the environment, and to more quickly return properties to productive use that are underutilized due to contamination.

Some key provisions create a licensing board and a code of ethics (including penalties for violations) for LSRPs; establish obligations of each person responsible for conducting remediation; institute mandatory timeframes for the completion of key phases of site remediation; set forth the circumstances under which NJDEP would undertake direct oversight of a remediation; and require NJDEP to establish presumptive remedies for residential development, schools and childcare facilities to ensure that the remediation at these sites is protective of human health and safety and of the environment (NJDEP Site Remediation Program, July 29, 2013).

The LSRP program does not apply to unregulated underground storage tanks (i.e. residential tanks) (see **Internet Resources**).

Known Contaminated Sites List (KCSL)

The NJDEP Site Remediation Program compiles a list of Known Contaminated Sites (KCS). The *Known Contaminated Sites List* [27] (non-homeowner) for New Jersey (as required under N.J.S.A. 58:10-23.16-17 and also the New Residential Construction Off-Site Conditions Disclosure Act N.J.S.A 46:3C1 et seq.) contains sites defined as those sites and properties within the state where contamination of soil or ground water has been confirmed at levels equal to or greater than applicable standards. Sites identified in the Known Contaminated Sites list can undergo a variety of activities, ranging from relatively simple soil removals to highly complex remedial activities. It is important to note that the list may include sites where remediation is either currently under way, required but not yet initiated or has been completed (and no longer considered contaminated). In addition, new contaminated sites may have been identified since the creation of this list and are not included here (NJDEP Site Remediation Program, February 2012).

Within the Borough of Oakland, there are 11 KCSs (see **Table 5.3** and **Figure 5f**). No sites in Oakland are currently on the National Priorities (Superfund) List, however one site, the Witco Chemical Corp. (located on Bauer Drive near Hoppers Lake) was previously on the list. Witco removed and landfilled contaminated soil and materials, and the EPA determined in 1995 that no further cleanup actions were needed at the site (USEPA, October 05, 2010).

[27] The GIS data is updated periodically (the most recent data currently available is from February 2012). The tabular data is updated frequently, with new sites added and remediated ones removed, and is available at: http://datamine2.state.nj.us/DEP_OPRA/OpraMain/categories?category=Site+Case+sub-category

Homeowner sites are not included in the GIS data or in **Table 5.3** because they generally involve small heating oil discharges from leaking underground storage tanks (USTs) that are resolved relatively quickly (see **Internet Resources** for a link to NJDEP's grant program for removal and cleanup of USTs) (NJDEP Site Remediation Program, April 12, 2012).

Classification Exception Area (CEA)

The *Classification Exception Area* (CEA) dataset identifies those sites where ground water contamination has been identified and the NJDEP has established a Classification Exception Area (CEA). CEAs are institutional controls in geographically defined areas within which the New Jersey Ground Water Quality Standards (NJGWQS) for specific contaminants have been exceeded. When a CEA is designated for an area, the constituent standards and designated aquifer uses are suspended for the term of the CEA. This data is intended to provide information to the public regarding areas of contaminated ground water to prevent inappropriate well placement, preventing potential health risks and can minimize unintended contaminant plume migration (NJDEP Site Remediation Program, February 30, 2013). There is one CEA in Oakland, Silicon Technology Corp on Spruce Street (see **Table 5.3** and **Figure 5f**).

Table 5.3: Contaminated Sites in and Near Oakland (See Figure 5f)

Site Id. # PI #	Name	Map ID	Address	Status*
Known Contaminated Sites (KCS)				
37818 G000009531	Russ Berrie & Company Incorporated	1	111 Bauer Dr	Pending
11546 008942	Exxon Store 3-2238 (bank)	2	160 Ramapo Valley Rd	Active
11548 006508	Zaina Group LLC	3	78 Ramapo Valley Rd	Active
11538 G000003081	Silicon Technology Corporation	4	48 Spruce St	Active
20915 006943	Engineering Laboratories Inc	5	360 W Oakland Ave	Active
91475 G000025770	260 Ramapo Valley Road (Gulf gas station)	6	260 Ramapo Valley Rd	Pending
64422 G000011603	Oakland Borough Water Department Well 5	7	Ramapo Valley Rd & Oak St	Active
11554 255206	Dewey Electronics Corporation	8	27 Muller Rd	Active
196181 257516	Gabrellian Associates	9	Terhune St	Pending
33288 008948	Exxon R/S 3-2232	10	4 Court House Plaza	Active
64591 G000021766	152 Hiawatha Boulevard	11	152 Hiawatha Blvd	Pending
Classification Exception Area (CEA)				
PI # 99659	Silicon Technology Corp.	Block 2212 Lot 1.04	48 Spruce St.	Active
Deed Notice Extent (DNA)				
PI # 255206	Dewey Electronics	Block 1201 Lot 2.18	27 Muller Rd.	Active
Note: Sites identified as homeowner sites were removed from the list and from **Figure 5f**.				
Sources: NJDEP SRP, February 2012; NJDEP SRP, February 30, 2013; NJDEP SRP, January 30, 2012; NJDEP Data Miner, August 2013				

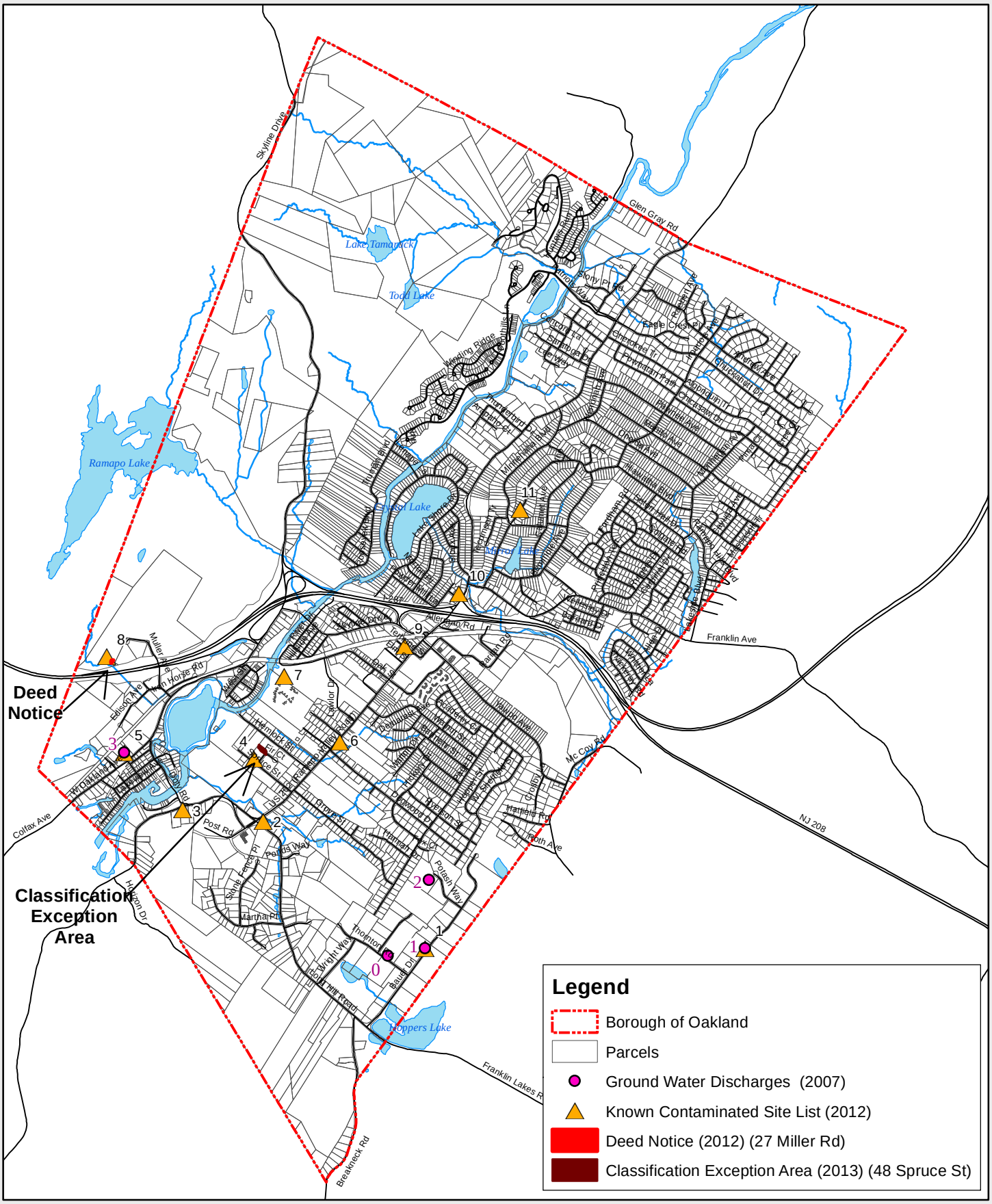


Figure 5f: Contaminated Sites & Ground Water Discharges

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Deed Notice

A *Deed Notice* is defined by NJSA 58:10B-13a as a "...notice to inform prospective holders of an interest in the property that contamination exists on the property at a level that may statutorily restrict certain uses of, or access to, all or part of that property...." The purpose of the deed notice GIS layer is to minimize any chance of exposure to contaminants remaining on the property (NJDEP Site Remediation Program, January 30, 2012). There is one Deed Notice delineated within the Borough of Oakland, Dewey Electronics, on Muller Road (see **Table 5.3** and **Figure 5f**).

Remediated Sites

A current Data Miner search revealed that 73 contaminated sites within Oakland have been remediated (34 homeowner and 39 non-homeowner) (NJDEP Site Remediation Program, August 14, 2013). These cases are closed and are not listed in **Table 5.3.**

I. Ground Water Level Monitoring

The *ground water level* is the distance from the land surface to the water in a well. Ground water level monitoring is critical for determining the current state of the ground water, identifying trends and predicting ground water drought. In addition to drought, over-withdrawal of ground water can occur in areas where more ground water is being pumped out of the aquifer than is replenished through recharge. This could lead to a drop in the ground water level, affecting well performance, and sometimes causing wells to go dry; in addition to causing a decrease in the baseflows of adjacent streams.

The USGS maintains a nation-wide network of wells to monitor the effects of droughts and other climate variability on ground water levels. While there are no USGS monitoring wells within Oakland, the nearest well that is in the stratified drift aquifer is Green Pond 5 Observation Well (located in Newfoundland, Morris County, approximately 9 miles west of Oakland). The USGS monitoring well nearest to Oakland and in the Passaic Formation aquifer is Saddle River 17 Observation Well (located in Saddle River, Bergen County, approximately 6 miles east of Oakland). While these wells do not precisely represent the ground water levels within Oakland, due to intervening ground water divides (boundaries), they are among the factors that NJDEP uses to determine drought status (see **Internet Resources**). A description of these sites and a graph of ground water level for 2012-2013 are shown in **Table 5.4**. Locations are shown in **Figure 5c**. On average, the lowest groundwater levels occur during June-September, while highest levels occur January-March. The Green Pond site in the stratified drift aquifer exhibits less seasonal variability than the well completed in the Passaic Formation.

Table 5.4: USGS Real-Time Ground Water Level Network – Wells Near Oakland

Site Number: USGS 410207074270001 270028-- Green Pond 5 Observation Well

Location: Latitude 41°02'07", Longitude -74°27'00" NAD27
Morris County, New Jersey , Hydrologic Unit 02030103

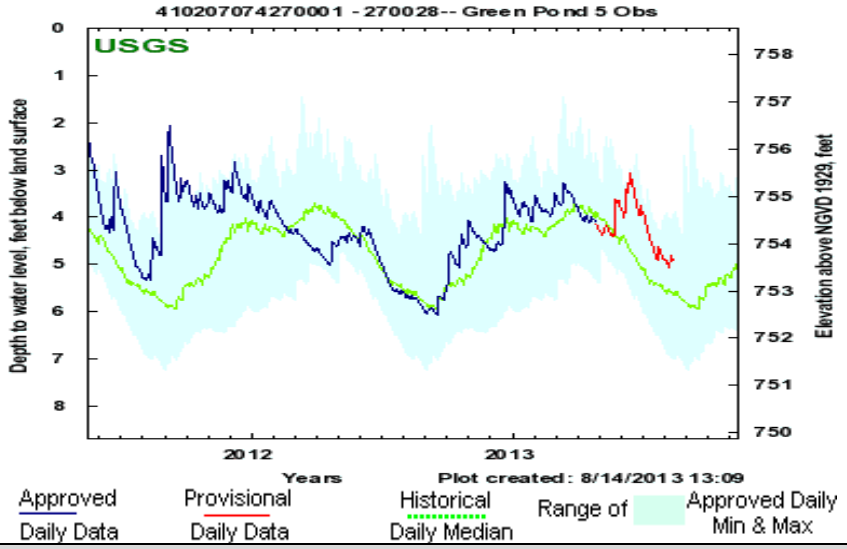
Well Characteristics: Depth: Well depth: 120 feet **Land surface altitude:** 758.56 feet above NGVD29.

Aquifer: Well completed in "Sand and gravel aquifers (glaciated regions)" national aquifer
Well completed in "Stratified Drift" local aquifer

Begin date (periodic record): 11/26/81

Extremes for Period of Record: *Highest Water Level*: 1.45' *Median*: 4.57' *Lowest Water Level*: 7.24'

Website: http://waterdata.usgs.gov/nwis/uv?site_no=410207074270001
http://groundwaterwatch.usgs.gov/AWLSites.asp?S=410207074270001&ncd=



Site Number: 410155074060201 - 030289-- Saddle River 17 Observation Well

Location: Latitude 41°01'55", Longitude -74°06'02" NAD27
Bergen County, New Jersey, Hydrologic Unit 02030103

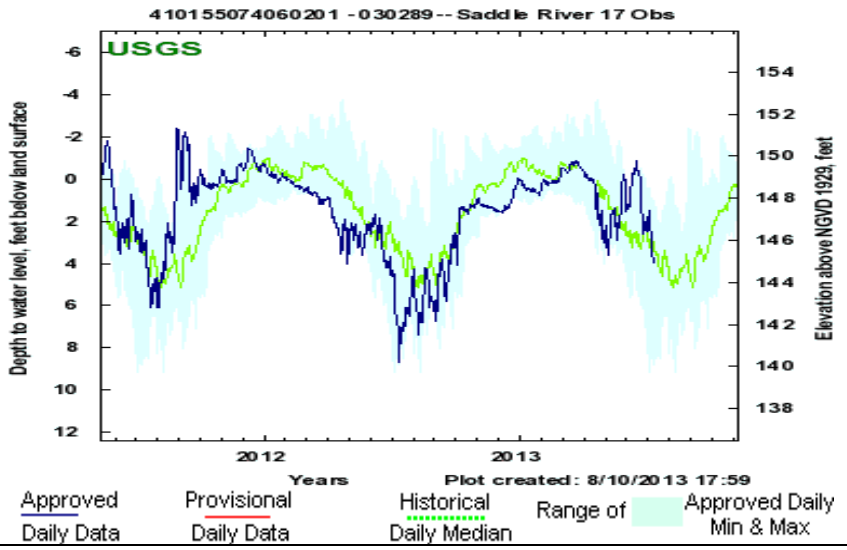
Well Characteristics: Depth: 175 feet **Land surface altitude:** 148.9 feet above NGVD29

Aquifer: Well completed in "Early Mesozoic basin aquifers" (N300ERLMZC) national aquifer.
Well completed in "Passaic Formation" (227PSSC) local aquifer

Begin date (periodic record): 07/13/89 **Begin date (continuous record):** 12/04/04

Extremes for Period of Record: *Highest Water Level*: -3.79' *Median*: 1.34' *Lowest Water Level*: 9.18'

Website: http://groundwaterwatch.usgs.gov/AWLSites.asp?S=410155074060201



Note: These sites are maintained by USGS New Jersey Water Science Center.
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USGS. 2013b. Groundwater Watch. Site Number: 410155074060201 - 030289-- Saddle River 17 Obs http://groundwaterwatch.usgs.gov/AWLSites.asp?S=410155074060201

Internet Resources: Ground Water

Ground Water Primer (US EPA): http://www.waterscape.org/projects/vanduo/dw_gen/grdshort/src/ground.htm#toc

Groundwater Watch
- Green Pond 5 Obs (NWIS) http://waterdata.usgs.gov/nwis/uv?site_no=410207074270001
- Green Pond 5 Obs http://groundwaterwatch.usgs.gov/AWLSites.asp?S=410207074270001&ncd=
- Saddle River 17 Obs http://groundwaterwatch.usgs.gov/AWLSites.asp?S=410155074060201

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- Report Categories: http://datamine2.state.nj.us/dep/DEP_OPRA/index2.html
- Contaminated Sites: http://datamine2.state.nj.us/DEP_OPRA/OpraMain/categories?category=Site+Case+sub-category

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NJDEP grants for Underground Storage Tank removal & remediation: http://www.nj.gov/dep/srp/finance/ustfund/

NJDEP Laws & Rules: http://www.nj.gov/dep/landuse/lawsregs.html
- Site Remediation Reform Act, N.J.S.A. 58:10C-1 et seq.: http://www.nj.gov/dep/srp/regs/statutes/srra.pdf
- Brownfield and Contaminated Sites Act: http://www.nj.gov/dep/srp/regs/statutes/bcsra.pdf
- Spill Compensation and Control Act: http://www.nj.gov/dep/srp/regs/statutes/spill_act.pdf
- Industrial Site Recovery Act: http://www.nj.gov/dep/srp/regs/statutes/isra.pdf
- Underground Storage Tanks: http://www.nj.gov/dep/rules/rules/njac7_14b.pdf

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

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NJ Geological Survey Home Page: http://www.state.nj.us/dep/njgs/index.html

Oakland Water Department - NJ Drinking Water Watch:
https://www11.state.nj.us/DEP_WaterWatch_public/JSP/WSDetail.jsp?tinwsys=44

Underground Storage Tanks: http://www.nj.gov/dep/srp/bust/

Uranium
- NJDEP: North Jersey Homeowner's Guide to Radioactivity in Drinking Water:
  http://www.state.nj.us/dep/rpp/rms/agreedown/urwater.pdf
- US EPA: Basic Information about the Radionuclides Rule.
  http://water.epa.gov/lawsregs/rulesregs/sdwa/radionuclides/basicinformation.cfm

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USGS - Water Resources of NJ: http://nj.usgs.gov/

USEPA – Region 2: http://www.epa.gov/region02/water/

6: SURFACE WATER

A. Watersheds

Watersheds

A *watershed* (or basin) is the land area within the confines of a drainage divide in which all surface runoff will drain into a river, river system, or body of water. The Borough of Oakland is within the Passaic River watershed (see top left inset in **Figure 6a**), which covers the northeastern corner of New Jersey. This watershed covers approximately 935 square miles (598,400acres) and includes parts of eight counties (Hudson, Bergen, Passaic, Sussex, Morris, Somerset, Union, and Essex counties). Headwaters of the Wanaque, Ramapo and Saddle Rivers originate in New York.

Nancy Krause

Ramapo River from Dotty Road Bridge

"Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy." (NJDEP NJAC 7:9B, April 4, 2011).

The Passaic River watershed is made up of smaller watersheds, including the Ramapo and Saddle Rivers. Oakland is located within the Ramapo River watershed. Sub-watersheds are those smaller drainage areas that make up a larger watershed. Oakland is located in the Ramapo River sub-watershed of the Passaic River watershed (**Figure 6a)**.

Watershed Management Areas

Watershed management is the process of managing and protecting all of the water resources within the area of a watershed, rather than on a site-specific basis. The NJDEP recognizes that watersheds are "nature's boundaries," and has established a watershed management approach (NJDEP, January 1997). A watershed management approach is based on three key components: 1) a geographic focus; 2) continuous improvement based on sound science; and 3) partnerships/stakeholder involvement. More information concerning watershed management is presented in **Section 10D**. NJDEP has divided the state's watersheds into 20 *Watershed Management Areas (WMAs)*. The Passaic River basin is divided into three WMAs. Oakland falls within *WMA 3: Pompton, Paquannock, Wanaque and Ramapo River* (see top right inset in **Figure 6a**). The Pequannock, Wanaque and Ramapo Rivers are all tributaries of the Pompton River, which is a major tributary of the Passaic River.

Hydrologic Unit Codes (HUC)

The classification system used by the NJDEP assigns each sub-watershed a *14-digit Hydrologic Unit Code (HUC14[28])*. The HUC14 is a hierarchical system where the first 2 digits refer to the USGS Water Resources Region and the first 4 digits (also known as a HUC4) refer to the major drainage basin, or sub-region. Therefore, a HUC2 of "02" is in the Mid-Atlantic Region, and a HUC4 of "0203" is in the Lower Hudson-Long Island major drainage basin (USGS, May 13, 2013).

The Passaic River basin is assigned a HUC8 of "02030103," and every sub-watershed within this basin has a HUC that starts with "02030103."

All of Oakland is within the Ramapo River watershed, with a HUC11 of "02030103100." HUC14 sub-watersheds and streams either within and surrounding the Borough of Oakland are shown in **Figure 6a**.

Table 6.1 lists the HUC14s for the subwatersheds encompassing Oakland.

Table 6.1: Hydrologic Unit Codes for Oakland's Sub-watersheds

HUC4	HUC8	14-Digit Hydrologic Unit Code (HUC14)	Sub-watershed Name
0203	02030103	02030103 100050	Ramapo River (Crystal Lake Bridge to Bear Swamp Brook)
0203	02030103	02030103 100060	Crystal Lake/Pond Brook
0203	02030103	02030103 100070	Ramapo River (below Crystal Lake Bridge)
Source: NJDEP NJGS, February 25, 2011			

River and Stream Descriptions

Ramapo River

The Ramapo River begins in a mountainous area of Orange County, New York. It crosses into New Jersey into Mahwah Township and continues to flow southwestward through the center of the Borough of Oakland (see **Figure 6b**). The Ramapo River flows into and out of Potash Lake in the southwestern area of Oakland. Upon exiting Oakland, the river enters Pompton Lake, where the lake and then the continuation of the Ramapo River form the border between Pompton Lakes Borough and Wayne Township. Approximately three miles south of Oakland, the Ramapo River joins the Pequannock River. Below this confluence, it becomes the Pompton River. The Pompton River, after flowing for approximately 8 miles, is a tributary of the Passaic River in Fairfield Township (Wikipedia, Accessed August 1, 2013).

Tributaries of the Ramapo River

All of the waters within Oakland drain to the Ramapo River. Some of these tributaries are unnamed. Pond Brook originates in Franklin Lakes Borough, to the east, and flows into Crystal Lake before joining the Ramapo River. Little Pond Brook is south of Pond Brook, and joins the Ramapo downstream of Potash Lake. Arising in Wanaque Borough, to the west of Oakland, Ramapo Lake Brook drains from Ramapo Lake and other tributaries, mostly from within Ramapo Mountain State Forest, intersecting with the Ramapo River near I-287 and Skyline Drive.

[28] The HUC14s have a minimum size of 3,000 acres, although some basins are defined with smaller areas. At other times, small subwatershed units are combined.

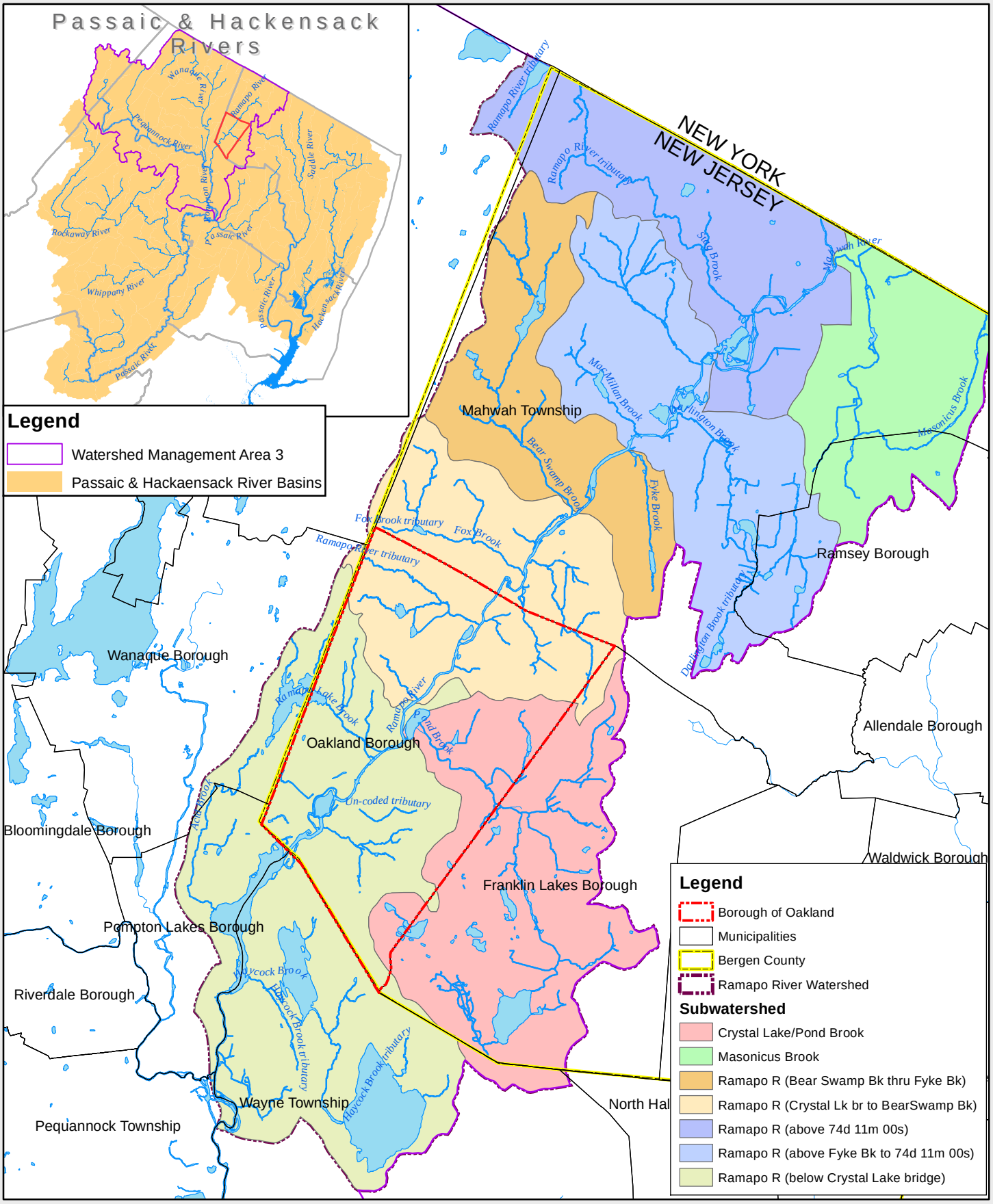

Figure 6a: Watersheds and Subwatersheds

0 0.5 1 2 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

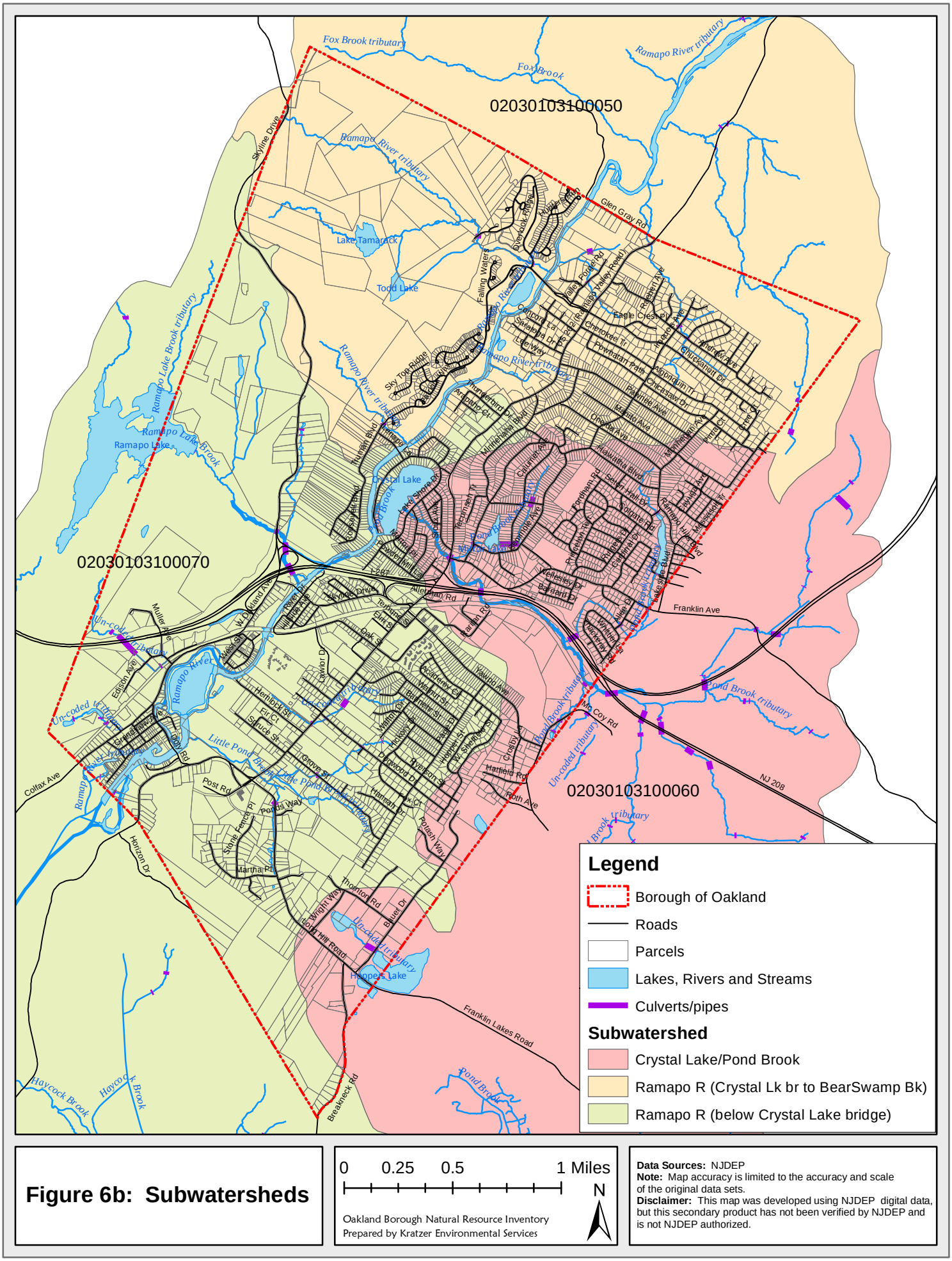

Figure 6b: Subwatersheds

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

B. Floodplains & Floods

Floodplains

A *floodplain* is the land along a river or stream that is subject to periodic flooding when the river or stream overflows its banks. As required by the Flood Disaster Protection Act of 1973, the Federal Emergency Management Administration (FEMA) is responsible for delineating floodplains.

According to FEMA, "Everyone lives in some type of flood zone." FEMA defines these geographic areas based on studies of flood risk.

FEMA publishes *Flood Insurance Rate Maps* (FIRMs) that show the flood zone boundaries. FIRMs are the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). Changes to the flood risk information may only be performed by FEMA. The digital FIRM (DFIRM) which are shown in **Figure 6c** are produced by FEMA in conjunction with the hardcopy FIRMs and generally matches the hardcopy map exactly. However, the hardcopy flood maps and flood profiles are the authoritative documents for the NFIP.

Special Flood Hazard Areas (SFHAs) are defined as areas subject to inundation by a flood having, on average, about 1 in 100 chance in any given year, also referred to as the 1% annual chance flood[29] (FEMA, 1996). Below are brief definitions of the FEMA flood zones that occur within Oakland.

Areas in *Zone X*, which includes the majority of Oakland, have low to moderate risk of flooding and are not in the SFHAs. They correspond to areas outside the 1% annual chance floodplain, areas of 1% annual chance sheet flow[30] flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding or where the contributing drainage area is less than 1 square mile. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in this zone (FEMA, 2013).

Zones with a high-risk of flooding, or SFHAs, include *Zone A* and *Zone AE*. *Zone A* corresponds to the 1% annual chance floodplains that are determined by approximate methods of analysis (i.e., not with Base Flood Elevations). *Zone AE* corresponds to the 1% annual chance floodplains that are determined by detailed methods of analysis, which includes detailed hydraulic analyses to determine Base Flood Elevations. In communities such as Oakland that participate in the NFIP, all homeowners in Zones A and AE are required to get flood insurance in order to get a loan from a federally regulated lender. These areas have a 26% chance of flooding over the life of a 30-year mortgage (FEMA, 2009).

Areas with a 0.2% annual chance of flooding (typically referred to as the 500 year flood) are not considered high risk, but are susceptible to periodic flooded.

Flood Facts

- Floods and flash floods happen in all 50 states.
- Hurricanes, winter storms and snowmelt are common (but often overlooked) causes of flooding.
- New land development can increase flood risk, especially if the construction changes natural runoff paths.
- Federal disaster assistance is usually a loan that must be paid back with interest.
- If you live in a Special Flood Hazard Area (SFHA) or high-risk area and have a Federally backed mortgage, your mortgage lender requires you to have flood insurance (FEMA, July 24, 2013).

[29] Flood designations are based on statistical averages, not the number of years between big floods. The term "100-year flood" does not mean a flood that happens once every 100 years. It is a statistical designation that there is a 1 in 100 chance that a flood of any given size will be equaled or exceeded during any year. Changes and variability in climate and land use over time can change flood frequency (Dinicola, 2005).

[30] Sheet flow, or overland flow, is flow that occurs overland in places where there are no defined channels, so the flood water spreads out over a large area at a uniform depth.

Nancy Krause

Ramapo River downstream from Glen Gray Road. The flood plain provides vital protection downstream when seasonal flood cause the river to swell beyond its banks.

Floodplains in Oakland are shown in **Figure 6c**, based on FEMA determinations (as of September 30, 2005, the most recent GIS data available). Frequent flooding occurs in areas adjacent to the Ramapo River, where the 1% annual chance floodplain varies from about 300 feet at its narrowest, near Arapaho Court, to its widest near Potash lake, where the floodplain is about 2,300 feet wide near Hemlock Street and Riverside Drive. The floodplain of Pond Brook, about 50 to 300 feet wide, extends from its outlet at Crystal Lake to Oakland's eastern border. The floodplain of Little Pond Brook extends about a mile from its confluence with the Ramapo River and is approximately 150 feet wide. Several other flood hazard areas exist on unnamed tributaries.

Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. Community involvement is an important element in making flood insurance available to home and business owners. These measures may include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances. Riparian buffer and wetlands protection regulations and ordinances can also reduce flood damage by protecting those areas most susceptible to flooding and providing natural flood control. These efforts benefit downstream areas, as well.

Oakland adopted a Flood Damage Prevention ordinance (Chapter XIV of the Borough Code) (Oakland, NJ, 2013). Another example of floodplain management is the borough's buyout of property in the floodplain at Ramapo Terrace (Block 2516 lot 1).

Ramapo River Floods

The flow of the Ramapo River is measured continuously both upstream (Ramapo, NY, Suffern, NY, and Mahwah, NJ) and downstream (at Pompton Lakes Dam and Pompton Lakes), of Oakland Borough. The station on the Ramapo River at Mahwah is over 4 miles north of Oakland, and is a good predictor of the flow of the Ramapo within Oakland. The Pompton Lakes site is not a good indicator, because the water level is affected by the dam. The flow level at Mahwah (and many other NJ sites) is reported in real-time at the National Weather Service Advanced Hydrologic Prediction Website (see **Internet Resources**). Flood stage at this location is 8 feet (2,260 cfs (cubic feet per second)), moderate flooding occurs between 9 and 12 feet (3,900 to 10,300 cfs), and a major flood is one greater than 12 feet stage (10,300 cfs). The Ramapo River has experienced 5 major floods, 31 moderate floods, and 19 minor floods since record keeping began in 1902.

The worst flood on record for this location was on August 28, 2011, due to tropical storm Irene, when crest stage reached 15.77 feet, or 15,000 cfs (see **Table 6.2**). 2011 was also notable for having so many floods – one major flood, 5 moderate floods and two minor floods. In contrast, the Ramapo River experienced only one minor flood in 2012 and no floods to date (August) in 2013.

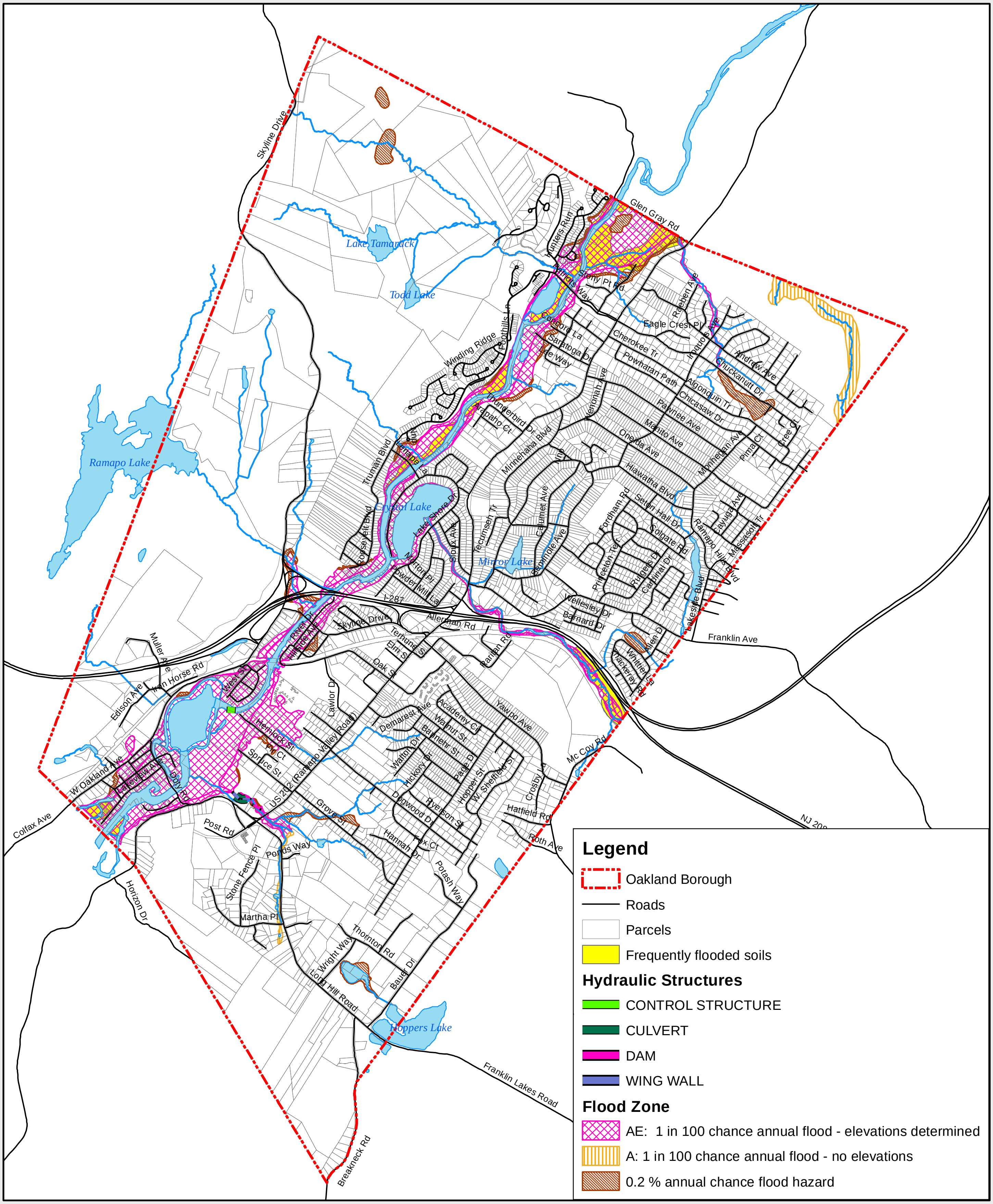

Figure 6c: Flood Zones FEMA Digital Flood Insurance Rate Map (9/30/2005)

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

Data Sources: NJDEP
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Table 6.2: Floods on the Ramapo River near Mahwah

Major Flood Crests (in order of highest gage height first)					
Rank*	**Gage Height (feet)**	**Flow (CFS)**	**Severity**	**Date**	**Tropical Storm?**
1	15.77	15,000	Major	8/28/2011	Irene
2	13.35	12,100	Major	4/5/1984	
3	12.53	10,900	Major	10/16/1955	
4	12.52	11,000	Major	9/16/1999	Floyd
5	12.44	11,800	Major	11/8/1977	
6	11.9	10,200	Moderate	3/14/2010	
7	11.87	8,770	Moderate	5/29/1968	
8	11.35	8,580	Moderate	8/19/1955	Connie & Diane
9	11.16	8,680	Moderate	3/7/2011	
10	11	12,400**	Moderate	10/9/1903	Tropical cyclone
Most Recent Flood Crests (in order of most recent first)					
Rank*	**Gage Height (feet)**	**Flow (CFS)**	**Severity**	**Date**	**Tropical Storm?**
45	NA	3.030[P]	Minor	12/21/2012	
26	9.54	4,970	Moderate	9/8/2011	Lee
1	15.77	15,000	Major	8/28/2011	Irene
41	8.74	3,550	Minor	6/23/2011	
25	9.55	5,040	Moderate	4/17/2011	
13	10.72	7,670	Moderate	3/11/2011	
9	11.16	8,680	Moderate	3/7/2011	
6	11.9	10,200	Moderate	3/14/2010	
54	8.07	3,090	Minor	12/12/2008	
11	10.99	8,870	Moderate	4/16/2007	

*Rank refers to the relative severity of each flood, i.e. Rank 1 is the highest flood crest on record (1902 - present).
**Discharge affected by dam failure; gage in different location.
[P] Provisional data subject to revision.

Sources: NOAA Hydrologic Prediction Service, July 2013; USGS, August 2013a; USGS 2013; Schwartz, 2013.

C. Wetlands

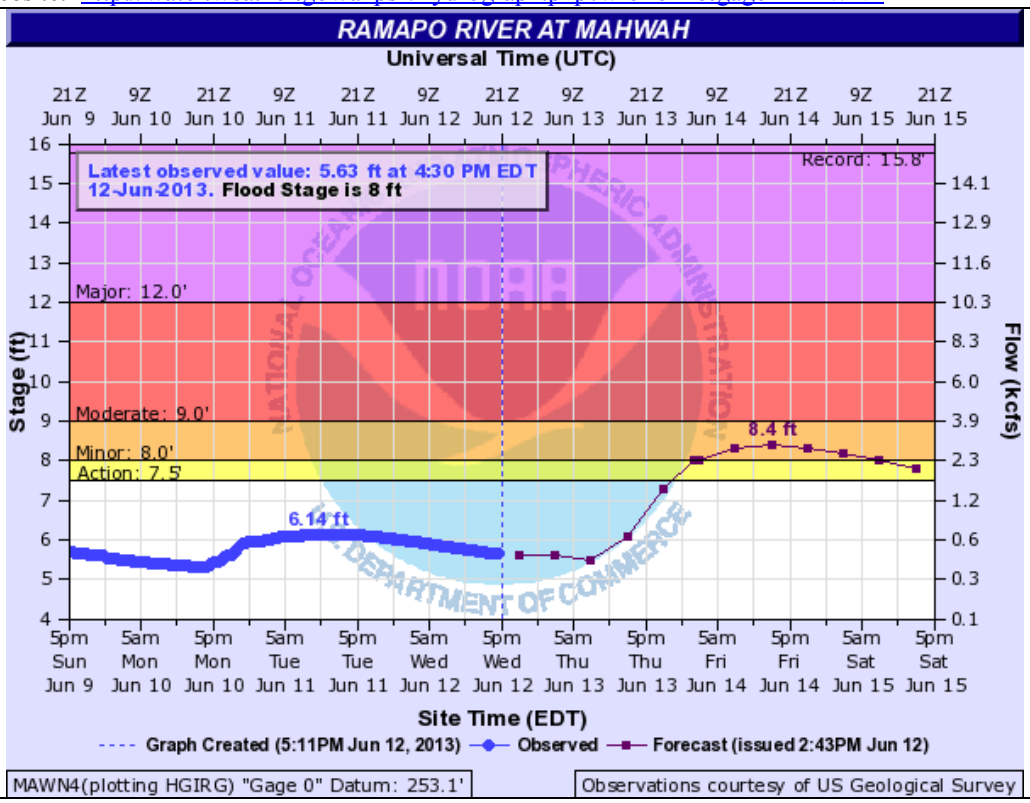
A *wetland* is a transitional area between aquatic and terrestrial ecosystems. Wetlands are those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation. To determine if an area is a wetland, the vegetation (plants that like wet conditions), soils (wetland types, which often show mottling) and hydrology (low spots or evidence of water) are evaluated. A *transition area*, or buffer, is an area of land adjacent to a freshwater wetland that minimizes adverse impacts on the wetland or serves as an integral component of the wetlands ecosystem (N.J.S.A. 13:9B-3 in NJDEP Division of Land Use Management, July 16, 1998).

