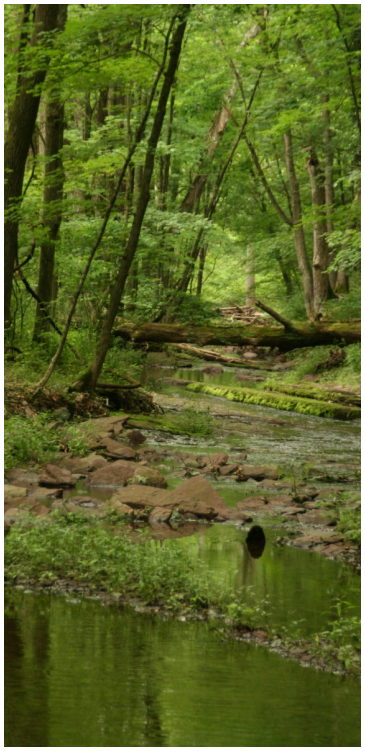
November 2013

Natural Resource Inventory

for

Horseshoe Bend Park

Kingwood Township, NJ



Prepared for:

Kingwood Township

Written by:

Deborah J. Kratzer

Kratzer Environmental Services

Natural Resource Inventory

For

Horseshoe Bend Park,

Kingwood Township
Hunterdon County, NJ

November 2013

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

Acknowledgements

This report was written by Deborah J. Kratzer.

Trails and many other park features were digitized by Richard Dodds.

Photo credits:
Jill Stein Dodds: pages 3, 4, 50, 56, 72, 78, and 87

Christopher T. Kratzer: pages 2 and 71

Deborah J. Kratzer: pages 1, 12, 13, 14, 17, 18, 21, 24, 65, 66, 76, 81, 82

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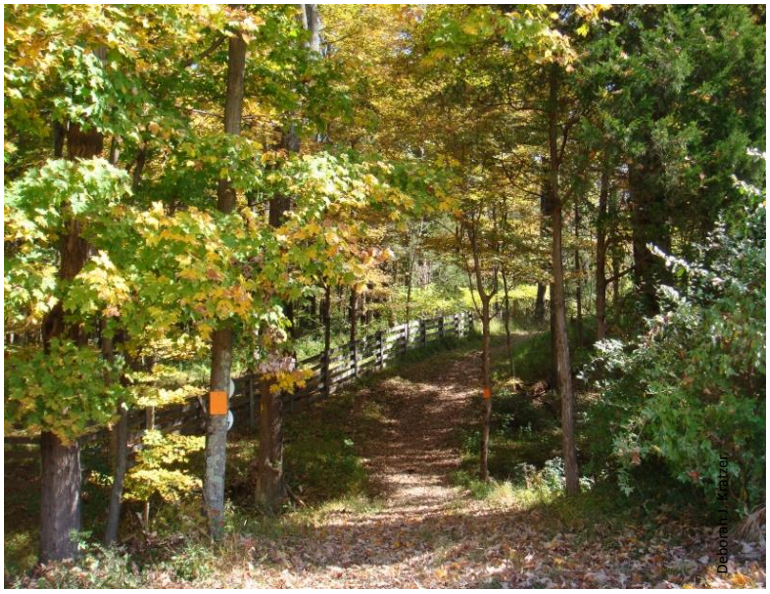
1: INTRODUCTION

1.1 Goal of the Natural Resource Inventory

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, both affecting and being affected by many physical and biological factors. The cumulative effects of many individual decisions have the potential to alter the environment in ways that cause harm directly to human health, and indirectly through complex environmental functions.



On the Orange Trail in Horseshoe Bend Park

A *Natural Resource Inventory* (NRI) (also called an Environmental Resource Inventory) is a compilation of objective information about the natural and environmental resources of an area.

Assembling an inventory of Horseshoe Bend Park's ecological framework 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 park managers create an ecologically healthy park.

The goal of the Horseshoe Bend Park NRI is to provide the objective information that park managers need in order to make resource-sensitive management decisions. It will also help park visitors appreciate and understand the special features of this park. Areas of specific concern may emerge which require additional protection strategies, such as further research and monitoring, public outreach and education, habitat restoration and volunteer projects.

1.2 Methods

Funding for this project was provided through the Hunterdon Land Trust by the Lower Delaware National Wild and Scenic River Watershed Protection Initiative of the U.S. Department of Interior, National Park Service.

An inventory of what is currently known