In the past, wetlands were often regarded as wastelands – only useful when drained and filled. In contrast, a 1978 Tufts University study showed that one acre of wetland provides at least $153,000 (1978 dollars) of public value, considering proven monetary benefits of flood protection, pollution reduction, water supply, recreation and aesthetics (Fair, 2004). Some of the benefits of wetlands include:

Table 6.3: Ramapo River Flood and Flow Resources

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions)

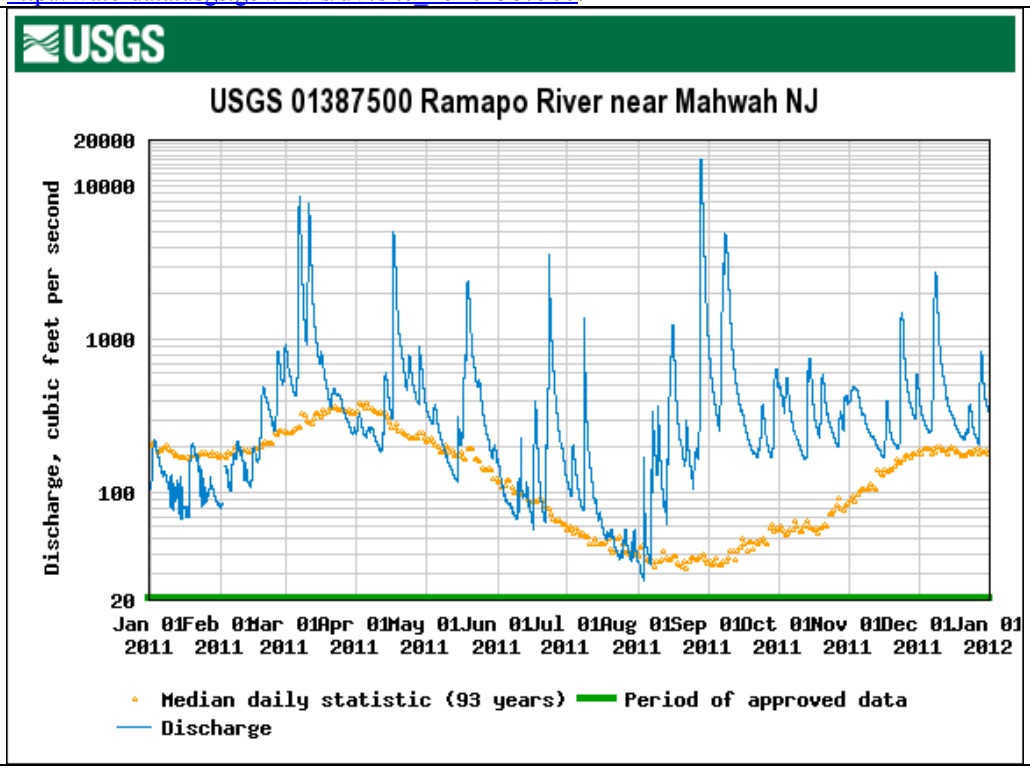
In this example, a flood was predicted to begin at 11pm on June 13, 2013, (although the river didn't flood in this case). Website: http://water.weather.gov/ahps2/hydrograph.php?wfo=okx&gage=MAWN4



USGS National Water Information System Data

By default, the site displays the most recent flow information. In this example, the Ramapo River flow for the year 2011 is shown to illustrate the numerous floods (over 2,260 cfs) that occurred that year.

Website: http://waterdata.usgs.gov/nwis/uv?site_no=01387500.



- Wetlands protect drinking water by filtering out pollutants and sediments that would otherwise obstruct and contaminate our waters.
- Wetlands soak up runoff from heavy rains and snow melts, providing natural flood control.
- Wetlands release stored waters during droughts.
- Wetlands provide critical habitats for a major proportion of the state's fish and wildlife, including many endangered, commercial and recreational species.
- Wetlands provide high quality open space for recreation and tourism (NJDEP Land Use Regulation, 2013 and July 16, 1998).

Deborah J. Kratzer

Buttonbush (Cephalanthus occidentalis) is an obligate Wetland species found in Oakland.

The value of wetlands was not broadly accepted until at least the 1970s and 1980s. By then, more than half of the country's wetlands had been destroyed (NJDEP Land Use Regulation, 2013). Loss of wetlands has resulted in erosion, flooding, sedimentation, and decreased populations of many types of wildlife. Structures built in wetlands suffer from frost heaving and other structural problems.

New Jersey protects wetlands under the 1987 New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9B) and Rules (N.J.A.C. 7:7A) (NJDEP Division of Land Use Management, July 16, 1998 and December 7, 2009). Under these, NJDEP regulates virtually all activities proposed within wetlands and transition areas or buffers around freshwater wetlands, including cutting of vegetation, dredging, excavation or removal of soil, drainage or disturbance of the water level, and filling or discharge of any materials. Development that would impair the wetland's ability to provide the values listed above (filtration, flood control, etc.) is prohibited. There are limited exemptions for existing farming, ranching, or forestry operations.

On-site inspection (direct testing and observation of soils, hydrology and vegetation) by a qualified professional is needed prior to making any disturbance within a wetland or transition area. Only an official determination from NJDEP, called a *Letter of Interpretation* (LOI) can verify the presence, absence, or boundaries of freshwater wetlands and transition areas on a site. Copies of these maps are filed at the NJDEP and the township building, but unfortunately, NJDEP does not digitize these determinations into a GIS layer[31].

In addition to defining the boundary of the wetland, the LOI establishes the value of the wetland, which will determine the width of the regulated transition area. *Ordinary Value* wetlands, such as man-made drainage ditches and swales, have a 0 foot buffer. *Intermediate Value* wetlands have a 50 foot buffer, which includes those wetlands not included in the definitions of Ordinary or Exceptional value. *Exceptional Value* wetlands have a 150 foot buffer width. Exceptional Value wetlands include wetlands that provide habitat for endangered and

[31] Digitizing involves giving latitude and longitude coordinates to areas and lines to depict mapped features.

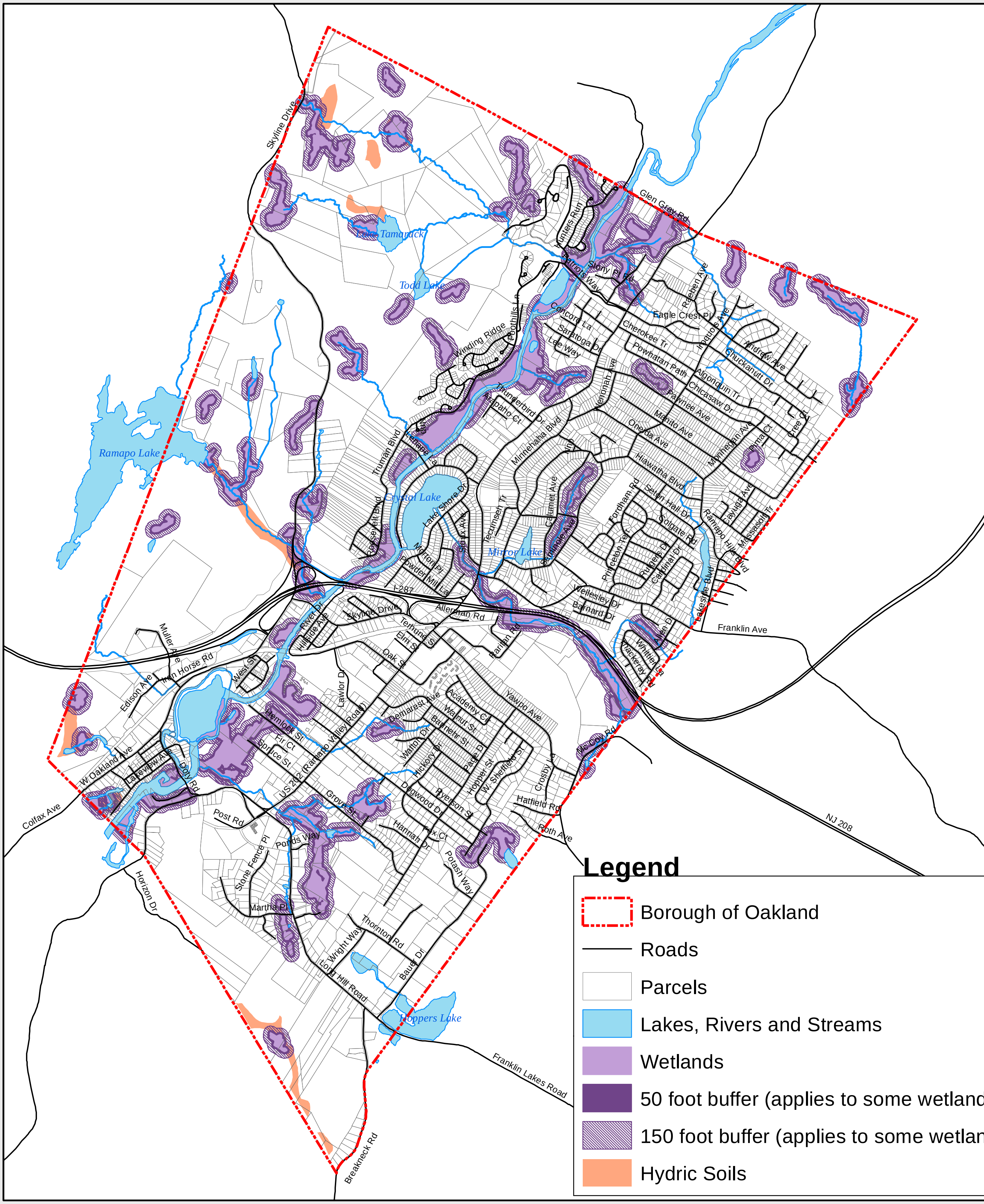


Figure 6d: Wetlands

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

threatened species and those contiguous with FW-1, FW-2 Trout Production waters and their tributaries, and Category 1 classified streams (see **Section 6D** for descriptions of stream classifications, below). A determination of threatened and endangered species habitat is provided by using the Landscape Project data (see **Section 7E**).

The wetlands shown in **Figure 6d** were determined by selecting all wetlands land use types from NJDEP's 2007 Land Use GIS data. **Figure 6d** provides guidance on where wetlands are found in Oakland. This dataset is intended to serve as a resource for analysis rather than regulatory delineations because it is derived from aerial photos rather than on-site surveys. The transition area widths of 0, 50 and 150 feet are mapped in **Figure 6d**, because the GIS data does not determine the value of each wetland. The actual transition area width required by the NJDEP is determined in the LOI.

There are approximately 219 acres of wetlands within Oakland, or 4% of the borough (NJDEP, July 12, 2010). There are several types of freshwater wetlands in Oakland, such as deciduous wooded wetlands, deciduous scrub/shrub wetlands, and managed wetland in built-up recreation area (see **Section 7A** and **Figure 7d**).

D. Surface Water Quality Standards

Surface Water Quality Standards (SWQS) are the rules in chapter N.J.A.C. 7:9B that set forth designated uses, use classifications, and water quality criteria for the State's waters based upon the uses, and the NJDEP's policies concerning these uses, classifications and criteria, which are necessary to protect the State's waters. The SWQS operate in conformance with the Federal Water Pollution Control Act (33 U.S.C. 1313(c)), commonly known as the Clean Water Act (CWA), and the Federal Water Quality Standards Regulation at 40 CFR 131.

According to the Surface Water Quality Standards N.J.A.C. 7:9B,

> "Water is vital to life and comprises an invaluable natural resource which is not to be abused by any segment of the State's population or economy. It is the policy of the State to restore, maintain and enhance the chemical, physical and biological integrity of its waters, to protect the public health, to safeguard the aquatic biota, protect scenic and ecological values, and to enhance the domestic, municipal, recreational, industrial, agricultural and other reasonable uses of the State's waters.
>
> "The restoration, maintenance and preservation of the quality of the waters of the State for the protection and preservation of public water supplies is a paramount interest of the citizens of New Jersey.... Toxic substances in waters of the State shall not be at levels that are toxic to humans or the aquatic biota, or that bioaccumulate in the aquatic biota so as to render them unfit for human consumption.... Human health-based ambient criteria have been established in freshwaters due to consumption of fish and water, and in saline water due to consumption of fish. For carcinogens, the criteria have been established at levels which would result in no greater than a one-in-one-million lifetime excess cancer risk. For non-carcinogens, the criteria have been established which would result in no appreciable risk of deleterious effect." (NJDEP Land Use Management, Water Monitoring and Standards, April 4, 2011).

According to the designated uses under the SWQS, NJDEP assigns *surface water classifications* to each stream in order to group waters and assign water quality criteria. Designated uses include potable water, propagation of fish and wildlife, recreation, agricultural and industrial supplies, and navigation. The *criteria* are numerical targets for constituent concentrations (such as toxic pollutants) or narratives that describe in-stream conditions to be attained, maintained or avoided, so that the specified uses are protected for the different use classifications.

The SWQS are used by several NJDEP programs, including the New Jersey Pollutant Discharge Elimination System program, Site Remediation program, Stream Encroachment, Land Use Regulation Program and Total Maximum Daily Loads (TMDLs, see **Section 6E**).

Table 6.4 describes the definitions of the surface water classifications. In **Figure 6e**, "category" is shown, which is a compendium of all surface water classification designations for a given water body. Category describes a stream's surface water classification in terms of its general surface water class (e.g. FW2), its trout water status (e.g. TP) and its antidegradation status (e.g. C1). The surface waters within Oakland are categorized as follows (as defined by N.J.A.C. 7:9B(f)(April 4, 2011)):

- **FW2-NT(C1):**
  - **RAMAPO RIVER** from the confluence with Fox Brook (in Mahwah Township, roughly ½ mile north of Oakland) to Patriots Way Bridge (about ½ mile south of the Mahwah/Oakland border), plus the lengths of two unnamed tributaries which join the Ramapo River from the east.
  - **RAMAPO LAKE** and all outlet streams and tributaries within the boundaries of Ramapo Mountain State Forest. Part of the lake and some tributaries are within neighboring Wanaque Borough. Segments of some of the streams are on private property, and are therefore FW2-NT (i.e. not C1).
- **FW2-TP(C1):**
  - **TRIBUTARY** (Oakland) - Entire length. This tributary originates in the Ramapo Mountain State Forest and joins the Ramapo River from the west just upstream of Patriots Way Bridge. It includes Lake Tamarack and Lake Todd; however, Lake Tamarack is designated FW2-NT.
  - **LITTLE POND BROOK** (Oakland) - Entire length. This stream is in the southeastern portion of the borough and joins the Ramapo River downstream of Potash Lake.
- **FW2-NT:**
  - **POND BROOK** (Oakland) - Entire length. This brook begins in Franklin Lakes Borough and crosses into Oakland near I-287. As it flows westward, two unnamed tributaries join it from the north. It empties into Crystal Lake, which flows into the Ramapo River.
  - **RAMAPO RIVER** downstream (south) of the Patriots Way Bridge.

The *Category One (C1)* antidegradation designation provides streams with additional protections that help prevent water quality degradation and discourage development where it would impair or destroy natural resources and water quality. Waterways can be designated C1 because of exceptional ecological significance, exceptional water supply significance, exceptional recreational significance, exceptional shellfish resource, or exceptional fisheries resource ((NJDEP Water Monitoring and Standards, June 21, 2010).

The antidegradation provisions of the SWQS are triggered when an applicant proposes an activity that has the potential to lower water quality. Previously approved wastewater discharges authorized through the NJPDES program as well as existing developments are not subject to the antidegradation policies unless a new or expanded activity is proposed. Under the Stormwater Management rules (N.J.A.C. 7:8) and the Flood Hazard Area Control Act rules (N.J.A.C. 7:13), for certain activities proposed adjacent to waters designated as C1, 300 foot buffers must be maintained in a natural state adjacent to all C1 waters and upstream tributaries of C1 waters (including named and unnamed tributaries), unless the disturbance is less than one acre and new impervious surface is less than 0.25 acres. However, where the buffer is already disturbed, the

width may be reduced in the disturbed area, but will not be permitted to extend less than 150 feet from either bank. The buffer will not affect existing development. The buffer requirement can also be adjusted to reflect local conditions through the approval of a stream corridor protection plan as part of a regional stormwater management plan (NJDEP Water Monitoring and Standards, June 21, 2010).

Table 6.4: Surface Water Quality Standards Classification

Category	Definition
Freshwater General Surface Water Class	
FW1	**FW1** means those fresh waters, as designated in N.J.A.C. 7:9B-1.15(j), that are to be maintained in their natural state of quality (set aside for posterity) and not subjected to any man-made wastewater discharges or increases in runoff from anthropogenic activities. These waters are set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s).
FW2	**FW2** means the general surface water classification applied to those fresh waters that are not designated as FW1 or Pinelands Waters. In all FW2 waters the designated uses are: 1. Maintenance, migration and propagation of the natural and established biota; 2. Primary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment (a series of processes including filtration, flocculation, coagulation, and sedimentation, resulting in substantial particulate removal but no consistent removal of chemical constituents) and disinfection; and 5. Any other reasonable uses.
Trout Water Status - this is for information only and does not affect the water quality criteria for those waters.	
TP	***Trout production*** means waters designated at N.J.A.C. 7:9B-1.15I through (i) for use by trout for spawning or nursery purposes during their first summer.
TM	***Trout maintenance*** means waters designated at N.J.A.C. 7:9B-1.15I through (i) for the support of trout throughout the year.
NT	***Nontrout waters*** means fresh waters that have not been designated in N.J.A.C. 7:9B-1.15I through (h) as trout production or trout maintenance. These waters are generally not suitable for trout because of their physical, chemical, or biological characteristics, but are suitable for a wide variety of other fish species.
Antidegradation	
ONRW	***Outstanding National Resource Waters*** means high quality waters that constitute an outstanding national resource (for example, waters of National/State Parks and Wildlife Refuges and waters of exceptional recreational or ecological significance). Waters classified as FW1 waters and Pinelands waters are Outstanding National Resource Waters.
FW1/Non-degrada-tion	***Nondegradation waters*** means those waters set aside for posterity because of their clarity, color, scenic setting, other characteristic of aesthetic value, unique ecological significance, exceptional recreational significance, or exceptional water supply significance. These waters include all waters designated as FW1.
C1	***Category one waters*** means those waters designated in the tables in N.J.A.C. 7:9B-1.15(c) through (i), for purposes of implementing the antidegradation policies set forth at N.J.A.C. 7:9B-1.5(d), for protection from measurable changes in water quality based on exceptional ecological significance, exceptional recreational significance, exceptional water supply significance or exceptional fisheries resource(s) to protect their aesthetic value (color, clarity, scenic setting) and ecological integrity (habitat, water quality and biological functions).
C2	***Category two waters*** means those waters not designated as Outstanding National Resource Waters or Category One at N.J.A.C. 7:9B-1.15 for purposes of implementing the antidegradation policies set forth at N.J.A.C. 7:9B-1.5(d).
Source: NJDEP Land Use Management, Water Monitoring and Standards, April 4, 2011	

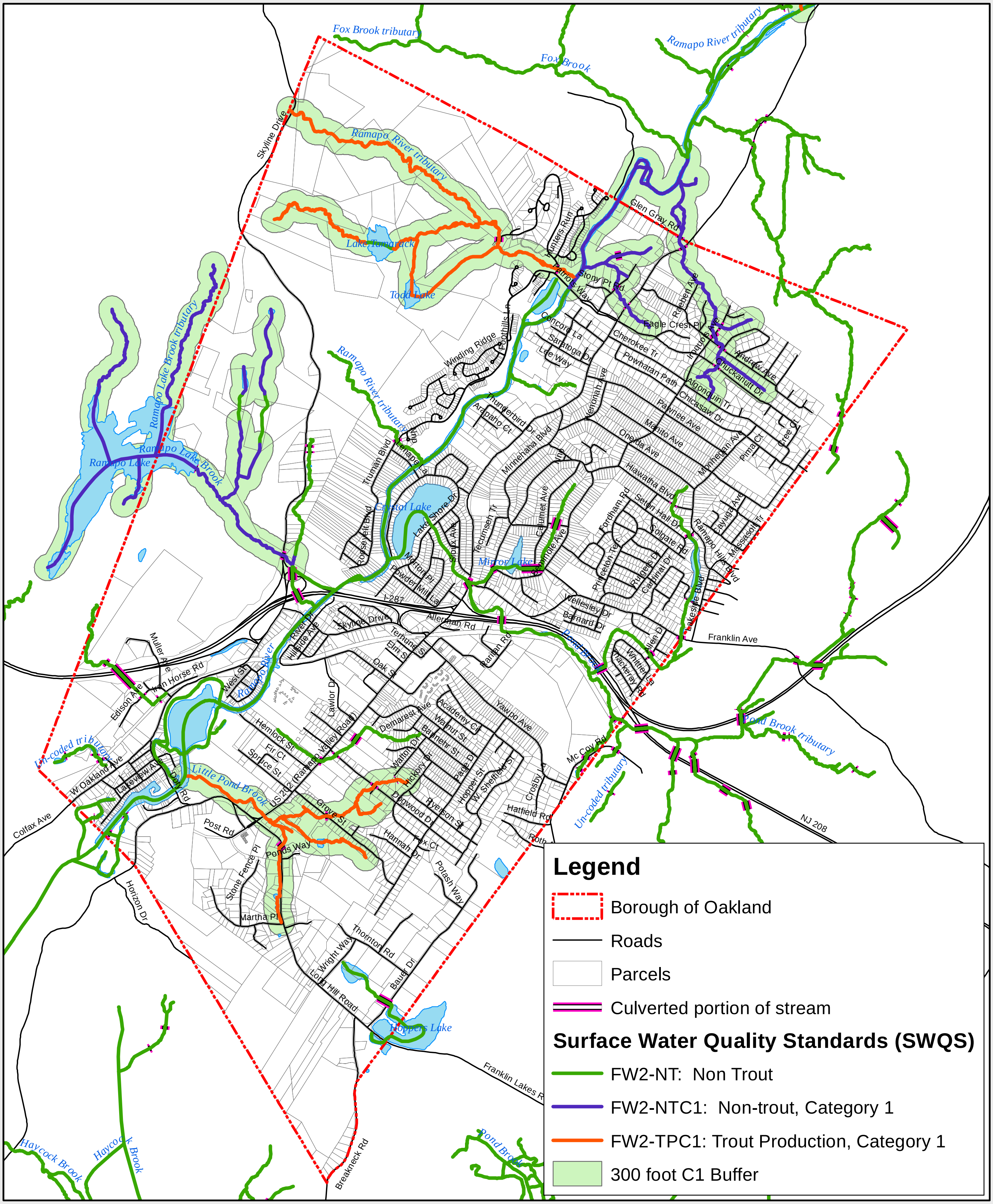


Figure 6e: Surface Water Quality Standards (SWQS)

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Most of the state's Category One waters were designated in 1985 amendments to the SWQS, however no specific basis for these upgrades was documented. C1 upgrades after that were documented, based on their value as trout production (FW2-TP) waters or exceptional ecological significance or exceptional water supply significance.

In 2008, NJDEP upgraded the portion of the Ramapo River from its confluence with Fox Brook (in Mahwah Township) to the Patriots Way Bridge (in Oakland Borough), including all unnamed and unlisted tributaries to this segment (which are mostly in Oakland) to C1 based on exceptional ecological significance. This stretch of the Ramapo River is home to two State Threatened mussels, the Eastern Lampmussel *(Lampsilis radiate)* and Triangle Floater (*Alasmidonta undulate)*, and one Special Concern mussel, the Creeper *(Strophitus undulates)* (see **Internet Resources** for a link to species descriptions). Freshwater mussels have a low tolerance for water pollution, and are therefore excellent indicators of water quality and overall stream health. For this reason, they are among the most rapidly declining groups of species in the country (NJDEP Land Use Management, Water Monitoring and Standards, May 21, 2007 and May 2008).

E. Integrated List and Total Maximum Daily Loads

States are required by the Federal Clean Water Act (US Federal Water Pollution Control Act, January 4, 2011) to develop a biennial Water Quality Inventory Report (required under Section 305(b) of the act) and a List of Water Quality Limited Segments (required under Section 303(d)). Since 2001, the USEPA has recommended that states integrate these two, producing the *Integrated List.* The goal is to provide an effective tool for maintaining high quality waters where designated uses (designated by the SWQS, discussed above in **Section 6D**) are attained, and improving the quality of surface waters that do not attain their designated uses (NJDEP Water Monitoring and Standards, July 2012a).

The Integrated List is subject to regulatory requirements, which include public participation and submission to the USEPA for approval and adoption. The Integrated List identifies the status of all applicable designated uses for every assessment unit (usually by HUC14[32] sub-watershed) by labeling the results of each designated use assessment as *Fully Supporting, Not Supporting*, or *Insufficient Information* (see **Table 6.5**).

The NJDEP is required to use all existing and readily available data to assess water quality for the Integrated List. As a result, assessment of the HUC14s that encompass Oakland may include sites in Mahwah, Pompton Lakes and Wayne, in addition to Oakland (see **Section 6H** for site information). A methods document summarizes each step in the assessment process; to evaluate stations and data quality, combine stations to evaluate an assessment unit, assess designated uses, rank and prioritize assessment units that do not attain designated uses, develop a monitoring and assessment plan and provide for public participation (NJDEP Water Monitoring and Standards, July 2012d).

The 2012 Integrated List, which summarizes whether or not the surface water quality of Oakland's three sub-watersheds meet the SWQS, is shown in **Table 6.5** and **Figure 6f**. The water quality supports the uses of industrial and public water supply, but does not support aquatic life (general), while there is insufficient data in at least one of the sub-watersheds for agricultural water supply, trout and fish consumption. **Table 6.6** displays more information about the impaired waters within Oakland.

[32] HUC14 = 14-digit Hydrologic Unit Code (see Section 6a for description)

Table 6.5: 2012 Integrated List (Overview)

Assessment Unit (HUC14)	Sub-watershed	Designated Use★						
		Agricultural Water Supply	Aquatic Life General	Aquatic Life Trout	Fish Consumption	Industrial Water Supply	Primary Contact Recreation	Public Drinking Water Supply
02030103100050	Ramapo River (Crystal Lake Bridge to Bear Swamp Brook) Freshwater Lake: 12.69 ACRES River: 21.42 MILES	F	N	N	I	F	N	F
02030103100060	Crystal Lake/Pond Brook Freshwater Lake: 178.73 ACRES River: 20.7 MILES	I	N	I	N	F	N	F
02030103100070	Ramapo River (below Crystal Lake Bridge) Freshwater Lake: 432.9 ACRES River: 25.71 MILES	F	N	N	N	F	F	F

★**Designated Uses:** F = Fully Supporting; N = Not Supporting; I = Insufficient Information

Minimum Suite of Parameters Needed to Determine if Water Quality is "Fully Supporting" a Use:

Agricultural Water Supply: Total Dissolved Solids (TDS)
Aquatic Life – General: Biological data
Aquatic Life – Trout: Biological data, Temperature and Dissolved Oxygen (DO)
Fish Consumption: Fish tissue data
Industrial Water Supply: Total Suspended Solids (TSS) and pH
Primary Contact Recreation: Pathogenic Indicator Bacteria
Public Drinking Water Supply: Nitrate and Total Dissolved Solids (TDS)

Source: NJDEP Water Monitoring and Standards, May 2012; July 2, 2012a; and July 2012d.

When surface waters do not meet the SWQS, *Total Maximum Daily Loads* (TMDLs) must be developed, as specified under Section 303(d) of the Federal Clean Water Act (US Federal Water Pollution Control Act, January 4, 2011). A TMDL identifies all the contributors to surface water quality impacts and sets goals for load[33] reductions for specific pollutants in order to meet the SWQS. Regulations concerning TMDLs are contained in EPA's Water Quality Planning and Management Regulations (USEPA, June 4, 2013).

TMDLs represent the assimilative capacity of surface water for a given parameter of concern. The development of TMDLs includes balancing the impacts from point sources, nonpoint sources and natural background levels of a specific pollutant. The TMDL then quantifies the amount of a pollutant a water body can assimilate without violating a state's water quality standards and allocates that load capacity to known point and nonpoint sources in the form of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, plus a margin of safety (MOS). Load allocations (for nonpoint source pollution) consist of identifying categories of nonpoint sources that contribute to the parameters of concern, followed by recommendations for implementation measures for specific load reductions. Examples include best management practices (BMPs), including structural (stormwater runoff controls) and non-structural (local ordinances for stormwater management and nonpoint source pollution control) mechanisms for addressing the water quality parameter(s) of concern (NJDEP Division of Watershed Management, July 30, 2013).

[33] Load is the total amount of material (pollutants) entering the system from one or multiple sources; measured as a rate in weight per unit time (USEPA, June 4, 2013).

Table 6.6: Integrated Water Quality Assessment (Details)

Use	Attain-ment	Cause	First on 303(d) List	TMDL Priority*	Source
NJ02030103100050-01: Ramapo River (Crystal Lake Bridge to Bear Swamp Brook)					
Aquatic Life	N	Cause Unknown	2006	Pollution Completed	• Urban Runoff/ Storm Sewers
Aquatic Life - Trout	N	Phosphorus (Total)	2006	Pollution Completed	
Fish Consumption	I				
Primary Contact Recreation	N	Fecal Coliform	2008	Completed	
NJ02030103100060-01: Crystal Lake/Pond Brook					
Agricultural Water Supply	I				• Industrial Point Source Discharge • Package Plant or Other Permitted Small Flows Discharges • Urban Runoff/Storm Sewers • Atmospheric Deposition - Toxics
Aquatic Life	N	pH Phosphorus (Total)	2010 2006	Medium Completed	
Aquatic Life - Trout	I				
Fish Consumption	N	Mercury in Fish Tissue	2008	Completed / Low	
Primary Contact Recreation	N	Fecal Coliform	2008	Completed	
NJ02030103100070-01: Ramapo River (below Crystal Lake bridge)					
Aquatic Life	N	Oxygen, Dissolved pH	2006 2006	Medium Medium	• Industrial Point Source Discharge • Municipal Point Source Discharges • Package Plant or Other Permitted Small Flows Discharges • Agriculture • Urban Runoff/Storm Sewers • Source Unknown
Aquatic Life - Trout	N	Oxygen, Dissolved pH	2006 2006	Medium Medium	
Fish Consumption	N	Chlordane in Fish Tissue DDD DDE DDT Mercury in Fish Tissue PCB in Fish Tissue	2008 2008 2008 2008 2010 2010	Low Low Low Low Medium Low	

*Designated Uses: N = Not Supporting; I = Insufficient Information
*Medium priority = NJDEP expects to complete TMDL in the near future, but not within the next two years.
Low priority = NJDEP does not expect to complete TMDL in the immediate or near future.

Source: NJDEP Water Monitoring and Standards, July 2, 2012a

Waters requiring TMDLs are identified in the Integrated List of Waterbodies that combines the 303(d) list of impaired waters and the surface water quality inventory report (305b), which NJDEP prepares every two years. After the Integrated List is approved, the NJDEP writes a TMDL report, which is a proposed Water Quality Management Plan Amendment. When this is published in the NJ Register for public review and comment, the TMDL is considered *proposed*. NJDEP then considers comments received during public comment and finalizes the TMDL report, and the TMDL is considered *established* when it is formally submitted to the US EPA Region 2 for thirty-day review. The TMDL is considered *approved* when the US EPA Region 2 approves it. Next, the TMDL is referred to as *adopted* when the EPA-approved TMDL is adopted by NJDEP as a water quality management plan amendment and the adoption notice is published in the NJ Register (NJDEP Division of Watershed Management, July 30, 2013).

In order to develop a TMDL to address the high phosphorus in Pompton Lake and the Ramapo River, a study was undertaken to assess the water quality, quantify sources of

phosphorus, determine relationships between phosphorus loads and in-lake phosphorus concentrations, and identify gaps in data (Quantitative Environmental Analysis, LLC, July 5, 2005).

Excessive phosphorus concentrations in surface water can lead to eutrophication – the excessive growth of algae and/or macrophytes. The normal daily fluctuations in pH and dissolved oxygen due to plant respiration become amplified, which can result in violation of criteria for pH and dissolved oxygen, and can adversely affect the aquatic community (such as macroinvertebrates and fish). In addition, dense plant biomass can physically interfere with designated uses, such as swimming or boating. Algal blooms can also affect taste and odor, which are significant to drinking water quality standards, as well as recreation. As stated in N.J.A.C. 7:9B-1.14(c) of the SWQS for Fresh Water 2 (FW2) waters, the criteria for Total Phosphorus is 0.05 mg/l in any lake, pond or reservoir, and 0.1 mg/l in any stream (NJDEP Division of Watershed Management, April 24, 2008).

Based on this study and others, a TMDL was adopted in 2008 to address phosphorus impairments in the Pompton Lake drainage area. Achievement of the SWQS will require a 76% reduction in phosphorus load coming from New York, and a 68% reduction within New Jersey. Actions will include water quality trading, measures restricting the application of phosphorus fertilizer, riparian restoration, and others (NJDEP Division of Watershed Management, April 24, 2008).

No other TMDLs for Oakland's three sub-watersheds are scheduled for completion, at least in the next two years (NJDEP Water Monitoring and Standards, July 2012c).

States may remove an assessment unit/pollutant combination from the Integrated List under specific situations, in a process commonly referred to as *delisting*. The 2012 Integrated List delisted mercury in fish tissue in 12 assessment units, including Crystal Lake/Pond Brook. The justification for this delisting is that the source of mercury is primarily atmospheric deposition, and these 12 sub-watersheds were added to an existing USEPA approved Statewide Mercury TMDL (NJDEP Water Monitoring and Standards, July 2012b; July 2012d). Implementation of the TMDL for mercury reduction is being achieved through the actions identified in the New Jersey Mercury Task Force Report. In recent years, New Jersey has substantially reduced mercury through regional and site-specific efforts (USEPA, September 14, 2011; NJDEP Office of Science, November 1, 2010).

F. Point Source Pollution

Point source pollution (as defined by N.J.A.C. 7:9B Surface Water Quality Standards) refers to discernible, confined, and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture (NJDEP Land Use Management, Water Monitoring and Standards, April 4, 2011).

NJPDES

Point source discharges are regulated by NJDEP under the New Jersey Pollutant Discharge Elimination System (NJPDES). There are 6 existing discharges within Oakland, and 4 revoked/terminated discharges within the Borough (see **Table 6.7** and **Figure 6g**) (NJDEP, Division of Water Quality, Bureau of Surface Water Permitting. November 16, 2011).

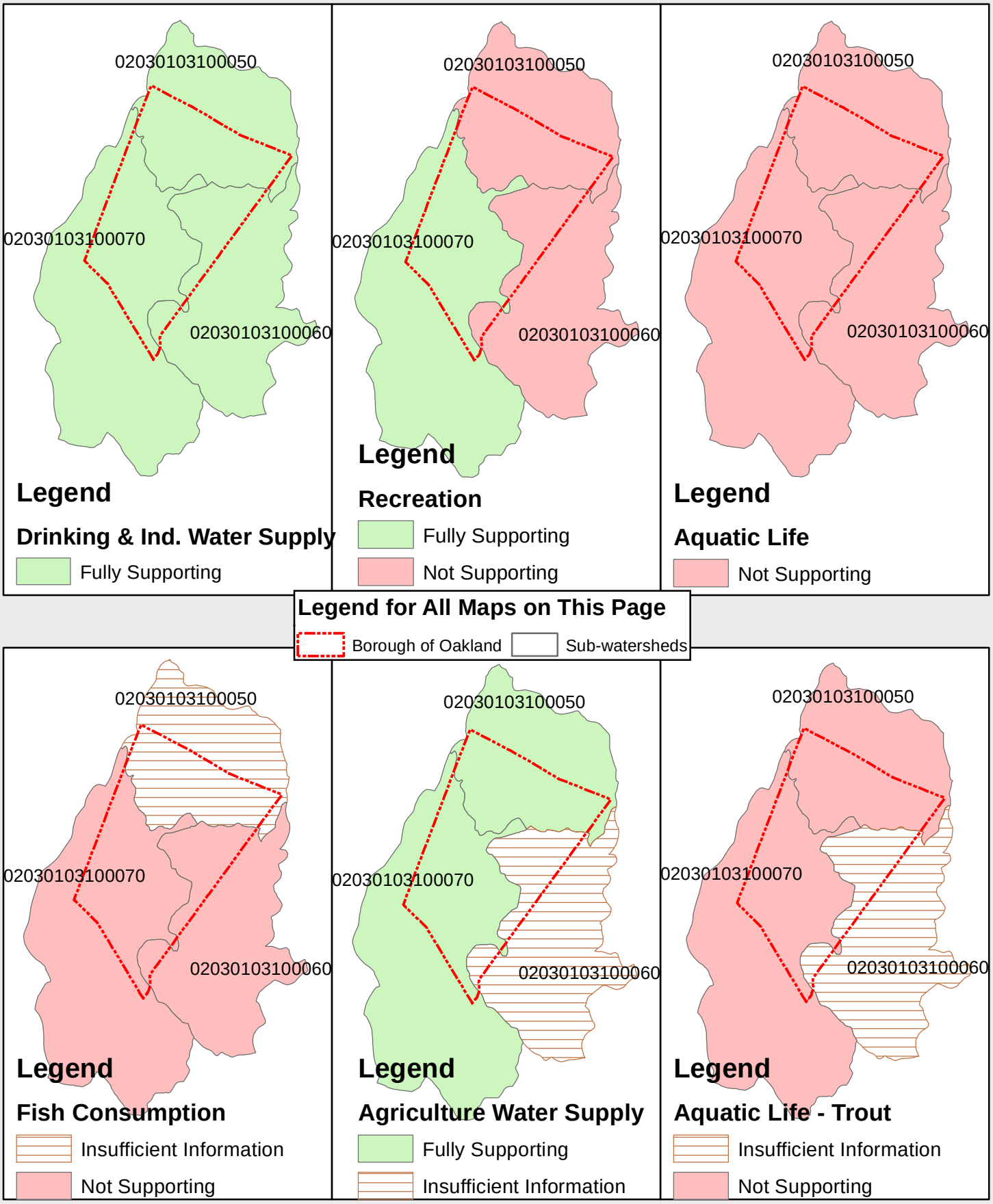


Figure 6f: Integrated List

0 1 2 4 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Table 6.7: NJ Pollutant Discharge Elimination System Surface Water Discharges

Map ID	NJPDES ID. # PI #	Facility Name	Status*	Discharge Type*	Receiving Waters	Comments
5	NJ0021253.001A PI # 46824	Ramapo-Indian Hills BOE 97 Yawpo Ave	E	MMI	Pond Brook (Ramapo River)	
7	NJ0021342.001A PI # 46717	Oakland Borough Skyview-Highbrook STP Lakeside Blvd	E	MMI	Caille Lk via unnamed trib & storm sewer	
4	NJ0027774.001A PI # 46718	Oakland Borough - Oakwood Knolls 101 East Oak Street	E	MMI	Ramapo R via Oak St storm sewer	
0	NJ0029858.001A PI # 46652	Oakland Care Center 20 Breakneck Road	E	MMI	Hoppers Pond via storm sewer	
8	NJ0030384.001A	Oakland BOE - Manito Avenue	R	MMI	Caille Lake via unnamed trib and storm sewer	
9	NJ0030384.001V	Oakland BOE - Manito Avene	R	MMI	Caille Lake via unnamed trib and storm sewer	
1	NJ0050661.001A	Witco Corporation	R	IMI	Hopper's Lake (Ramapo River)	
10	NJ0053112.001A PI # 46719	Oakland Borough - Chapel Hill Estates Hiawatha Blvd & Mountain Lakes Road	E	MMI	Ramapo River via Mirror Lk and storm sewer	At Mountain Lakes Road
2	NJ0080811.001A PI # 47178	Ramapo River Reserve WWTP 27 Waters Edge	E	MMI	Ramapo River	At discharge to Ramapo River
3	NJG0114642.001A	S & S Auto Recyclers	X	RF	Acid Brook via storm sewer	
6	NJG0132101.001A	Vinyl Building Products	R	CG	Ramapo River via storm sewer	Discharges to a holding lake

***Notes for Above Codes** (NJDEP's codes and definitions were used):
Status: **E**=Existing in the Point Source Permitting Regions; **R**=Revoked/Terminated - Pipe no longer permitted for discharge; **X**= Transferred to BNPC - Permits transferred to Bureau of Nonpoint Pollution Control
Discharge type: **CG**= Non-contact Cooling Water; **MMI=** Municipal Minor - publicly owned sewage treatment plants which discharge less than 1 MGD; **IMI**= Industrial Minor - based on the amount of pollutant(s) in the effluent; **RF**=Stormwater Discharge

Source: NJDEP, Environmental Regulation, Division of Water Quality, November 16, 2011

Aquatic Pesticides

The NJDEP Pesticide Control Program is responsible for issuing permits for aquatic pesticide use for the control of aquatic weeds throughout the state. The purpose of this database is to determine trends in aquatic pesticide use. Three of Oakland's waterbodies are in the database: Crystal Lake (treated with copper sulfate), Hubers Lake (treated with copper sulfate and diquat dibromide) and a private waterbody near Lee Way (also treated with copper sulfate and diquat dibromide) (see **Figure 6g**) (NJDEP, C&E, BPO, October 2009).

G. Nonpoint Source Pollution

Nonpoint source or NPS pollution is any man-made or man-induced activity, factor, or condition, other than a point source, from which pollutants are or may be discharged. Nonpoint pollution may temporarily or permanently change any chemical, physical, biological, or radiological characteristic of water from what was or is the natural, pristine condition of such water.

Impervious surfaces are materials that prevent the infiltration of water into the soil (e.g. parking lots, roads, buildings, sidewalks and compacted soil). The construction of impervious surfaces disrupts the natural water cycle, and is one of the more significant landscape impacts attributable to urbanization (Hasse and Lathrop, 2008). When water flows off impervious surfaces, it is known as *stormwater*. Nonpoint source pollution is directly associated with stormwater.

An increase in impervious surface results in less water infiltrating to the soil and groundwater, which instead runs off the surface and gains velocity. As the velocity of water increases, the amount that can infiltrate into the soil and ground water is reduced and scouring and erosion increase. The stormwater eventually discharges into streams and rivers, carrying pollutants that it has picked up along the way (e.g. trash, used motor oil, sediments, fertilizers, pesticides, pet droppings, etc.). The transport of these pollutants into local water bodies can result in the destruction of fish, wildlife, and habitats; threats to public health due to contaminated food and drinking water supplies; and losses of recreational and aesthetic values. In addition, increased stormwater results in greater frequency and magnitude of floods (Hasse and Lathrop, 2008; Kaplan and Ayers, 2000).

Studies have shown that the level where impacts begin to be seen is above 10% impervious surfaces, and that impacts become severe over 25 to 30% (Kaplan and Ayers, 2000).

NJDEP determined approximate percent impervious surface based on particular land uses. Because so much of the borough is forested, 58% of Oakland has less than 10% impervious surface; 15% of the borough has between 10 and 25% impervious surface, and 27% of the borough has greater than 25% impervious surfaces (see **Figure 6h)** (NJDEP, July 12, 2010).

The goals of New Jersey's Stormwater Management Rule (N.J.A.C. 7:8) include reducing runoff, flooding, erosion and non-point pollution for public safety as well as ecological and biological integrity. There are requirements for stormwater management measures and regional and municipal stormwater management planning (NJDEP, April 2010).

The purpose of the Municipal Stormwater Regulation Program is to ensure a consistent approach to stormwater management statewide, reduce costs for regulated entities, and allow for a simple process for requesting authorization. All municipalities within the State are assigned either Tier A (more developed or coastal municipalities, including Oakland) or Tier B (less developed and non-coastal) (NJDEP Bureau of Nonpoint Pollution Control, December 2006).

The permits address stormwater quality related issues to new and existing development and redevelopment by requiring the preparation of a stormwater program and implementation of specific permit requirements referred to as Statewide Basic Requirements (SBRs). The Tier B Permit concentrates on new development and redevelopment projects and public education. The Tier A Permit has additional requirements aimed at controlling stormwater pollutants from existing development, such as public education, disposal of waste, solids and floatable controls, maintenance yard operations and employee training (NJDEP Bureau of Nonpoint Pollution Control, April 2004).

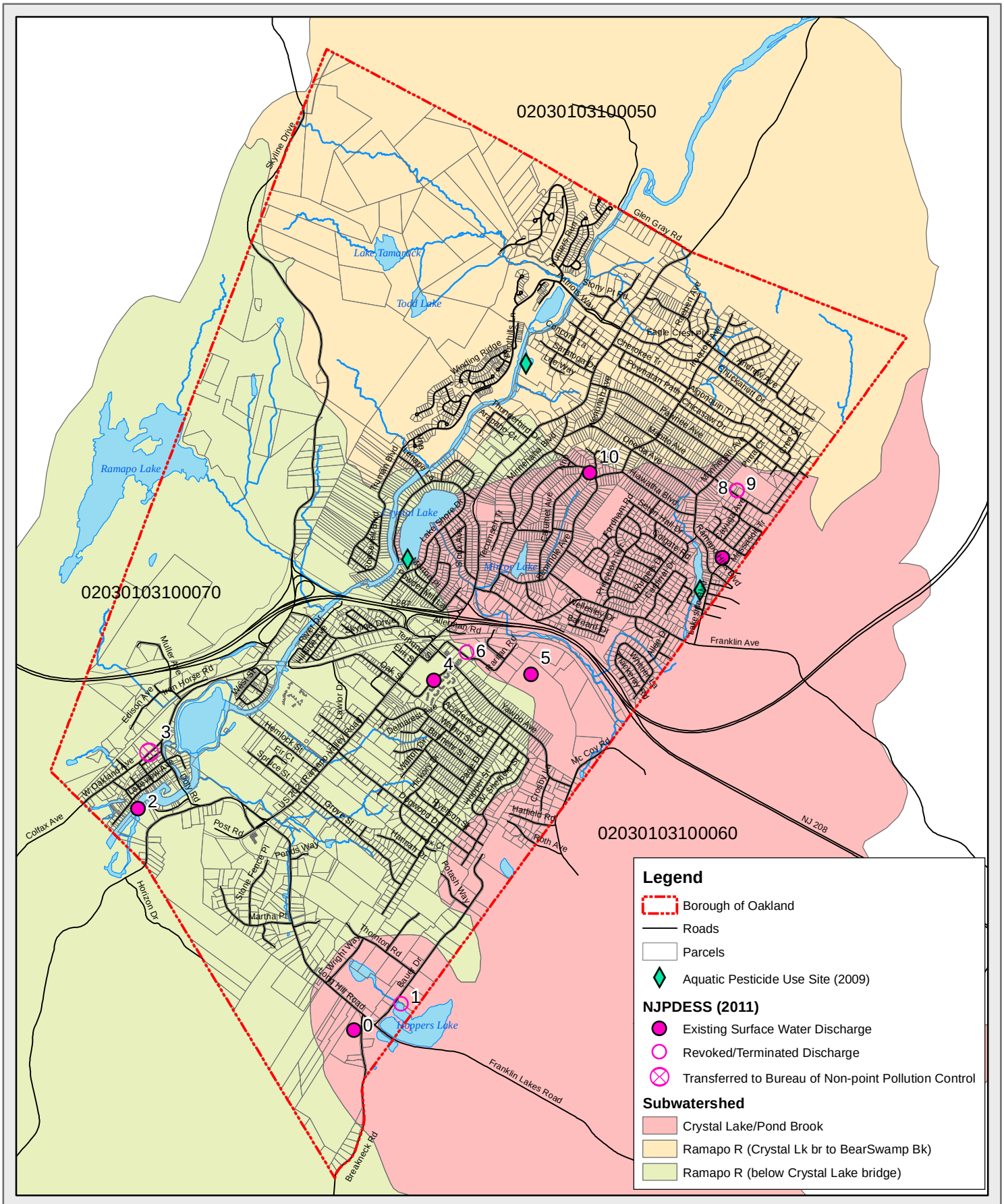


Figure 6g: Surface Water Discharges

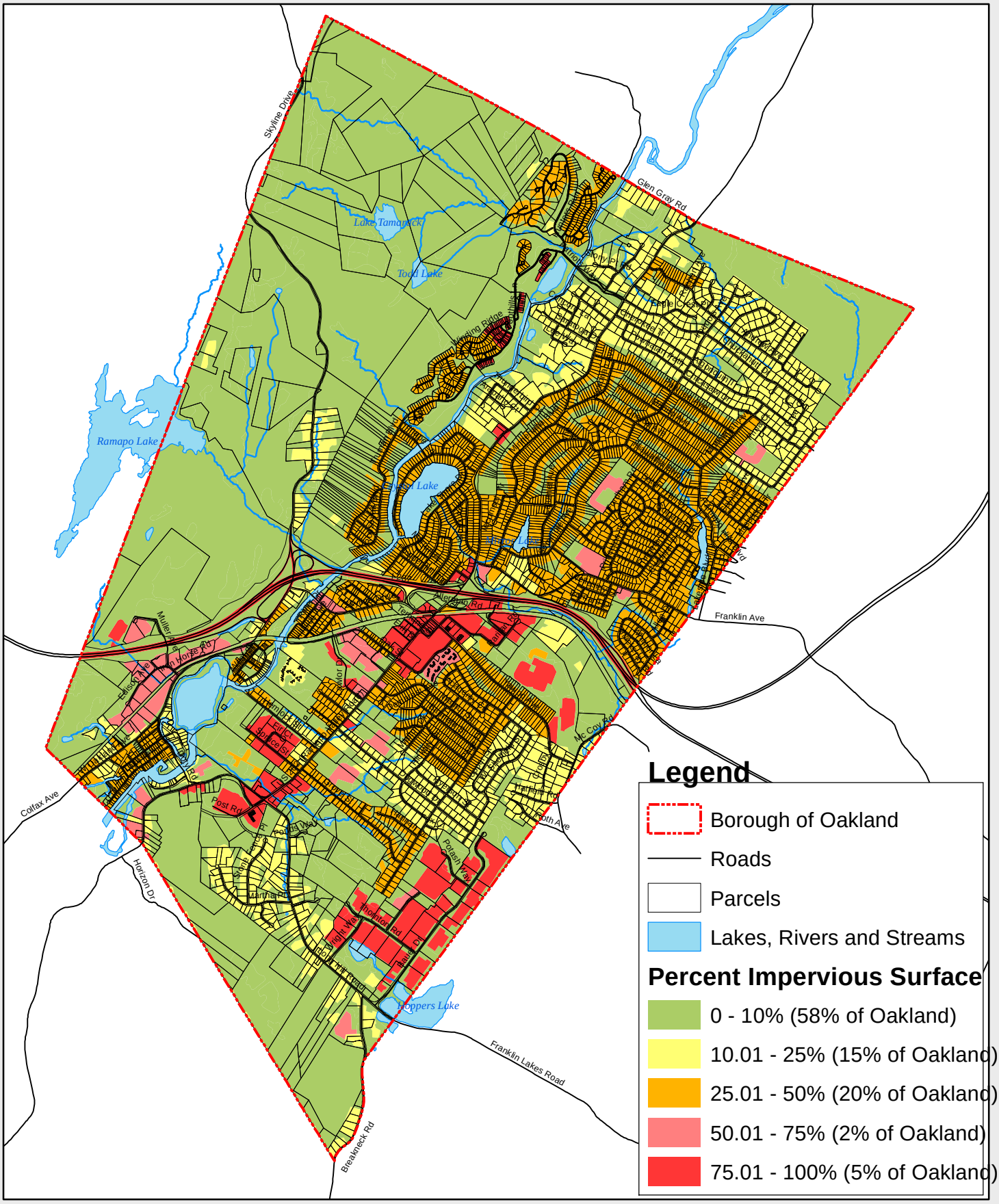


Figure 6h: Percent Impervious Surface (from 2007 Land Use)

0 0.25 0.5 1 Miles

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Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Chapter XX of the Oakland Borough Code addresses stormwater management (see **Internet Resources**).

H. Surface Water Quality and Flow Monitoring

The various water quality and flow monitoring programs in the region are discussed below. A list of the sites sampled for each program is provided in **Table 6.8** and shown on **Figure 6i**. Sites located outside of Oakland (but upstream) are included because of the usefulness of knowing the water quality and stream flow entering the borough. Downstream sites are also useful, as they may be indicative of water quality exiting the borough.

NJDEP Ambient Stream Quality Monitoring Sites for New Jersey (SWpoints)

These data represent ambient stream sites monitored cooperatively by the NJDEP and the USGS for water quality parameters. This network was established in 1976 to determine status and trends of ambient surface waters in New Jersey. The sampling frequency is four times per year. A wide range of conventional parameters, metals, pesticides and sediments are monitored in this program. Metals, pesticides and sediments are monitored on a reduced sampling frequency. Data is available from the following sources: 1.) the USGS computerized data system, NWIS, and 2.) USGS's annual reports "Water Resources Data-New Jersey". The Ramapo River is sampled in Oakland at upstream near Mahwah (NJDEP, November 20, 2008).

NJDEP Existing Water Quality Stations in New Jersey (EWQPOI)

These data represent sampling points for the EWQ (Existing Water Quality) project at NJDEP. The EWQ Network was designed to provide supplemental data for water quality for the entire state to support water management and monitoring activities within NJDEP, and to be a valuable layer for computerized cartographic products. One location in this sampling network is located on the Ramapo River in Pompton Plains, downstream of Oakland (NJDEP, October 19, 2007).

NJDEP Ambient Biomonitoring Network (AMNET) (Biopts)

Sites are sampled for benthic aquatic macroinvertebrate using the Rapid Bioassessment Protocol in order to make assessments at three levels of impairment; non-impaired, moderately impaired, and severely impaired. Sites are sampled every 5 years. The data is used as a primary environmental indicator of water quality impairment for New Jersey's Environmental Performance Partnership Agreement (NEPPS) with USEPA. There is one monitoring site within Oakland, the Ramapo River at Lenape Lane; and there is one downstream of the borough on the Ramapo River at West Ramapo Avenue (NJDEP, November 2010). AMNET is described in more detail below, and results are summarized in **Table 6.9**.

Fish Index of Biotic Integrity Stations (FIBI)

The Fish Index of Biotic Integrity supplements the macroinvertebrate biomonitoring network by assessing the biological health of a stream based on resident fish populations. Like AMNET, sites are sampled once every 5 years. One site is located within Oakland, on the Ramapo River. Two sites are upstream of Oakland in Mahwah, one on the Ramapo River and one on the Mahwah Brook (NJDEP, December 15, 2010). FIBI is described in more detail below, and results are summarized in **Table 6.10**.

NJDEP/USGS Surface WQ Gage (WQgage)

This network is jointly funded by USGS and NJDEP. USGS maintains a network of gages across NJ at which surface water quality is measured. As project needs and funding levels change, different sites may be active in any given year. The data measured at the active sites are published annually as part of the USGS' series of annual water-data reports. While no sites are located within the Borough, one station is on the Ramapo River near Mahwah and 2 stations are downstream, on the Ramapo River in Pompton Plains and Wayne (USGS, April 17, 2002a).

USGS Continuous-Stream Flow Gaging (Streamgage)

These sites are maintained by the United States Geological Survey (USGS), Water Resource Division (WRD). One station in Oakland on the Ramapo River is located downstream of Pond Brook. The gage continuously monitors stream flow and these data are available online in real-time (see **Internet Resources**). One upstream and one downstream are located near Mahwah and at Pompton Lakes, respectively (USGS, April 17, 2002b).

USGS Stream Crest Gaging (Creststage)

USGS measures gage height (relative height of water level; not actual flow volume) occasionally at these sites. There is one USGS Stream Crest Gage located in Oakland, which is on Pond Brook (USGS, April 17, 2002c).

USGS Stream Low Flow Gaging (Lowflow)

USGS measures gage height (relative height of water level; not actual flow volume) occasionally at these sites. There is one active site located on Masonicus Brook in Mahwah Township. The remaining 8 sites shown are currently inactive (USGS, April 17, 2002d).

STORET Stations

Data collected by some sampling programs and from certain sites are input into EPA's national water quality database. These sites are indicated by an asterisk in **Table 6.8** and by an orange circle on **Figure 6i**. It is possible that data from other sites might be available, even if not noted here.

Macroinvertebrate Data (AMNET) (Biopts)

Macroinvertebrates are larger-than-microscopic fauna, which are found in freshwater and estuarine environments, and are an essential part of the aquatic food web. These include insects (primarily immature forms), worms, mollusks (snails, clams) and crustaceans (scuds, shrimp, crayfish, etc.), most of which are bottom-dwelling (benthic). They are more easily collected and quantified than other biological indicators (fish or periphyton communities). Assessments of benthic macroinvertebrates provide a good indication of localized conditions of water quality. Due to the creatures' limited mobility, they are suitable for the evaluation of site-specific pollution impacts. Different species differ in their sensitivity to pollutants and environmental impacts from both point and non-point sources of pollution. Combined with relevant chemical/physical parameters, benthic macroinvertebrate communities can be used to identify sources of impairment (NJDEP BFBM, December 2012).

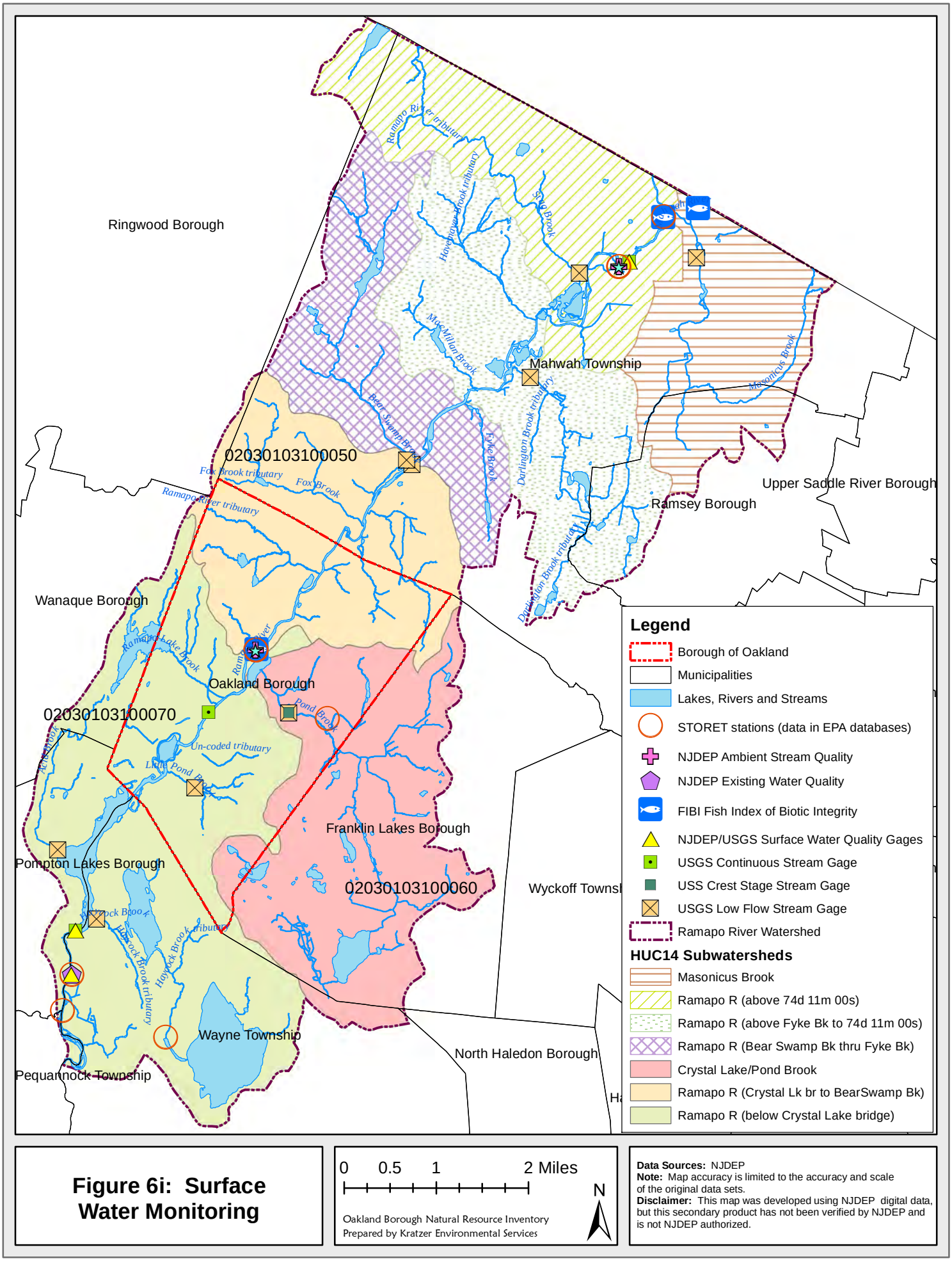

Figure 6i: Surface Water Monitoring

0 0.5 1 2 Miles

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Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Table 6.8: Surface Water Monitoring Stations

Program Name	Station ID	Name	Muni-cipality	Sub-watershed	Data Collected
Upstream sites, within Ramapo Watershed					
FIBI	FIBI076a	Mahwah Brook at Franklin Parkway	Mahwah Township	Masocnicus Brook	Fish Index of Biotic Integrity
FIBI	FIBI052*	Ramapo River at end of Catherine	Mahwah Township	Ramapo River (above 74d 11m 00s)	Fish Index of Biotic Integrity
LowFlow	1387490	Masonicus Brook at W. Mahwah NJ	Mahwah Township	Masocnicus Brook	Stream Flow
StreamGage & WQgages	1387500*	Ramapo River near Mahwah NJ	Mahwah Township	Ramapo River (above 74d 11m 00s)	Stream Flow (continuous) and water quality
LowFlow	1387700	Bear Swamp Brook near Oakland NJ	Mahwah Township	Ramapo River (Crystal Brook to Bear Swamp)	Stream Flow
LowFlow	1387670	Ramapo River near Darlington NJ	Mahwah Township	Ramapo River (Crystal Brook to Bear Swamp)	Stream Flow
SWpoints	01387500 (AN0266)*	Ramapo River near Mahwah	Mahwah Township	Ramapo River (above 74d 11m 00s)	Water Quality
Biopts	AN0266*	Ramapo River at W Ramapo Ave	Mahwah Township	Ramapo River (above 74d 11m 00s)	Habitat and Macroin-vertebrates
LowFlow	1387520	Stag Brook near Mahwah NJ	Mahwah Township	Ramapo River (above 74d 11m 00s)	Stream Flow
LowFlow	1387600	Darlington Brook near Darlington NJ	Mahwah Township	Ramapo River (above Fyke Bk to 74d 11m 00s)	Stream Flow
Sites in Oakland					
FIBI	FIBI006*	Ramapo River at Lenape Lane	Oakland Borough	Ramapo River (below Crystal Lake Bridge)	Fish Index of Biotic Integrity
Biopts	AN0267*	Ramapo River at Lenape Lane	Oakland Borough	Ramapo River (below Crystal Lake Bridge)	Habitat and Macroin-vertebrates
SWpoints	01387811 (AN0267)	Ramapo River at Oakland	Oakland Borough	Ramapo River (below Crystal Lake Bridge)	Water Quality
Storet	29072000 14*	Macopin River	Oakland Borough	Crystal Lake/Pond Brook	Water Quality
LowFlow	1387880	Pond Brook at Oakland, NJ	Oakland Borough	Crystal Lake/Pond Brook	Stream Flow
CrestStage	1387880	Pond Brook at Oakland, NJ	Oakland Borough	Crystal Lake/Pond Brook	Stream Flow
StreamGage	1387890	Ramapo River Downstream of Pond Brook at Oakland, NJ	Oakland Borough	Ramapo River (below Crystal Lake Bridge)	Stream Flow (continuous)

LowFlow	1387930	Ramapo River 5 at Oakland, NJ	Oakland Borough	Ramapo River (below Crystal Lake Bridge)	Stream Flow
Downstream sites, within Ramapo Watershed					
LowFlow	01387950	Acid Brook at Pompton Lakes NJ	Pompton Lakes Borough	Ramapo River (below Crystal Lake Bridge)	Stream Flow
LowFlow	01387980	Haycock Brook at Pompton Lakes NJ	Wayne Township	Ramapo River (below Crystal Lake Bridge)	Stream Flow
StreamGage & WQgages	01388000	Ramapo River at Pompton Lakes NJ	Pompton Lakes/ Wayne	Ramapo River (below Crystal Lake Bridge)	Stream Flow (continuous) and water quality
WQgages & EWQpoints	01388100 *	Ramapo River at Dawes Highway at Pompton NJ	Pompton Lakes/ Wayne	Ramapo River (below Crystal Lake Bridge)	water quality and stream flow
Drought5	2528*	Ramapo River at Pompton Lakes Municipal Utilities Authority	Pompton Lakes/ Wayne	Ramapo River (below Crystal Lake Bridge)	
Drought2	1149*	Haycock Brook at Tamarack Road	Wayne Township	Ramapo River (below Crystal Lake Bridge)	
Discontinued or inactive sites are shown in gray					
✳Data from these program sites are input into STORET, EPA's water quality database.					
Sources: NJDEP, November 20, 2008; October 19, 2007; November 2010; December 15, 2010; USGS, 2002a, 2002b, 2002c, 2002d					

The Ambient Biomonitoring Network (AMNET) is the NJDEP's ongoing macroinvertebrate monitoring program. From 1992 to 2004, the New Jersey Impairment Score (NJIS) was used to assign a rating of non-impaired, moderately impaired, or severely impaired. Beginning in 2004, an improved index has been used, which takes into account the different ecoregions in the state. The Highlands, Ridge and Valley and Piedmont regions (including Oakland) comprise the region using the *High Gradient Macroinvertebrate Index (HGMI)*. In addition, the HGMI uses genus-level instead of family level identification, which provide four assessment rating levels; excellent, good, fair and poor. NJDEP uses this information in assessing progress toward the goals of the Clean Water Act through the Integrated Water Quality Monitoring and Assessment Report (see **Section 6E**), and for designation of Category 1 waters, based on exceptional ecological significance (see **Section 6D**) (NJDEP BFBM, December 2012). Locations of monitoring sites are shown on **Figure 6i**, and results are shown in **Table 6.9**.

Fish Index of Biotic Integrity Stations (FIBI) Data

Fish are good indicators of long term water quality because they are relatively mobile and long-lived, compared to macroinvertebrates. The monitoring of stream fish communities is used in determining the *aquatic life use* support designations for the Integrated Water Quality Monitoring and Assessment Report (see **Section 6E**) (in terms of fisheries - coldwater, coolwater, warmwater, sport, forage) and direct evaluation of *fishability*. In New Jersey, Surface Water Quality Criteria (SWQS, see **Section 6D**) include descriptors such as *trout production, trout maintenance and non-trout* waterways (NJDEP BFBM, December 2000).

Table 6.9: Macroinvertebrate and Habitat Scores

Site ID	Site	Date of Sampling	Macroinvertebrate Rating NJIS or HGMI*	Habitat Analysis
The following site is in Oakland				
AN0267	Ramapo River at Lenape Lane, Oakland Borough	10/2/2008	HGMI: Fair (29.83)	Suboptimal (146)
		10/21/2003	NJIS: Nonimpaired (30)	Optimal (170)
		08/07/1998	NJIS: Nonimpaired (27)	Suboptimal (145)
		07/10/1990	NJIS: Moderately impaired (18)	-
The following sites are upstream of Oakland, in Mahwah Township				
AN0266	Ramapo River, end of West Ramapo Ave, Mahwah Twp	10/02/2008	HGMI: Poor (14.11)	Marginal (100)
		10/02/2003	NJIS: Nonimpaired (24)	Suboptimal (141)
		08/07/1998	NJIS: Nonimpaired (27)	Suboptimal (134)
		07/10/1990	NJIS: Moderately impaired (18)	-
AN0286	Ramsey Brook, Masonicus Rd, Mahwah Twp	11/13/2008	HGMI: Fair (30.67)	Suboptimal (154)
		07/10/2003	NJIS: Moderately impaired (18)	Optimal (179)
		08/14/1998	NJIS: Severely impaired (6)	Suboptimal (143)
		07/16/1990	NJIS: Severely impaired (6)	-

* Parameter:
HGMI (High Gradient Macroinvertebrate Index): **Excellent** 63 - 100 Full Attainment; **Good** <63-42 Full Attainment; **Fair** <42-21 Non-Attainment; **Poor** < 21 Non-Attainment

NJIS (New Jersey Impairment Score): A composite of 5 scores based on family level taxonomy. **N=Non-impaired**: score of 24 to 30; benthic community comparable to other undisturbed streams within the region; community characterized by a maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals. **M=Moderately Impaired**: score of 9 to 21; macroinvertebrate richness reduced, in particular, EPT taxa; reduced community balance and number of intolerant taxa. **S= Severely Impaired**: score of 0 to 9; benthic community drastically different from those in less impaired situations; macroinvertebrates dominated by few taxa, but with many individuals; only intolerant individuals present.

HABITAT SCORES: **OPTIMAL**= 160 – 200; **SUB-OPTIMAL**=110 – 159; **MARGINAL**= 60 – 109; **POOR**= < 60. Parameters evaluated included in-stream substrate, channel morphology, bank structural features, and riparian vegetation for the sample site and its immediate surroundings (usually 100-200 foot radius).

Source: NJDEP BFBM, December 2012, February 2008, June 2000, December 1994.

Table 6.10: Fish Index of Biotic Integrity (FIBI) and Habitat Scores

Site Code	Site Name	Parameter*	Date Sampled	
			Round 1	Round 2
The following site is in Oakland				
FIBI006	Ramapo River at Lenape Lane	FIBI	09/08/2000 Fair (36)	08/15/2005 Poor (28)
		Habitat	Optimal (161)	Sub-Optimal (135)
The following sites are upstream of Oakland, in Mahwah Township				
FIBI052	Ramapo River at end of Catherine	FIBI	08/22/2002 ★ Good (38)	08/28/2007 Fair (36)
		Habitat	Sub-Optimal (141)	Sub-Optimal (112)
FIBI076a	Mahwah Brook at Franklin Parkway	FIBI	-	07/21/2008 Poor (28)
		Habitat	-	Marginal (96)

* Parameter:
FIBI (Fish Index of Biotic Integrity): **Excellent**=45-50; **Good** =37-44; **Fair** =29-36; **Poor**=10-28

HABITAT SCORES: **OPTIMAL**= 160 – 200; **SUB-OPTIMAL**=110 – 159; **MARGINAL**= 60 – 109; **POOR**= < 60. Parameters evaluated included in-stream substrate, channel morphology, bank structural features, and riparian vegetation for the sample site and its immediate surroundings (usually 100-200 foot radius).

★ Round 1 data was scored prior to the FIBI metric recalibration.

Sources: NJDEP BFBM, December 2000, June 2003, January 2008, July 2009, October 2010

I. Fish Consumption Advisories

When toxic pollutants are present in surface water, they are consumed by the organisms that live in the water. The process of *bioaccumulation* is when there is an increase in concentration of certain fat-soluble chemicals, such as DDT and PCBs, in successively higher trophic levels of a food chain or web. For example, insects living in contaminated sediments may have accumulated a certain amount of a toxin. Fish, by eating many of these insects, then ingest the toxin into their own bodies. Anything that eats that contaminated fish, including humans and other predators, will absorb the toxin. When the concentration of toxin becomes high enough, the individual's health will be impacted.

The NJDEP samples fish for certain toxic pollutants and, when necessary, issues state and regional *fish consumption advisories*, to reduce exposure to dioxin, PCBs and mercury. This information is intended to help individuals make an informed choice on the number of meals of fish to consume. The 2013 fish consumption advisories for fish caught anywhere in the state are listed in **Table 6.11**. See the **Internet References** for more information, such as fish preparation guidelines and annual updates.

Table 6.11: 2013 Fish Consumption Advisories – Statewide Freshwaters

LOCATION	SPECIES	ADVISORY/PROHIBITION[1]	
		General Population Range of Recommended Meal Frequency	High-Risk Individuals [2]
		DO NOT EAT MORE THAN:	DO NOT EAT MORE THAN:
Ramapo River Lake at Oakland	Largemouth Bass	One meal per week	One meal per month
	Bluegill Sunfish	No restrictions	
Ramapo River at Pompton/Wayne	Largemouth Bass	One meal per week	Do Not Eat
	Smallmouth Bass	One meal per week	Do Not Eat
	Black Crappie	One meal per week	One meal per month
	Rock Bass	One meal per week	Do Not Eat
	Redbreast Sunfish	One meal per week	One meal per month
	Pumpkinseed Sunfish	One meal per week	Do Not Eat
	Yellow Bullhead	One meal per week	Do Not Eat
New Jersey Statewide – All water bodies except those listed separately	Freshwater species not listed below	One meal per week	One meal per month
	Trout - (Brown, Brook Rainbow and Hybrid)	One meal per week	One meal per week
	Largemouth bass	One meal per week	One meal per month
	Smallmouth Bass		
	Chain Pickerel		
	Yellow bullhead	No restrictions	One meal per month
	Sunfish [3]	No restrictions	One meal per month
	Brown Bullhead	No restrictions	One meal per week

[1] Eat only the fillet portions of the fish. Use proper trimming techniques to remove fat, and cooking methods that allow juices to drain from the fish (e.g., baking, broiling, frying, grilling, and steaming). See web site for full description. One meal is defined as an eight-ounce serving.
[2] High-risk individuals include infants, children, pregnant women, nursing mothers and women of childbearing age.
[3] Sunfish includes bluegill, pumpkinseed, and redbreast sunfish.

Source: NJDEP Division of Science and Research, May 2013 http://www.state.nj.us/dep/dsr/njmainfish.htm

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CHAPTER XX STORMWATER MANAGEMENT

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Internet Resources: Surface Water

General Water Resources Protection
Home*A*Syst: Evaluate your home and property for pollution and health risks (USDA):
https://prod.nrcs.usda.gov/wps/portal/nrcs/detail/nj/people/partners/?cid=nrcs141p2_018827

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

Basic Watershed Information (Watershed Restoration Section):
http://www.nj.gov/dep/watershedrestoration/info.html

The Clean Water Book: Choices for Watershed Protection:
http://www.nj.gov/dep/watershedrestoration/waterbook_tble.html

NJDEP Laws & Rules: http://www.nj.gov/dep/landuse/lawsregs.html

Water Quality Fact Sheets and Bulletins (NJ Agricultural Experiment Station Rutgers Cooperative Research & Extension): http://njaes.rutgers.edu/pubs/subcategory.asp?cat=6&sub=50&order=LastRevised

Floodplains & Floods
Flood Hazard Area Program (NJDEP Land Use Regulation) http://www.nj.gov/dep/landuse/fha_main.html

FloodSmart: The Official Site of the National Flood Insurance Program: http://www.floodsmart.gov

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions):
Ramapo River at Mahwah: http://water.weather.gov/ahps2/hydrograph.php?wfo=okx&gage=MAWN4
Ramapo River at Pompton Lakes: http://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=pptn4

National Weather Service Forecast Oakland, NJ: http://forecast.weather.gov/MapClick.php?lat=41.0322496&lon=-74.23554039999999&site=all&smap=1&searchresult=Oakland%2C%20NJ%2007436%2C%20USA

USGS Real-Time Stream Flow Stations:
Ramapo River near Mahwah: http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01387500&PARAmeter_cd=00065,00060
Ramapo River at Pompton Lakes: http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01388000&PARAmeter_cd=00065,00060

Wetlands
Freshwater Wetlands Program (NJDEP Land Use Regulation): http://www.nj.gov/dep/landuse/fww/fww_main.html

Freshwater Wetlands Program: Before You Buy – Before You Build: http://www.nj.gov/dep/landuse/bybob.html

SWQS
Category One Waters: http://www.nj.gov/dep/wms/bwqsa/c1waters.htm

Eastern Lampmussel: http://www.conservewildlifenj.org/species/fieldguide/view/Lampsilis%20radiata/

Triangle Floater: http://www.conservewildlifenj.org/species/fieldguide/view/Alasmidonta%20undulata/

Creeper: http://www.conservewildlifenj.org/species/fieldguide/view/Strophitus%20undulatus/

Integrated List & TMDL
NJDEP Integrated WQ monitoring and Assessment Report: http://www.state.nj.us/dep/wms/bwqsa/generalinfo.htm

NJDEP Total Maximum Daily Load (TMDL): http://www.nj.gov/dep/wms/bear/tmdls.html

USEPA Laws and Regulations: http://www2.epa.gov/laws-regulations

USEPA Watershed Assessment, Tracking & Environmental Results 2010 Waterbody Reports:
Crystal Lake/Pond Brook
Ramapo R (Below Crystal Lake Bridge)
Ramapo R (Crystal Lk Br To Bearswamp Bk)

Point Source Pollution
NJPDES Permitting: http://datamine2.state.nj.us/DEP_OPRA/OpraMain/categories?category=NJPDES%20Permitting

Non-Point Source Pollution / Stormwater:
NJDEP's Stormwater Website (includes links to all of the following, and more): http://www.njstormwater.org/
NJDEP Municipal Stormwater Regulation Program: http://www.state.nj.us/dep/dwq/msrp_home.htm
Stormwater Best Management Practices Manual: http://www.njstormwater.org/bmp_manual2.htm
Clean Water NJ: http://www.cleanwaternj.org/index.htm
Multimedia Resources: http://www.cleanwaternj.org/multimedia.html

Oakland, NJ Borough Code - Chapter XX Stormwater Management:
http://clerkshq.com/default.ashx?clientsite=oakland-nj

USEPA Nonpoint Source Pollution: http://water.epa.gov/polwaste/nps/index.cfm

Surface Water Quality and Flow
Benthic Macroinvertebrate Sampling: http://www.state.nj.us/dep/wms/bfbm/downloads.html

National Weather Service Advanced (NOAA) Hydrologic Prediction Service (flood predictions):
Ramapo River at Mahwah: http://water.weather.gov/ahps2/hydrograph.php?wfo=okx&gage=MAWN4

Ramapo River at Pompton Lakes: http://water.weather.gov/ahps2/hydrograph.php?wfo=phi&gage=pptn4

NJDEP Drought Information: http://www.nj.gov/dep/drought/status.html

USEPA STORET Database: http://www.epa.gov/storet

USGS Real-Time Stream Flow Stations:
01387500 Ramapo River near Mahwah: http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01387500&PARAmeter_cd=00065,00060
01388000 Ramapo River at Pompton Lakes: http://waterdata.usgs.gov/nj/nwis/uv/?site_no=01388000&PARAmeter_cd=00065,00060

USGS Real-time flow data index of NJ sites: http://waterdata.usgs.gov/nj/nwis/current/?type=flow

USGS Water Data Mapper (enter year & navigate to location): http://wdr.water.usgs.gov/adrgmap/index.html

Fish Advisories & Guides
NJ Division of Science & Research Fish Advisories Home Page: http://www.state.nj.us/dep/dsr/njmainfish.htm

Fish Smart Eat Smart: http://www.state.nj.us/dep/dsr/fishsmart.pdf

NJDEP Regulations:
NJDEP Rules & Regulations, current and proposed: http://www.state.nj.us/dep/rules

Phone Contacts:
NJ Drought Hotline: 1-800-4-ITS DRY (1-800-448-7379)

NJ Environmental Incident Hotline (hazardous spill, fire, explosion, illegal dumping, wildlife problem):
1-877-WARNDEP / 1-877-927-6337 (toll-free, 24 hours)

NJDEP – Other Hotlines; http://www.nj.gov/dep/warndep.htm

NJDEP Bureau of Coastal & Land Use Compliance & Enforcement: 1-609-292-1240

NJDEP Division of Land Use Regulation (Wetlands, Streams/Rivers, Flood Hazard Areas):
Technical Support Center: (609) 777-0454
Forms: http://www.nj.gov/dep/landuse/forms.html

7: BIOLOGICAL RESOURCES

A. Dominant Vegetation (Land Cover)

The New Jersey Comparative Risk Project (March 2003) listed habitat fragmentation and habitat loss as the highest ranking stressors of Statewide ecological quality. Certain species that require large expanses of intact habitat are becoming less common. Other factors that impact ecological health include exotic species (e.g. the hemlock wooly adelgid, an insect that causes the decline and death of hemlock trees) and exotic diseases, overpopulations of deer and geese, and pollution.

Deborah J. Kratzer

Deciduous Forest in Ramapo Mountain State Forest

The 2007 Land Use/Land Cover (LU/LC) data layer was created by a consultant to NJDEP by comparing the 2002 LU/LC layer to 2007 color infrared imagery (2002 and 2007 aerial photos are shown in **Figure 1d** and **Figure 1e**, respectively) and delineating and coding areas of change with a 1 foot pixel resolution. The classification system used was a modified Anderson Classification System (USGS, 2010) that provided the parameters for proper and consistent coding of the LU/LC feature classes and subclasses. It should be noted that 1) changes since 2007 are not shown, and 2) the method is not 100% accurate. In addition, since it is based on interpretation of aerial photographs, it cannot provide information about the particular species found in an area. The land cover classifications are shown in **Figures 7a, 7b, 7c and 7d**. The number of acres of each within Oakland is noted on the maps and included in the acreage figures in **Table 7.1** (NJDEP, 2010).

The largest portion of land in Oakland has a land cover of *Deciduous Forest (>50% Crown Closure)* (41% of the borough), followed by *Residential, Single Unit, Medium Density* (20%), and *Residential, Single Unit, Low Density* (12%). Together, these top three land uses make up 73% of the borough (NJDEP, 2010).

In recognition of the many benefits of trees, the Borough of Oakland adopted a Tree Removal and Protection Ordinance (Borough of Oakland, Chapter XIX).

Table 7.1: Land Use/Land Cover (Anderson Classification) in Oakland

Code	Description	Acres*	Percent
Urban Land Use Type:			
1110	Residential, high density or multiple dwelling	26.21	0.47
1120	Residential, single unit, medium density	1109.50	19.77
1130	Residential, single unit, low density	665.51	11.86
1140	Residential, rural, single unit	151.35	2.70
1200	Commercial/Services	181.75	3.24
1300	Industrial	176.60	3.15

Code	Description	Acres*	Percent
1400	Transportation/Communication/Utilities	4.55	0.08
1410	Major Roadway	55.32	0.99
1419	Bridge Over Water	1.05	0.02
1420	Railroads	10.79	0.19
1463	Upland Rights-of-Way Undeveloped	2.97	0.05
1499	Stormwater Basin	2.05	0.04
1700	Other Urban or Built-up Land	169.72	3.02
1710	Cemetery	3.07	0.05
1800	Recreational Land	13.76	0.25
1804	Athletic Fields (schools)	52.14	0.93
	Total of all Urban Land Uses (excludes urban wetlands)	**2626.35**	**46.80**
Agriculture Land Use Type:			
2100	Cropland and Pastureland	2.80	0.05
2200	Orchards/Vineyards/Nurseries/Horticultural Areas	11.15	0.20
2400	Other Agriculture	10.89	0.19
	Total of all Agriculture Land Uses (excludes agricultural wetlands)	**24.84**	**0.44**
Forest Land Use Type:			
4110	Deciduous Forest (10-50% Crown Closure)	109.90	1.96
4120	Deciduous Forest (>50% Crown Closure)	2279.78	40.63
4220	Coniferous Forest (>50% Crown Closure)	5.53	0.10
4311	Mixed Forest (>50% Coniferous with 10-50% Crown Closure)	1.61	0.03
4321	Mixed Forest (>50% Deciduous with 10-50% Crown Closure)	7.70	0.14
4410	Old Field (<25% Brush Covered)	64.84	1.16
4420	Deciduous Brush/Shrubland	32.33	0.58
4430	Coniferous Brush/Shrubland	8.65	0.15
4440	Mixed Deciduous/Coniferous Brush/Shrubland	7.81	0.14
	Total of all Forested Land Uses	**2518.15**	**44.87**
Water Land Use Type:			
5100	Streams and Canals	66.63	1.19
5190	Exposed Flats	1.75	0.03
5200	Natural Lakes	37.07	0.66
5300	Artificial Lakes	68.90	1.23
	Total of all Water Land Uses	**174.35**	**3.11**
Wetland Land Use Type:			
1750	Managed Wetland in Maintained Lawn Greenspace	4.22	0.08
1850	Managed Wetland in Built-up Maintained Rec Area	0.90	0.02
2140	Agricultural Wetlands (modified)	4.33	0.08
6210	Deciduous Wooded Wetlands	194.58	3.47
6231	Deciduous Scrub/Shrub Wetlands	15.42	0.27
	Total of all Wetland Land Uses	**219.46**	**3.91**
Barren Land Use Type:			
7200	Bare Exposed Rock, Rock Slides, etc.	20.56	0.37
7400	Altered Lands	19.27	0.34
7430	Disturbed Wetlands (Modified)	2.16	0.04
7500	Transitional Areas	3.75	0.07
7600	Undifferentiated Barren Lands	2.83	0.05
	Total of all Barren Land Uses	**48.57**	**0.87**
ALL	**TOTAL for all Land Use Types:**	**5611.72**	**100.00**
* Acreage from the GIS data varies from acreage calculated based on tax maps.			
Source: NJDEP, 2010; USGS, 2010			

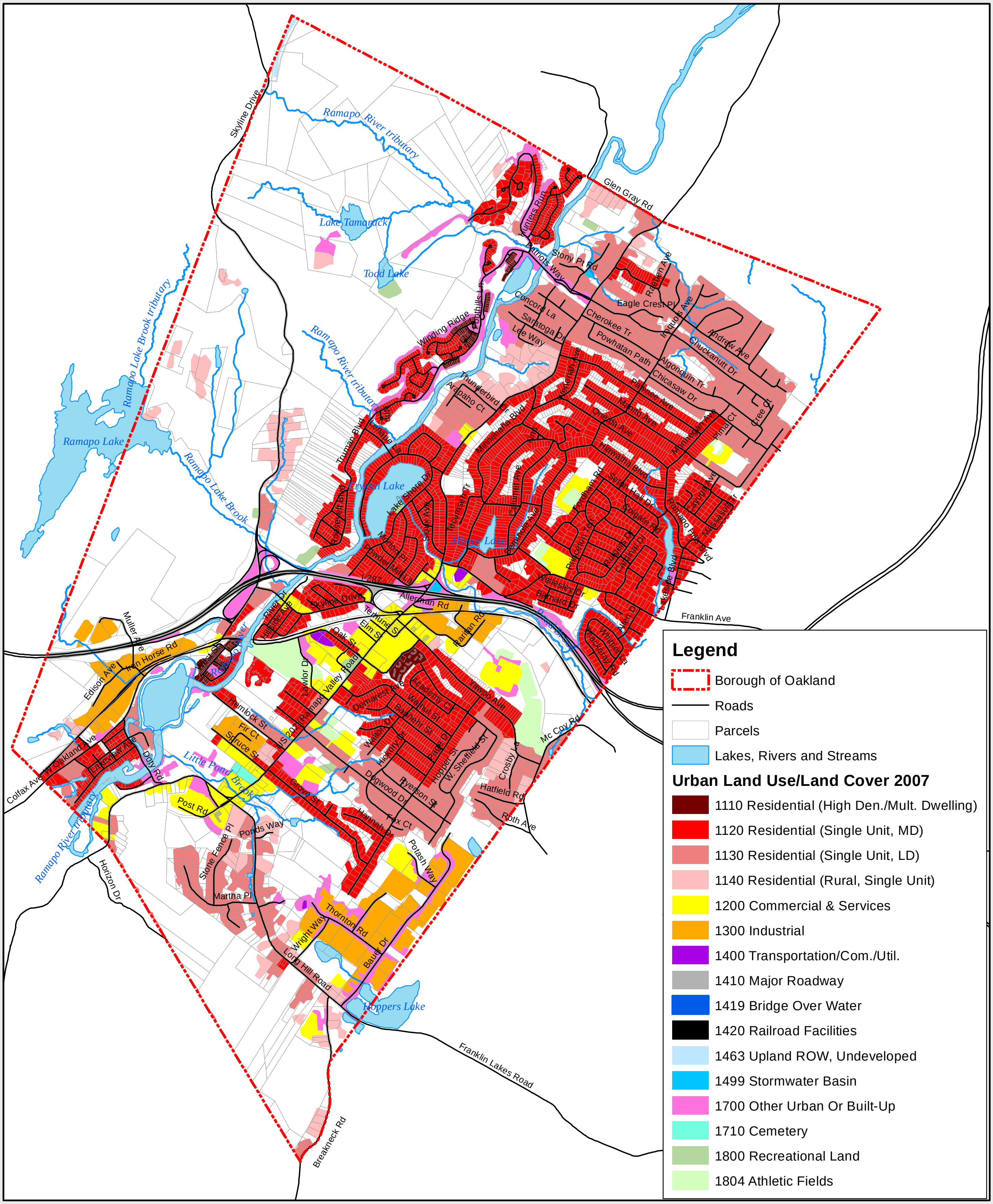

Figure 7a: Land Cover 2007 Urban Land Uses

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

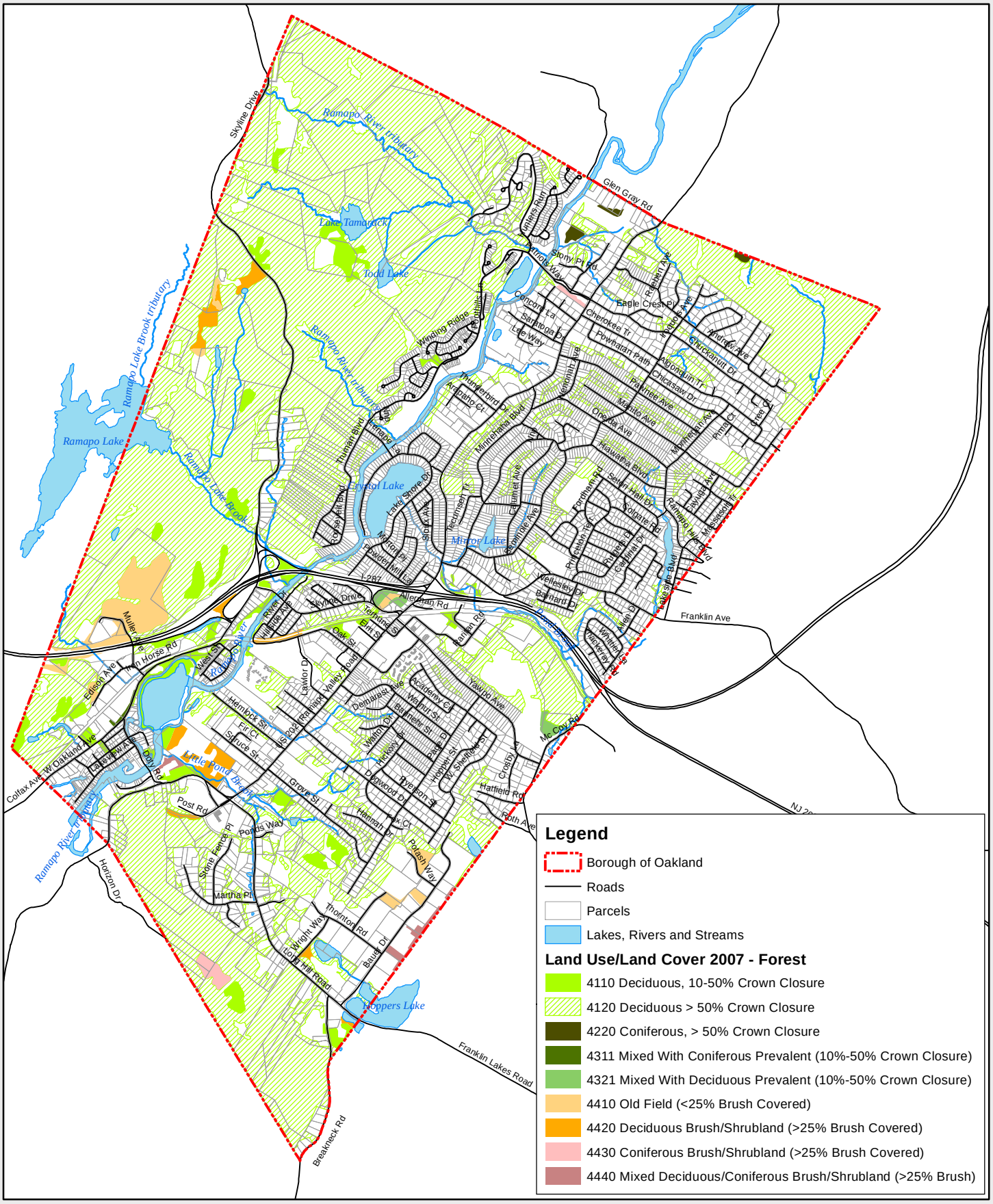

Figure 7b: Land Cover 2007 Forest Land Uses

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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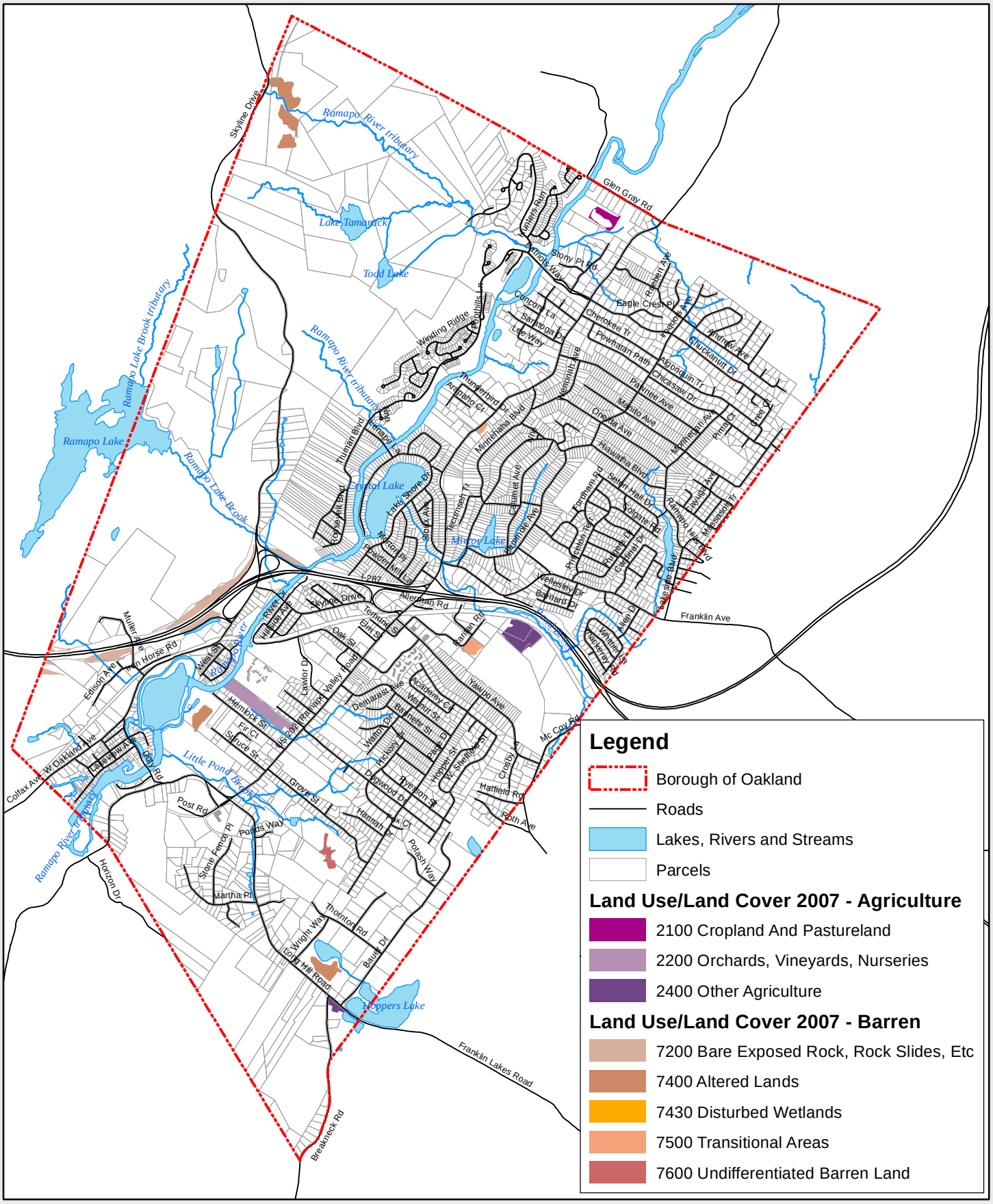

Figure 7c: Land Cover 2007 Agriculture & Barren Land Uses

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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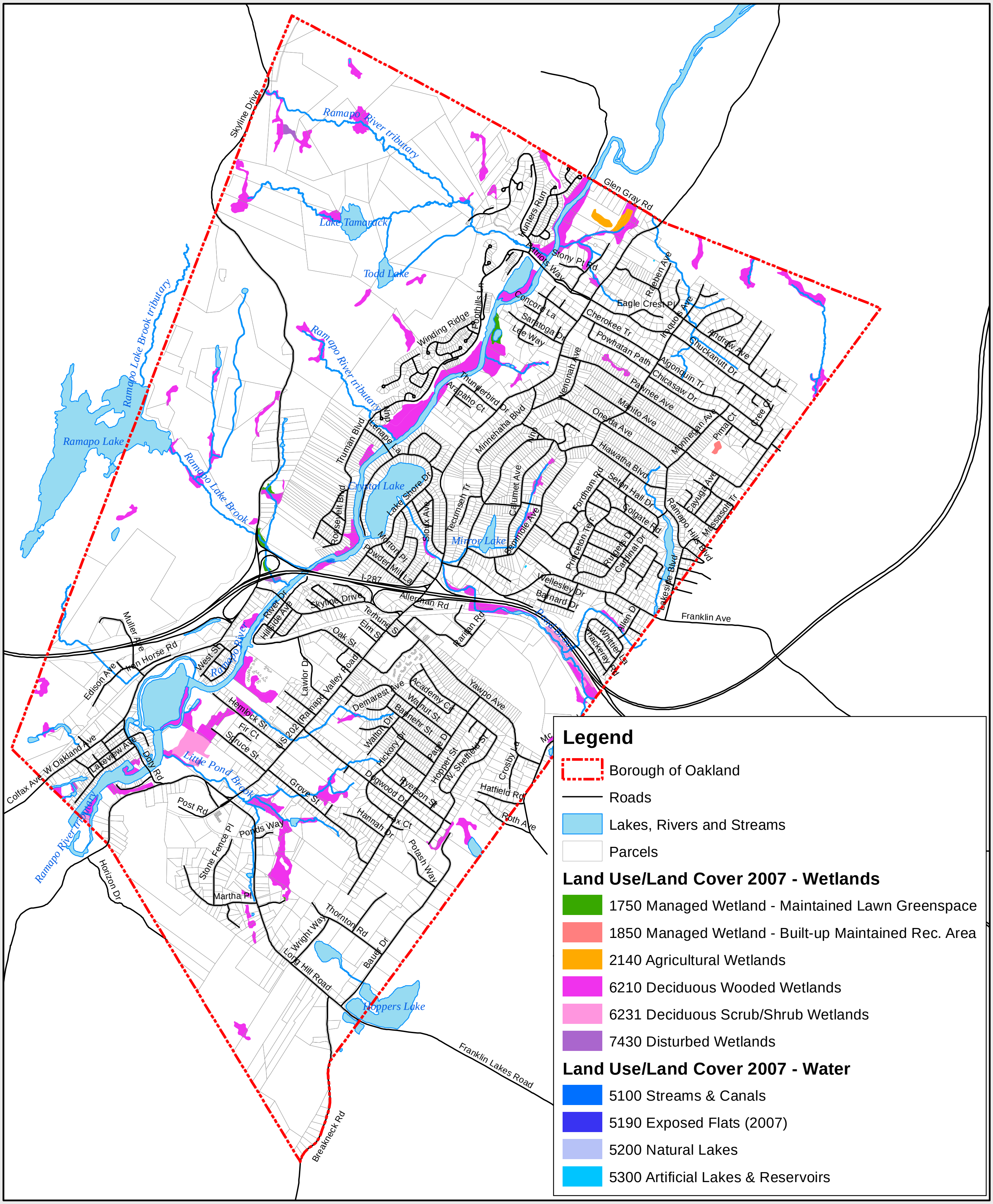

Figure 7d: Land Cover 2007 Water & Wetlands Land Uses

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

Data Sources: NJDEP
Note: Map accuracy is limited to the accuracy and scale of the original data sets.
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B. Wildfire Fuel Hazard

The New Jersey Forest Fire Service (NJFFS), a division of NJDEP, assessed *Wildfire Fuel Hazard* (WFH) throughout New Jersey (see **Figure 7e**). The purpose is to provide information for NJ Forest Fire Service personnel, government agencies, and others interested in assessing WFH throughout New Jersey. Modified Anderson Land Use/Land Cover Classifications from the 2002 Land Use/Land Cover dataset were assigned Wildfire Fuel Hazard Rankings (0 = Water, 1 = Low, 2 = Moderate, 3 = High, 4 = Very High, 5 = Extreme, 6 = Urban, 7 = Agriculture, 8 = Barren Land). Areas with 30% or greater slope and Wildfire Fuel Hazard 1 to 4 were increased by 1 (e.g. Low became Moderate, etc.) (NJDEP, 2009).

The majority of Oakland is Low Wildfire Fuel Hazard. The mature deciduous forests have less undergrowth, therefore are lower fire hazard. Most of the areas with Very High or Extreme WFH are in the few areas in the borough with brush/shrubland, old fields or coniferous forest.

C. Wildlife

New Jersey hosts 323 bird species, 89 mammal species, 44 reptile, 35 amphibian, 85 freshwater fish and over 300 marine finfish species. This high diversity in such a small state is partly due to New Jersey's geographic position where northern ecosystems reach their southern limit and where southern ecosystems reach their northern limit. In addition, the state provides a wide variety of habitats including mountains, valleys, rolling hills, wetlands, pinelands, beaches, estuaries and rivers (NJDEP, January 19, 2012).

The NJDEP website offers checklists for the birds, mammals, reptiles and amphibians of New Jersey; with notes on the status of each (e.g. common or rare) (see **Internet Resources**). A variety of plant and animal species enjoy Oakland's diversity of habitat types. A list of bird species in Oakland has been developed, but may be revised with additional sightings and surveys (see **Appendix C.1**). Lists of mammals, reptiles, amphibians and fish are not available specifically for either Bergen County or the Borough.

Black Bear

Black bears (*Ursus americanus*), the largest land mammals in the state, have been seen in Oakland Borough since at least 1995. After indiscriminate hunting and habitat loss for centuries, the bear population has rebounded in the last 30 years. The NJ bear population in 2010 was estimated to be approximately 3,278 in the area open to hunting (north of I-78 and west of I-287). Bears are most frequently seen during the breeding season of June and July, when the males travel extensively in search of females. Black bears are omnivorous in food preferences, consuming a range of foods from skunk cabbage, berries, nuts, insects, small mammals, road-kill and human garbage. They are sometimes responsible for damage to bird feeders, beehives, sweet corn, livestock, garbage, etc. Black bears that are fed, unintentionally or intentionally, can become dangerous and may have to be destroyed (NJ Division of Fish and Wildlife, August 12, 2013).

The Division of Fish and Wildlife offers information and techniques for damage and nuisance prevention (see **Internet Resources**).

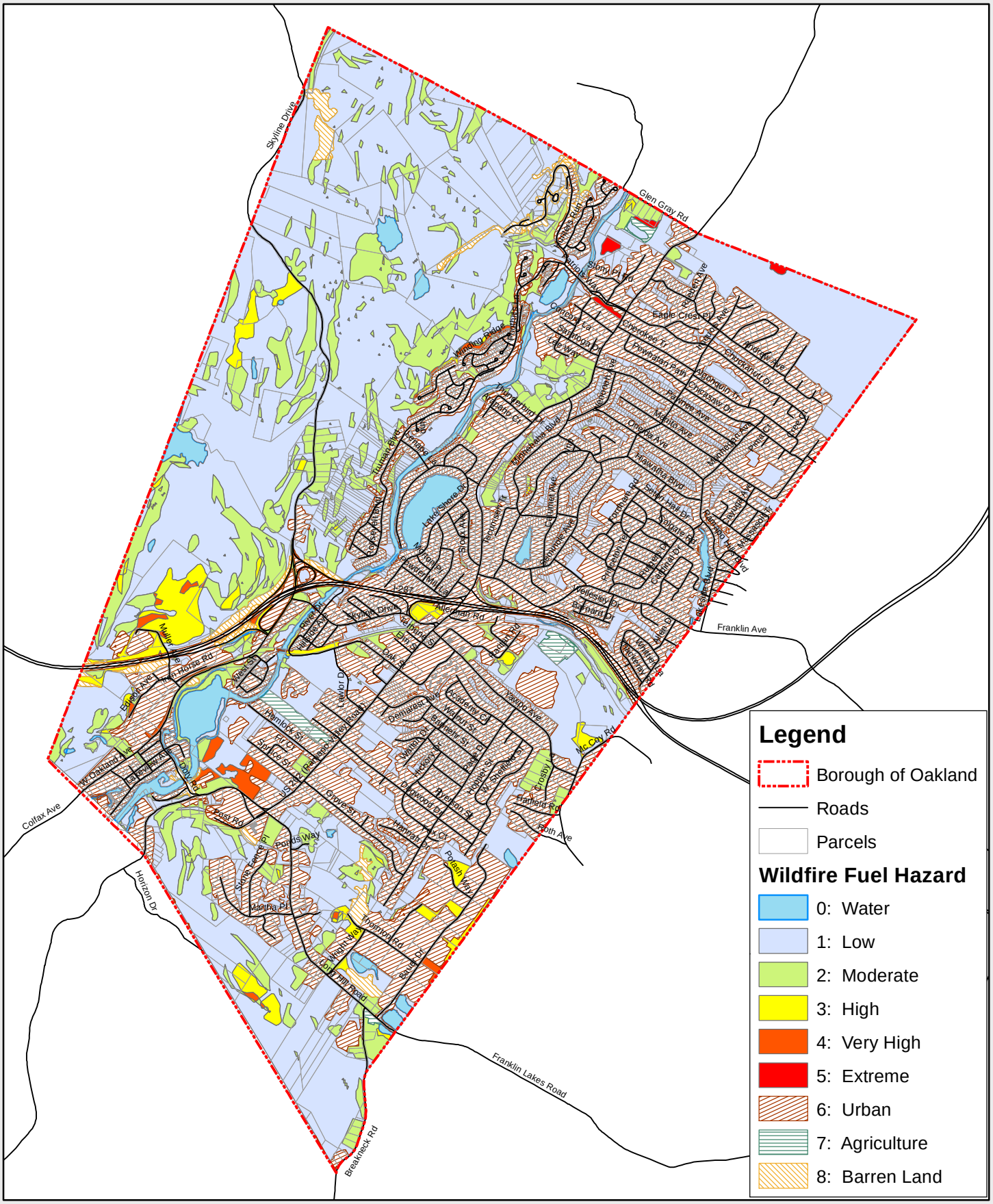

Figure 7e: Wildfire Fuel Hazard

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

White-tailed Deer

The white-tailed deer (*Odocoileus virginianus*), the largest herbivore living wild in New Jersey, is seen frequently in Oakland. Although the deer is a large animal, individuals tend to stay in a one square mile or less home range, one of the smallest ranges among wild ruminants (Burnett, 2004).

Biologists have estimated that before the arrival of European settlers, there were about 8-11 white-tailed deer per square mile. By the early 1900's, New Jersey's deer herd was reduced to a handful by unregulated hunting. However, efforts to protect the deer herd were so successful that deer were considered over-populous by the 1920's (Latham et al, 2005). In addition, deer have been able to adapt to human-altered habitats. Studies have shown that deer densities of over 10-15 per square mile have negative impacts on the diversity of understory vegetation and on the native songbird and wildflower populations that depend on a diverse understory, while deer populations in excess of 20 per square mile prevent tree regeneration (Latham et al, 2005).

Where deer are overabundant, this results in excessive damage to agricultural crops, gardens and residential landscaping; an increased incidence of deer/vehicle collisions; prevention of forest regeneration (which impacts plants and animals dependent on the forest); and the potential for reduced deer health due to inadequate nutrition and the spread of disease (Honachefsky, 2000; Latham et al, 2005; Sauer, 1998). Despite these impacts, deer remain a natural part of the ecosystem, and are not solely responsible for diversity loss and habitat degradation.

Deborah J. Kratzer

White-tailed deer

Documentation of deer population numbers is not available for Bergen County or Oakland, therefore it is unknown whether the population exceeds either the number that can be sustained over an extended period (*ecological carrying capacity*) or the number that can coexist compatibly with local human populations (*cultural carrying capacity*) (NJDEP, 1999).

The state is divided into 70 Deer Management Zones (DMZs), with differing deer hunting regulations applied to different DMZs. The portion of Oakland north of Interstate 287 and west of US Route 202 falls within DMZ 3, while the rest of the borough is in DMZ 36. In Oakland, the only public land open to deer hunting is the Ramapo Mountain State Forest (in DMZ 3). There are no public areas open to hunting in Zone 36. From the 1995/1996 season to the 2010/2011 season, about 52 deer were harvested each season in Bergen County. The 2011/2012 season saw a jump to 100 deer harvested in the county (NJDEP Division of Fish and Wildlife, September 9, 2013).

Birds

Birders in Oakland have identified 124 species of birds within the Borough (Paolillo, 2013). A list is provided in **Appendix C.1**. Sightings of endangered, threatened and special concern birds are discussed in **Section 7E**. The Canada goose is discussed below.

Canada Goose

The Canada goose (*Branta canadensis*) is one of New Jersey's most easily recognized birds, with its black head and neck, white check patch and undersides, brown back and large size (2'-3' tall, 10-12 lbs.). There are two distinct populations in NJ, migratory geese that visit the

state in the winter and non-migratory geese, that nest in the state. Sources estimate the NJ population of resident Canada geese at approximately 83,000 to 96,800 (USDA, January 2003; NJDEP, March 2001).

While many people enjoy the sight of a few geese, this high population of non-migrating geese can cause the following problems:

- overgrazing of lawns and athletic fields, which impacts aesthetics and causes erosion
- damage to cropland, increasing erosion hazard and crop losses
- accumulations of feces on land, creating a health risk from disease-causing organisms
- degradation of water quality, from fecal bacteria, nitrogen and phosphorous
- hazards to aircraft at airports
- aggression and attacks on humans
- noise (USDA, January 2003; NJDEP, March 2001).

As migratory game species, Canada geese are afforded federal and state protection. Therefore, any management techniques involving handling nests, eggs or birds require a permit (NJDEP Division of Fish and Wildlife, No date).

The borough has an ordinance prohibiting the feeding of wild waterfowl (Oakland Borough Code Chapter V Animal Control Section 5).

Wildlife of Vernal Pools

Vernal pools are defined as confined depressions, either natural or man-made, that maintain ponded water for part of the year, have no permanent outflow, and are devoid of breeding fish populations. These temporary wetlands provide habitat to many species of amphibians, several of which breed exclusively in vernal pools, as well as a multitude of insects, reptiles, plants, and other wildlife. Certification of a vernal pool may be achieved by documenting breeding activity of obligate vernal pool species (such as wood frogs or spotted salamanders; see **Table 7.2**) or by documenting both the presence of facultative species and photographic evidence that the pool goes dry or demonstrating the absence of fish (Tesauro, no date).

Table 7.2: Obligate And Facultative Fauna Species Found In Vernal Habitats

Obligate Vernal Pool Breeding Species	Facultative Vernal Pool Breeding Amphibians	Reptiles that Inhabit Vernal Pools on a Seasonal Basis
Eastern tiger salamander *ENDANGERED* Marbled salamander *Special Concern* Spotted salamander Jefferson salamander *Special Concern* Blue-spotted salamander *ENDANGERED* Jefferson x Blue-spotted salamander *ENDANGERED* Wood frog Eastern spadefoot toad Fairy shrimp (order Anostraca)	Green frog Bullfrog Pickerel frog Southern leopard frog Carpenter frog *Special Concern* Northern spring peeper Northern cricket frog New Jersey chorus frog Upland chorus frog Northern gray treefrog Southern gray treefrog *ENDANGERED* Pine barrens treefrog *ENDANGERED* Four-toed salamander Long-tailed salamander *THREATENED*	Wood turtle *THREATENED* Spotted turtle *Special Concern* Mud turtle Eastern painted turtle Common snapping turtle (These reptiles visit vernal pools primarily to eat the eggs and larvae of amphibians.)
Note: Species in black are either known to occur in Oakland Borough or their ranges include Bergen County; species in gray have ranges that do not include Bergen County, therefore it would be unlikely to find them in Oakland.		
Sources: Kenney et al, no date; Gessner and Stiles, February 2001; N.J.A.C 7:7A, Appendix 1.		

There are two areas of confirmed vernal pool habitats within Oakland: one on private property near Overlook Ridge Road, and one within the Ramapo Mountain State Forest, on the border with Wanaque Borough. There are also two areas with potential vernal pools within Oakland: in the northwest corner of the borough, in Ramapo Valley County Reservation, and in Camp Todd and nearby in Ramapo Mountain State Forest (see **Figure 7f**).

Fish

Fish Index of Biotic Integrity (FIBI) sampling (see **Section 6H**) is the only known scientific survey of fish species found in Oakland. One site on the Ramapo River was sampled in 2000 and 2005 (see **Table 7.3**). This data has shown that the health of the fish population was fair in 2000 and poor in 2005. The site is likely influenced by upstream and surrounding urban development, lack of riparian buffer, lack of overhead cover, and excessive nutrient load, high water temperature and low dissolved oxygen (NJDEP Water Monitoring & Standards, BFBM, 2000, 2005, January 2008).

Recreational fishing is available in Oakland's many water bodies (with a license and subject to fishing regulations), including Lake Tamarack, Lake Todd, Little Pond Brook, Pond Brook, Ramapo Lake and Ramapo River (Recreational Boating and Fishing Foundation, September 13, 2013). Trout are stocked in Potash Lake and Ramapo River (NJDEP Division of Fish and Wildlife, June 4, 2013). However, as discussed in **Section 6E**, two of the three subwatersheds that include Oakland are rated *Non-attainment for Aquatic Life – Trout*; and two of the three are rated *Non-attainment for Fish Consumption* (the third in each case has insufficient information for evaluating). See **Section 6I** for Fish Consumption Advisories.

Table 7.3: Fish Caught at Site FIBI006-Ramapo River

Common Name	Scientific Name	8/15/2005		09/08/2000	
		Abundance	Size Range (inches)	Abundance	Size Range (inches)
Tessellated Darter	*Etheostoma olmstedi*	175	-	65	
Green Sunfish*	*Lepomis cyanellus*	63	1.5 - 5.3	46	2.4 - 5.9
Largemouth Bass*	*Micropterus salmoides*	45	2.2 - 5.3	19	1.6 - 3.9
Redbreast Sunfish*	*Lepomis auritus*	37	1.5 - 6.1	13	2.4 - 5.5
White Sucker*	*Catostomus commersoni*	33	-	24	-
Creek Chub	*Semotilus atromaculatus*	10	-	-	-
Cutlips Minnow	*Exoglossum maxillingua*	8	-	1	
Rock Bass*	*Ambloplites rupestris*	8	6.8 - 10.0	23	3.1 - 8.9
Yellow Bullhead*	*Ameiurus natalis*	7	2.4 - 7.3	1	
Smallmouth Bass*	*Micropterus dolomieu*	4	2.6 - 7.1	2	2.4 - 9.6
Yellow Perch	*Perca flavescens*	4	2.0 - 9.3	-	-
Bluegill*	*Lepomis macrochirus*	2	1.5 - 4.9	3	1.6 - 4.7
White Perch	*Morone americana*	2	3.0 - 8.0	-	-
Brown Trout*	*Salmo trutta*	-	-	6	10.2 - 12.0
Satinfin Shiner	*Cyprinella analostana*	-	-	1	
Pumpkinseed*	*Lepomis gibbosus*	-	-	1	4.3
Index of Biotic Integrity Score:		**28**	**Poor**	**32**	**Fair**
*Regulated as a fishable species under current New Jersey Fish and Wildlife codes					
Source: NJDEP Water Monitoring & Standards, BFBM, 2000 and 2005					

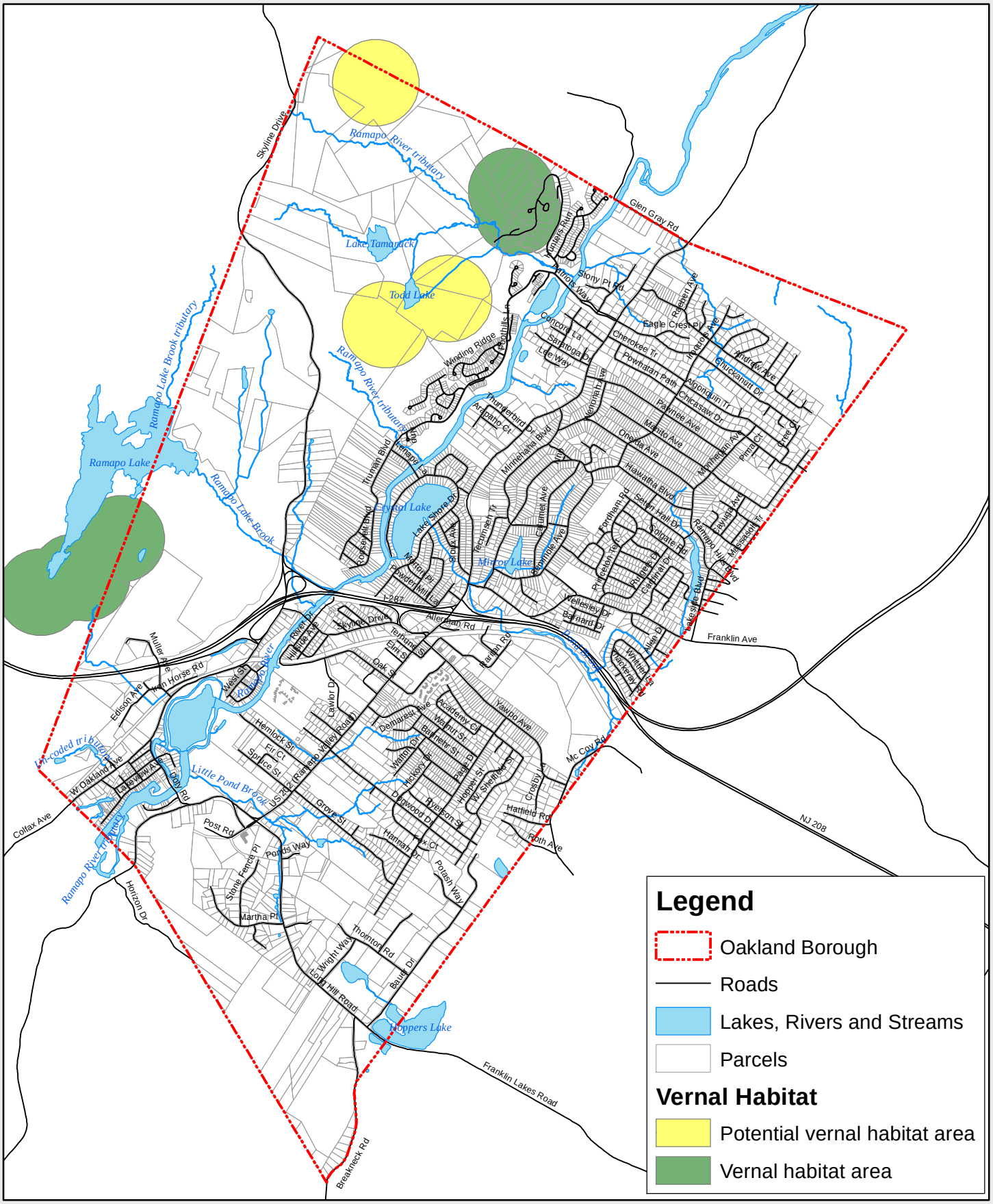


Figure 7f: Vernal Pool Habitats

D. Endangered, Threatened and Special Concern Species

The health of an area's animal and plant populations can be an indicator of the health and sustainability of the environment for people. The decline or disappearance of one (or more) species may signal the deterioration of the habitat. Other species, and human health and welfare, may soon follow. Preserving the future of endangered and threatened species helps preserve our own species, benefiting human health and quality of life by protecting watersheds, preserving land in its natural state, and restoring wildlife habitat. Many people also place an intrinsic value on all species (Conserve Wildlife Foundation, 2002).

Many species are naturally rare in parts of their range, especially at the periphery. New Jersey often lies at the southern periphery of the range for many "northern" species and at the northern edge of the range of many "southern" species. Therefore, a species considered rare or imperiled within the state of New Jersey is not necessarily in danger of extinction worldwide. In addition, many rare species depend on large tracts of continuous undisturbed habitat to survive. If these habitats are interrupted by developed areas, the patches may become too small to support certain species.

The NJ Endangered Species Conservation Act was signed into law on December 14, 1973 (N.J.S.A. 23:2A-1 - 15), preceding the federal Endangered Species Act by two weeks. This milestone legislation established laws to protect and restore the state's endangered and threatened wildlife whose survival in New Jersey is imperiled by loss of habitat, over-exploitation, pollution, or other impacts (NJDEP, October 6, 2004). In February 2012, NJDEP updated the Endangered and Nongame Species rules (N.J.A.C. 7:25), revising the species list based on science, upgrading the status of some recovering species and adding some declining species to the list (NJDEP Division of Fish and Wildlife, April 2 2012 and January 18, 2011).

Table 7.4 presents the definitions used by NJDEP in describing the status of species. In order to better document the status or change in status of species, NJDEP solicits information from the general public concerning sightings of endangered, threatened and special concern species. People should use the appropriate reporting forms (see **Internet Resources** and **Appendix D.3 and D.4)**.

Table 7.4: Definitions of Species Status

STATE STATUS	STATE STATUS DEFINITIONS
Animals: Two animal lists provide state status codes after the Endangered and Nongame Species Conservation Act of 1973 (N.J.S.A. 23:2A-13 et. seq.): the list of endangered species (N.J.A.C. 7:25-4.13) and the list defining status of indigenous, nongame wildlife species of New Jersey (N.J.A.C. 7:25-4.17(a)). The status of animal species is determined by the Endangered and Nongame Species Program (ENSP), with the review and approval of the Endangered and Nongame Species Advisory Committee. Status for animals separated by a slash(/) indicate a dual status. First status refers to the state breeding population, and the second status refers to the migratory or winter population.	
E	An **endangered species** is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.
T	A **threatened species** is a species that may become endangered if conditions surrounding the species begin to or continue to deteriorate.
SC	The term **Special Concern** applies to animal species that warrant special attention because of some evidence of decline, inherent vulnerability to environmental deterioration, or habitat modification that would result in their becoming a Threatened species. This category would also be applied to species that meet the foregoing criteria and for which there is little understanding of their current population status in the state.
S	A **stable species** is one whose population is not undergoing any long-term increase/decrease within its natural cycle.
U	An **undetermined species** is one about which there is not enough information available to

	determine the status.
Plants: Plant taxa listed as endangered are from New Jersey's official Endangered Plant Species List (N.J.A.C. 7:5C – 5.1).	
E	Native New Jersey plant species whose survival in the State or nation is in jeopardy.
FEDERAL STATUS	**FEDERAL STATUS DEFINITIONS**
LE	Taxa formally listed as **endangered.**
LT	Taxa formally listed as **threatened.**
REGIONAL STATUS	**REGIONAL STATUS CODES FOR PLANTS AND ECOLOGICAL COMMUNITIES**
LP	Indicates taxa listed by the **Pinelands Commission** as endangered or threatened within their legal jurisdiction. Not all species currently tracked by the Pinelands Commission are tracked by the Natural Heritage Program. A complete list of endangered and threatened Pineland species is included in the NJ Pinelands Comprehensive Management Plan.
HL	Indicates taxa or ecological communities protected by the **Highlands Water Protection and Planning Act** within the jurisdiction of the Highlands Preservation Area.
GLOBAL & STATE CODE	The Nature Conservancy developed a ranking system for use in identifying elements (rare species and ecological com-munities) of natural diversity most endangered with extinction. Each element is ranked according to its global, national, and state (or subnational in other countries) rarity. These ranks are used to prioritize conservation work so that the most endangered elements receive atten-tion first. Definitions for element ranks are after The Nature Conservancy (1982: Chapter 4, 4.1-1 through 4.4.1.3-3).
GLOBAL CODE	**GLOBAL ELEMENT RANK DEFINITIONS**
G1	**Critically imperiled globally** because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction.
G2	**Imperiled globally** because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.
G3	Either **very rare and local throughout its range or found locally** (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range; with the number of occurrences in the range of 21 to 100.
G4	**Apparently secure globally**; although it may be quite rare in parts of its range, especially at the periphery.
G5	**Demonstrably secure globally**; although it may be quite rare in parts of its range, especially at the periphery.
GH	Of **historical occurrence** throughout its range i.e., formerly part of the established biota, with the expectation that it may be rediscovered.
STATE CODE	**STATE ELEMENT RANK DEFINITIONS**
S1	**Critically imperiled in New Jersey** because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres). Elements so ranked are often restricted to very specialized conditions or habitats and/or restricted to an extremely small geographical area of the state. Also included are elements which were formerly more abundant, but because of habitat destruction or some other critical factor of its biology, they have been demonstrably reduced in abundance. In essence, these are elements for which, even with intensive searching, sizable additional occurrences are unlikely to be discovered.
S2	**Imperiled in New Jersey** because of rarity (6 to 20 occurrences). Historically many of these elements may have been more frequent but are now known from very few extant occurrences, primarily because of habitat destruction. Diligent searching may yield additional occurrences.
S3	**Rare in state** with 21 to 100 occurrences (plant species and ecological communities in this category have only 21 to 50 occurrences). Includes elements which are widely distributed in the state but with small populations/acreage or elements with restricted distribution, but locally abundant. Not yet imperiled in state but may soon be if current trends continue. Searching often yields additional occurrences.

S4	**Apparently secure** in the state, with many occurrences.
S5	**Demonstrably secure** in state and essentially ineradicable under present conditions.
SH	Elements of **historical occurrence** in New Jersey. Despite some searching of historical occurrences and/or potential habitat, no extant occurrences are known. Since not all of the historical occurrences have been field surveyed, and unsearched potential habitat remains, historically ranked taxa are considered possibly extant, and remain a conservation priority for continued field work with the expectation they may be rediscovered.
B	Refers to the **breeding** population of the element in the state.
N	Refers to the **non-breeding** population of the element in the state.
Note: To express *uncertainty*, the most likely rank is assigned and a question mark added (e.g., G2?). A range is indicated by combining two ranks (e.g., G1G2, S1S3).	
Source: NJDEP Division of Fish and Wildlife, March 22, 2010	

Endangered, Threatened & Special Concern Animals

The NJDEP Division of Fish and Wildlife, Endangered and Nongame Species Program's (ENSP) mission is: "To actively conserve New Jersey's biological diversity by maintaining and enhancing endangered and nongame wildlife populations within healthy functioning ecosystems." The program is responsible for the protection and management of New Jersey's wildlife, including 50 endangered, 36 threatened and 100 species currently listed as special concern (NJDEP Division of Fish and Wildlife, April 2, 2012 and February 21, 2012). For state-wide species lists, see **Internet Resources**.

A search of NJDEP Division of Parks and Forestry *Natural Heritage Database* in March 2013 revealed the documented presence of 25 special concern animals in Oakland (see **Tables 7.4** for code definitions and **Table 7.5** for list)**.** Special concern animal species, which warrant concern due to evidence of decline or vulnerability, include one amphibian, 10 birds, 6 insects and 2 reptiles. State threatened species include one bird and one reptile. State endangered species within Oakland include 2 birds, one insect, one mammal and one reptile. The Natural Heritage Database has no records of federally-listed endangered or threatened species in Oakland. One additional species, the Long Dash, a skipper butterfly, is being tracked by the Endangered and Nongame Species Program, but is does not have a special designation.

Table 7.5: Natural Heritage Database Animal Species in Oakland

Class	Common Name	Scientific Name	Feature Type	LP Rank	State Protection	Global Rank	State Rank
Amphibia	Marbled Salamander	*Ambystoma opacum*	Occupied Habitat	2	Special Concern	G5	S3
Aves	Bald Eagle*	*Haliaeetus leucocephalus*	Nest	4	State Endangered	G5	S1B,S2N
	Barred Owl*	*Strix varia*	Breeding Sighting	3	State Threatened	G5	S2B,S2N
	Brown Thrasher	*Toxostoma rufum*	Breeding Sighting	2	Special Concern	G5	S3B,S4N
	Cerulean Warbler	*Dendroica cerulea*	Breeding Sighting	2	Special Concern	G4	S3B,S3N
	Cliff Swallow	*Petrochelidon pyrrhonota*	Breeding Sighting-Confirmed	2	Special Concern	G5	S3B,S3N
	Cooper's Hawk	*Accipiter cooperii*	Breeding Sighting	2	Special Concern	G5	S3B,S4N
	Great Blue Heron	*Ardea herodias*	Foraging	2	Special Concern	G5	S3B,S4N
	Hooded Warbler	*Wilsonia citrina*	Breeding Sighting	2	Special Concern	G5	S3B

Class	Common Name	Scientific Name	Feature Type	LP Rank	State Protection	Global Rank	State Rank
	Red-shouldered Hawk*	*Buteo lineatus*	Breeding Sighting	4	State Endangered	G5	S1B, S3N
	Red-shouldered Hawk*	*Buteo lineatus*	Non-breeding Sighting	2	Special Concern	G5	S1B,S3N
	Veery	*Catharus fuscescens*	Breeding Sighting	2	Special Concern	G5	S3B
	Wood Thrush	*Hylocichla mustelina*	Breeding	2	Special Concern	G5	S3B
	Worm-eating Warbler	*Helmitheros vermivorum*	Breeding Sighting	2	Special Concern	G5	S3B
Insecta	Arrowhead Spiketail	*Cordulegaster obliqua*	Territorial Display	2	Special Concern	G4	S3
	Brush-tipped Emerald	*Somatochlora walshii*	Foraging	2	Special Concern	G5	S3
	Gray Petaltail (dragonfly)	*Tachopteryx thoreyi*	Occupied Habitat	4	State Endangered	G4	S1
	New England Bluet	*Enallagma laterale*	Breeding/ Courtship	2	Special Concern	G3G4	S3
	Sable Clubtail	*Gomphus rogersi*	Foraging	2	Special Concern	G4	S3
	Tiger Spiketail	*Cordulegaster erronea*	Occupied Habitat	2	Special Concern	G4	S3
	Tiger Spiketail	*Cordulegaster erronea*	Territorial Display	2	Special Concern	G4	S3
	Williamson's Emerald	*Somatochlora williamsoni*	Foraging	2	Special Concern	G5	S3
	Long Dash	*Polites mystic*	n/a	n/a	n/a	G5	S3?
Mammalia	Bobcat*	*Lynx rufus*	Live Individual Sighting	4	State Endangered	G5	S1
	Bobcat*	*Lynx rufus*	Physical evidence	4	State Endangered	G5	S1
Reptilia	Eastern Box Turtle	*Terrapene Carolina Carolina*	Occupied Habitat	2	Special Concern	G5T5	S3
	Northern Copperhead	*Agkistrodon contortrix mokasen*	Occupied Habitat	2	Special Concern	G5T5	S3
	Timber Rattlesnake*	*Crotalus horridus horridus*	Occupied Habitat	4	State Endangered	G4T4	S1
	Wood Turtle*	*Glyptemys insculpta*	Occupied Habitat	3	State Threatened	G4	S2

Note: See **Table 7.4** for Global and State Rank definitions and **Table 7.8** for Landscape Project Rank definitions.

Source: Natural Heritage Program, March 21, 2013

Gray Petaltail

Timber rattlesnake

Wood Turtle

Experienced birders have observed and recorded 124 bird species in Oakland (Poalillo, 2013). Some of these are on the list of endangered, threatened and special concern species of NJ, but are not recorded in the Natural Heritage Database. These are listed in **Table 7.6**. A total of 3 endangered, 3 threatened and 15 special concern birds have been sighted in the Borough (Poalillo, 2013; see **Appendix C.1** for the full list of birds observed).

Table 7.6: Sightings of NJ Threatened and Endangered Birds in Oakland

Common Name	Scientific Name	Status
Great Blue Heron	*Ardea herodias*	Breeding-special concern
Osprey	*Pandion haliaetus*	Breeding-Threatened
Northern Harrier	*Circus cyaneus*	Breeding-Endangered; Non-Breeding-special concern
Sharp-shinned Hawk	*Accipiter striatus*	Breeding-special concern
Cooper's Hawk	*Accipiter cooperii*	Breeding-special concern
Bald Eagle	*Haliaeetus leucocephalus*	Breeding-Endangered; Non-Breeding-Threatened
Red-shouldered Hawk	*Buteo lineatus*	Breeding-Endangered; Non-Breeding--special concern
Broad-winged Hawk	*Buteo platypterus*	Breeding-special concern
American Kestrel	*Falco sparverius*	Breeding-Threatened Non-breeding-Threatened
Blue-headed Vireo	*Vireo solitarius*	Breeding-special concern
Cliff Swallow	*Petrochelidon pyrrhonota*	Breeding-special concern
Winter Wren	*Troglodytes hiemalis*	Breeding-special concern
Wood Thrush	*Hylocichla mustelina*	Breeding-special concern
Brown Thrasher	*Toxostoma rufum*	Breeding-special concern
Worm-eating Warbler	*Helmitheros vermivorum*	Breeding-special concern
Nashville Warbler	*Oreothlypis ruficapilla*	Breeding-special concern
Northern Parula	*Setophaga americana*	Breeding-special concern
Black-throated Blue Warbler	*Setophaga caerulescens*	Breeding-special concern
Black-throated Green Warbler	*Setophaga virens*	Breeding-special concern
Canada Warbler	*Cardellina canadensis*	Breeding-special concern
Savannah Sparrow	*Passerculus sandwichensis*	Breeding-Threatened
Note: This table is based on actual past observations. It is likely not inclusive of all species that occur in Oakland.		
Source: Poalillo, 2013; NJDEP Division of Fish and Wildlife, February 21, 2012 and April 2, 2012		

Endangered, Threatened & Special Concern Plants

The Endangered Plant Species List Act (N.J.S.A. 13:1B-15.151) was enacted in 1989, defining endangered plants as "any native plant species whose survival in the State or the nation is in jeopardy... and any species having five or fewer extant populations within the State." The Division of Parks and Forestry has the responsibility of creating the list of NJ endangered plant species (N.J.A.C. 7:5C–1.1). While the rule does not provide any protection for officially listed species, several regulatory agencies within NJDEP responsible for protecting plant habitat have incorporated the Endangered Plant Species List into their criteria for review of permits (NJDEP Division of Parks and Forestry, January 4, 2007).

Information on the rare plants and natural communities of NJ is tracked in the *New Jersey Natural Heritage Database* by the NJDEP Office of Natural Lands Management (ONLM). A search of the Natural Heritage Database in March 2013 revealed, based on data currently recorded in the database, the possibility of two special concern plants in Oakland (see **Table 7.4**

for code definitions and **Table 7.7** for the species list). Both are critically imperiled in New Jersey due to extreme rarity (5 or fewer occurrences in the state) (NJDEP ONLM, March 2013).

Appendix C.4 includes a list of Bergen County rare plant species and natural communities. The species found in nearby locations within the county could be present in Oakland if suitable habitat is present within the Borough.

Table 7.7: Natural Heritage Database Plant Species in Oakland

Scientific Name	Common Name	Federal Status	State Protection
Pycnanthemum torrei	Torrey's Mountain-mint		E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G2	S1 (Critically Imperiled in NJ)	2011-07-07

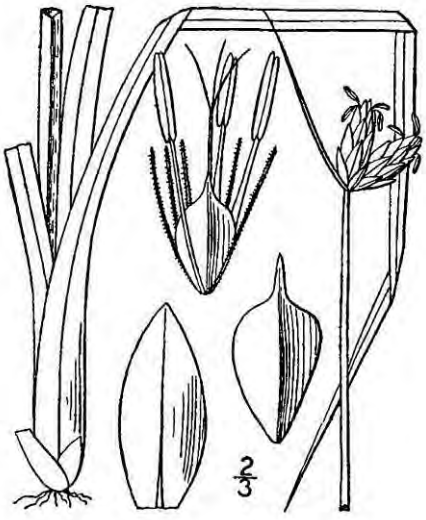
Description:
Mint family (Lamiaceae)
1 to 3' tall, square stems, aromatic, narrow opposite leaves
Irregular ¼" to ½" white flowers in dense head
Distinguished from similar mountain-mints by calyx and pubescence.

Habitat:
Open, dry, rocky glades in oak/hickory forests, on slopes near the tops of south- facing hillsides. Most occurrences are from trap rock or diabase rock formations. Habitat is within the traprock glade/rock outcrop community.

Scientific Name	Common Name	Federal Status	State Protection
Schoenoplectus torreyi	Torrey's Bulrush		E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5?	S1 (Critically Imperiled in NJ)	1939-09-16

Description:
Sedge family (Cyperaceae)
plants mat-forming; rhizomes 0.1" diameter
1.3 to 5' tall, stems sharply triangular 0.05 to 0.2" wide
Fruits in summer.
Distinguished from other sedges by details of the flower and fruit.

Habitat:
Emergent in fresh water ponds and marshes, often with fluctuating water levels



Note: For status and rank definitions, refer to **Table 7.4.**

Sources: NJDEP ONLM, March 21, 2013; Description of *Schoenoplectus torreyi* from Flora of North America, 2008; illustration from USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913.
Description and *Pycnanthemum torrei* from Encyclopedia of Life, 2012; Herbarium photo from Royal Botanic Garden Edinburgh (E), 1836.

E. Protecting Endangered, Threatened and Special Concern Species

Wildlife Action Plan

NJDEP Division Fish and Wildlife prepared a Wildlife Action Plan (WAP) in 2008, required by the US Fish and Wildlife Service in order to qualify for future federal funds through the State Wildlife Grants program. This program provides federal funds to states for the conservation of species that are endangered, threatened, or have special conservation needs. A 25% match, provided by citizen contributions, is required. NJ has received approximately $1.2 million dollars of State Wildlife Grants funding each year (NJDEP, January 23, 2008).

The report states,

> "The greatest threats to NJ's natural resources include habitat loss, destruction, alteration, and fragmentation. This has been a recurring theme within NJ for years as it is the most densely populated state in our nation with an annually increasing population requiring additional homes, roads, commercial buildings, schools, etc. Additional threats include, but are not limited to, invasive species (flora and fauna, aquatic and terrestrial), pollution, and unsustainable land management practices." (NJDEP, January 23, 2008)

A WAP specific to each region identifies habitats, wildlife of greatest conservation need, and threats. Conservation goals and actions are identified and prioritized, and potential partnerships are outlined with landowners, the public and conservation organizations, wildlife professionals and local, state and federal agencies. Oakland is in the Northern Highlands of the Skylands Landscape region.

On August 10, 2011, Oakland Borough adopted a resolution in support of New Jersey's Wildlife Action Plan (Oakland, August 10, 2011).

The Landscape Project

The state's *Landscape Project* (see **Figure 7g**) is a pro-active, ecosystem-level approach to the long-term protection of rare species and their important habitats in New Jersey. Its goal is to protect New Jersey's biological diversity by maintaining and enhancing rare wildlife populations within healthy, functioning ecosystems. It provides users with peer reviewed, scientifically sound wildlife data that is easily accessible and can be used by state, county, and local governments, as well as nongovernmental conservation organizations and private land owners for planning, open space acquisition, and land-use regulation (NJDEP Division of Fish and Wildlife, 2012).

Wikipedia

Bobcat

The NJDEP, Division of Fish and Wildlife, Endangered and Nongame Species Program is responsible for the Landscape Project. Version 3.1 was released in 2012. The dataset was created by intersecting endangered, threatened and priority species data with the 2007 Land Use/Land Cover GIS layer, which was derived from aerial photography. The resulting data layer identifies, delineates and ranks (based on the conservation status of species present) critical habitat statewide. **Table 7.8** lists rank definitions. Each habitat patch is coded for the number of special concern, state threatened, state endangered and federally listed species present.

More than half of Oakland is ranked as habitat for priority species according to the Landscape Project Version 3.1. Thirty-six percent of the borough is Rank 4 for the presence of

Table 7.8: Landscape Project Habitat Rank Definitions

Rank	Definition
1	**Suitable Habitat** – 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.
2	**Special Concern** – Rank 2 is assigned to patches containing one or more occurrences of species considered to be species of special concern
3	**State Threatened** – Rank 3 is assigned to patches containing one or more occurrences of State threatened species.
4	**State Endangered** – Rank 4 is assigned to patches with one or more occurrences of State endangered species.
5	**Federally Listed** – Rank 5 is assigned to patches containing one or more occurrences of wildlife listed as endangered and threatened pursuant to the Federal Endangered Species Act of 1973.
Source: NJDEP Division of Fish and Wildlife, 2012	

state endangered species; 8% is Rank 3 for state threatened species; 6% is Rank 2 for special concern species; and 8% is Rank 1 for suitable habitat (see **Table 7.9** and **Figure 7g)**.

Table 7.9: Landscape Project v.3.1

Land Use Type	Acres	Percent
Rank 1	457.2	8.1%
Rank 2	324.4	5.9%
Rank 3	448.7	8.0%
Rank 4	2,045.8	36.4%
No rank	2,335.6	41.6%
Total Acres	**5,611.7**	**100.00**
Source: NJDEP, 2010		

Natural Heritage Grid and Priority Sites

The NJDEP Office of Natural Lands Management (ONLM) has developed the Natural Heritage Grid Map (see **Figure 7h**[34]), which provides a general representation of the locations of rare plant species and natural communities, including both historically and recently documented habitat. The purpose of the Grid Map is to document rare plant species and natural community habitats to inform decision-makers who need to address the conservation of natural resources. According to a Natural Heritage Program data request dated March 21, 2013, the species found (or historically found) in the grids are Torrey's Mountain-mint (*Pycnanthemum torrei*) and Torrey's Bulrush (*Schoenoplectus torreyi*), both S1-critically imperilled in New Jersey (see **Table 7.7** for descriptions). The map identifies potentially sensitive areas, and indicates where custom database searches are needed for land use decision-making. The Grid Map does not include habitat for animal species, and not all areas have been surveyed (NJDEP ONLM, November 2009).

In addition, the Natural Heritage Program makes lists of New Jersey rare plant species and ecological communities by county (see **Appendix C.4**). If suitable habitat exists in the borough, it is possible that these species could be found in Oakland (NJDEP ONLM NHP, July 30, 2008).

Natural Heritage Priority Sites have been identified by the ONLM as areas critically important for preservation of New Jersey's biological diversity. These are considered some of the best and most viable occurrences of endangered and threatened plant species and natural communities, but other occurrences of endangered and threatened plant species may exist. There are no Natural Heritage Priority Sites in Oakland (NJDEP ONLM, 2007).

[34] The Natural Heritage Database search results (2013) differed from the most recent GIS data (2009) for the Natural Heritage Grid, therefore the search information (more recent) is shown.

Figure 7g: Landscape Project Version 3.1

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

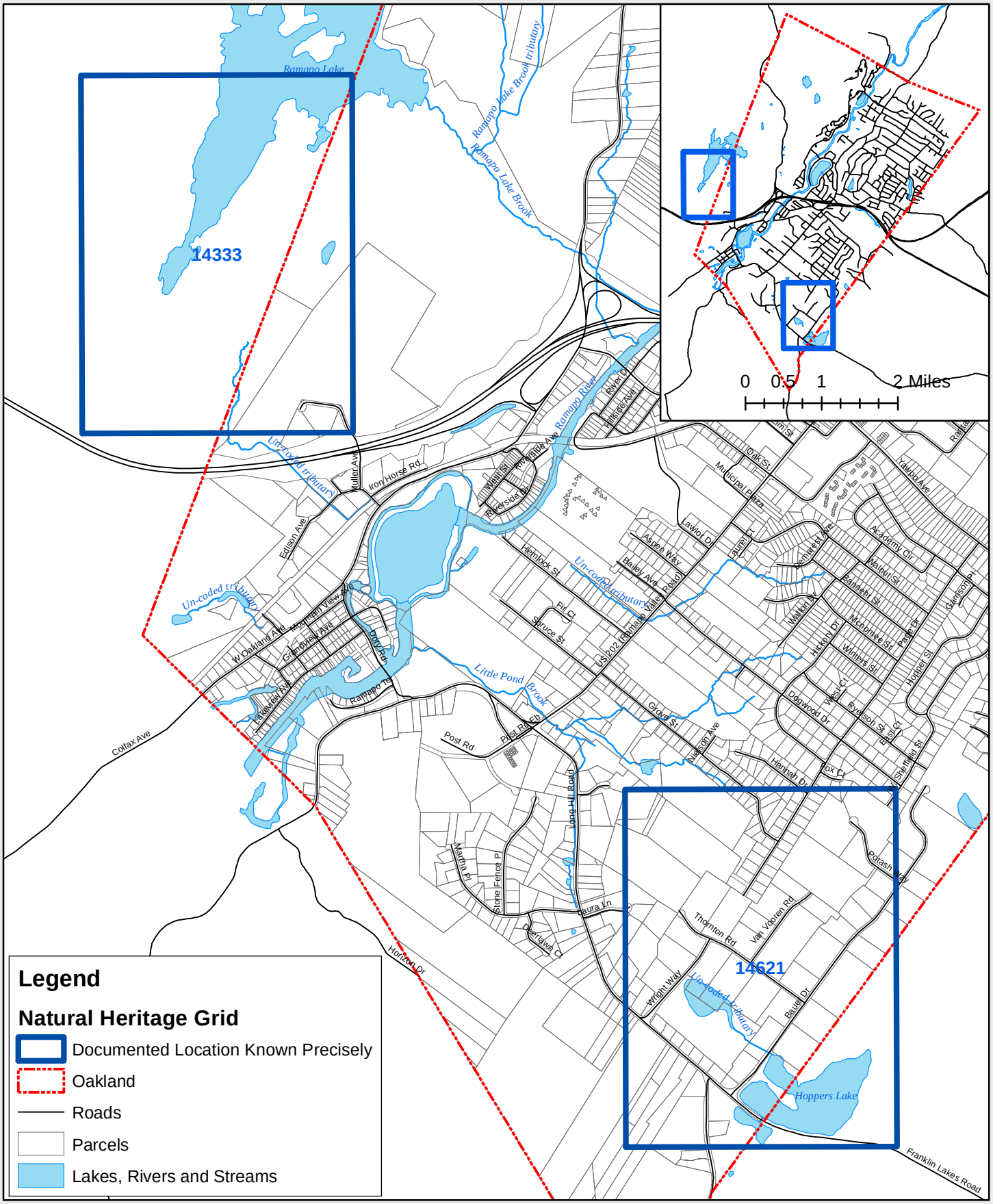


Figure 7h: Natural Heritage Grid

0 0.1 0.2 0.4 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

F. Invasive Nonindigenous Species

Non-native species (also called alien, exotic or introduced species) are those species that have been introduced outside their natural geographic range as a result of human actions, whether intentionally (e.g. as sources of food, for landscaping purposes or the release of unwanted pets) or unintentionally (e.g. in the ballast of a ship or in a load of lumber). Executive Order 13112 defines an *invasive species* as a species that is non-native to the ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (USDA, February 3, 1999). The most problematic of these displace native species, contribute to local elimination of species or even extinctions, alter the community structure, and may eventually disrupt ecosystem processes (Snyder et al, 2004). Preliminary research in NJ has documented over 1,200 species of nonindigenous plant species, or as much as 62% of the state's total vascular flora (Snyder et al, 2004).

Native plants can be susceptible to introduced diseases, which they have not evolved resistance to. The chestnut blight fungus was an accidental introduction that destroyed all mature American chestnut (*Castanea dentata*) trees, once one of the dominant trees in the New Jersey landscape. Another introduced fungus, Dutch elm disease, destroyed the American elm (*Ulmus americana*).

In addition, native plants may have little resistance to certain introduced insects, and/or these insects may have no natural enemies in their new surroundings, allowing them to rapidly reach pest proportions. Introduced insects, which may be impacting Oakland's trees, include the hemlock wooly adelgid, gypsy moth, scarlet oak sawfly and Beech Bark Disease (which is caused by a non-native scale insect that introduces a fungal disease) (NJ Forest Service, 2010). They weaken their host trees, which often succumb to successive years of infestation, to diseases carried by the insect pests, such as bacterial leaf scorch, or other environmental stresses.

For these reasons, the Final Report of the New Jersey Comparative Risk Project, which evaluated the relative risks of environmental problems to the people and ecosystems of New Jersey identified invasive species (including plants, insects, and other organisms) as one of the state's top environmental problems (Steering Committee of the New Jersey Comparative Risk Project, 2003).

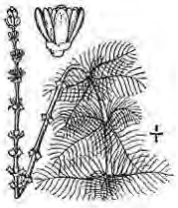
Some of the most problematic invasive exotic species in Oakland include Norway maple, autumn olive, multiflora rose, mugwort, barberry and stiltgrass. While there is no official invasive species list for New Jersey, An Overview of Nonidigenous Plant Species in New Jersey (Snyder et al, 2004) profiles 27 nonindigenous plant species that aggressively invade natural plant communities in New Jersey, which are summarized in **Table 7.10**.

Table 7.10: Invasive Nonindigenous Plants

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Acer platanoides	Norway maple	Dispersed seeds easily sprout in shade, crowding out native plants. Canopy produces deep shade and roots produce a toxic substance preventing growth of wildflowers and other trees under its canopy.		Jan Samanek, State Phytosanitary Administration, Bugwood.org

Ailanthus altissima	tree of heaven	Aggressive in disturbed areas, crowding out native plants.		Britton and Brown, 1913, Vol. 2: 446.
Alliaria petiolata	garlic mustard	Aggressive in shady habitats, crowding out native plants.		Deborah J. Kratzer
Artemisia vulgaris	Mugwort or common wormwood	Aggressive, crowding out native plants.		Deborah J. Kratzer
Berberis thunbergii	Japanese barberry	Can grow so thick in the understory of open forests that it shades out indigenous understory plants. Affects soil properties, particularly pH, which can affect plant establishment. Can form nearly impenetrable thorny thickets that impact the recreational value of natural lands.		Deborah J. Kratzer
Celastrus orbiculatus	Oriental bittersweet	The vine twines around surrounding plants, impeding sap flow. Also makes host plants too heavy, increasing wind, snow & ice damage.		Deborah J. Kratzer
Cirsium arvense	Canada thistle	Competes with crops and degrades pastures (inedible to livestock).		Deborah J. Kratzer

Dipsacus fullonum	wild teasel	Highway mowing equipment and discarded dried teasel heads from flower arrangements can lead to the establishment of new colonies, often forming a monoculture that displaces native communities.		Steve Dewey, Utah State University, Bugwood.org
Elaeagnus umbellate	autumn olive	Sprouts vigorously in disturbed areas, produces shade, preventing sprouting of native trees.		Deborah J. Kratzer
Euonymus alatus	burning bush	Grows well in many sites, especially upland forests and pastures, crowding out native plants.		James H. Miller, USDA Forest Service, Bugwood.org
Hedera helix	English ivy	Grows vigorously in deep shade, inhibiting growth of native woodland plants. Vines up tree trunks, adding to weight, and increasing likelihood of wind damage.		Deborah J. Kratzer
Ligustrum vulgare	common privet	Crowds out more desirable native plants.		USDA PLANTS Database, Bugwood.org
Lonicera japonica Thunberg	Japanese honey-suckle	Spreads aggressively in disturbed habitats, crowding out native plants. Aggressive roots can decrease the growth of native trees and vines. Vines engulf small trees and shrubs, causing them to collapse. Leafs out very early in spring, which could inhibit flowering by spring ephemerals.		Deborah J. Kratzer

Lythrum salicaria	purple loosestrife	Spreads aggressively in wetlands, eliminating open water habitats and crowding out native plants. Contributes to the loss of wildlife that depend on native wetland plants.		John D. Byrd, Mississippi State University, Bugwood.org
Microstegium vimenium	Japanese stiltgrass	Spreads aggressively in disturbed, moist, shady areas, crowding out native plants. May raise pH and reduce organic soil horizon.		Deborah J. Kratzer
Myriophyllum spicatum L.	Eurasian water-milfoil	An aquatic plant that begins growing earlier in spring than most indigenous aquatic plants, it quickly overtops, outshades, and outcompetes surrounding vegetation.		Britton and Brown, 1913, Vol. 2: 614.
Miscanthus sinensis	Chinese silver grass	Escapes from ornamental plantings and can form large clumps along disturbed areas, crowding out native vegetation. It is also extremely flammable and increases fire risks where it grows.		James H. Miller, USDA Forest Service, Bugwood.org
Phyllostachys aurea	Golden bamboo	Forms dense monocultural thickets that crowd out other plants. Difficult to eradicate once established.		Chuck Bargeron, Univ. of Georgia, Bugwood.org
Polygonum cuspidatum	Japanese knotweed	Spreads aggressively in disturbed, sunny areas, especially river banks and wetlands, crowding out native plants.		Tom Heutte, USDA Forest Service, Bugwood.org

Potamogeton crispus L.	curly leaf pondweed	An aquatic plant that begins growing earlier in spring than most indigenous aquatic plants, it quickly overtops, outshades, and outcompetes surrounding vegetation. Can form dense mats that disrupt boating, swimming, and fishing.		Mohlenbrock , 1995
Rosa multiflora	multiflora rose	Spreads everywhere, except standing water, crowding out native plants and degrading pastures.		James H. Miller, USDA Forest Service, Bugwood.org
Rubus phoenicolasius	wineberry	Forms an extensive, nearly impenetrable understory layer in favorable locations such as moist soils in forests over dolomite, marble, shale, diabase, and traprock, crowding out native plants.		Jil M. Swearingen, USDI National Park Service, Bugwood.org
Viburnum plicatum	Japanese viburnum	Shade tolerant shrub considered highly threatening to native plant communities.		Richard Webb, Self-employed horticulturist, Bugwood.org
Vinca minor	periwinkle	Spreads in shady forests, crowding out native plants.		Jil M. Swearingen, USDI National Park Service, Bugwood.org
Wisteria floribunda and W. sinensis	Japanese and Chinese Wisteria	Aggressive climbing vines that girdle tree trunks and branches. Dense canopies weigh down branches and shade underlying areas.		Ted Bodner at USDA-NRCS PLANTS Database
Sources: Snyder & Sylvan, 2004; Swearagain et al., 2002; Courtney, 1997; Center for Invasive Species and Ecosystem Health (bugwood.org), 2010; Britton and Brown, 1913; Mohlenbrock , 1995; Bodner at USDA-NRCS PLANTS Database				

Loss of Biodiversity

The deciduous forests of Northern New Jersey are not as static as they appear. For many people, the forest is a stable place; trees never move and from year to year they look the same, save the effects of storms and other destructive processes. The truth is, the forests of Northern New Jersey are constantly changing. The presence of invasive species is a hazard to both the function and stability of a healthy forest (Morin et al., 2007). This threat is exacerbated by other factors that stress the ecosystem, such as climate change and direct human interference (Evans et al., 2010). The structure of plant communities and dynamics of the vegetation can be affected, as well as the importance values[35] of the species present in the ecosystem (Morin et al., 2007). There are a large number of species that are having an adverse effect on the forests of New Jersey, however the major contributors are Beech Bark Disease, Dutch Elm Disease, Chestnut Blight and the introduction of the Norway Maple (*Acer platanoides*). All of these invasive species and pathogens were introduced by humanity, both intentionally and unintentionally.

Oak and chestnut trees dominated the forest prior to European arrival. **Table 7.11** presents forest inventory data from the USDA Forest Service that shows that forest composition is changing. The American Chestnut (*Castanea dentata*) is completely missing from the forest. All of the species of oak, while still present, are only present in their mature sizes. The most predominant juvenile species group is that of maple. Within that group is the Norway Maple (*Acer platanoides*). This table shows how the mature oak species are being replaced by maples. The process, in conjunction with the effects of the other invasive species, decreases the number of species present in the forest, thus attacking at the roots of the ecosystem and reducing biodiversity.

Table 7.11: Number of Live Trees on Forest Land by Species Group and Diameter Class

Tree species groups	Tree diameter classifications									
	5.0-6.9"	7.0-8.9"	9-10.9"	11-12.9"	13-14.9"	15-16.9"	17-18.9"	19-20.9"	21-28.9"	Total
Select white Oaks (25)	-	-	0	40,122	-	-	-	-	-	40,122
Select red oaks (26)	-	40,122	120,367	40,122	120,367	40,122	120,367	40,122	40,122	561,711
Other white oaks (27)	-	0	40,122	120,367	120,367	-	0	40,122	-	320,978
Hickory (29)	80,244	80,244	-	40,122	-	-	-	-	-	200,611
Yellow birch (30)	80,244	-	-	-	-	-	-	-	-	80,244
Hard maple (31)	40,122	80,244	-	40,122	-	-	-	-	-	160,489
Soft maple (32)	120,367	160,489	80,244	0	80,244	-	40,122	-	-	481,467
Tupelo and black gum (35)	40,122	40,122	80,244	-	-	-	-	-	-	160,489
Ash (36)	-	40,122	-	-	-	-	-	-	-	40,122
Yellow-poplar (39)	-	-	-	-	-		-	40,122	-	40,122
Other eastern hard hardwoods (42)	0	40,122	240,733	-	-	-	-	-	-	280,856
Totals:	361,100	481,467	561,711	280,856	320,978	40,122	160,489	120,367	40,122	2,367,212

Source: USDA Forest Service, 2012 (http://apps.fs.fed.us/fido/standardrpt.html, using the following search terms: Area of Interest=NJ, Bergen County; Reports=Tree Count Reports; Survey Years=2012 (which gives you 2008-2012); Filter Options=none; Submit request; Display 4.1 - Number of live trees (at least 1 inch d.b.h./d.r.c.) by species group and diameter class

Beech Bark Disease

Beech Bark disease is a disease that is decimating the populations of the American Beech tree (*Fagus grandifolia*) in the northeastern areas of its native range (Busby and Canham, 2011).

[35] The importance value is a measure of the dominance of a species in a particular community.

It is a general term given to the combined effects of the beech scale insect (*Cryptococcus fagisuga* Lind.) and two different canker causing fungi, *Neonectria coccinea* var. *faginata* Lohm., a non-native species, and *Neonectria galligena* Bres., a native species (Busby and Canham, 2011; Evans and Finkral, 2010; Morin et al, 2007). The scale insect feeds on the beech bark causing injuries that the fungi use as a vector to enter the tree and infect it. The fungus can also be spread from tree to tree by the insect.

Beech Bark disease came to the continent of North America in Nova Scotia around 1890 and has been spreading ever since (Busby et al., 2011) (Morin et al., 20007). It began affecting trees in this area around 1960 (Busby and Canham, 2011). It caused an 80-90% morality rate when first introduced to a new location and the residual effects maintain the population at very low levels (Busby and Canham, 2011). The forest is changing from a healthy population of Beech trees to "diseased thickets of small trees" and indicates a drastic change in the carbon balance of the forest overall (Morin et al., 2011).

Dutch Elm Disease

Dutch Elm Disease is a fungal infection by *Ophiostoma ulmi* (Buisman) Nanf. and *Ophiostoma novo-ulma Basier* (Evans and Finkral, 2010; Flores, 2006). The fungus is spread by exotic beetles that feed in the American Elm tree (*Ulmus americana*) (Evans and Finkral, 2010). The disease enters the xylem and inhibits the tree's ability to transport water and nutrients (Evans and Finkral, 2010).

This disease was introduced to the United States in 1931 (Flores, 2006). It came to Cleveland, Ohio from France aboard elm logs (Flores, 2006). It has been estimated that this disease has killed approximately 77 million elm trees (Flores, 2006).

Chestnut Blight

The American Chestnut (*Castanea dentata*) was once one of the most common species of the deciduous forest of the Eastern United States, making up 25% of trees in many of these forests (Evans and Finkral, 2010). A disease, *Cryphonectria parasitica*, was introduced from Asia that decimated the populations of American Chestnut (Evans and Finkral, 2010; Griffin, 2000). The disease does not fully kill the tree, as it does not affect the roots, however any stem that appears above the surface of the soil is susceptible to the disease (Griffin, 2000). The disease forms a canker on the bark of the tree that attacks the cambium, starving the tree of nutrients and water and killing it (Griffin, 2000).

Chestnut Blight was first observed in New York City in 1904 (Griffin, 2000). It originated somewhere in Asia, likely Japan (Evans and Finkral, 2010). As early as the 1950s, the American Chestnut was "functionally removed from its ecological role" in the forests of Eastern North America (Griffin, 2000).

Norway Maple (Acer platanoides)

Norway Maple (*Acer platanoides*) is native to much of Europe (Galbraith-Kent et al., 2008). It was introduced intentionally in 1756 (Galbraith-Kent et al., 2008).

The Norway maple does not directly attack native species as other invasive species do. Instead, it outcompetes native species for resources and thus causes the native species to become less prevalent. A study performed in 2004-2006 at Duke Farms in Central New Jersey, determined that Norway Maple has a distinct, negative impact on the growth of juvenile native species (Galbraith-Kent et al., 2008). The survey found that the presence of mature Norway Maple has such a negative effect that the presence of juvenile Norway Maple is irrelevant (Galbraith-Kent et al., 2008). When no mature Norway Maple is present, the presence of

saplings does have a negative impact on the growth rate of sapling native species (Galbraith-Kent et al., 2008).

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Internet Resources: Biological Resources

Wildlife and Plants

Backyard Habitats & Conservation:

- Deer Tolerant/Resistant Native Plants: http://www.bhwp.org/cms/files/file_ID96121.pdf
- Gardening for Butterflies: http://www.state.nj.us/dep/fgw/ensp/pdf/literature/butterfly_gardening.pdf
- National Audubon Society: http://www.audubon.org/bird/at_home/
- New Jersey Audubon Society: http://www.njaudubon.org/SectionBackyardHabitat/Welcome.aspx
- NJDEP Outdoor Classroom links: http://www.state.nj.us/dep/seeds/syhart/outclass.htm
- USDA NRCS: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?cid=nrcs143_023574

Bear Facts for Homeowners: http://www.state.nj.us/dep/fgw/bearfacts_homeowner.htm

Checklists

- Birds of NJ: http://www.state.nj.us/dep/fgw/chkbirds.htm
- Butterflies of NJ: http://www.naba.org/chapters/nabanj/butterflies.html
- Endangered & Threatened Wildlife of NJ: http://www.njfishandwildlife.com/tandespp.htm
- Freshwater Fish Of NJ: http://www.njfishandwildlife.com/chkfish.htm
- Mammals of NJ: http://www.state.nj.us/dep/fgw/chkmamls.htm
- Native Plants of Bergen County: http://www.npsnj.org/plant_lists/native_plants__Bergen.xls
- Reptiles and Amphibians of NJ: http://www.state.nj.us/dep/fgw/ensp/fieldguide_herps.htm
- Species of Special Concern of NJ: http://www.njfishandwildlife.com/ensp/pdf/spclspp.pdf

Cornel Lab of Ornithology, All About Birds: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/

Injured birds & baby wildlife: http://www.co.bergen.nj.us/index.aspx?nid=607

Native Plants:

- Bowman's Hill Wildflower Preserve: http://www.bhwp.org
- Native Plant Society of NJ: http://www.npsnj.org/
- USDA Plants Database: http://plants.usda.gov

NJDEP:

- Conserve Wildlife Foundation of New Jersey: http://www.conservewildlifenj.org/
- Division of Fish and Wildlife Home Page: http://www.njfishandwildlife.com/wildlife.htm
- Environmental Rules: http://www.nj.gov/dep/rules/nj_env_law.html
- Endangered and Nongame Species Program Home Page: http://www.state.nj.us/dep/fgw/ensphome.htm
- Landscape Project: http://www.state.nj.us/dep/fgw/ensp/landscape/
- NJ Wildlife Action Plan: http://www.state.nj.us/dep/fgw/ensp/wap/wap_outline.htm
- Rare Plants & Communities: http://www.state.nj.us/dep/parksandforests/natural/index.html

North American Butterfly Association, North Jersey Butterfly Club: http://www.naba.org/chapters/nabanj/

- Long dash (*Polites mystic*): http://www.naba.org/chapters/nabanj/butterflies/long_dash.html

Rare Wildlife Sighting Form: http://www.njfishandwildlife.com/ensp/rprtform.htm

Rare Plant Report Form: http://www.state.nj.us/dep/parksandforests/natural/heritage/natherrareplantspeciesreportform1_2008.doc

Invasive Species

Invasive Species – New Jersey: http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml

Native Plant Society of New Jersey – Invasive Species: http://www.npsnj.org/pages/nativeplants_Plant_Lists.html

New Jersey Invasive Species Strike Team (NJISST): http://www.njisst.org/

Forest Health: http://www.state.nj.us/dep/parksandforests/forest/njfs_forest_health.html

8: OPEN SPACE & RECREATION

A. Purposes & Funding

The purposes of open space preservation include:

- provide adequate active and passive recreation;
- provide recreational and open space opportunities on an equal and accessible basis for all citizens;
- maintain water quality and groundwater recharge areas;
- protect sensitive environmental features;
- protect historic areas;
- maintain biodiversity;
- minimize erosion or damage from flooding;
- maintain rural character (ANJEC, no date).

Deborah J. Kratzer

Ramapo Lake in Ramapo Mountain State Forest

Funding for open space comes from a variety of sources, including municipal, county, state and federal sources and private land trusts. Private land trusts are non-profit organizations that "can often act faster and be more creative in their real estate transactions than established government agencies" according to Howe (1989). Landowners are able to reap tax benefits through charitable donations to a land trust. Many successful open space purchases combine a number of funding sources and strategies.

Bergen County assesses a tax which is designated for land preservation, parks and recreation projects and historic preservation. The rate not to exceed one cent per $100 of total County equalized real property valuation provides approximately $11 million annually (Bergen County Department of Planning & Economic Development, August 2004).

The Borough of Oakland has had its open space trust fund approved by residents in 2003, 2008, and the latest fund in 2013 will be for 10 years. The money is for current open space obligations, future open space purchases, and other passive recreation, conservation, farmland preservation or historic reservation purposes. The trust fund enables the borough to apply for other open space grant money that it would not otherwise eligible for (Birchenough, August 22, 2013).

The Garden State Preservation Trust Act provides state funds for land acquisition and park development through the Green Acres program.

Private land trusts working to preserve land in northern New Jersey and the Association of New Jersey Environmental Commissions (ANJEC) are sources for in-depth information concerning open space preservation through various funding, planning, and zoning techniques (see **Internet Resources**).

B. Greenway Establishment & Maintenance

A *greenway* is a corridor of undeveloped land or open space, which often protects environmental features, such as a stream corridor, floodplain, forested ridgeline, or animal migration route, but which can also preserve a scenic view and provide recreational opportunities, such as parks or biking/hiking trails. Greenway corridors also have the potential for positive economic impacts, by creating jobs, enhancing property values, expanding local businesses, attracting new businesses, increasing local tax revenues, decreasing local government expenditures, and promoting a local community. The publication Economic Impacts of Protecting Rivers, Trails and Greenway Corridors outlines procedures for analyzing economic impacts of a greenway project, and provides examples. Decision makers can benefit from recognition of potential economic impacts as well as intrinsic values of greenways in support of decisions that enhance the well-being of the community (National Park Service, 1995).

Garden State Greenways is an online planning tool designed for all those involved in conserving open space, farmland, and historic areas in New Jersey. It uses GIS to identify *hubs* (larger areas of undeveloped land with important natural resource values) and linear *connectors* between these hubs. The goal of the program is to help coordinate efforts of both private groups and government agencies (NJ Conservation Foundation, 2005).

Local governments often use a variety of planning and zoning techniques for establishing greenways, including creating a greenway map and adopting it as part of the Master Plan, creating a Greenway Overlay District, cluster zoning and Transfer of Development Rights. These strategies can be combined with land preservation, private land trusts, and conservation easements to meet the Borough's open space and recreation goals (Howe, 1989).

Before a greenway is established, issues of maintenance, public access and monitoring of easements must be addressed to ensure long-term success of the project (Howe, 1989).

One of the five major initiatives of the Regional Plan Association (RPA) (a planning organization focused on the New York/New Jersey/Connecticut metropolitan region) is a regional Greensward. By establishing a regional network of greenways and revitalized urban parks and open spaces, to safeguards water supplies and recreational opportunities and shapes future growth by integrating protected large-scale landscape resources, an established regional network of greenways, and revitalized urban parks and open spaces. The benefits of this regional greenway include aquifer protection, habitat preservation, recreational opportunities and aesthetically pleasing viewsheds (RPA, 1996; Maser Consulting, August 2009).

A large part of the Borough of Oakland is part of preserved open space greenway that includes state parks and forests, water authorities and county parks in the New Jersey and New York Highlands. The location of the greenway within the most densely populated metropolitan area of the United States underscores its significance (Maser Consulting, August 2009).

A variety of active and passive open space and recreation opportunities are available within the Borough of Oakland. Some of these are described in the paragraphs below.

C. Open Space & Recreation in Oakland

An updated inventory of the preserved open space & recreation properties within the Borough is presented in **Table 8** and **Figure 8a**. Using the acreage figures in the GIS data files (which may differ somewhat from deed acreage), a total of 1,709 acres (788 state, 449 county, and 472 acres municipal land) have been preserved in Oakland, which is approximately 30% of the Borough.

State Open Space

Ramapo Mountain State Forest

Ramapo Mountain State Forest is a 4,269 acre park located in Bergen and Passaic Counties. Approximately 752 acres of the state forest is within the Borough of Oakland. Two of the public access points are located on Skyline Drive in Oakland. Extensive forests cover the Ramapo Mountain's steep rocky slopes and provide a sanctuary for wildlife. Bedrock outcrops and glacial erratics can be seen.

The many miles of trails are used for hiking, mountain biking, horseback riding and cross-country skiing. Scenic vistas include views of the New York City skyline. Fishing and hunting are permitted, subject to rules of the Division of Fish and Wildlife Regulations.

Hoeferlin Trail in Ramapo Mountain State Forest

The Ramapo Lake Natural Area (1,417 acres) within the forest encompasses the 120 acre Ramapo Lake. Fishing and birdwatching are enjoyed there, but swimming is not permitted. The Lake and surrounding wetlands provide excellent habitat for a variety of amphibians and reptiles. The forest borders the Ramapo Mountain Reservation, which is part of the Bergen County Park System, as well as Ringwood State Park (NJDEP Division of Parks and Forestry, August 7, 2013).

Another access point is from the end of Pool Hollow Road. The trail connects to the Cannonball Trail with an overpass across Interstate Route 287. The Cannonball Trail is a historic trail once used by the Continental army for supplies during the American Revolution (Griffin, February 17, 2013).

Bergen County Open Space

Ramapo Reservation County Park

The Ramapo Reservation County Park is comprised of four contiguous areas owned and managed by Bergen County, including Ramapo Reservation County Park (Mahwah Township), Camp Glen Gray, the former Camp Tamarack, and the former Camp Todd. Together, these areas encompass approximately 4,500 acres of preserved lands (Maser Consulting, September 22, 2010).

This park is located in the northwest corner of Oakland and extends into neighboring Mahwah Township (see **Figure 8a**). The Ramapo Reservation County Park is included within the Highlands physiographic province (see **Section 3A**) and is part of the Appalachian Mountain chain. Adjacent open space and protected lands include Mahwah Township Park, Ringwood State Park, Ramapo Mountain State Forest, Wawayanda State Park, Tranquility Ridge County Park, Norvin Green State Forest, Long Pond Iron Works State Park, Wanaque Wildlife Management Area, Wanaque Reserve, lands adjacent to Wanaque Reservoir (North Jersey District Water Supply Commission), Sterling Forest State Park, Palisades Interstate Park and Harriman State Park (Maser Consulting, September 22, 2010). Together, this greenway totals over 12,950 acres of preserved land. Ramapo Reservation County Park is hilly and forested. It includes 19.7 miles of trails, tent camping and access to the Ramapo River (in Mahwah Township) (Bergen County Department of Planning & Economic Development, August 2004).

At the time of this writing, Bergen County is in the process of developing a management plan for the park and accepting public comments on Phase 2: Develop and Evaluate Preliminary Alternatives (Bergen County Department of Planning & Economic Development, September 3, 2013).

Camp Glen Gray

A former Boy Scout Camp, Camp Glen Gray is a camping facility located along the border of the municipalities of Oakland and Mahwah, located off of State Routes 202 and 208 and Interstate Route 287. This 750 acre camp was acquired by Bergen County in 2002. The park is available weekends (by reservation and for a fee), and managed by the Friends of Glen Gray. The park offers hiking trails, camping, dining hall, amphitheater, recreation field, and fishing and boating opportunities on Lake Vreeland (Maser Consulting, September 22, 2010).

Tamarack Recreation Area

The Tamarack Recreation Area was also a former Boy Scout camp that is now owned by Bergen County. In 1993, NJDEP declared the site an illegal waste dump, and it was then remediated. Access to this 182 acre site is from Skyline Drive in Oakland. There are no facilities, but trails lead through woodlands along a ridgeline of the Ramapo Mountains, connecting adjacent open space at Camp Glen Gray, Todd Recreation Area and Ramapo Mountain State Forest (Maser Consulting, September 22, 2010).

An unnamed Category 1 Trout Production tributary of the Ramapo River flows through the recreation area (FW2-TPC1; see **Section 6D**). A dam approximately 11 feet high and 200 feet long on the creek creates Lake Tamarack. It is owned by Bergen County and is primarily used for recreational purposes, including fishing (Maser Consulting, September 22, 2010).

Todd Recreation Area

Another former Boy Scout camp, the Todd Recreation Area comprises 73 acres of woodlands along a ridgeline of the Ramapo Mountains. The park can be accessed on the eastern side of Skyline Drive in Oakland. Hiking trails connect to the adjacent Ramapo Mountain State Forest and Tamarack Recreation Area. Lake Todd is available for fishing. In addition, the site contains ecologically significant features such a trout production stream and several vernal pools (see **Section 7c**) (Maser Consulting, September 22, 2010).

Campgaw Mountain County Reservation

The 1,352 acre Campgaw Mountain County Reservation is a Bergen County park located mostly within Mahwah, and partially within Oakland and Franklin Lakes. This county park is bordered by US Route 202 to the west, Interstate 287 to the east and private properties to the north and south. The area includes a ski area located on the Reservation's highest peak, Campgaw Mountain, which is 735 feet above sea level. Facilities include ski lifts, snow tubing, a small lodge, snack bar, and equipment rental shop. The Reservation was formerly a U.S. Army Nike Missile station for the defense of the New York Metropolitan Area from strategic bombers but closed in 1971 (Maser Consulting, September 22, 2010).

Municipal Open Space

Great Oak Park

In 2011, the Borough of Oakland obtained the approximately 40 acre property formerly known as Heritage Hills, Pleasureland, Mueller's Park or FRG (see **Figure 8b**). The area adjacent to the Ramapo River is deciduous forest and deciduous wooded wetlands, while much of the site is deciduous brush/shrubland and deciduous scrub/shrub wetland. Little Pond Brook, a Category 1, Trout Production stream (FW2-TPC1; see **Section 6D**) runs near the southern border of the park and the joins the Ramapo River near the southwestern corner of the property. About half the property is within the 300-foot C-1 stream buffer and almost the entire property is within the "100-year" floodplain (see **Section 6B**). Several trails are present as well as remnants of extensive paved areas and foundations of buildings from earlier development. Two large swimming pools have been filled in for safety reasons.

A view of the Ramapo River looking north at Great Oak Park.

In 2012, the Oakland Environmental Commission and the Oakland Recreation Commission worked together to draft an environmentally and financially responsible plan for low impact recreation at the site. Plans under consideration include possible botanical gardens and picnic area, river access and docks, skate park, great lawn, band shell, and dog park, in addition to trails (Great White Oak Park Feasibility Study/Business Plan; Oakland Recreation, May 7, 2013).

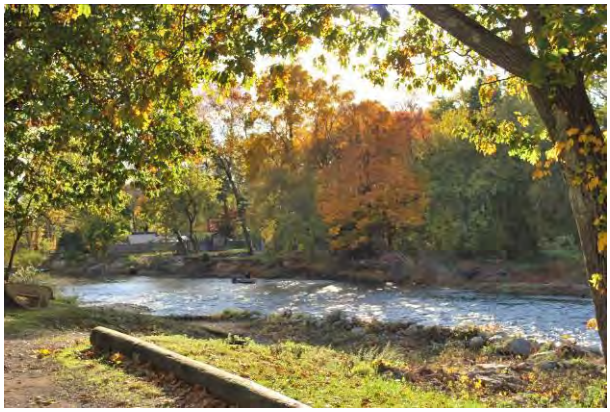
Above left: Great White Oak Park (formerly Pleasureland) was named after this white oak (Quercus alba) that dominates the entrance of the park. Above right: Approximately 30% of the Great White Oak Park is comprised of open fields that are in transition of early succession. Mixed in with seasonal grasses and wild flowers are young cedars.

Breakneck Road

The open space known as the former NJ Capital property on Breakneck Road consists of 5 parcels totaling 13 acres. It is located in the southern tip of the borough. It is near a National Heritage Priority site and is covered with mature deciduous forest (see **Figure 8c**).

Oakland Recreation Complex

The Oakland Recreation Complex is composed of two lots totaling about 28 acres. It is located on Lawlor Drive and Spring Avenue (see **Figure 8d**). The western corner of the property borders the Ramapo River, where there is access to the river. The floodplain extends roughly 150 to 200 feet into the property. The park consists of athletic fields, including baseball and softball fields, tennis courts and a roller hockey rink. There is a preschool playground near the hockey rink. A few wooded areas are along the edges of the property. A strip approximately 50 feet wide bordering the railroad is deciduous brush/Shrubland.



Nancy Krause

Top left: Oakland Recreation Complex. Bottom left: Ramapo River railroad crossing. Usually two freight trains pass through town a day. This is a popular access point to the river since it is next to the recreation field. Right: Ramapo River looking downstream from recreation field.

Potash Lake

The open space known as Potash Lake is made up of about 40 acres including Potash Lake and its shoreline and islands (see **Figure 8b**). Most of the area is water (artificial lake and streams and canals), while the land areas are deciduous forest and deciduous wooded wetlands, all of which are within the floodplain. Great Oak Park borders this property to the southeast. The western side of the lake has a walking trail along the entire length. A public boat ramp is also accessible from West Oakland Avenue park entrance.

Nancy Krause

Stewart Woods contains the largest specimen of Chestnut Oak (Quercus prinus) in Oakland.

Stewart Woods

Two parcels totaling 7 acres make up Stewart Woods, which is situated near the Oakland Recreation Complex (see **Figure 8d**). There is walk in access from Route 202 and McNomee Street. Surrounded by residential development, the property is covered by mature deciduous forest, with a swath of deciduous wooded wetlands through the center. Along the hillside there is a guided nature trail. Along Ramapo Valley Road there is a walking trail with benches and picnic tables.

Nancy Krause

Stewart Woods features a nature trail, benches and picnic tables.

Soons Well Field

Near the northern border of the borough, off Valley Forge Road, 12 acres form the open space known as Soons Well Field (see **Figure 8e**). The Ramapo River, which is designated a Category 1 stream in this section, borders the property on the west, and an unnamed Category 1 stream (see **Section 6D**) flows near the southeastern edge and intersects with the Ramapo River near the southwestern corner of the property. Nearly all of the property is within the 300-foot C-1 stream buffer and it is entirely within the floodplain (see **Section 6B**). The park is roughly $^1/_3$ deciduous wooded wetland, $^1/_3$ coniferous forest and $^1/_3$ deciduous forest with the exception of one soccer field.

Truman Field

The Truman Field property is approximately 20 acres and is accessed from Roosevelt Boulevard (see **Figure 8d**). The land is almost completely deciduous forest, with the exception of Worischeck Field, a soccer field. The floodplain of the Ramapo River extends into the eastern border of this property, and the floodplain of Ramapo Lake Brook spreads into the southwestern corner. Ramapo Lake Brook is designated Category 1 (see **Section 6D**). In addition, Ramapo Mountain State Forest borders this property to the south.

Veteran's Park

This landscaped 6 acre park is located in the center of town with the library framing the back of the property and Ramapo Valley Road at the front. It is a memorial to the Veterans of all wars.

Nancy Krause

Left: View of Veteran's Park with the Public Library in the background. Right: Veteran's Park with the Ponds Reformed Church spire in the background.

Table 8: Preserved Open Space & Recreation Areas

Owner	Park Name	Block	Lot	Acres
Bergen County	Campgaw Mountain	5504	5	6.5
Bergen County	Campgaw Mountain	5701	2	176.7
Bergen County	Glen Gray	601	8	11.03
Bergen County	Glen Gray	601	9	61.71
Bergen County	Glen Gray	701	11	9.65
Bergen County	Ramapo Mtns	701	12	11.49
Bergen County	Ramapo Reservation	701	18	6.367
Bergen County	Tamarack	601	4	25.53
Bergen County	Tamarack	601	11	5.28
Bergen County	Tamarack	601	12	8.8
Bergen County	Tamarack	601	13	9.76
Bergen County	Tamarack	601	14	16.35
Bergen County	Tamarack	701	1	19.55
Bergen County	Tamarack	701	2	44.43
Bergen County	Todd	701	4	35.5
Municipal	Algonquin Trail – vacant land	5404	24	3.86
Municipal	Back Wayne Line- Bi County Open Space	2207	1	30.36
Municipal	Back Wayne Line- Bi County Open Space	2401	1	38.004
Municipal	Back Wayne Line- Bi County Open Space	2401	10	0.9
Municipal	Back Wayne Line- Bi County Open Space	2901	4	2.52
Municipal	Back Wayne Line- Bi County Open Space	3101	18	2.28
Municipal	Back Wayne Line- Bi County Open Space	3101	19	3.1
Municipal	Back Wayne Line- Bi County Open Space	3101	20	1.28
Municipal	Breakneck Road – vacant land	3101	8	50.47
Municipal	Great Oak Park	2007	5	0.173
Municipal	Great Oak Park	2201	11	0.181
Municipal	Ramapo Mtns	601	6	50.4
Municipal	Ramapo Mtns	601	10	39.26
Municipal	Ramapo Mtns	701	6	29.98
Municipal	Ramapo Mtns	701	8	20.02
Municipal	Ramapo Mtns	701	9	9.9
Municipal	Ramapo Mtns	701	10	38.47
Municipal	Ramapo Mtns	701	13	7.52
Municipal	Ramapo Mtns	701	14	4.02

Owner	Park Name	Block	Lot	Acres
Municipal	Ramapo Mtns	701	15	4.34
Municipal	Ramapo Mtns	701	17	1.7
Municipal	Ramapo Ridge-Open Space	901	7	8.09
Municipal	Recreation Field	1803	16	0.174
Municipal	Riverside Field	1803	17	0.172
Municipal	Riverside Field	1803	18	5.75
Municipal	Schuyler Lake Park	1901	1	26.64
Municipal	Schuyler Lake Park	2007	2	1.4
Municipal	Stewart Woods Park	3801	52	3.48
Municipal	Stewart Woods Park	3801	112	3.16
Municipal	Tamarack	701	5	29.98
Municipal	Tamarack	701	7	21.6
Municipal	Truman Field	402	39	20.68
Municipal	Van Allen House- Historic Landmark	4601	13	0.658
Municipal	Veterans Park	901	8	1.589
Municipal	Veterans Park	901	9	4.4
Municipal	Veterans Park	1803	15	0.069
Municipal	Horizon Drive – vacant land	2901	5	0.2
Municipal	Horizon Drive – vacant land	3001	19	3.33
Municipal	Horizon Drive – vacant land	3101	1	2.3
State DEP	Ramapo Park	101	1	57.24
State DEP	Ramapo Park	103	1	0.39
State DEP	Ramapo Park	301	1	16.68
State DEP	Ramapo Park	301	10	196.4
State DEP	Ramapo Park	401	1	166
State DEP	Ramapo Park	401	8	10.9
State DEP	Ramapo Park	401	9	10.5
State DEP	Ramapo Park	402	2	19.6
State DEP	Ramapo Park	501	1	19.33
State DEP	Ramapo Park	501	3	64.89
State DEP	Ramapo Park	502	1	144.7
State DEP	Ramapo Park	601	1	21.3
State DEP	Ramapo Park	601	2	20.41
State DEP	Ramapo Park	601	7	0.19
State DEP	Todd	701	3	39.02
			Total Acres:	1,708.6

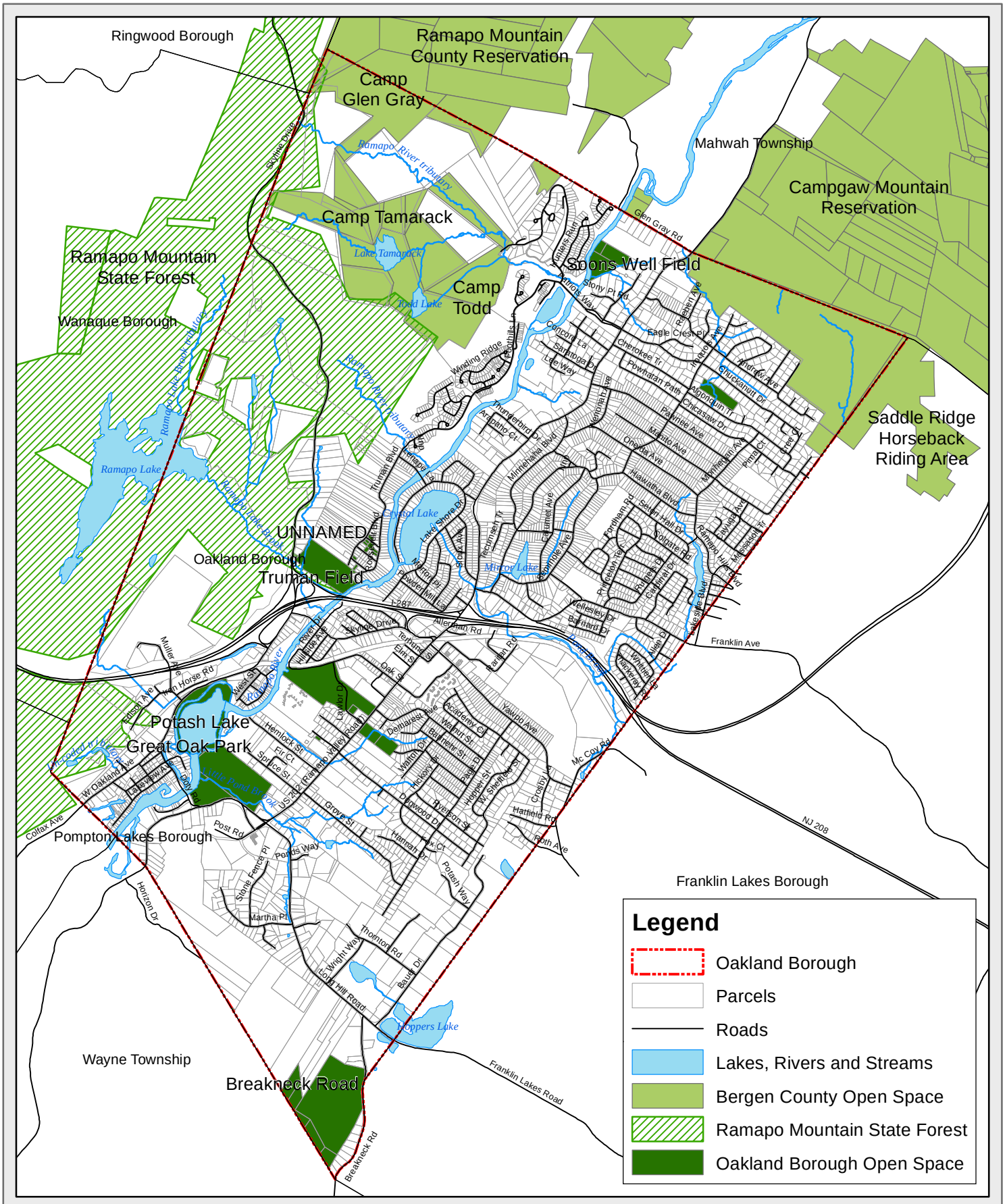


Figure 8a: Open Space & Recreation Areas

0 0.25 0.5 1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Figure 8b: Open Space & 2012 Aerial Photo Great Oak Park & Potash Lake

0 0.025 0.05 0.1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

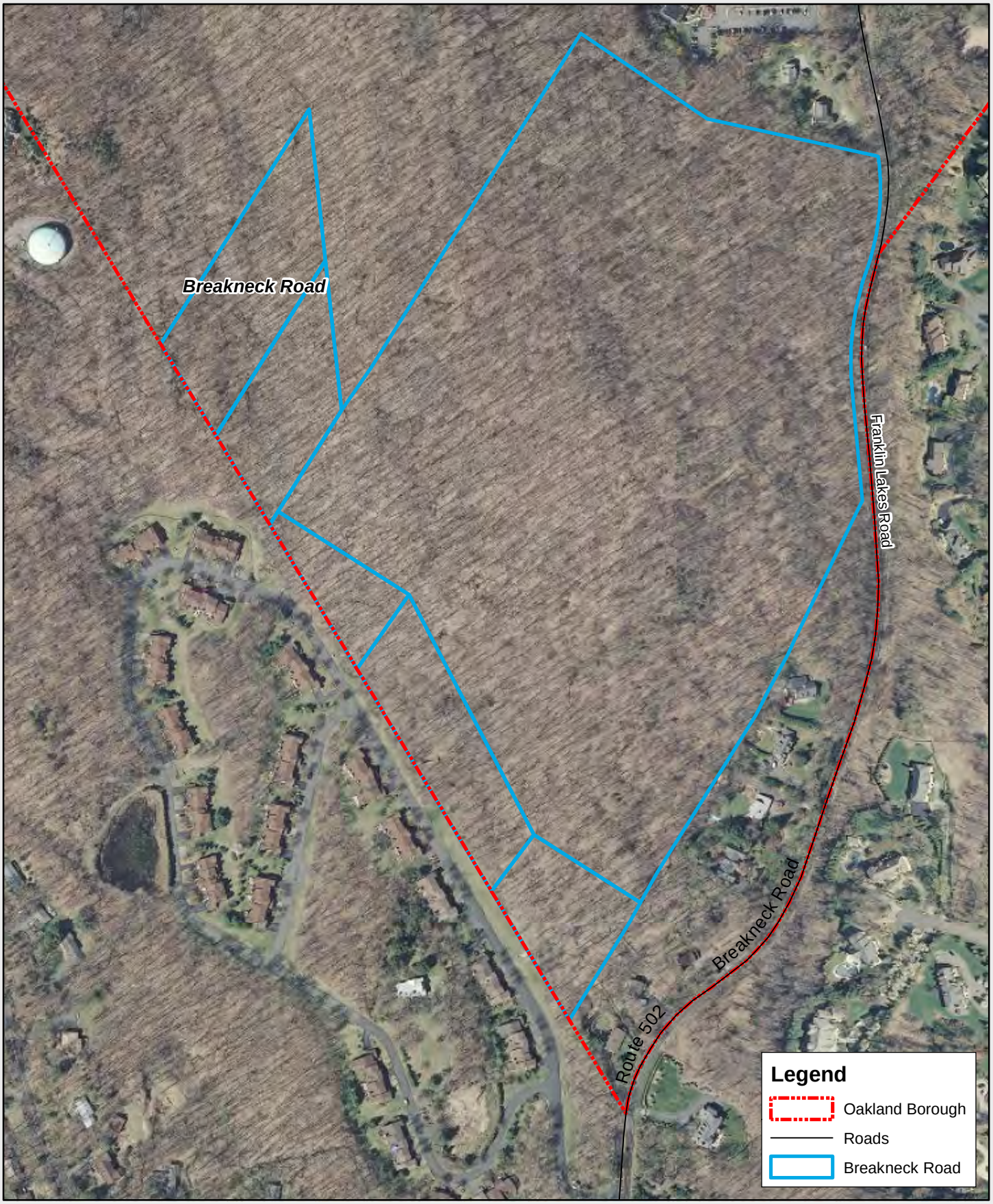


Figure 8c: Open Space and 2012 Aerial Photo Breakneck Road

0 0.025 0.05 0.1 Miles

N

Oakland Borough Natural Resource Inventory
Prepared by Kratzer Environmental Services

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

Figure 8d: Open Space & 2012 Aerial Photo Recreation Complex & Stewart Woods

0 0.025 0.05 0.1 Miles

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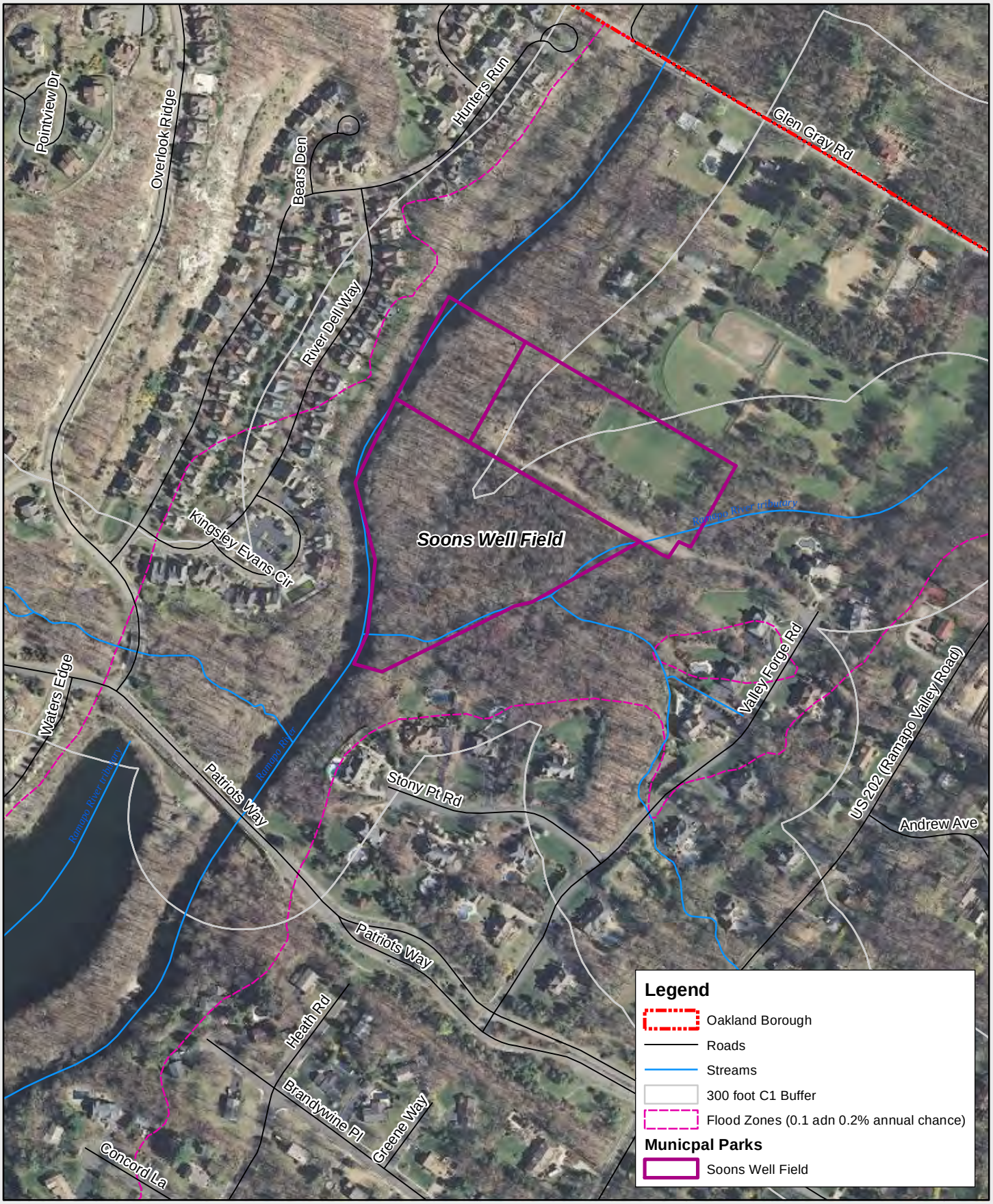

Figure 8e: Open Space and 2012 Aerial Photo Soons Well Field

0 0.025 0.05 0.1 Miles

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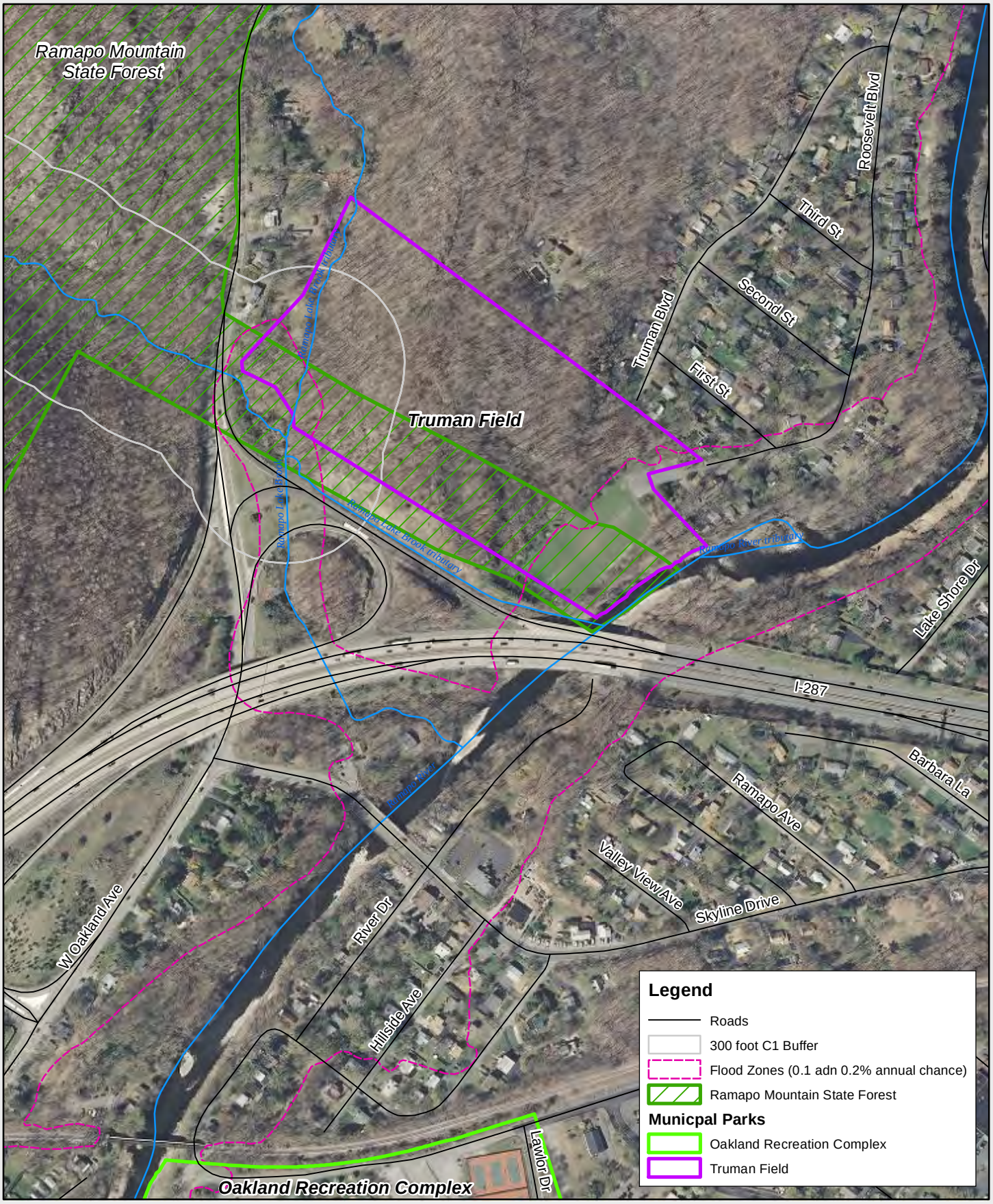

Figure 8f: Open Space & 2012 Aerial Photo Truman Field

0 0.025 0.05 0.1 Miles

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9: REGIONAL RELATIONSHIPS

A. The Highlands Water Protection and Planning Act

The Highlands Water Protection and Planning Act (Highlands Act) (N.J.S.A. 13:20-1 et seq.), which became effective in August 2004, is a law that aims to preserve open space and protect the state's greatest diversity of natural resources including the precious water resources that supply drinking water to more than half of New Jersey's population. The Highlands Act defines the geographical boundary of the Highlands Region and the Highlands Preservation and Planning Areas; requires the NJDEP to establish regulations in the Highlands Preservation Area; and creates a Highlands Water Protection and Planning Council, which is responsible for developing a regional master plan for the Highlands Region.

Of the 800,000 acre Highlands Region, the *Highlands Preservation Area* includes 398,000 acres that is designated as exceptional natural resource value. More than $^{1}/_{3}$ of this area is undeveloped. Proposals for "major development" on properties within the preservation area will require a NJDEP Highlands Preservation Area Approval, which will be guided by the environmental regulations within the act. An example of major development is one that disturbs 1 or more acres of land or increases impervious surface by ¼ acre or more. Improvements to existing single family dwellings, such as an addition, garage, patio, driveway, swimming pool, garden or septic system are exempt. The *Highlands Planning Area* encompasses all areas of the Highlands that are not designated as the Highlands Preservation Area. The Highlands Act does not establish any new regulations for development within the Planning Area, however, the *Regional Master Plan*, which will be adopted by the Highlands Water Protection and Planning Council, will provide for enhanced standards, transfer of development rights and smart growth in this area.

In Oakland Borough, most of the area west of the Ramapo River, plus the area east of the Ramapo River and south of Long Hill Road (County Route 931), fall within the Highlands Preservation Area (2,605 acres), while the remainder of the borough lies within the Highlands Planning Area (3,007 acres) (see **Figure 9a**) (NJHWPPC, October 1, 2011).

The Highlands Water Protection and Planning Council (Highlands Council) is composed of 15 members appointed by the Governor, 5 of whom must be municipal officials from the Highlands Region and 3 of whom must be county officials from the Highlands Region. The Council is responsible for carrying out the provisions of the Highlands Act.

The Highlands Council officially released the Highlands Regional Master Plan in November 2008, as well as the supporting technical information contained in the Technical Reports (NJDEP Highlands Council, 2008). This process generated an extensive amount of information at a regional scale.

The Oakland Borough Council adopted a resolution of Notice of Intent to petition the Highlands Council for Plan Conformance in November 2008 (Borough of Oakland, November 2008).

In March 2009, the Highlands Council announced its Plan Conformance Grant Program specifications for *Module 4: Highlands Environmental Resource Inventory*. The *Module 4: Highlands Environmental Resource Inventory for Oakland Borough (draft)* was submitted in 2009 as required for Basic Conformance.

The purpose of the Highlands ERI document echoes the purpose of this NRI, to "provide the base source for resource conservation," but with the additional goal of providing

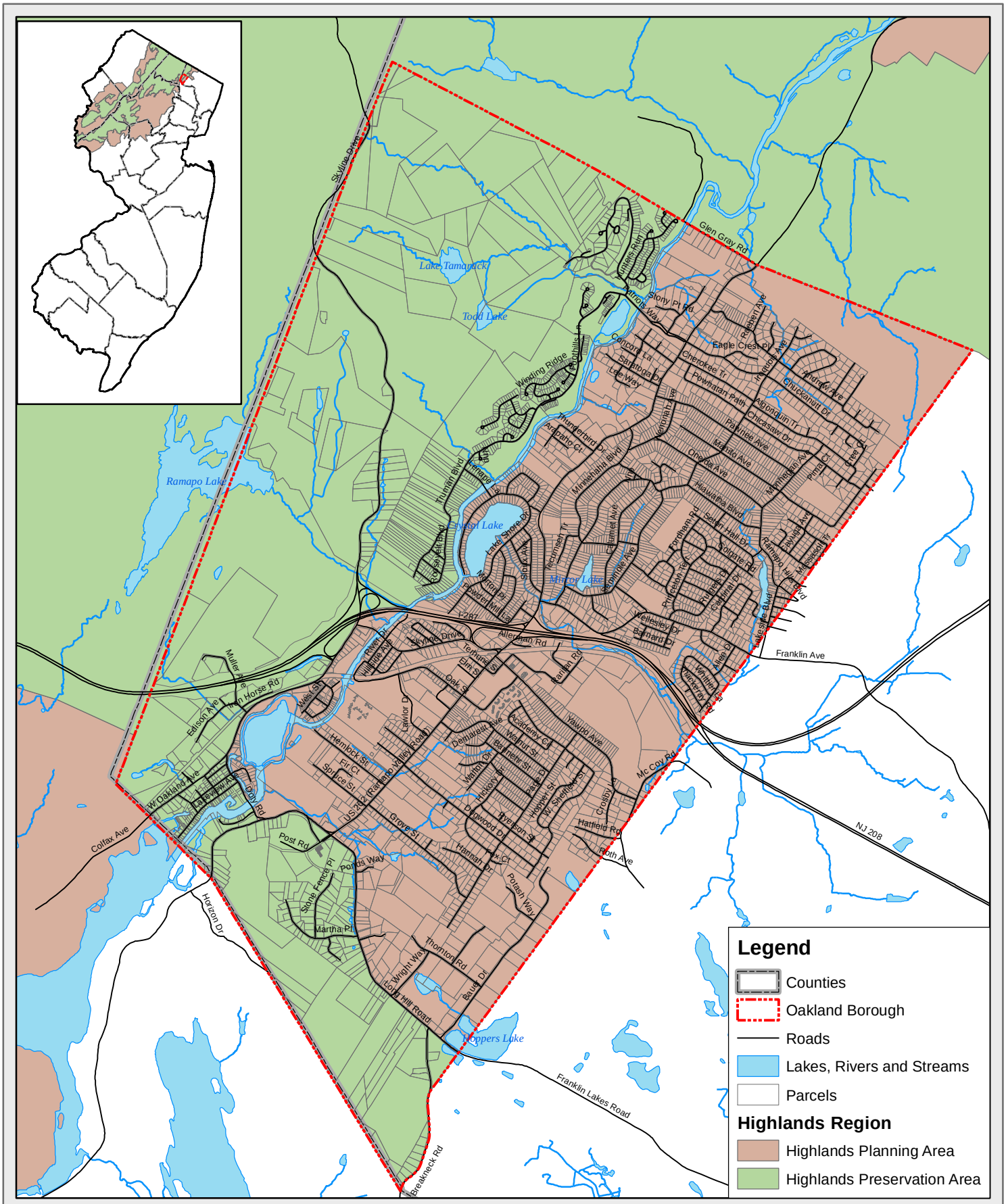

Figure 9a: Highlands Preservation and Planning Areas

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"a framework that supports the efforts of the Borough of Oakland to bring its master plan, including the ERI, into conformance with the RMP [Regional Master Plan]. The ERI Addendum is one requirement for Basic Plan Conformance. It provides critical support to the Conservation Plan Element of the municipal master plan related to implementation of resource protection requirements in the land use ordinance and health codes of the Borough of Oakland. Additional modifications to the ERI will occur during later stages of the Plan Conformance process to more fully address requirements of the RMP and to integrate the Highlands provisions of the ERI with the existing ERI of this municipality." (Borough of Oakland, 2009).

As of June 2013, Oakland was among 15 municipalities that have petitioned for plan conformance, but not yet been approved (NJ Highlands Council, June 17, 2013).

B. Sustainable Jersey

NJDEP Sustainability and Green Energy (SAGE) "promotes and supports programs that both reduce greenhouse gas emissions and preserve and expand natural carbon sinks such as forests, soils and wetlands to ensure compliance with the NJ Global Warming Response Act. In addition, SAGE promotes and supports initiatives designed to help New Jersey to adapt to climate-related impacts that are unavoidable" (SAGE, 2013).

Oakland Borough received a *Sustainable Jersey Community Bronze Certification* in 2011, with 160 points. Sustainable actions include tree planting and maintenance, Environmental Commission, sustainable land use pledge, green building policy, creation of a green team, recycling, composting and others (Oakland Borough, 2011).

C. Water Supply Planning

The goal of statewide water supply planning, mandated by the Water Supply Management Act (N.J.S.A. 58:1A-1), is to make recommendations on the management of the State's surface and ground water supplies to ensure that the State's water supplies could withstand foreseeable drought and that aquifers are not depleted.

One result of the first Statewide Water Supply Plan, developed in 1982, was the Wanaque South/Monksville Reservoir Project in neighboring Passaic County. The 1996 Statewide Water Supply Plan, a revision of the 1982 plan, recommended improved water resources protection, water supply and water delivery management, and water conservation. To accomplish these goals, NJDEP's Water Quality Planning Rules were developed to ensure that water supply withdrawals do not interfere with the assimilative capacity of streams, rivers and estuaries. In addition, water purveyors (such as the Borough of Oakland Water Department) are required to develop water conservation plans that are implemented during periods of drought (NJDEP Division of Watershed Management, 2011).

D. Water Quality Management Planning

Watershed management is the process of managing all of the water resources within the area of a watershed, rather than on a site-specific basis. A watershed management approach is based on three key components: 1) a geographic focus; 2) continuous improvement based on sound science; and 3) partnerships/stakeholder involvement (NJDEP Office of Environmental Planning, 1997).

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**).

This process includes development and adoption of a *Wastewater Management Plan (WMP)*, a document that provides 20 year planning for wastewater and certain other water quality concerns. Revisions to the rules were adopted in 2008, establishing:

- procedures for preparation, adoption, amendment, revision, and certification *Water Quality Management (WQM) Plans*;
- procedures for NJDEP's review of projects and activities for consistency with WQM plans;
- adoption of other NJDEP rules, priority systems and project priority lists, sludge management plans, regional stormwater management plans, effluent limitations, wastewater management plans, 201 Facilities Plans, and other documents in WQM Plans;
- coordination of WQM planning with the Highlands RMP, other programs and municipal zoning;
- mechanisms to resolve conflicts;
- procedures for submission, adoption, and updating *wastewater management plans (WMPs)* (wastewater planning responsibility is assigned to counties and requires them to update the WMPs);
- the process for identifying water bodies on the List of Water Quality Limited Segments and establishing total maximum daily loads (TMDLs) (see **Section 6E** for more about TMDLs) (NJDEP, July 7, 2008).

Throughout the state, counties are often the responsible agency for WQM, but in Bergen County, municipalities perform this role (NJDEP Division of Water Quality Management Planning. October 24, 2003). Oakland Borough, as the responsible agency for the borough, must notify, seek comments from, and offer to confer with all government units that have regulatory or planning jurisdiction over wastewater or land use in the area, and all government units and public utilities that own, operate, or have contracts or NJDEP permits for sewerage facilities identified in the WMP. A WMP is valid only after submission to NJDEP and adoption by the Governor or his designee as a WQM plan amendment (NJDEP Division of Water Quality Management Planning, August 7, 2013).

The WMP includes mapping the planned method of wastewater disposal for specific areas. On these maps, the public *Sewer Service Areas* (SSAs) are areas served by sewers. 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). The current SSAs within Oakland Borough are shown earlier in this document in **Figure 2c** (NJDEP BWR, October 2, 2013).

Statewide, WMPs are being updated at the time of this writing.

E. State Development & Redevelopment Plan

The NJ Department of State's Business Action Center Office for Planning Advocacy[36] "coordinates statewide planning to protect the environment and guide future growth into compact, mixed-use development and redevelopment. The office implements the goals of the State Development and Redevelopment Plan to achieve comprehensive, long-term planning; and

[36] The State Plan was formerly under the NJ Department of Community Affairs Office of Smart Growth (OSG).

integrates that planning with programmatic and regulatory land-use decisions at all levels of government and the private sector." (NJ Department of State, 2011).

The *State Development and Redevelopment Plan* is a dynamic vision of New Jersey's development and conservation patterns, incorporating new data from state agencies, counties and municipalities on a continuing basis. It should be noted that the following information and map are current as of August 2013, but may change.

The purpose of the 2001 State Plan is to:

> "Coordinate planning activities and establish Statewide planning objectives in the following areas: land use, housing, economic development, transportation, natural resource conservation, agriculture and farmland retention, recreation, urban and suburban redevelopment, historic preservation, public facilities and services, and intergovernmental coordination" (N.J.S.A. 52:18A-200(f)) (NJ Department of State, December 2011).

The State Plan Policy Map has two major components: Planning Areas, which identify the current natural and built characteristics in each area, and Centers, where most growth will be accommodated. There are 5 main Planning Areas in the state: Metropolitan, Suburban, Fringe, Rural and Environmentally Sensitive (shown in **Figure 9b)**.

Much of Oakland (48%) is within the *PA-1 Metropolitan Planning Area*. The State Plan's goals for the Metropolitan Planning Area are to "Provide for much of the state's future redevelopment; revitalize cities and towns; promote growth in compact forms; stabilize older suburbs; redesign areas of sprawl; and protect the character of existing stable communities" (NJ State Planning Commission, 2001).

Table 9: State Planning Areas in Oakland

PA	Detail	Acres	Percent
1	Metropolitan	2674.41	47.66
5	Environmentally Sensitive	169.74	3.02
6	Park 1ST Plan	162.6	2.90
10	Highlands Preservation	2604.98	46.42
Total		5611.72	100
Source: NJ Department of State, August 21, 2013			

The area of Oakland that is PA-1 is further designated as part of the *Smart Growth Area.* Smart Growth is the term used to describe well-planned, well-managed growth that adds new homes and creates new jobs, while preserving open space, farmland, and environmental resources. In New Jersey, Smart Growth supports development and redevelopment in recognized Centers, with existing infrastructure that serves the economy, the community and the environment.

Nearly half of the borough is labeled *PA-10: Highlands Preservation*. This Special Resource Areas is defined as an area with unique characteristics or resources of statewide importance in order to establish a receptive environment for regional planning efforts. The Highlands region is the first Special Resource Area in New Jersey (NJ State Planning Commission, 2001).

About 3% of Oakland is *PA-5: Environmentally Sensitive*. PA-5 areas are large contiguous areas containing valuable ecosystems, geological features and wildlife habitats. The future environmental and economic integrity of the state rests in the protection of these irreplaceable resources (NJ State Planning Commission, 2001).

While the Environmentally Sensitive Planning Area is used to protect and manage large areas of natural and environmental resources, there are significant cultural and environmental resources found throughout the other Planning Areas, as well. The Plan refers to these sites as *Historic and Cultural Sites* and *Critical Environmental Sites* (see **Figure 9b**). The Plan treats these designated areas with the relevant provisions of historic, cultural and scenic and environmental Statewide Policies and the Environmentally Sensitive Planning Area. Within Oakland, the Route 202 corridor north of Route 287 is designated a scenic vista and corridor;

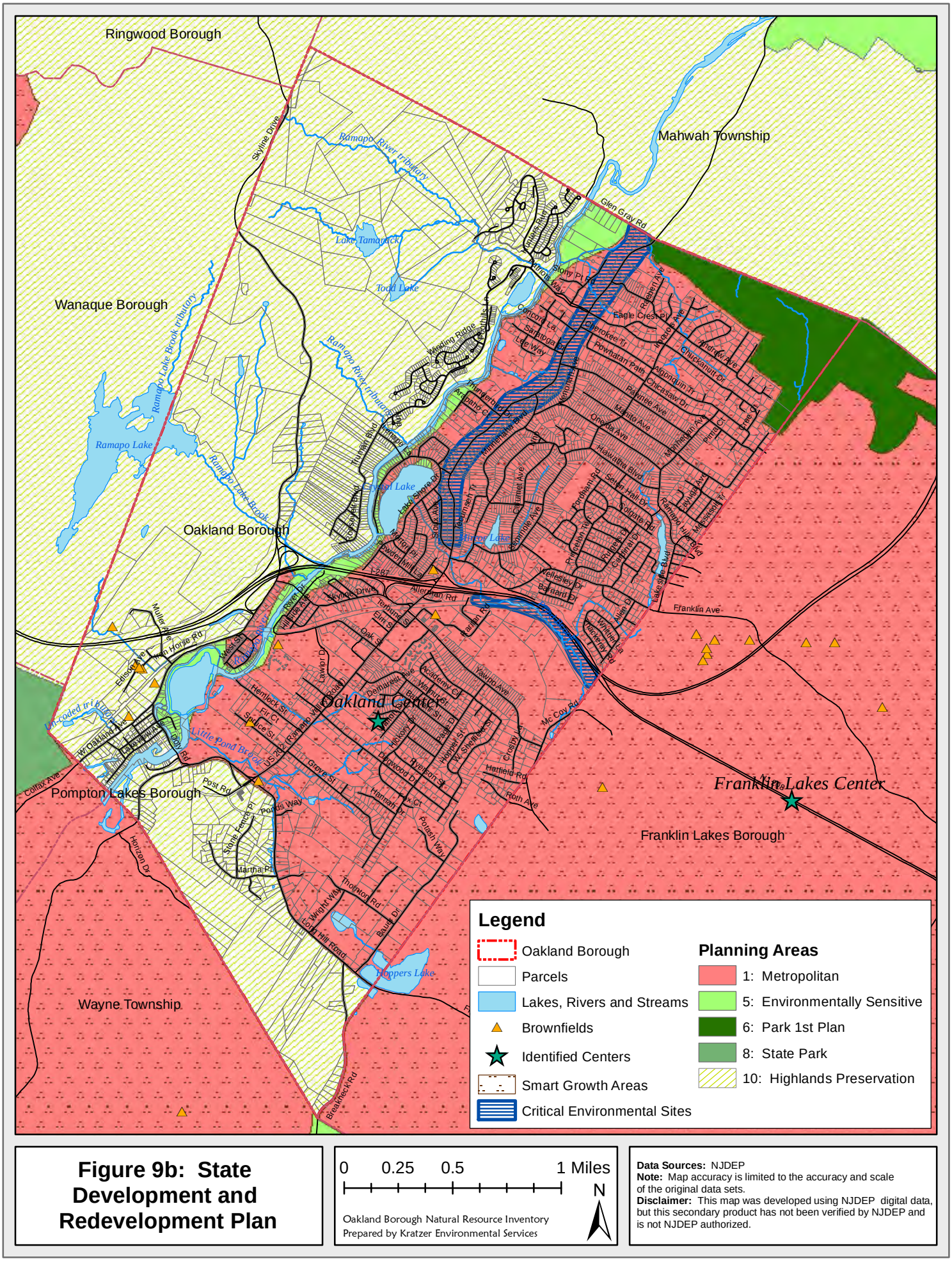

Figure 9b: State Development and Redevelopment Plan

0 0.25 0.5 1 Miles

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while an area along Route 287 near the eastern border of the borough is also designated as a Critical Environmental Site (NJ State Planning Commission, 2001).

Another aspect of the state planning process is the denotation of *brownfields*, defined as any former or current commercial or industrial site, currently vacant or underutilized, on which there has been, or there is suspected to have been, a discharge of a contaminant. Brownfields are discussed in **Section 2C**.

References: Regional Relationships

Highlands

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Critical Environmental and Historic Sites, 10/17/2012 cehs2.zip
Identified Centers, 01/18/2013 cenpt2.zip (one)
Planning Areas, 01/18/2013 splan2.zip
Smart Growth Areas, 10/16/2013 sgareas.zip
Center boundaries (10/16/2013); Cores (09/12/2012); Endorsed Plans (10/16/2013); Historic and Cultural Sites (10/11/2001); Nodes (08/21/2013); Urban Complex (03/01/2001) – **none in Oakland**

NJ State Planning Commission. March 1, 2001. New Jersey State Development and Redevelopment Plan Executive Summary. 58 pages. http://www.state.nj.us/state/planning/docs/execsumm030101.pdf

Internet Resources: Regional Relationships

Highlands

NJDEP Highlands Council: http://www.highlands.state.nj.us/

Sustainability

New Jersey Global Warming Home Page: http://nj.gov/globalwarming/

NJDEP Sustainability and Green Energy: http://www.nj.gov/dep/sage/climate-energy.html

US Environmental Protection Agency (USEPA) Climate Change: http://epa.gov/climatechange/index.html

Water Quality Management Planning

NJDEP Water Quality Management Planning: http://www.nj.gov/dep/wqmp/

State Development and Redevelopment Plan

State Development and Redevelopment Plan: http://www.nj.gov/state/planning/

Maps & GIS Data: http://www.nj.gov/state/planning/resources-maps.html

10: COMPOSITE MAP OF ENVIRONMENTALLY CRITICAL AREAS

Throughout this document, many environmental and natural features of the Borough of Oakland have been documented, described and mapped. One of the greatest values of mapping with GIS is to easily combine features in new ways. To accomplish this, **Figure 10** combines some of the mapped layers from previous sections, displaying features that make an area environmentally critical together on one map.

A useful definition of an "environmentally critical area" is provided in the Stormwater Management regulations (N.J.A.C. 7:8):

> " 'Environmentally critical area' means an area or feature which is of significant environmental value, including, but not limited to: stream corridors; natural heritage priority sites; habitats of endangered or threatened species; large areas of contiguous open space or upland forest; steep slopes; and well head protection and groundwater recharge areas. Habitats of endangered or threatened species are identified using the Department's Landscape Project as approved by the Department's Endangered and Nongame Species Program (NJDEP, April 19, 2010)."

Figure 10 combines the following:

- Steep slopes greater than 30%
- Floodplains
- Wetlands (from 2007 Land Use data; an LOI is necessary to determine actual boundary of wetlands)
- 50 foot wetlands buffers (from 2007 Land Use data; an LOI is necessary to determine actual buffer for wetlands – not all wetlands are given a 50 foot buffer)
- Landscape Project Vernal Pools (potential and certified)
- Landscape Project version 3.1: Rank 3 or 4 habitats
- Natural Heritage Grid Map (for generalized locations of rare plants)
- Open space
- State Development and Redevelopment Plan Critical Areas

References: Environmentally Critical Areas

NJDEP. April 19, 2010. N.J.A.C. 7:8 Stormwater Management Rule. Date last amended: April 19, 2010. 39 pages. http://www.nj.gov/dep/rules/rules/njac7_8.pdf

Steep slopes: See Section 3B; Figure 3d
Floodplains: See Section 6B; Figure 6c
Wetlands & wetlands buffers: See Section 6C; Figure 6d
Landscape Project Vernal Pools: See Section 7F; Figure 7f
Landscape Project v3.1 Rank 3 or 4: See Section 7F; Figure 7g
Natural Heritage Grid Map: See Section 7F; Figure 7h
Open Space: See Section 8C; Figure 8
State Development and Redevelopment Plan Critical Areas: See Section 9D; Figure 9b

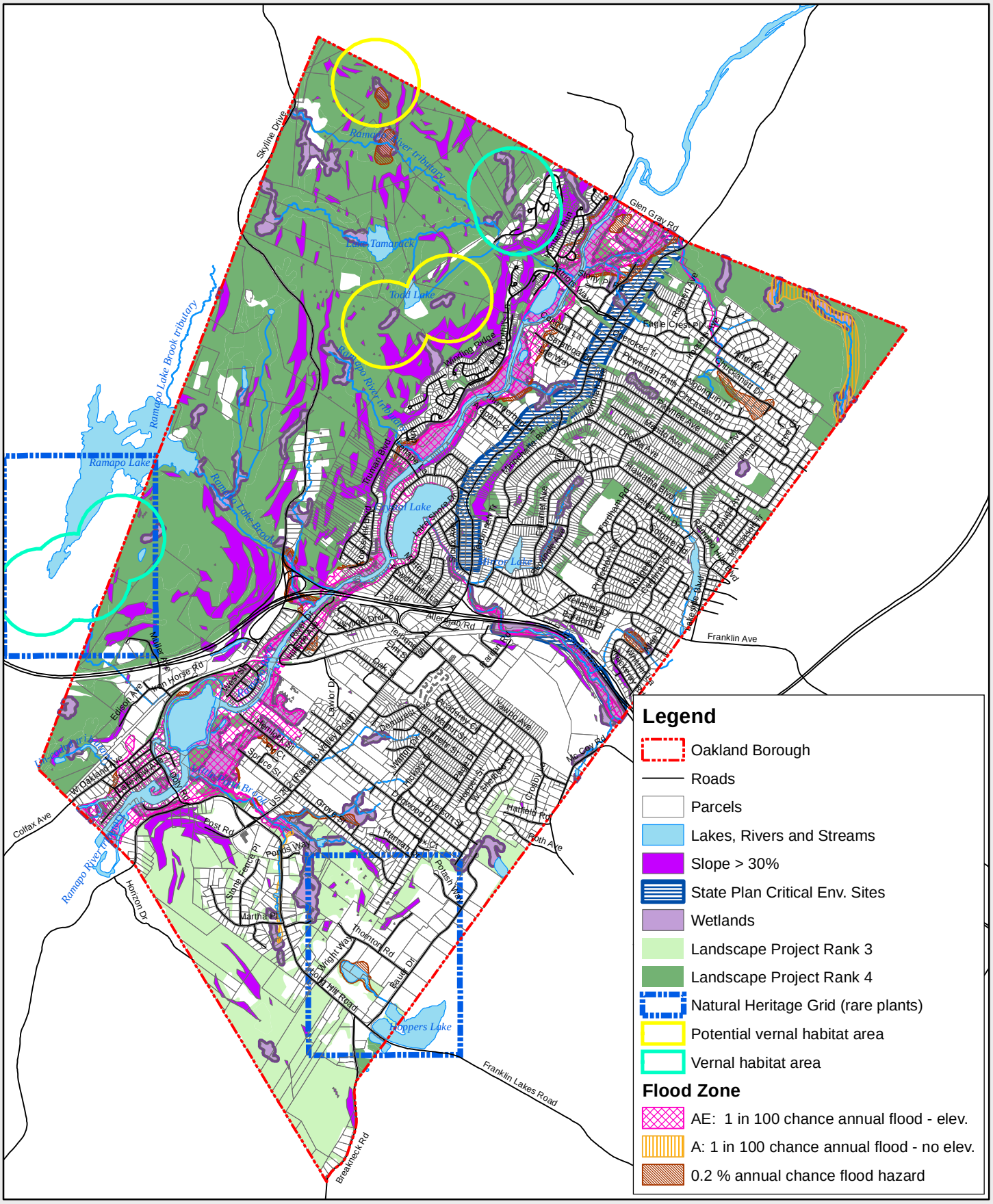

Figure 10: Environmentally Critical Features

0 0.25 0.5 1 Miles

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APPENDIX A: DATA USE AGREEMENTS

Contents

A.1 Terms of Agreement for use of NJDEP GIS data

(Required by NJDEP Office of Information Management, Bureau of Geographic Information and Analysis.)

1. Digital data received from the NJDEP are to be used solely for internal purposes in the conduct of daily affairs.

2. The data are provided, as is, without warranty of any kind and the user is responsible for understanding the accuracy limitations of all digital data layers provided herein, as documented in the accompanying Data Dictionary and Readme files. Any reproduction or manipulation of the above data must ensure that the coordinate reference system remains intact.

3. Digital data received from the NJDEP may not be reproduced or redistributed for use by anyone without first obtaining written permission from the NJDEP. This clause is not intended to restrict distribution of printed mapped information produced from the digital data.

4. Any maps, publications, reports, or other documents produced as a result of this project that utilize NJDEP digital data will credit the NJDEP Geographic Information System (GIS) as the source of the data with the following credit/disclaimer:

> This (map/publication/report) was developed using New Jersey Department of Environmental Protection Geographic Information System digital data, but this secondary product has not been verified by NJDEP and is not state-authorized.

5. Users shall require any independent contractor, hired to undertake work that will utilize digital data obtained from the NJDEP, to agree not to use, reproduce, or redistribute NJDEP GIS data for any purpose other than the specified contractual work. All copies of NJDEP GIS data utilized by an independent contractor will be required to be returned to the original user at the close of such contractual work. Users hereby agree to abide by the use and reproduction conditions specified above and agree to hold any independent contractor to the same terms. By using data provided herein, the user acknowledges that terms and conditions have been read and that the user is bound by these criteria.

A.2 Cautions and Restrictions on Use of Natural Heritage Data

(Required by NJDEP Division of Parks and Forestry, Natural Lands Management.)

CAUTIONS AND RESTRICTIONS ON NATURAL HERITAGE DATA

The quantity and quality of data collected by the Natural Heritage Program is dependent on the research and observations of many individuals and organizations. Not all of this information is the result of comprehensive or site-specific field surveys. Some natural areas in New Jersey have never been thoroughly surveyed. As a result, new locations for plant and animal species are continuously added to the database. Since data acquisition is a dynamic, ongoing process, the Natural Heritage Program cannot provide a definitive statement on the presence, absence, or condition of biological elements in any part of New Jersey. Information supplied by the Natural Heritage Program summarizes existing data known to the program at the time of the request regarding the biological elements or locations in question. They should never be regarded as final statements on the elements or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments. The attached data is provided as one source of information to assist others in the preservation of natural diversity.

This office cannot provide a letter of interpretation or a statement addressing the classification of wetlands as defined by the Freshwater Wetlands Act. Requests for such determination should be sent to the DEP Division of Land Use Regulation, P.O. Box 439, Trenton, NJ 08625-0439.

The Landscape Project was developed by the Division of Fish & Wildlife, Endangered and Nongame Species Program in order to map critical habitat for rare animal species. Natural Heritage Database response letters will also list all species (if any) found during a search of the Landscape Project. However, this office cannot answer any inquiries about the Landscape Project. All questions should be directed to the DEP Division of Fish and Wildlife, Endangered and Nongame Species Program, P.O. Box 400, Trenton, NJ 08625-0400.

This cautions and restrictions notice must be included whenever information provided by the Natural Heritage Database is published.

NJ Department of Environmental Protection
Division of Parks and Forestry
Natural Lands Management

APPENDIX B: METADATA FOR GIS DATA LAYERS USED FOR THIS REPORT

Data Disclaimers in **Appendix A** apply to the use of these data layers and the maps created from them. The user is responsible for understanding the accuracy limitations of the digital data layers, as documented in the accompanying report and metadata summaries, and the metadata files which accompany the data.

APPENDIX B: GIS DATA LAYERS USED FOR THIS REPORT

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
All	All	NJDEP BGIS	Municipalities of New Jersey (Clipped to Coast), Version 20090116	1/16/2009	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/muncoast.zip
Most Maps Display these Base Layers	Most	NJDEP BGIS	NJDEP 2002 Waters of New Jersey (Lakes and Ponds), Version 20080501	5/1/2008	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/njwaterbody.zip
	Most	NJDEP BGIS	National Hydrography Dataset (NHD) Streams 2002	11/1/2010	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/nhdstreams2002shp.zip
	Most	NJDEP BGIS	State of New Jersey Composite of Parcels Data, New Jersey State Plane NAD83 and MOD-IV Tax List Search Database	07/29/2011	n/a	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp?DLayer=Parcels by County/Muni
	Most	NJDOT	New Jersey Roadway Network	4/4/2013	1:2,400	http://www.state.nj.us/transportation/gis/data.shtm
Figure 1a: Location of Borough	1a	NJDEP BGIS	NJDEP State Boundary of New Jersey	11/1/1998	1:24,000	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/state.zip
	1a	NJDEP BGIS	NJDEP County Boundaries for the State of New Jersey	1/23/2003	1:24,000	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/stco.zip
Figure 1b: 1930 Aerial Photography	1b	NJOIT OGIS	1930s Aerial Photography of New Jersey Web Map Service (WMS)	10/1/2009	1:24,000	https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp
Figure 1c: 1995 Aerial Photography	1c, 1h	USGS	USGS 1997 Digital Orthophoto Quadrangles for New Jersey, MRSID format (NJSPC, NAD83)	11/23/97	1:40,000	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp
Figure 1d: 2002 Aerial Photography	1d, 1h	NJOIT OGIS	New Jersey 2002 High Resolution Orthophotography	7/31/2003	1:19,200	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp
Figure 1e: 2007 Aerial Photography	1e, 1h	NJOIT OGIS	New Jersey 2007 - 2008 High Resolution Orthophotography, JPEG2000 5K Tiles (2009 revision)	11/1/2009	1:2,400	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 1f: 2012 Aerial Photography	1f, 1h, 8a-f	NJOIT OGIS	New Jersey 2012 - 2013 High Resolution Orthophotography, NAD83 NJ State Plane Feet, MrSID Tiles	3/1/2013	1:2,400	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp
Figure 1g: Land Use Type (2007)	1g, 1h	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 1h: Change to Urban Land Use	1h	NJDEP BGIS	NJDEP 1995/97 Land use/Land cover Update, Pompton, Wanaque and Ramapo Watershed Management Area, WMA-3	12/1/2000	1:12,000	http://www.state.nj.us/dep/gis/lulc95shp.html
	1h	NJDEP BGIS	NJDEP 2002 Land use/Land cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA-3	3/4/2008	1:2,400	http://www.state.nj.us/dep/gis/lulc02shp.html
Figure 2a: Drought Regions, Weather & Air Quality	2a	NADP	National Atmospheric Deposition Netowrk	1/10/2004	n/a	n/a
	2a	NJDEP BAM	NJDEP Ambient Air Quality Monitors	3/1/2006	1:1,600	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/airqm.zip
	2a	NJGS	DGS00-1: NJDEP Drought Regions of New Jersey	5/1/2004	1:24,000	http://www.state.nj.us/dep/njgs/geodata/dgs00-1.htm
	2a	Oakland Resident	Precipitation (1986-2012) at Location on Algonquin Trail, Oakland, NJ	12/9/2013	n/a	n/a
	2a	ONJSC	Weather Stations	3/8/2013	n/a	n/a
Figure 2b: Public Water	2b	NJDEP DSRT	NJDEP Public Community Water Purveyor Service Areas, 1998	1/1/2004	1:24,000	http://www.state.nj.us/dep/gis/digidownload/zips/statewide/watpurv1998.zip

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 2b: Public Water	2b	NJGS	DGS97-1: NJDEP Public-Community Water-Supply Wells of New Jersey	7/7/2011	1:24,000	http://www.state.nj.us/dep/njgs/geodata/dgs97-1.htm
Figure 2c: Sewer Service Areas	2c	NJDEP BWR	Statewide Sewer Service Area for New Jersey (Util_wastewater_servicearea)	10/2/2013	n/a	http://www.nj.gov/dep/gis/listall.html
Figure 2d: Brownfields	2d	NJ DS OPA	Brownfields SiteMart Locations	1/12/2013	n/a	http://www.nj.gov/state/planning/bfsitemart.zip
Figure 3a: Physiographic Provinces	3a	NJGS	DGS02-7: Physiographic Provinces of New Jersey	6/30/2002	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs02-7.htm
Figure 3b: Elevation Contours	3b	NJGS	DGS00-3: Topographic Elevation Contours for New Jersey (1:100,000 Scale): Paterson	12/29/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs00-3.htm
Figure 3c: Shaded Elevation (Hillshade)	3c	NJGS	DGS99-4 Digital Elevation Grids for New Jersey (1:100,000 scale) (100 foot cell hillshade grid)	1/1/1999	3m	http://www.state.nj.us/dep/njgs/geodata/dgs99-4.htm
Figure 3d: Steep Slopes	3d	Highlands	Constrained and Limited Constrained Slopes	1/30/2012	n/a	http://www.highlands.state.nj.us/njhighlands/actmaps/maps/gis_data.html
	3d	Highlands	Moderately Constrained Slopes	1/30/2012	n/a	http://www.highlands.state.nj.us/njhighlands/actmaps/maps/gis_data.html
	3d	Highlands	Severely Constrained Slopes	1/30/2012	n/a	http://www.highlands.state.nj.us/njhighlands/actmaps/maps/gis_data.html
	3d	NJDEP NJFFS	2002 NJFFS Wildfire Fuel Hazard for Bergen County, New Jersey	4/17/2009	1:2,400	http://www.state.nj.us/dep/gis/digidownload/zips/njfh/midfh02.zip
Figure 3e: Bedrock Geology	3e	NJGS	DGS04-6: Bedrock Geology for New Jersey 1:100,000 Scale	6/30/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs04-6.htm
	3e, 3f	NJGS	DGS04-6: Bedrock Geology for New Jersey - Faults	6/30/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs04-6.htm
	3e, 3f	NJGS	DGS04-6: Bedrock Geology for New Jersey - Folds	6/30/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs04-6.htm

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 3f: Earthquakes and Faults	3f	NJGS	DGS04-1: Earthquakes Epicentered In New Jersey	6/24/2013	n/a	http://www.state.nj.us/dep/njgs/geodata/dgs04-1.htm
Figure 3g: Surficial Geology	3g	NJGS	DGS07-2: Surficial Geology of New Jersey	1/1/2006	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs07-2.htm
	3g, 3h	NJGS	DGS04-7: Historic Fill For New Jersey As Of February 2009	2/17/2009	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs04-7.htm
Figure 3h: Rock Outcrops, Glacial Sediments and Fill	3h	NJGS	DGS96-1: Glacial Sediments of New Jersey	1/1/2002	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs96-1.htm
	3h	NJGS	DGS07-2: Bedrock Outcrops of New Jersey	9/15/2006	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs07-2.htm
	3h	NJGS	DGS05-1: Selected Sand, Gravel and Rock Surficial Mining Operations in New Jersey	12/12/2006	n/a	http://www.state.nj.us/dep/njgs/geodata/dgs05-1.htm
	3h	NJGS	DGS06-3: Landslides In New Jersey	12/12/2006	n/a	http://www.njgeology.org/geodata/dgs06-3.htm
Figure 4a: Soil Map Units	4a	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 4b: Soils - Depth to Restrictive Layer	4b	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 4c: Soils - Depth to High Water Table	4c	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 4d: Soils - Hydrologic Group	4d	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 4e: Soils - Septic Limitations	4e	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 4f: Soils - Drainage Class	4f	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	5/24/2010	1:100,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 4g: Soils - Frost Action	4g	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 5b: Aquifers & Public Wells (PCWS)	5b	NJGS	DGS98-5: Aquifers of New Jersey	4/22/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs98-5.htm
	5b	NJGS	DGS98-5: Aquifers of New Jersey (Surficial Aquifers)	4/22/1999	1:100,000	http://www.state.nj.us/dep/njgs/geodata/dgs98-5.htm
	5b, 5d	NJGS	DGS97-1: NJDEP Public-Community Water-Supply Wells of New Jersey	7/7/2011	1:24,000	http://www.state.nj.us/dep/njgs/geodata/dgs97-1.htm
Figure 5c: Sole-Source Aquifer & USGS monitoring wells	5c	NJGS	DGS98-6: NJDEP Sole-Source Aquifers in New Jersey	5/19/1998	1:24,000	http://www.state.nj.us/dep/njgs/geodata/dgs98-6.htm
	5c	NJGS	DGS05-2: New Jersey's Ambient Ground-Water Quality Network (AGWQN)	5/24/2007	n/a	http://www.njgeology.org/geodata/dgs05-2.htm
	5c	USGS	Active Groundwater Level Network	8/15/2013	n/a	http://groundwaterwatch.usgs.gov/default.asp
Figure 5d: Ground Water Recharge (NJGS)	5d	NJGS	DGS02-3: Ground-Water Recharge for Watershed Management Area 3, (Pompton, Wanaque and Ramapo Rivers), NJ	10/21/2004	1:24,000	http://www.njgeology.org/geodata/dgs02-3/dgs02-3.htm
Figure 5e: Aquifer Potential (NJGS)	5e	NJGS	DGS07-1: Aquifer Recharge Potential for Bergen County, NJ	1/4/2005	1:24,000	http://www.njgeology.org/geodata/
Figure 5f: Contaminated Sites	5f	NJDEP DWQ	New Jersey Pollution Discharge Elimination System (NJPDES) Regulated Discharge to Ground Water Facility Locations	7/18/2007	1:12,000	http://www.nj.gov/dep/gis/stateshp.html#NJPDESGWD
	5f	NJDEP SRP	NJDEP Known Contaminated Site List for New Jersey (Non-Homeowner), Edition 201202	2/1/2012	1:1,000	http://www.nj.gov/dep/gis/stateshp.html#KCSL

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Continued Figure 5f: Contaminated Sites	5f	NJDEP SRP	Classification Exception Areas-Well Restriction Areas for New Jersey, Edition 20130230	02/30/2013	1:1,000	http://www.nj.gov/dep/gis/stateshp.html#CEA
	5f	NJDEP SRP	NJDEP Deed Notice Extent Polygons in New Jersey, (Edition 20120130)	1/30/2012	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#DEEDPOLY
Figure 6a: Watersheds & Sub-watersheds	6a	NJDEP DWM	NJDEP Watershed Management Areas in New Jersey (Version 200901)	1/1/2009	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#WMAS
	6a, 6g	NJGS	14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)	2/25/2011	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#HUC14
Figure 6b: Sub-watersheds	6b	NJGS	14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)	2/25/2011	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#HUC14
Figure 6c: Floodplains	6c	FEMA	Digital Flood Insurance Rate Map (DFIRM) Database, Bergen County, NJ (Flood hazard zone areas)	9/30/2005	1:12,000	http://msc.fema.gov/
	6c	FEMA	Digital Flood Insurance Rate Map (DFIRM) Database, Bergen County, NJ (Hydraulic structures shown on the DFIRM such as levees, weirs, bridges, dams, culverts)	9/30/2005	1:12,000	http://msc.fema.gov/
	6c	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Figure 6d: Wetlands	6d	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
	6d	USDA	Gridded Soil Survey Geographic (gSSURGO) Database for New Jersey	11/21/2012	1:24,000	http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 6e: Surface Water Quality Standards	6e	NJDEP WMS BFBM	NJDEP Surface Water Quality Standards of New Jersey (Version 201012)	12/1/2010	1:2,400	http://www.nj.gov/dep/gis/stateshp.html#SWQS
Figure 6f: Integrated List	6f	NJDEP WMS BWQSA	2010 New Jersey Integrated List of Waters (Integrated List) (Edition 201205)	5/1/2012	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#IR
Figure 6g: Surface Water Discharges	6g	NJDEP C&E BPO	NJDEP Aquatic Pesticides	10/1/2009	n/a	http://www.nj.gov/dep/gis/stateshp.html#AQUA
	6g	NJDEP DWQ	NJPDES Surface Water Discharges in New Jersey, (1:12,000) Version 20111116	11/16/2011	1:12,000	http://www.nj.gov/dep/gis/stateshp.html#NJPDESSWD
Figure 6h: Percent Impervious Surface	6h	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 6i: Surface Water & Stream Flow Monitoring Sites	6i	NJDEP BFBM	STORET Water Quality Monitoring Stations	8/1/2005	n/a	http://www.nj.gov/dep/gis/stateshp.html#STORET
	6i	NJDEP BFBM	NJDEP Fish Index of Biotic Integrity Monitoring Network (2000-2009)	12/15/2010	n/a	http://www.nj.gov/dep/gis/stateshp.html#FISHIND
	6i	NJDEP BFBM	NJDEP Ambient Biomonitoring Network (AMNET) Edition 201205	5/1/2012	1:1,200	http://www.nj.gov/dep/gis/stateshp.html#AMNET
	6i	NJDEP BFBM	Ambient Stream Quality Monitoring Sites (1998 - 2010)	11/20/2008	1:12,000	http://www.nj.gov/dep/gis/stateshp.html#AMBIENT
	6i	NJDEP BFBM	NJDEP Existing Water Quality Stations in New Jersey	10/19/2007	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#WATQUA
	6i	NJGS	14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)	2/25/2011	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#HUC14
	6i	USGS	USGS surface-water quality gaging stations in New Jersey	4/17/2002	n/a	http://www.njgeology.org/geodata/dgs02-5/wqgages.zip

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Continued Figure 6i: Surface Water & Stream Flow Monitoring Sites	6i	USGS	USGS continuous-streamflow gaging locations in New Jersey	4/17/2002	n/a	http://www.njgeology.org/geodata/dgs02-5/streamgage.zip
	6i	USGS	USGS stream crest gaging locations in New Jersey	4/17/2002	n/a	http://www.njgeology.org/geodata/dgs02-5/creststage.zip
	6i	USGS	USGS stream lowflow gaging locations in New Jersey	4/17/2002	n/a	http://www.njgeology.org/geodata/dgs02-5/lowflow.zip
Figure 7a: Land Cover - Urban	7a	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 7b: Land Cover - Forest	7b	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 7c: Land Cover - Barren & Agriculture	7c	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 7d: Land Cover - Water & Wetlands	7d	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
Figure 7e: Wildfire Fuel Hazard	7e	NJDEP NJFFS	2002 NJFFS Wildfire Fuel Hazard for Bergen County, New Jersey	4/17/2009	1:24,000	http://www.nj.gov/dep/gis/njfh.html
Figure 7f: Vernal pools	7f	NJDEP DFW ENSP	NJDEP Species Based Habitat, Vernal Habitat (Version 3.1, 20120221)	2/21/2012	1:12,000	http://www.nj.gov/dep/gis/landscape.html
Figure 7g: Landscape Project version 3.1	7g	NJDEP DFW ENSP	NJDEP Species Based Habitat, Piedmont Plains Region (Version 3.1, 20120221)	2/21/2012	1:12,000	http://www.nj.gov/dep/gis/landscape.html
Figure 7h: Natural Heritage Grid	7h	NJDEP ONLM	NJDEP Natural Heritage Grid Map, Version 200911	3/21/2013	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#NHPGRID

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Figure 8a: Preserved Open Space & Recreation	8a	NJDEP GA	NJDEP County Open Space and Recreation Areas in New Jersey (Version 201107)	7/1/2011	n/a	http://www.nj.gov/dep/gis/stateshp.html#COOPEN
	8a	NJDEP GA	NJDEP State Owned, Protected Open Space and Recreation Areas in New Jersey (Version 200812)	12/10/2008	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#STOPEN
	8a	Oakland EC	Oakland Borough Open Space	11/25/2013	n/a	n/a
Figures 8b - 8f: Open Space & 2012 Aerial Photography	8b-f	FEMA	Digital Flood Insurance Rate Map (DFIRM) Database, Bergen County, NJ (Flood hazard zone areas)	9/30/2005	1:12,000	http://msc.fema.gov/
	8b-f	NJDEP WMS BFBM	NJDEP Surface Water Quality Standards of New Jersey (Version 201012)	12/1/2010	1:2,400	http://www.nj.gov/dep/gis/stateshp.html#SWQS
	8b-f	NJOIT OGIS	New Jersey 2012 - 2013 High Resolution Orthophotography, NAD83 NJ State Plane Feet, MrSID Tiles	3/1/2013	1:2,400	https://njgin.state.nj.us/NJ_NJGINExplorer/IW.jsp
	8b-f	Oakland EC	Oakland Borough Open Space	11/25/2013	n/a	n/a
Figure 9a: Highlands	9a	Highlands	New Jersey Highlands Council Preservation and Planning Area Boundary as Defined by the New Jersey Highlands Water Protection and Planning Act of 2004	10/1/2011	n/a	http://www.highlands.state.nj.us/njhighlands/actmaps/maps/gis_data.html
Figure 9b: State Development and Redevelopment Plan	9b	NJ DS OPA	Critical Environmental and Historic Sites (polygons) of the NJ State Development and Redevelopment Plan, adopted March 1, 2001	10/17/2012	1:24,000	http://nj.gov/state/planning/resources-gis.html
	9b	NJ DS OPA	Planning Areas of the NJ State Development and Redevelopment Plan, adopted March 1, 2001	1/17/2013	1:24,000	http://nj.gov/state/planning/resources-gis.html

Figure	#	Source of Data*	Data Title	Date	Scale	Online Linkage
Continued Figure 9b: State Development and Redevelopment Plan	9b	NJ DS OPA	Smart Growth Areas	10/16/2013	1:24,000	http://nj.gov/state/planning/resources-gis.html
	9b	NJ DS OPA	Brownfields SiteMart Locations	1/12/2013	n/a	http://nj.gov/state/planning/resources-gis.html
	9b	NJ DS OPA	Identified Centers of the State Development and Redevelopment Plan	1/17/2013	1:24,000	http://nj.gov/state/planning/resources-gis.html
Figure 10: Composite Map of Environmentally Critical Areas	10	FEMA	Digital Flood Insurance Rate Map (DFIRM) Database, Bergen County, NJ (Flood hazard zone areas)	9/30/2005	1:12,000	http://msc.fema.gov/
	10	NJ DS OPA	Critical Environmental and Historic Sites (polygons) of the NJ State Development and Redevelopment Plan, adopted March 1, 2001	10/17/2012	1:24,000	http://nj.gov/state/planning/resources-gis.html
	10	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Pompton, Pequannock, Wanaque, Ramapo Watershed Management Area, WMA03	7/12/2010	1:2,400	http://www.state.nj.us/dep/gis/lulc07shp.html
	10	NJDEP DFW ENSP	NJDEP Landscape Project Species Based Habitat, Piedmont Plains Region (Version 3.1, 20120221)	2/21/2012	1:12,000	http://www.nj.gov/dep/gis/landscape.html
	10	NJDEP DFW ENSP	NJDEP Species Based Habitat, Vernal Habitat (Version 3.1, 20120221)	2/21/2012	1:12,000	http://www.nj.gov/dep/gis/landscape.html
	10	NJDEP NJFFS	2002 NJFFS Wildfire Fuel Hazard for Bergen County, New Jersey	4/17/2009	1:24,000	http://www.nj.gov/dep/gis/njfh.html
	10	NJDEP ONLM	NJDEP Natural Heritage Grid Map, Version 200911	3/21/2013	1:24,000	http://www.nj.gov/dep/gis/stateshp.html#NHPGRID

***Source of GIS Data:**

Abbreviation	Source
FEMA	Federal Emergency Management Agency
Highlands	New Jersey Highlands Water Protection and Planning Council (NJ Highlands Council)
NADP	National Atmospheric Deposition Network
NJ DS OPA	NJ Department of State, Office for Planning Advocacy
NJDEP BAM	New Jersey Department of Environmental Protection (NJDEP), Department of Environmental Regulation (DER), Bureau of Air Monitoring (BAM)
NJDEP BFBM	New Jersey Department of Environmental Protection (NJDEP) Bureau of Freshwater Biological Monitoring (BFBM)
NJDEP BGIS	New Jersey Department of Environmental Protection (NJDEP), Office of Information Resources Management (OIRM), Bureau of Geographic Information Systems (BGIS)
NJDEP BWR	New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management (DWM), Bureau of Watershed Regulation (BWR)
NJDEP C&E BPO	New Jersey Department of Environmental Protection (NJDEP), Division of Compliance and Enforcement (C&E), Bureau of Pesticide Operations (BPO)
NJDEP DFW ENSP	New Jersey Department of Environmental Protection (NJDEP), Division of Fish Wildlife (DFW), Endangered Nongame Species Program (ENSP)
NJDEP DSRT	New Jersey Department of Environmental Protection (NJDEP), Division of Science, Research, and Technology (DSRT), Bureau of Environmental Assessment
NJDEP DWM	New Jersey Department of Environmental Protection (NJDEP), Division of Watershed Management (DWM)
NJDEP DWQ	New Jersey Department of Environmental Protection (NJDEP), Division of Water Quality, Bureau of Surface Water Permitting
NJDEP GA	New Jersey Department of Environmental Protection (NJDEP), Green Acres Program
NJDEP NJFFS	New Jersey Department of Environmental Protection (NJDEP), New Jersey Forest Fire Service (NJFFS)
NJDEP ONLM	New Jersey Department of Environmental Protection (NJDEP), Office of Natural Lands Management (ONLM)
NJDEP SRP	New Jersey Department of Environmental Protection (NJDEP), Site Remediation Program (SRP)

Abbreviation	Source
NJDEP WMS BFBM	New Jersey Department of Environmental Protection (NJDEP), Water Monitoring & Standards (WMS), Bureau of Freshwater and Biological Monitoring (BFBM)
NJDEP WMS BWQSA	New Jersey Department of Environmental Protection (NJDEP), Water Monitoring & Standards (WMS), Bureau of Water Quality Standards and Assessment (BWQSA)
NJGS	New Jersey Department of Environmental Protection (NJDEP), New Jersey Geological Survey (NJGS)
NJOIT OGIS	New Jersey Office of Information Technology, Office of Geographic Information Systems
Oakland EC	Oakland Borough Environmental Commission
Oakland Resident	
ONJSC	Office of the New Jersey Climatologist
USDA	U.S. Department of Agriculture, Natural Resources Conservation Service, National Geospatial Management Center
USGS	U.S. Geological Survey, Water Resources Division

APPENDIX C: SPECIES LISTS

Contents:

C.I: List of Birds of Oakland

Compiled by Dan Poalillo. Sightings by Dan Poalillo with additional contributions from Lisa Potash.

This table is based on actual past observations. It is likely not inclusive of all species that occur in Oakland.

Status	**Meaning**
Confirmed Breeder [B]	nest and/or chicks observed
Hypothetical [H]	expected based on range (but not yet confirmed with sight record)
Passage Migrant [M]	only passes through Oakland (Summer refers to northbound migration, Winter to southbound migration)
Common Resident [C]	common during this season in the correct habitat
Uncommon [U]	occurs irregularly
Rare Vagrant [R]	rare; has occurred but should not be expected
Total Count:	124

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Canada Goose	*Branta canadensis*	M	H	M	C
Mute Swan	*Cygnus olor*	C	H	H	C
Wood Duck	*Aix sponsa*	M	H		
Gadwall	*Anas strepera*				U
American Black Duck	*Anas rubripes*	M			
Mallard	*Anas platyrhynchos*	C	H	H	C
Northern Pintail	*Anas acuta*	R			
Green-winged Teal	*Anas crecca*	R			
Ring-necked Duck	*Aythya collaris*	H			C
Bufflehead	*Bucephala albeola*	H			C
Common Goldeneye	*Bucephala clangula*				U
Hooded Merganser	*Lophodytes cucullatus*	M		M	C
Common Merganser	*Mergus merganser*	M		M	C
Ruffed Grouse	*Bonasa umbellus*	R			
Wild Turkey	*Meleagris gallopavo*	U	B	U	
Common Loon	*Gavia immer*	R			
Double-crested Cormorant	*Phalacrocorax auritus*	M			
Great Blue Heron	*Ardea herodias*	H	H	H	U
Great Egret	*Ardea alba*			M	
Black Vulture	*Coragyps atratus*	C	H		U
Turkey Vulture	*Cathartes aura*	M	H	M	C
Osprey	*Pandion haliaetus*	M		M	
Northern Harrier	*Circus cyaneus*			M	
Sharp-shinned Hawk	*Accipiter striatus*	M		M	U
Cooper's Hawk	*Accipiter cooperii*	M		M	
Bald Eagle	*Haliaeetus leucocephalus*	H		M	U

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Red-shouldered Hawk	*Buteo lineatus*	M		M	
Broad-winged Hawk	*Buteo platypterus*	M		M	
Red-tailed Hawk	*Buteo jamacensis*	C	H	C	C
Killdeer	*Charadrius vociferus*	M	H	H	
Ring-billed Gull	*Larus delawarensis*	M		M	C
Herring Gull	*Larus argentatus*				C
Glaucous Gull	*Larus hyperboreus*				R
Rock Pigeon	*Columba livia*	C	H	C	C
Mourning Dove	*Zenaida macroura*	C	H	C	C
Eastern Screech Owl	*Megascops asio*	H	H	H	H
Great Horned Owl	*Bubo virginianus*				
Chimney Swift	*Chaetura pelagica*		H		
Ruby-throated Hummingbird	*Archilochus colubris*	H	C		
Belted Kingfisher	*Megaceryle alcyon*	H	H		U
Red-bellied Woodpecker	*Melanerpes carolinus*	C	C	C	C
Yellow-bellied Sapsucker	*Sphyrapicus varius*	H		M	H
Downy Woodpecker	*Picoides pubescens*	C	C	C	C
Hairy Woodpecker	*Picoides villosus*	C	C	C	C
Northern Flicker	*Colaptes auratus*	C	C	C	U
Pileated Woodpecker	*Dryocopus pileatus*	U	H	U	H
American Kestrel	*Falco sparverius*	M		M	
Merlin	*Falco sparverius*	M		M	
Eastern Wood-Pewee	*Contopus virens*	U	H	U	
Acadian Flycatcher	*Empidonax virescens*			M	
Eastern Phoebe	*Sayornis phoebe*	C	H	C	
Great Crested Flycatcher	*Myiarchus crinitus*	U	H	U	
Blue-headed Vireo	*Vireo solitarius*			M	
Warbling Vireo	*Vireo gilvus*	C	H		
Red-eyed Vireo	*Vireo olivaceus*	C	H	C	
Blue Jay	*Cyanocitta cristata*	C	C	C	C
American Crow	*Corvus brachyrhynchos*	C	C	C	C
Fish Crow	*Corvus ossifragus*	C	C	C	C
Common Raven	*Corvus corax*	C	H	C	C
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	C	C		
Tree Swallow	*Tachycineta bicolor*		H		
Barn Swallow	*Hirundo rustica*		B		
Cliff Swallow	*Petrochelidon pyrrhonota*		H		
Black-capped Chickadee	*Poecile atricapillus*	C	H	C	C
Tufted Titmouse	*Baeolophus bicolor*	C	H	C	C
White-breasted Nuthatch	*Sitta carolinensis*	C	H	C	C
House Wren	*Troglodytes aedon*		H		
Winter Wren	*Troglodytes hiemalis*				U
Carolina Wren	*Thryothorus ludovicianus*	H			
Golden-crowned Kinglet	*Regulus satrapa*				
Ruby-crowned Kinglet	*Regulus calendula*	M		M	
Eastern Bluebird	*Sialia sialis*				
Bicknell's Thrush	*Catharus bicknelli*			R	

Common Name	Scientific Name	Spring	Summer	Fall	Winter
Swainson's Thrush	*Catharus ustulatus*	M			
Hermit Thrush	*Catharus guttatus*	M			
Wood Thrush	*Hylocichla mustelina*	H			
American Robin	*Turdus migratorius*	C	C	C	U
Gray Catbird	*Dumetella carolinensis*	C	C	C	
Northern Mockingbird	*Mimus polyglottos*	C	C	C	U
Brown Thrasher	*Toxostoma rufum*	M			
European Starling	*Sturnus vulgaris*	C	C	C	C
American Pipit	*Anthus rubescens*	M		M	
Cedar Waxwing	*Bombycilla cedrorum*	C	C	C	
Worm-eating Warbler	*Helmitheros vermivorum*	M			
Black-and-white Warbler	*Mniotilta varia*	M		M	
Nashville Warbler	*Oreothlypis ruficapilla*			M	
American Redstart	*Setophaga ruticilla*	M		M	
Northern Parula	*Setophaga americana*	M		M	
Magnolia Warbler	*Setophaga magnolia*			M	
Yellow Warbler	*Setophaga aestiva aestiva*	M	H		
Chestnut-sided Warbler	*Setophaga pensylvanica*				
Blackpoll Warbler	*Setophaga striata*	M		M	
Black-throated Blue Warbler	*Setophaga caerulescens*	M			
Palm Warbler	*Setophaga palmarum*	M		M	
Pine Warbler	*Setophaga pinus*	M			
Yellow-rumped Warbler	*Setophaga coronata*	M		M	
Black-throated Green Warbler	*Setophaga virens*	M		M	
Canada Warbler	*Cardellina canadensis*			M	
Eastern Towhee	*Pipilo erythrophthalmus*	M		M	
Chipping Sparrow	*Spizella passerina*	C	C	C	
Savannah Sparrow	*Passerculus sandwichensis*	M		M	
Fox Sparrow	*Passerella iliaca*	M			
Song Sparrow	*Melospiza melodia*	C	C	C	C
Lincoln's Sparrow	*Melospiza lincolnii*			U	
White-throated Sparrow	*Zonotricha albilora*	C		C	C
White-crowned Sparrow	*Zonotrichia leucophrys*	M		M	
Dark-eyed Junco	*Junco hyemalis*	C		C	C
Scarlet Tanager	*Piranga rubra*	M		M	
Northern Cardinal	*Cardinalis cardinalis*	C	C	C	C
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	M		M	
Indigo Bunting	*Passerina cyanea*				
Red-winged Blackbird	*Agelaius phoeniceus*	C	C	C	U
Rusty Blackbird	*Euphagus carolinus*	M		M	
Common Grackle	*Quiscalus quiscula*	C	C	C	
Brown-headed Cowbird	*Molothrus ater*	C	C	C	
Orchard Oriole	*Icterus spurius*	U	H		
Baltimore Oriole	*Icterus galbula*	C	H		
Purple Finch	*Haemorhous purpureus*			U	
House Finch	*Haemorhous mexicanus*	C	C	C	C
Common Redpoll	*Acanthis flammea*			R	
Pine Siskin	*Spinus pinus*			R	R

Common Name	Scientific Name	Spring	Summer	Fall	Winter
American Goldfinch	*Spinus tristis*	C	C	C	C
Evening Grosbeak	*Coccothraustes vespertinus*			R	
House Sparrow	*Passer domesticus*	C	C	C	C

C.2: List of Mammals of Oakland

Mammals have not been inventoried specifically in Oakland Borough. Check marks indicate those species confirmed to occur in Oakland, but this list can be updated as more species sightings are confirmed.

Common Name	Scientific Name	Status	Habitat	Range In NJ	Confirmed in Oakland?
Beaver	*Castor candensis*	Increasing	near water		
Big Brown Bat	*Eptesicus fuscus*	Stable	caves, buildings	state	
Black Bear	*Ursus americanus*	Increasing	forests		✓
Black Rat	*Rattus rattus*	Introduced	mainly buildings, docks	state	
Black-tailed Jackrabbit	*Lepus californicus*	Introduced	open and agricultural areas		
Bobcat	*Felis rufus*	Endangered			✓
Brown Rat (Norway Rat)	*Rattus norvegicus*	Introduced	anywhere around humans, but also in the wild	state	
Eastern Coyote	*Canis latrans, var.*	Increasing	grasslands and woodlands	state	✓
Eastern Chipmunk	*Tamias striatus*	Stable	variety of habitats, thickets & brush piles	state	
Eastern Cottontail	*Sylvilagus floridanus*	Stable	brushy areas	state	
Gray Squirrel	*Sciurus carolinensis*	Stable	forests, including urban areas	state	✓
Eastern Mole	*Scalopus aquaticus*	Stable	caves, mines	state	
Eastern Pipistrel (bat)	*Pipistrellus subflavus*	Undertermined	rocky areas	north	
Eastern Wood Rat	*Neotoma floridana*	Endangered	open fields	state	
Ermine (short-tailed weasel)	*Mustela erminea*	Undertermined	woodlands and meadows	higher elevations	
European Hare	*Lepus capensis*	Introduced	variety of habitats		
Gray Fox	*Urocyon cinereoargenteu*	Stable	woodlands	state	
Hairy-tailed Mole	*Parascalops breweri*	Undertermined			
Hoary Bat	*Lasiurus cincrcus*	Undertermined	evergreens	state	
House mouse	*Mus musculus*	Introduced	buildings, farm fields	state	
Indiana Bat	*Myotis sodalis*	Endangered			
Keen Myotis (bat)	*Myotis septentrionalis*	Undertermined			
Least Shrew	*Cryptotis parva*	Undertermined	grassy areas	state	
Little Brown Bat	*Myotis lucifugus*	Stable	caves	north	
Long-tailed Shrew	*Sorex dispar*	Undertermined			
Long-tailed Weasel	*Mustein frenata*	Stable	likes farms & streams	state	
Marsh Rice Rat	*Oryzomys palustris*	Stable		central, south	

Common Name	Scientific Name	Status	Habitat	Range In NJ	Confirmed in Oakland?
Masked Shrew	*Sorex cinereus*	Stable	moist fields to dry woods	state	
Meadow Jumping Mouse	*Zapus hudsonius*	Undertermined	moist fields to dense woods	state	
Meadow Vole	*Microtus pennsylvanicus*	Stable	also woodland glades	state	
Mink	*Mustela vison*	Stable	streams surrounded by brush or forest	state	
Muskrat	*Ondatra zibethlcus*	Stable	water areas	state	
New England Cottontail	*Sylvilagus transitionalis*	Undertermined	brushy areas	state	
Northern Flying Squirrel	*Glaucomys sabrinus*	Undertermined			
Northern yellow bat	*Lasiurus intermedius*	Peripheral			
Nutria	*Myocastor coypus*	Introduced (invasive)	dens in riverbanks	rare but destructive	
Opossum	*Didelphis marsupialis*	Stable	open woodlands and brushlands, tolerant of residential areas	state	✓
Pine Vole (woodland vole)	*Microtus pinetorum*	Stable	pine forests, variety of habitats	state	
Porcupine	*Erethizon dorsatum*	Increasing	forests		
Pygmy Shrew	*Sorex hoyii*	Undertermined			
Raccoon	*Procyon lotor*	Stable	common, often near streams or resting in trees	state	✓
Red-backed Mouse	*Clethrionomys gapperi*	Stable		state	
Red Bat	*Lasiurus borealis*	Stable	trees	state	
Red Fox	*Vulpes vulpes*	Stable	variety of habitats	state	✓
Red Squirrel	*Tamiasciurus hudsonicus*	Stable	pine forests	state	
River Otter	*Lutra canadensis*	Stable	near water		
Short-tailed Shrew	*BIarina brevicauda*	Stable		state	
Silver-haired Bat	*Lasionycteris noctivagan*	Undertermined	trees, cracks, buildings	state	
Small-footed Myotis (bat)	*Myotis leibii*	Undertermined			
Smokey Shrew	*Sorex fumeus*	Undertermined			
Southern Bog Lemming	*Synaptomys cooperi*	Undertermined	meadows	state	
Southern Flying Squirrel	*Glaucomys volans*	Undertermined	coniferous and mixed forests	state	
Star-nosed Mole	*Condylura cristata*	Undertermined	near water and wetlands, occasionally lawns	state	

Common Name	Scientific Name	Status	Habitat	Range In NJ	Confirmed in Oakland?
Striped Skunk	*Mephitis mephitis*	Stable	variety of habitats	state	✓
Tuckahoe Masked Shrew	*Sorex cinereus nigriculus*	Undertermined			
Water Shrew	*Sorex palustris*	Undertermined			
White-footed Mouse	*Peromyscus leucopus*	Stable	anywhere	state	✓
White-tailed Deer	*Odocoileus virginianus*	Decreasing	edges of forests and brushlands, farms, residential areas	state	✓
White-tailed Jackrabbit	*Lepus townsendii*	Introduced			
Woodchuck (Groundhog)	*Marmota monax*	Stable	open woodlands, hibernates in winter		✓
Woodland Jumping Mouse	*Napaeozapus insignis*	Undertermined			

NJDEP, Division of Fish and Wildlife. December 10, 2004. Mammals of New Jersey. http://www.state.nj.us/dep/fgw/chkmamls.htm

Eder, Tamara. 2002. Animal Tracks of New Jersey. Lone Pine Publishing. Renton, VA. 144 pages.

C.3: List of Reptiles and Amphibians of Oakland

Reptiles and amphibians have not been inventoried specifically in Oakland Borough. Check marks indicate those species confirmed to occur in Oakland, but this list can be updated as more species sightings are confirmed.

Common Name	Scientific Name	Habitat	Range In NJ	Confirmed in Oakland?
TURTLES				
Bog Turtle (E✳)	*Clemmys muhlenbergii*	marshes and fens	state	
Common Musk Turtle	*Sternotherus odoratus*	still or slow-moving water	state	
Common Snapping Turtle	*Chelydra serpentina*	fresh or brackish water	state	✓
Eastern Box Turtle	*Terrapene c. carolina*	woods and meadows	state	✓
Eastern Mud Turtle	*Kinosternon s. subrubrum*	shallow slow-moving water with mud bottoms	Includes Bergen County	
Eastern Painted Turtle	*Chrysemys p. picta*	Any standing body of water	state	✓
Red-eared Slider	*Trachemys scripta elegans*	not native to NJ; prefers still water with mud bottom	state	
Spotted Turtle	*Clemmys guttata*	wooded wetlands	state	
Wood Turtle (T✳)	*Clemmys insculpta*	clean streams through woods, meadows & farm	Includes Bergen County	✓
LIZARDS				
Five-lined Skink	*Eumeces fasciatus*	wooded areas	state	
SNAKES				
Black Rat Snake	*Elaphe o. obsoleta*	woodlands, rocky hillsides, meadows, trees	state	
Eastern Garter Snake	*Thamnophis s. sirtalis*	woods, fields & suburban neighborhoods	state	✓
Eastern Hognose Snake	*Heterodon platyrhinos*	habitats with sandy substrate	state	
Eastern Milk Snake	*Lampropeltis t. triangulum*	habitats, barns and buildings with rodents	state	
Eastern Ribbon Snake	*Thamnophis s. sauritus*	slow-moving or quiet waters	state	
Eastern Worm Snake	*Carphophis a. amoenus*	under rocks or rotting logs; burrows in ground	state	
Northern Black Racer	*Coluber c. constrictor*	fields, open woods; occasionally in suburban areas	state	
Northern Brown Snake	*Storeria d. dekayi*	moist areas under debris; unpolluted suburban areas	state	
Northern Copperhead	*Agkistrodon contortrix mokasen*	favors rocky woods, rotting woodpiles, leaves	Includes Bergen County	✓
Northern Redbelly Snake	*Storeria o. occipitomaculata*	wooded areas and bogs	state	
Northern Ringneck Snake	*Diadophis punctatus edwardsii*	under logs, stones, even trash in woods and open areas	state	
Northern Water Snake	*Nerodia s. sipedon*	Near or in water	state	✓
Smooth Green Snake	*Opheodrys vernalis*	Grass and terrestrial habitats	Includes Bergen County	
Timber Rattlesnake	*Crotalus horridus*	Rocky, wooded ledges	Includes Bergen County	✓
SALAMANDERS				
Blue-spotted Salamander (E)	*Ambystoma laterale*	woods and wetlands; breeds in vernal pools and wetlands	Includes Bergen County	
Four-toed Salamander	*Hemidactylium*	wooded swamps and fens	state	

Common Name	Scientific Name	Habitat	Range In NJ	Confirmed in Oakland?
	scutatum	with sphagnum moss		
Jefferson Salamander	*Ambystoma jeffersonianum*	breeds in vernal pools in deciduous forests	Includes Bergen County	
Longtail Salamander (T)	*Eurycea l. longicauda*	slow moving streams, fens and swamps	Includes Bergen County	
Marbled Salamander	*Ambystoma opacum*	under logs & rocks; breeds in vernal pools	state	
Northern Dusky Salamander	*Desmognathus f. fuscus*	under stream-edge debris; near small sources of flowing water	Includes Bergen County	
Northern Red Salamander	*Pseudotriton r. ruber*	Requires cool, clean, flowing streams	state	
Northern Slimy Salamander	*Plethodon glutinosus*	Moist woodland ravines or hillsides	Includes Bergen County	
Northern Spring Salamander	*Gyrinophilus p. porphyriticus*	cool mountain streams and shaded seepages	Includes Bergen County	
Northern Two-lined Salamander	*Eurycea bislineata*	clean streams and under streamside debris	Includes Bergen County	
Redback Salamander	*Plethodon cinereus*	wooded areas under logs, bark, stones and trash	state	
Red-spotted Newt	*Notophthalmus v. viridescens*	adult is aquatic; eft stage prefers moist woods	state	
Spotted Salamander	*Ambystoma maculatum*	Deciduous/ mixed woods; breeds in vernal ponds	Includes Bergen County	
FROGS AND TOADS				
American Toad	*Bufo americanus*	anywhere from backyards to remote woodlands	Includes Bergen County	✓
Bullfrog	*Rana catesbeiana*	any permanent body of freshwater	state	✓
Fowler's Toad	*Bufo woodhousii fowleri*	mainly in sandy habitats	Includes Bergen County	
Green Frog	*Rana clamitans melanota*	any body of freshwater	state	✓
New Jersey Chorus Frog	*Pseudacris triseriata kalmi*	variety of habitats; breeds in swamps & vernal pools	Includes Bergen County	
Northern Cricket Frog	*Acris c. crepitans*	sunny, shallow, permanent pools or streams	state	
Northern Gray Treefrog	*Hyla versicolor*	in trees in forests; breeds in swamps & vernal pools	state	
Northern Spring Peeper	*Pseudacris c. crucifer*	variety of habitats	state	✓
Pickerel Frog	*Rana palustris*	variety of habitats	state	
Southern Leopard Frog	*Rana utricularia*	wetland habitats	state	
Upland Chorus Frog	*Pseudacris triseriata ferarium*	variety of habitats; breeds in swamps & vernal pools	Includes Bergen County	
Wood Frog	*Rana sylvatica*	moist, wooded areas; breed in vernal pools	state	
E= State endangered; T=State Threatened				

Reference: Schwartz, Vicki and David M. Golden. 2002. Field Guide to Reptiles and Amphibians of New Jersey. NJ Division of Fish and Wildlife. 87 pages. http://www.nj.gov/dep/fgw/ensp/fieldguide_herps.htm

APPENDIX D: ENDANGERED SPECIES

Contents:

D.1 List of Rare Plant Species of Bergen County
Source: http://www.nj.gov/dep/parksandforests/natural/heritage/textfiles/bergen.pdf

D.2 Rare Plant Reporting Form
Source: http://www.nj.gov/dep/parksandforests/natural/heritage/natherrareplantspeciesreportform1_2008.doc
Note: Use the following address, not the one on the reporting form:
The New Jersey Natural Heritage Program
DEP - Office of Natural Lands Management
Mail Code 501-04
P.O. Box 420
Trenton, New Jersey 08625-0420

D.3 Rare Wildlife Reporting Form
Source: http://www.state.nj.us/dep/fgw/ensp/pdf/rptform.pdf

The following fact sheets are authored by the NJDEP Endangered and Nongame Species Program and are found at http://www.nj.gov/dep/fgw/tandespp.htm. These threatened and endangered species have been reported within the Borough of Oakland. Fact sheets were not available for all species.

D.4 Fact Sheet: Bald Eagle (*Haliaeetus leucocephalus*)

D.5 Fact Sheet: Barred Owl (*Strix varia)*

D.6 Fact Sheet: Red-shouldered Hawk (*Buteo lineatus)*

D.7 Fact Sheet: Bobcat *(Lynx rufus)*

D.8 Fact Sheet: Timber Rattlesnake (*Crotalus horridus horridus)*

D.9 Fact Sheet: Wood Turtle (*Glyptemys insculpta)*

7/30/2008

Rare Plant Species and Ecological Communities Presently Recorded in the NJ Natural Heritage Database

Scientific Name	Common Name	Federal Status	State Status	Regional Status	G Rank	S Rank
County: **Bergen**						
Nonvascular Plant						
Sphagnum contortum	Sphagnum		E	LP, HL	G5	S1
Sphagnum majus ssp. norvegicum	Sphagnum		E	LP, HL	G5?TNR	S1.1
Vascular Plant						
Adlumia fungosa	Climbing Fumitory			HL	G4	S2
Agastache nepetoides	Yellow Giant-hyssop			HL	G5	S2
Agastache scrophulariifolia	Purple Giant-hyssop			HL	G4	S2
Alopecurus aequalis var. aequalis	Short-awn Meadow-foxtail			HL	G5TNR	S2
Amelanchier humilis	Low Service-berry			HL	G5	S1
Ammannia latifolia	Koehn's Toothcup		E	LP, HL	G5	S1
Anemone canadensis	Canada Anemone			HL	G5	SX
Aplectrum hyemale	Puttyroot		E	LP, HL	G5	S1
Arabis hirsuta var. pycnocarpa	Western Hairy Rockcress			HL	G5T5	S1
Asclepias verticillata	Whorled Milkweed			HL	G5	S2
Athyrium pycnocarpon	Glade Fern		E	LP, HL	G5	S1
Betula papyrifera var. papyrifera	Paper Birch			HL	G5T5	S2
Botrychium oneidense	Blunt-lobe Grape Fern			HL	G4Q	S2
Bouteloua curtipendula	Side-oats Grama Grass		E	LP, HL	G5T5	S1
Callitriche palustris	Marsh Water-starwort			HL	G5	S2
Carex disperma	Soft-leaf Sedge			HL	G5	S1
Carex haydenii	Cloud Sedge		E	LP, HL	G5	S1
Carex pseudocyperus	Cyperus-like Sedge		E	LP, HL	G5	S1

County: **Bergen**

Carex tuckermanii	Tuckerman's Sedge	E	LP, HL	G4	S1
Carex utriculata	Bottle-shaped Sedge		HL	G5	S2
Castilleja coccinea	Scarlet Indian-paintbrush		HL	G5	S2
Cercis canadensis	Redbud	E	LP, HL	G5T5	S1
Chenopodium simplex	Maple-leaf Goosefoot		HL	G5	S2
Corallorhiza wisteriana	Spring Coralroot		HL	G5	SX
Coreopsis rosea	Rose-color Coreopsis		LP, HL	G3	S2
Crataegus chrysocarpa var. chrysocarpa	Fireberry Hawthorn		HL	G5TNR	S1
Cryptogramma stelleri	Slender Rockbrake	E	LP, HL	G5	SH.1
Cuphea viscosissima	Blue Waxweed		HL	G5?	S3
Cypripedium reginae	Showy Lady's-slipper	E	LP, HL	G4	S1
Dirca palustris	Leatherwood		HL	G4	S2
Doellingeria infirma	Cornel-leaf Aster		HL	G5	S2
Dryopteris celsa	Log Fern		HL	G4	SX
Elatine americana	American Waterwort		HL	G4	S2
Eleocharis halophila	Salt-marsh Spike-rush		HL	G4	S2
Epilobium angustifolium ssp. circumvagum	Narrow-leaf Fireweed		HL	G5T5	S1
Equisetum pratense	Meadow Horsetail	E	LP, HL	G5	S1
Eriophorum gracile	Slender Cotton-grass	E	LP, HL	G5TNR	SH
Eriophorum viridicarinatum	Thin-leaf Cotton-grass		HL	G5	S3
Gnaphalium macounii	Winged Cudweed	E	LP, HL	G5	SH
Gymnocarpium dryopteris	Oak Fern		HL	G5	S1
Hemicarpha micrantha	Small-flower Halfchaff Sedge	E	LP, HL	G4	S1
Hottonia inflata	Featherfoil	E	LP, HL	G4	S1
Hydrocotyle ranunculoides	Floating Marsh-pennywort	E	LP, HL	G5	S1

County: **Bergen**

Hypericum adpressum	Barton's St. John's-wort		E	LP, HL	G2G3	S2
Hypericum majus	Larger Canadian St. John's Wort		E	LP, HL	G5	S1
Isotria medeoloides	Small Whorled Pogonia	LT	E	LP, HL	G2	S1
Juncus brevicaudatus	Narrow-panicle Rush			HL	G5	S2
Lemna perpusilla	Minute Duckweed		E	LP, HL	G5	S1
Lemna trisulca	Star Duckweed			HL	G5	S2
Lemna valdiviana	Pale Duckweed		E	LP, HL	G5	S1
Limosella subulata	Awl-leaf Mudwort		E	LP, HL	G4G5	S1
Linum sulcatum	Grooved Yellow Flax		E	LP, HL	G5T5	S1
Luzula acuminata	Hairy Wood-rush		E	LP, HL	G5T4T5	S2
Lycopodiella inundata	Northern Bog Club-moss			HL	G5	S1
Lysimachia hybrida	Lowland Loosestrife			HL	G5	S3
Malaxis unifolia	Green Adder's-mouth			HL	G5	S2
Melanthium virginicum	Virginia Bunchflower		E	LP, HL	G5	S1
Menyanthes trifoliata	Buck-bean			HL	G5	S2
Mimulus alatus	Winged Monkey-flower			HL	G5	S3
Muhlenbergia glomerata	Eastern Smoke Grass			HL	G5	S2
Nuphar microphyllum	Small Yellow Pond-lily		E	LP, HL	G5T4T5	SH
Obolaria virginica	Virginia Pennywort			HL	G5	S2
Phaseolus polystachios var. polystachios	Wild Kidney Bean			HL	G4TNR	S2
Platanthera hyperborea var. hyperborea	Leafy Northern Green Orchid			HL	G5T5	SX
Poa autumnalis	Flexuous Spear Grass		E	LP, HL	G5	SH.1
Potamogeton oakesianus	Oakes' Pondweed			HL	G4	S2
Prenanthes racemosa	Smooth Rattlesnake-root		E	LP, HL	G5TNR	SH
Ptelea trifoliata	Wafer-ash		E	LP, HL	G5T5	S1

County: **Bergen**

Pycnanthemum clinopodioides	Basil Mountain-mint	E	LP, HL	G2	S1
Pycnanthemum torrei	Torrey's Mountain-mint	E	LP, HL	G2	S1
Ranunculus ambigens	Water-plantain Spearwort		HL	G4	S2
Ranunculus flabellaris	Yellow Water Buttercup		HL	G5	S3
Ranunculus micranthus	Rock Buttercup		HL	G5	S2
Rotala ramosior	Toothcup		HL	G5	S3
Saccharum alopecuroidum	Silver Plume Grass		HL	G5	SH
Sagittaria subulata	Awl-leaf Arrowhead		HL	G4	S2
Salix candida	Hoary Willow		HL	G5	S2
Salix lucida ssp. lucida	Shining Willow		HL	G5T5	S1
Salix pedicellaris	Bog Willow	E	LP, HL	G5	S1
Schoenoplectus torreyi	Torrey's Bulrush	E	LP, HL	G5?	S1
Scirpus maritimus	Saltmarsh Bulrush	E	LP, HL	G5	SH
Scleria pauciflora var. caroliniana	Carolina Nut-rush		HL	G5T4T5	S2
Scleria verticillata	Whorled Nut-rush	E	LP, HL	G5	S1
Scutellaria leonardii	Small Skullcap	E	LP, HL	G4T4	S1
Silene caroliniana var. pensylvanica	Wild-pink		HL	G5T4	S3
Solidago rigida	Prairie Goldenrod	E	LP, HL	G5T5	S1
Sphenopholis pensylvanica	Swamp Oats		HL	G4	S2
Sporobolus compositus var. compositus	Long-leaf Rush-grass		HL	G5T5	S2
Stachys hyssopifolia	Hyssop Hedge-nettle		HL	G5	S2
Thuja occidentalis	Arborvitae	E	LP, HL	G5	S1
Tiarella cordifolia	Foamflower	E	LP, HL	G5T5	S1
Triphora trianthophora	Three Birds Orchid	E	LP, HL	G3G4	S1
Trollius laxus ssp. laxus	Spreading Globe Flower	E	LP, HL	G4T3	S1
Utricularia intermedia	Flat-leaf Bladderwort		HL	G5	S3

County: **Bergen**

Verbena simplex	Narrow-leaf Vervain	E	LP, HL	G5	S1
Viola canadensis	Canadian Violet	E	LP, HL	G5TNR	S1
Viola septentrionalis	Northern Blue Violet	E	LP, HL	G5	S1
Vitis novae-angliae	New England Grape	E	LP, HL	G4G5Q	S1

Natural Heritage Rare Plant Species Reporting Form

This form is used to report a personal field sighting of a rare plant species tracked by the Natural Heritage Database. It may also be used to summarize locational information from a published or unpublished report. Plant species tracked include those appearing on the State Endangered Plant Species List or the Plant Species of Concern List (http://www.nj.gov/dep/parksandforests/natural/heritage/spplant.html). The Office of Natural Lands Management can provide copies of the lists upon request. In order for this form to be processed, the sections preceded by an asterisk (*) must be completed.

Send completed form to: DEP, Division of Parks and Forestry, Office of Natural Lands Management, Natural Heritage Program, P.O. Box 404, Trenton, NJ 08625-0404.

Today's Date: (date this form is being completed) _____

Common Name: _____ **Scientific Name:** _____

***Location Map:** *A mapped location of the occurrence must accompany this form.* The ideal format is to locate the site on a photocopied section of a U.S. Geological Survey 7.5 minute topographical map, and to also sketch a second map showing finer details. Be sure to provide the name of the USGS map.

GPS Coordinates (If available please provide the following):

Datum Used:	☐ NAD 1983	☐ NAD 1927	☐ WGS84	☐ Other _____
Lat/Long (if applicable):	_____ N (Latitude)		_____ W (Longitude)	
UTM (if applicable)	18 N/S: _____ Northing		_____ Easting	
Accuracy Level:	+/-_____ ☐feet or ☐meters			

***Directions to Site:** Directions to the element occurrence using a readily locatable and relatively permanent landmark on or near the site (such as a road intersection, a prominent hill or cliff) as the starting point. Use clear, complete sentences so that someone who is unfamiliar with the area will be able to relocate the element occurrence using your written directions (e.g., "About 50 ft. N. of small stream draining Brindel Lake, 0.5 mi. SE of Brindeltown and 0.2 mi. WSW of jct. of Range Rd. and Rt. 539, Fort Dix").

***Date(s) of the Observation(s):** _____

Identification: How was the species identification made? Name the identification manuals used or the experts consulted. Were there identification problems?

***Number of Individuals Observed:**

☐ 1-10 ☐ 11-50 ☐ 101-1,000 ☐ 1,001-10,000 ☐ >10,000

If possible, provide the exact number of individuals and an estimated percentage of flowering/fruiting individuals. For rhizomatous plants such as grasses and sedges, what was counted as individual – separate culms or entire clumps or patches?

Life Stages Present: Check life stages observed or provide an estimate of the numbers of individuals for each life stage.

☐ vegetative ☐ in bud ☐ flower ☐ seed dispersing ☐ seedling ☐ dormant

Associated Species/Additional Biological Data: List any associated species and/or additional rare species observed at this site. What else was observed? Provide information on the general condition or vigor of the individuals and viability of the population(s).

Habitat Data: Describe the specific area where the occurrence is located. List natural community types, dominant vegetation and information on the physical environment such as substrate type, hydrology, moisture regime, slope and aspect. Also, describe the surrounding landscape.

Threats: Describe any current or potential threats to this occurrence. If invasive species are present, please list.

Ownership: If known, please provide landowner(s) name, address, phone #.

Information Source:

***Name, Address and Phone #** (of person filing report):

Name:	
Address:	
Phone Number:	

*Does this information come directly from ☐ a field visit or ☐ a published or unpublished report?

Citation: For information taken from a published or unpublished report, please provide a copy of the cover page and the pertinent portions of the report. If a copy can not be provided, list below the author, date, title, publisher, and page numbers.

Voucher: Was the observation vouchered with ☐ a photograph? ☐ a video/digital format? ☐ a specimen?
If possible, attach a copy of the photograph or tape. If specimen voucher, please provide the name of the repository:

Confirmation: Would you accompany a biologist to the site if needed? ☐ yes ☐ no.

Additional Comments: (use extra sheets if needed)

RARE WILDLIFE SIGHTING REPORT FORM

REPORT FORM MUST BE ACCOMPANIED BY AN AERIAL PHOTOGRAPH, SATELLITE IMAGE, OR TOPOGRAPHIC MAP WITH THE LOCATION PRECISELY MARKED. PLEASE PRINT LEGIBLY.
*The inclusion of a map is mandatory, please see other side for further information on obtaining a map.

General Information

Today's Date _____
Common Name _____ Scientific Name (If known) _____

Where did the sighting take place?

Municipality/ Township _____ County _____

Topographic quad (if known) _____ Coordinates in state plane feet (if known) _____ _____

Directions to location with landmarks, which will enable the future relocation of the site where the species was sighted:

_____

_____

_____

Land Owner (name, address and phone number, if known) _____
Describe habitat at the point of sighting and habitat in the general area of the sighting location.

_____

_____

Would you accompany a biologist to the site if needed? ☐ Yes ☐ No
Can you describe any immediate or future plans to develop or disturb the site? ☐ Yes ☐ No
If so, please describe. _____

_____

Locational Accuracy

1. Is your depiction of the sighting location on the topographic map or aerial photo within 6m (20ft) of the animals actual location on the ground? ☐ Yes ☐ No (if no, answer question 2 below)

2. Your mapping is accurate to within ___ meters ___ feet ___ miles of the actual location.

What was observed?

How was the species identification made? (ex. Sighting, Call, Road Kill, etc.) _____

Date and time of this sighting (ex. August 20, 2004, 10:30am) _____

How frequently has this species been sighted at this location and over how long a period of time? _____

_____

Number of individuals sighted: Adult ____ Immature ____ Larva ____ Unknown/Other ____

Describe sighting and activity observed (ex. Nesting, Perched, Flying, Sunning, etc.) _____

Describe physical features that identify the sighted animal as the species you are reporting. _____

_____

_____

Were photos taken? ☐ Yes ☐ No Was video recorded? ☐ Yes ☐ No Was audio recorded? ☐ Yes ☐ No
(PHOTOS/VIDEO/AUDIO ARE STRONGLY ENCOURAGED IN ORDER TO VERIFY THE ACCURACY OF A SIGHTING. Items should be identified with the date taken, location, and observer signature. Items will not be returned.)

List manuals used or experts consulted to verify identification. _____

Provide a brief background on wildlife knowledge and/or experience, or additional information that would add to the validity of the sighting. _____

_____

Can this be verified by someone else or can anyone vouch for your identification skills? ☐ Yes ☐ No _____

Describe any additional information that may be useful in regards to the condition of the animal or location.

_____

_____

Your Contact information

Name _____
Street _____
City _____ State _____ ZIP_____
Daytime Phone (____) ____-_____ E-mail _____

Preferred method of contact _____

Signature _____

Conserve Wildlife
N.J. Division of Fish, Game & Wildlife
Endangered & Nongame Species Program

Return to:
Endangered and Nongame Species Program
NJ Division of Fish and Wildlife
PO Box 400
Trenton, NJ 08625-0400
(609) 292-9400

NEW JERSEY DIVISION OF
Fish and Wildlife

Instructions

1. Complete this form for first-hand field observations only.
2. DO NOT COMPLETE THIS FORM if the source of your information is a report, letter, conversation, or other document. Send us the documentation instead.
3. Attach a copy of a map.(*see below*)
4. Only report one species at each location per form and map.

***Mapping**
A map is necessary to help our biologists determine if suitable habitat is present at the location. Once the suitability of the area is determined the map provided aids in the delineation of land to be protected. Ideally the most accurate form of map is an aerial photo, which can be obtained from http://www.state.nj.us/dep/gis/newmapping.htm, if you are comfortable with your ability to identify the location of the sighting accurately on them. In addition, satellite-derived images are available at http://www.maps.google.com. These images can be printed and clearly marked with a pen. An alternative to an aerial photo or satellite image is a topographic map. You may also print copies of topographic maps from the internet at http://www.topozone.com. Please use 1:24,000 scale topographic maps only. Please provide either an image or a topographic map, but NOT both. Thank you.

Refer to the DFW website for further information: http://www.njfishandwildlife.com/ensp/rprtform.htm

Wildlife Notes

NJ Division of Fish and Wildlife
Endangered and Nongame Species Program

Bald Eagle

(Haliaeetus leucocephalus)

THE BALD EAGLE IN NEW JERSEY

New Jersey was once home to more than 20 pairs of nesting bald eagles. As a result of the use of the pesticide DDT, the number of nesting pairs of bald eagles in the state declined to only one by 1970 and remained at one into the early 1980's. Use of DDT was banned in the United States in 1972. That ban combined with restoration efforts by biologists within the NJ Division of Fish and Wildlife's Endangered and Nongame Species Program (ENSP) acted to increase the number of New Jersey bald eagles to 119 active pairs in 2012.

The bald eagle is currently listed as endangered in New Jersey. Recently, the status of the bald eagle was changed from endangered to threatened on the federal endangered species list, and the species is being considered for removal from the federal list.

ENSP recovery efforts - implemented in the early 1980's - are now bearing fruit, as New Jersey's eagle population rebounds from the edge of extinction. In 1982, after Bear Swamp - New Jersey's only active bald eagle nest since 1970 - had failed to produce young for at least six consecutive years, ENSP biologists removed an egg for artificial incubation, and fostered the young back to the nest. The necessity of this fostering technique was due to eggshell thinning as a result of DDT contamination. The eggs, if left in the nest for the adult eagles to incubate, would crack under the birds' weight. Fostering continued successfully until 1989, when the previous female of the pair died and a new female was able to hatch her own eggs.

Increasing the production from a single nest, however, was not enough to boost the state's population in a reasonable amount of time. Mortality rates are high in young eagles (as high as 80%), and they do not reproduce until four or five years of age. ENSP instituted a hacking project in 1983 that resulted in the release of 60 young eagles in NJ over an eight-year period. These eagles have contributed to the increase in nesting pairs since 1990.

IDENTIFICATION

Adult bald eagles are distinguished by their full white heads and tails, but subadult and juvenile birds are brown overall with some white mottling. Both sexes have similar plumage, although the female is slightly larger than the male. With a wing span of six to seven feet, eagles are larger than most birds, but can be confused with vultures from a distance. While eagles eat mostly fish during the warmer months, they feed on waterfowl, muskrat, and carrion during winter and early spring.

BREEDING BIOLOGY

In New Jersey, nesting bald eagles reside year-round, usually remaining in the area of their nest. Eagles usually build their large stick nests close to water in trees taller than the forest canopy. They begin courtship and nest building in early January, adding to their existing nest. Pairs lay one to three eggs in mid-January to early March, and incubate for about 35 days. Upon hatching, the chicks are helpless and require close parental care. After about five weeks, the young birds begin to stand up and feed themselves when the adults deliver food. Young birds fledge the nest at 11 weeks of age in early July. Adults continue to feed young near the nest for several weeks while the young learn to fly and hunt. In late August many young eagles leave the area and may spend the following winter in the Chesapeake Bay area, where open water and abundant food provide favorable conditions.

MANAGEMENT

ENSP biologists continually work to manage and reduce disturbance in eagle habitats, especially around nest sites. Eagles are sensitive to human disturbance and will abandon their nest sites if people encroach on the area during the nesting season. Education and established viewing areas are important in minimizing disturbance, as are the efforts of eagle project volunteers. Biologists also work to protect habitat in a variety of ways, including working with landowners, land acquisition experts, and through the state's land use regulations.

Bald eagles are proven indicators of environmental health. As residents and consumers of fish, their health reflects the quality of resources shared by humans. ENSP is continuing to investigate the possible impacts of organochlorines and heavy metals in eagles and other raptors nesting in the Delaware Bay region. ENSP monitors these species during the nesting season to evaluate nest success and assess any problems that occur.

How You Can Help

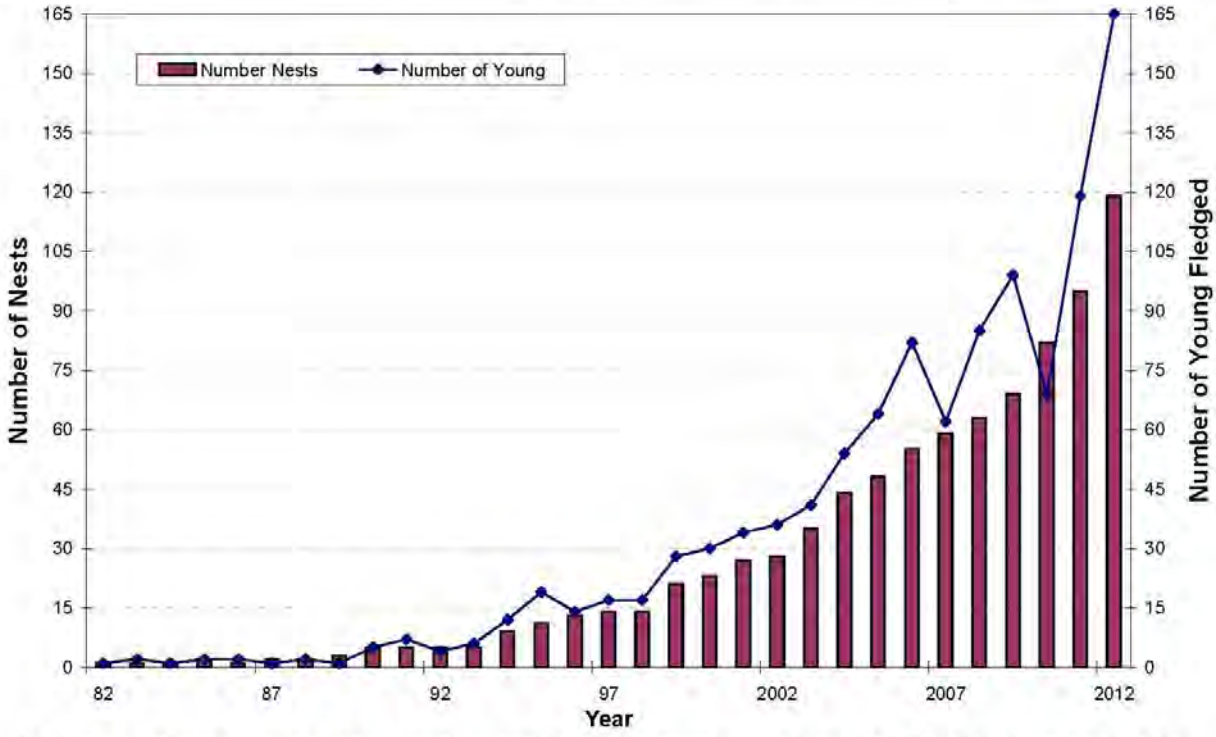
The ENSP receives no funding from state tax dollars. You can help support New Jersey's bald eagles by:

- Checking-Off for Wildlife on the NJ State Income Tax Form
- Purchasing a *Conserve Wildlife* license plate
- Participating in the *Adopt an Eagle Nest Program*
- Making a donation to the Conserve Wildlife Foundation of NJ, a non-profit organization dedicated to supporting the eagle project
  www.conserverwildlifenj.org

For more information, please contact the ENSP at:

Endangered & Nongame Species Program
NJ Division of Fish and Wildlife
MC 501-03
P.O. Box 420
Trenton, NJ 08625-0420
(609) 292-9400
www.njfishandwildlife.com

VISIT THE NJ EAGLE CAM AT:
www.conservewildlifenj.org/education/eaglecam



To learn where you can view eagles in the state, purchase the NJ Wildlife Viewing Guide, available from the CWF

Barred Owl, *Strix varia*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

© Blaine Rothauser

On still spring evenings, the hooting and eerie caterwauling of barred owls resonate throughout the remote, swampy woodlands of New Jersey. The resounding song of the barred owl, often represented as "who cooks for you, who cooks for you allll," is often accompanied by loud "hoo-ah" calls and yowling reminiscent of monkeys. Barred owls may vocalize throughout the year, but are most expressive during courtship, from late February to early April. These owls often call at night but may also vocalize during the day.

The barred owl is a large fluffy-looking owl with brown barring on the upper breast and brown streaking on the lower breast and belly. The upperparts are brown with buffy-white barring. The tail is patterned with alternating bands of brown and buff-gray. The throat is white and the round head lacks ear tufts. The facial disk is grayish-white with a brown outline. The large facial disk funnels sounds towards the owl's proportionally gigantic ears, providing it with extraordinary hearing for detecting minute noises, such as the rustling of mice in the dark. Unlike all other eastern owls excluding the barn owl, the eyes of the barred owl are dark brown. The hooked bill is buff yellow. The feet and toes are feathered and the talons are dark brownish-black. Sexes are similar in plumage and, although there is much overlap, females may be larger than males. Juveniles resemble adults.

Barred owls fly with slow, moth-like wing beats that are interspersed with glides. In flight, the head appears large and the wings are broad and rounded. Soft feathers and serrated edges on the outer wing feathers minimize noise, enabling these and all other owls to fly silently--an advantage that enables them to surprise their prey.

The barred owl can be distinguished from most other New Jersey owls by its plumage, large size, distinctive vocalizations, and habitat selection. The great horned owl (Bubo virginianus), a common breeding species in the state, is also a large owl but has rich brown plumage and yellow eyes. The ear tufts of great horned owls may not be noticeable in flight, making them appear round-headed like a barred owl. The call of the great horned owl is a melancholy "hoo-hoo-hoo." Great horned owls, which often reside in forested uplands or near human habitation, are less restrictive in their habitat choice than barred owls. The barn owl (Tyto alba), the only other New Jersey owl with dark eyes, is white below and golden brown above. In addition, the barn owl, which resides in

open fields and grasslands, has a narrow body, long unfeathered legs, and a heart-shaped facial disk.

Habitat

Traditionally known as the "swamp owl," the barred owl is a denizen of remote, contiguous, old-growth wetland forests. These owls require mature wet woods that contain large trees with cavities suitable for nesting. Barred owl habitats typically have an open understory through which the owls can fly and hunt. The lack of large nesting cavities is often the primary limiting factor for barred owls. Consequently, these owls may nest immediately outside of a wetland or in sub-climax wetland forests if adequate nest sites are unavailable within a mature wetland forest. Barred owls are typically found in remote wilderness areas that may also contain other rare species such as the red-shouldered hawk (Buteo lineatus) or the Cooper's hawk (Accipiter cooperii). Barred owls typically shun human activity by avoiding residential, agricultural, industrial, or commercial areas. In northern New Jersey, barred owls favored sites that were at least 500 meters (1640 ft.) from human habitation and had little or no forest clearings or trails (Bosakowski 1987).

In southern New Jersey, barred owls inhabit both deciduous wetland forests and Atlantic white cedar (Chamaecyparis thyoides) swamps associated with stream corridors. Often such lowland forests are buffered by surrounding pine or pine/oak uplands that may protect the owls from human disturbance and provide additional foraging habitat. Mixed hardwood swamps are often dominated by red maple (Acer rubrum) and black gum (Nyssa sylvatica) and may include highbush blueberry (Vaccinium corymbosum), swamp magnolia (Magnolia virginiana), or greenbrier (Smilax spp.) in the shrub layer. Although barred owls utilize white cedars for roosting, they infrequently provide cavities that are large enough for nesting owls.

In northern New Jersey, barred owls inhabit hemlock ravines and mixed deciduous wetland or riparian forests. Oak hardwood forests containing white oak (Quercus alba), red maple, black birch (Betula lenta), black willow (Salix nigra), hickory (Carya spp.), white ash (Fraxinus americana), basswood (Tilia americana), tulip poplar (Liriodendron tulipifera), black cherry (Prunus serotina), and black gum may be occupied. Barred owls may also inhabit northern hardwood forests that contain sugar maple (A. saccharum), birch (Betula spp.), and beech (Fagus grandifolia). Dense stands of hemlock (Tsuga canadensis), white pine (Pinus strobus), Norway spruce (Picea abies), or other conifers provide cover for roosting owls and protection from harsh weather. Barred owls prefer flat, lowland terrain and avoid rocky slopes and hillsides.

As a resident species, barred owls establish territories with fairly stable boundaries that are continuously maintained throughout the year. In eastern North America, home range sizes of 86 to 370 hectares (213 to 914 acres) have been documented for barred owls (Johnsgard 1988).

Status and Conservation

The barred owl was traditionally a common resident within the deep wooded swamps of New Jersey. Historically, these owls were shot as trophies or because of alleged poultry predation. Collectors also looted young owls and eggs. Despite human

persecution, the barred owl persisted virtually unscathed until the early 1940s when the cutting of old growth forests and the filling of wetlands greatly reduced habitat throughout the state. Rampant habitat loss and associated barred owl population declines continued for the next several decades. Consequently, these owls were lost from many historic breeding locales.

Due to population declines and habitat loss, the barred owl was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the barred owl to be "demonstrably secure globally," yet "rare in New Jersey" (Office of Natural Lands Management 1992). Currently, barred owl populations appear to be declining due to development and fragmentation of large tracts of private forested lands. The barred owl population has been estimated at 37 pairs in South Jersey and 75 pairs in North Jersey (Sutton and Sutton 1985, Bosakowski 1988). But recent surveys in South Jersey indicate as much as a 30 percent decline there.

Red-shouldered Hawk, *Buteo lineatus*

Status: ***State:*** Endangered (breeding population), Threatened (nonbreeding population)
Federal: Migratory Nongame Bird of Management Concern

Identification

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The red-shouldered hawk is a crow-sized buteo, or soaring hawk. The adults are strikingly plumed, with rufous (brownish red) shoulder patches and a rufous barred breast. Rufous lesser and median upperwing coverts form the "red shoulders" evident on this species. The flight feathers of adults are barred black and white and show a white crescent-shaped window across the primaries, which is visible in flight. The underparts, which are rufous with white barring, often exhibit thin, dark streaks on the chest. The head and back are dark brown. The black tail is bisected by several narrow white bands. Although females average slightly larger than males, plumage is similar for both sexes. The call of the red-shouldered hawk is a series of nasal drawn-out "aahhh" cries.

Juvenile red-shouldered hawks can be distinguished from adults by their overall browner, less brilliant plumage. The shoulder patches of juveniles are paler rufous and the crescents across the primaries are tawny. The underparts are whitish with variable amounts of brown streaking. The tail is brown with several thin pale bands. Adult plumage appears in the second year.

The red-shouldered hawk is a long-tailed buteo with squared-off wings and a protruding head. Characterized by quick choppy wingbeats interspersed with short glides, the flight style of this hawk is similar to that of an accipiter. When soaring, most buteos hold their wings straight out, whereas the red-shouldered hawk bows its wings forward.

Habitat

Mature wet woods such as hardwood swamps and riparian forests typify red-shouldered hawk breeding habitat. Nesting territories, which occur in deciduous, coniferous, or mixed woodlands, are typically located within remote and extensive old growth forests containing standing water. Consequently, breeding barred owls (Strix varia) and Cooper's hawks (Accipiter cooperii) are often found in habitats containing red-shouldered hawks.

Red-shouldered hawks select large deciduous and, to a lesser extent, coniferous trees for nesting. Nests have been documented in oak (Quercus spp.), pine (Pinus spp.), maple (Acer spp.), ash (Fraxinus spp.), beech (Fagus grandifolia), birch (Betula spp.),

basswood (Tilia americana), chestnut (Castanea dentata), hemlock (Tsuga canadensis), elm (Ulmus spp.), cherry (Prunus spp.), hickory (Carya spp.), and tulip poplar (Liriodendron tulipifera). Forest characteristics include a closed canopy of tall trees, an open subcanopy, and variable amounts of understory cover.

Red-shouldered hawks inhabit wetland forest types unique to the different physiographic regions throughout northern and southern New Jersey. In north Jersey, they occupy riparian forests, wooded wetlands, beaver meadows, and mesic (slightly moist) lowland forests. Within the Pequannock Watershed, red-shouldered hawks are found in stream bottomlands and coniferous or mixed forests containing eastern hemlock or white pine (Pinus strobus). Nests are predominately located in wilderness areas where there are abundant wetlands, small forest openings, and limited areas of large open water such as lakes. In the Pequannock Watershed, red-shouldered hawks avoid areas of human inhabitation, steep uplands, dry slopes, open water, areas with limited conifers, and areas with too many or too few forest openings. Although red-shouldered hawks require extensive tracts of forested habitat for nesting, territories may also contain edges where the birds forage.

The majority of red-shouldered hawk nests in southern New Jersey are contained within vast contiguous freshwater wetlands. Hardwood or mixed hardwood/cedar swamps containing red maple (Acer rubrum), black gum (Nyssa sylvatica), sassafrass (Sassafras albidum), sweetbay magnolia (Magnolia virginiana), and Atlantic white cedar (Chamaecyparis thyoides) are occupied by red-shouldered hawks. Often, such large forested tracts are surrounded by oak/pine forests or agricultural fields. Although red-shouldered hawks nest in large contiguous tracts of wet old growth forests in Cumberland County, they occupy younger wet woods, often on private property safeguarded from high levels of human activity, in Cape May County.

An-area sensitive species, the red-shouldered hawk typically nests away from residences, roads, and development. In the Pequannock Watershed, red-shouldered hawk nests were located an average of 1,013 m and a standard deviation of plus or minus 614 m (3,324 ± 2,014 ft.) from the nearest building; and an average of 812 m and a standard deviation of plus or minus 634 m (2,664 ± 2,080 ft) from the nearest road (Bosakowski et al. 1991). Red-shouldered hawks avoid small fragmented woodlots and forests that do not contain trees large enough for nesting.

Red-shouldered hawks require large contiguous wooded tracts of 100 to 250 hectares (250 to 620 acres) (Johnsgard 1990). Eastern populations occupy breeding home ranges of 109 to 339 hectares (270 to 838 acres) (Crocoll 1994). In the Pequannock Watershed, red-shouldered hawk breeding densities were estimated at one nest per 450 hectares (1,112 acres) with an average distance of 1.2 to 1.6 km (0.75 to 1.0 mi.) between nests in areas containing the highest breeding concentrations (Bosakowski et al. 1991). Home range sizes of males exceed those of females, during both the breeding and nonbreeding seasons. Individuals of either sex may expand their home ranges while rearing young or throughout the winter months.

During the nonbreeding season, red-shouldered hawks are less restrictive in their habitat use. They inhabit the traditional wetland forests occupied during the breeding season as well as uplands, fragmented woods, smaller forests, open areas, and edges.

Status and Conservation

The red-shouldered hawk was once considered a common resident of wet lowland forests in New Jersey. Only a century ago, bounties were placed on birds of prey, which were accused of poultry and game predation. This unfortunate practice, coupled with egg collecting and the placement of wild red-shouldered hawks in captivity, may have caused initial population declines. The clearing of forests and filling of wetlands exacerbated red-shouldered hawk declines, which were noted as early as the mid-1920s. Reduced numbers of red-shouldered hawks wintering in New Jersey were documented from the early 1950s to the 1970s, as development increased and forest contiguity and patch size decreased. As a result, the red-shouldered hawk, with an estimated 100 breeding pairs in the state, was listed as a threatened species in New Jersey in 1979. In 1982, the U.S. Fish and Wildlife Service listed the red-shouldered hawk as a Migratory Nongame Bird of Management Concern due to population declines and restricted habitat requirements. In addition, the red-shouldered hawk was included on the National Audubon Society's Blue List of Imperiled Species from 1972 to 1986, the final year of the list.

During the 1980s, habitat loss continued to pose an increasing threat, causing red-shouldered hawk populations to decline ever further. By the late 1980s and early 1990s, the state's breeding population was estimated at only 36 pairs, nearly one-third the population size at the time of original listing. As a result, the breeding population of the red-shouldered hawk was reclassified as endangered in 1991. The nonbreeding population remained listed as threatened. The New Jersey Natural Heritage Program considers the red-shouldered hawk to be "demonstrably secure globally," yet "imperiled in New Jersey because of rarity" (Office of Natural Lands Management 1992). Habitat loss and declines of red-shouldered hawks in the Northeast have resulted in the listing of this species as threatened in New York and of special concern in Connecticut.

Bobcat, *Lynx rufus*

Status: ***State*: Endangered** ***Federal*: Not listed**

Identification

The bobcat is a medium sized-cat, about two feet tall — larger than a housecat, but much smaller than a cougar or lion. Adult females in NJ generally weigh between 18 and 25 lbs. while adult males can weigh as much as 35 lbs. Their fur ranges from yellowish brown to reddish brown and bears markings that vary from 'tabby' stripes to heavy spotting. They possess slightly tufted ears and a short bobbed tail (between three and seven inches long) that is black above at the tip. Generally they hunt both by night and day, although there is evidence to suggest that most hunting takes place at dawn and dusk. They are extremely shy animals that are seldom seen by humans although as numbers have increased in northern parts of the state more and more people are seeing bobcats.

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Distribution and Habitat

The bobcat is restricted to North America, and is found in coniferous and mixed forest in the north, swamp and coastal areas in and around Florida, and desert and scrubland in the southwestern United States. They are absent in the highly cultivated areas of the northern mid-western states, and were once widespread and common in New Jersey, probably occurring in all counties. Massive deforestation, development and changes in agricultural practices since the turn of the century have led to its decline in some areas of the country. However, a recent range-wide status assessment conducted by researchers at Cornell University and the University of Montana reported that bobcat numbers are on the rise. Currently, bobcats are listed as an endangered species in NJ.

Diet

Bobcats prey on rabbits, mice, squirrels, ground-nesting songbirds, turkeys, and even small or sick deer. They only eat about 3 pounds of meat at a time, so if they manage to catch a larger animal, they will drag it to a safe spot, cover it up, and return later to feed again. They have excellent vision and hearing, and use these senses most in hunting. The soft pads on their feet help them sneak up quietly on their prey.

Life Cycle

Bobcats like to den in crevices in rocks, under fallen logs, in thick tangles of vegetation or under the root mass of a fallen tree. They generally breed between February and June, and have a litter

size of 1-6 young (2-3 is typical) that are born after a gestation period of approximately 60 days. The spotted kittens are weaned at about 12 weeks. As the kittens are weaned, they begin eating meat that the mother brings back for them. Later, she will bring live animals (like mice) back to the den, so the kittens can practice hunting. A bobcat becomes independent of its mother at about 10-12 months of age, and may live 12-13 years in the wild.

Management & Research

In New Jersey, European settlement brought hard times for bobcats. Early settlers hunted and trapped them for their pelts and changes in land-use occurred that were unfavorable for bobcats. The greatest blow to the once large population was the massive deforestation that occurred here at the turn of the century. As forests were cleared for lumber, fuel and charcoal, and land was converted to agricultural use, bobcat habitat became fragmented. As NJ's human population grew, along with roads and development, bobcat habitat became even more fragmented. Populations became isolated and plummeted. Scattered reports of bobcats being seen or killed on roads continued throughout the 1950s and 1960s, and the species was listed as endangered in NJ in June of 1991. Today, roads and fragmented habitat in NJ prevent extant populations from returning to previously occupied habitat in central and southern NJ.

The NJ Division of Fish and Wildlife conducted a restoration project where 24 bobcats captured in Maine were released in northern New Jersey from 1978-1982. By the 1990's reports of bobcat sightings began to increase. Today, bobcat reports from northern NJ are on the increase. Unfortunately, so are the numbers of bobcats killed by automobiles on our highways. During a one year period between 2008 and 2009, fourteen bobcats were observed on NJ roads and ten of these were hit by cars.

Since 1991, the Division's management efforts have led to consistent bobcat sightings from an increasingly larger area of northern New Jersey. Most sightings continue to come from Warren, Sussex, Passaic and Morris counties but there have been scattered, recent sightings from Bergen and Hunterdon counties. Bobcats are difficult to study because they exhibit elusive behavior, occur at relatively low densities, and have large area requirements. Yet, monitoring of population characteristics (e.g. size and sex ratio) and distribution are essential components needed to develop and implement a recovery plan for the species. In recent years, biologists have used a few different methods in an attempt to gather this information.

In February of 1997, biologists conducted a pilot project to determine if bobcats could be tracked using radio telemetry. They captured three adult male bobcats and fitted them with radio collars. Biologists use telemetry data to track bobcat movements and help them determine the kind of habitat they use and the size of their home range. The information from this study provides important data necessary to protect the habitat needed for bobcats to survive in New Jersey. In recent years new technology has improved our ability to track bobcats in NJ. Both satellite and GPS collars have been used to track bobcat movements since 2002. These collars provide biologists with a tremendous volume of "fixes" or location information during the life of the collar and the locations are accurate to within a few meters. This represents a vast improvement in data quality and quantity over the older radio collars. In addition, the GPS locations are

gathered without biologists having to spend hundreds of hours in the field tracking the animals. All of the location data is stored on the collar and is downloaded directly to a computer.

In late 2005 ENSP contracted with Working Dogs for Conservation to acquire Bear, a professionally trained detection dog who is used to locate and alert biologists to bobcat scats. DNA can be extracted from sloughed intestinal cells contained in scat and can provide a wealth of information. DNA analyses of scat allow biologists to identify individual animals, their sex and movements. Systematic surveys conducted in northern New Jersey by the dog-handler team since 2006 have resulted in over 200 bobcat scats from 83 different bobcats. The DNA data from scats as well as tissue samples we collect from bobcats that have been killed on the road, accidentally snared, or trapped by ENSP in order to fit with GPS collars, are being fed into a capture-recapture analysis. The analysis will provide us with an estimate of survival rate, population size, and sex ratio.

In addition, we plan to use the dog-handler team as well as remotely triggered cameras in selected areas of northern NJ to examine roadways as a barrier to bobcat movements between suitable habitats. The goal is to target road segments where we can create wildlife passages to get the bobcats across safely.

Recently ENSP biologists have been working with colleagues from New York, Pennsylvania, and Maine (the source of the 24 bobcats for NJ's restoration project between 1978 and 1982) to obtain bobcat tissue samples for a regional genetic variability study. This study is aimed at understanding the genetic structure and origin of the New Jersey population in hopes that this information will help inform a New Jersey bobcat recovery plan effort.

The constant threat from habitat loss and fragmentation, changes in land use, the existence of barriers to free movement between suitable habitats and automobile collisions on our busy and abundant roadways will likely limit the growth of NJ's bobcat population. It is likely that bobcats will remain only locally abundant in areas of suitable habitat, primarily in the areas north of Interstate Route 80. In the future, the Division may propose to move bobcats from healthy populations in northern NJ to areas of suitable habitat in the Pinelands and other areas of south Jersey. However, public sentiment may prove to be the biggest barrier to the return of bobcats to south Jersey.

Timber Rattlesnake, *Crotalus horridus*

Status: ***State:*** Endangered ***Federal:*** Not listed

Identification

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The timber rattlesnake is one of only two venomous reptiles found in the Garden State. The only other venomous reptile is the northern copperhead, Agkistrodon contortrix mokasen. The rattlesnake is unique in that it is the only animal that nature has equipped with a rattle, which is found at the end of its black-colored tail. The timber rattlesnake is a member of the family Viperidae and sub-family Crotalinae or pit vipers. Pit vipers are aptly named for the two facial pits found midway between the nostrils and the eyes on each side of the head. In addition, its head is noticeably wider than the body portion directly behind the head. Other distinguishing characteristics include a single row of scales on the ventral, or underneath, side of the snake from the vent to the end of the tail, and vertical, elliptical shaped pupils. These features are found only on our two venomous snakes and are not found on any non-venomous species of snake found in New Jersey.

Timber rattlesnakes have dark brown to black blotches on the body section just behind the head. Moving backwards from the head and neck, the blotches generally become connected and form primarily unbroken lateral crossbands, or chevrons by the mid-section of the body. The dark bands are typically outlined with a lighter color. There are actually three different color phases. On light-phased snakes, the background colors vary from brilliant to pale to brownish yellow. Intermediate phase snakes have shades of grays, blacks, and white. Dark phase timber rattlesnakes are almost completely black, revealing their skin patterns only from a close distance. Although difficult to see on most of specimens in the Northeast, light phase rattlesnakes have a reddish-brown to olive-green colored stripe running down the center of the dorsal (or upper) side; the intermediate phase rattlers have an olive-green stripe, while the dark phase's darkened stripe is less discernible.

In addition to the shovel-shaped head and rattle, a dark-phased rattlesnake can be differentiated from a black rat snake or black racer by its keeled scales. Black rat snakes and black racers have smooth scales. A black racer also has a small patch of white on its chin, while the black rat has traces of white showing throughout its body.

Habitat

Timber rattlesnake habitat varies greatly between northern and southern New Jersey. In the north rattlesnakes are primarily associated with deciduous upland forest habitats (Reinert 1984). Here rattlesnakes use hardwood and hemlock forests, seeps, open

fields, floodplains, talus slopes and rock outcrops to varying degrees based on the season and their physiological state (e.g. ecdysis (shedding their skins), their current reproductive state, etc.) (Schantz, pers.comm. 2000). In northern New Jersey the typical timber rattlesnake den is located on a rocky, sparsely to moderately wooded steep slope that faces southeast to southwest. Extensive survey work by Martin (1992) described dens in the mountainous habitat of the northeastern U.S. as being either a fissure in a ledge or crevice between the ground and a rock outcrop, talus slopes, or fallen rock partially covered by soil. Here snakes are able to gain access to underground cavities and voids below the frost line.

Populations in southern New Jersey are typically found in pinelands habitats that consist primarily of pitch pine (Pinus rigida), short-leaf pine (P. echinata), scrub oak (Quercus ilicifolia), blackjack oak (Q. marilandica), and blueberry (Vaccinium spp.) Dens in the Pinelands are usually found in cedar swamps and along streambanks.

The summer ranges of male and non-gravid female timber rattlesnakes typically include forested habitats with greater than 50% canopy cover and approximately 75% vegetative ground cover (Reinert and Zappalorti 1988). Gravid (pregnant) females prefer areas with approximately 25% canopy cover, nearly equal amounts of vegetation and leaf litter covering the ground and numerous fallen logs (Reinert and Zappalorti 1988).

Both populations hibernate in communal dens sharing the hibernacula with other rattlesnakes as well as northern copperheads (northern population only), black rat snakes, and others (Martin 1992).

Status and Conservation

The statuses of timber rattlesnake populations vary among the states within its range. The timber rattlesnake is listed as a threatened or endangered species in Connecticut, Massachusetts, New Hampshire, New York, Vermont, Indiana, and Ohio (Rubio 1998). Although not listed in Pennsylvania, they are considered a candidate species for listing.

Once thriving throughout New Jersey, loss of habitat and wanton killings has limited the populations. The timber rattlesnake was listed as an endangered species in New Jersey in 1979. Under state endangered species laws, it is illegal to harm, harass, or collect the timber rattlesnake.

Timber rattlesnake research has been limited to the efforts of only a few biologists over the past few decades. This research has attempted to determine their habitat use, breeding biologies, activity ranges, and population genetics. Over the past two decades, research involving the timber rattlesnake in New Jersey has increased with studies being conducted along the Kittatinny Ridge and in the Pinelands. This research has helped wildlife managers and ENSP biologists to better understand the needs and requirements of this cryptic and elusive species. Efforts by the ENSP are being made to limit the impact of development on rattlesnake habitat, minimize human – rattlesnake interaction, and to educate the public about rattlesnakes.

The ENSP is conducting research to identify timber rattlesnake den locations and map critical habitat surrounding dens. The information is used to protect habitat through the Land Use Regulation Program within the Department of Environmental Protection.

The ENSP has instituted a nuisance venomous snake response program in areas of the state where timber rattlesnakes live in close proximity to people. Volunteers, under the authority and supervision by the state, capture and remove nuisance timber rattlesnakes that find their way into areas inhabited by people. This results in saving snakes that might normally be destroyed and provides an opportunity for the public to learn more about the species. These interactions often result in people becoming more tolerant of the species.

Wood Turtle, *Glyptemys insculpta*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

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As the taxonomic name insculpta indicates, the wood turtle is distinguished by the sculpted or grooved appearance of its carapace, or upper shell. Each season a new annulus, or ridge, is formed, giving each scute (a scale-like horny layer) a distinctive pyramid-shaped appearance. As the turtle ages, natural wear smoothes the surface of the shell. While the scutes of the carapace are brown, the plastron, or underneath the shell, consists of yellow scutes with brown or black blotches on each outer edge. The legs and throat are reddish-orange. The male wood turtle has a concave plastron while that of the female is flat or convex. The male also has a thicker tail than the female. Adult wood turtles measure 14 to 20 cm (5.5 to 8.0 in.) in length (Conant and Collins 1991).

Habitat

Unlike other turtle species that favor either land or water, the wood turtle resides in both aquatic and terrestrial environments. Aquatic habitats are required for mating, feeding, and hibernation, while terrestrial habitats are used for egg laying and foraging. Freshwater streams, brooks, creeks, or rivers that are relatively remote provide the habitat needed by these turtles. Consequently, wood turtles are often found within streams containing native brook trout (Salvelinus fontinalis). These tributaries are characteristically clean, free of litter and pollutants, and occur within undisturbed uplands such as fields, meadows, or forests. Open fields and thickets of alder (Alnus spp.), greenbrier (Smilax spp.), or multiflora rose (Rosa multiflora) are favored basking habitats. Lowland, mid-successional forests dominated by oaks (Quercus spp.), black birch (Betula lenta), and red maple (Acer rubrum) may also be used. Wood turtles may also be found on abandoned railroad beds or agricultural fields and pastures. Nevertheless, wood turtle habitats typically contain few roads and are often over one-half of a mile away from developed or populated areas (Zappalorti et al. 1984). Individuals from relict or declining populations are also sighted in areas of formally good habitat that have been fragmented by roads and development.

Status and Conservation

Historically, the wood turtle was a fairly common species within suitable habitat in New Jersey. By the 1970s, however, declines were noted as wood turtles were absent from many historic sites due to habitat loss and stream degradation. Consequently, the wood turtle was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the wood turtle to be "demonstrably secure globally," yet "rare in New Jersey" (Office of Natural Lands Management 1992).
Since the late 1970s, biologists have monitored and surveyed wood turtle sites in New Jersey, providing valuable data regarding the life history, reproduction, and habitat use of these turtles in the state. There is, however, a continuing need to examine the productivity and juvenile survival of wood turtles, which may be threatened by disturbance or predation.

In 1995, the wood turtle was proposed for inclusion on the federal endangered species list. Despite declines in several northeastern states, populations were considered stable enough throughout the species' entire range to deny listing. However, the wood turtle was considered by the U.S. Fish and Wildlife Service as a species that, "although not necessarily now threatened with extinction may become so unless trade in them is strictly controlled" (U.S. Fish and Wildlife Service 1995). As a result, international trade of these turtles is strictly monitored and regulated through the CITES Act (Convention on International Trade in Endangered Species of Wild Flora and Fauna Act). The New Jersey Endangered Species Act prohibits the collection or possession of wood turtles.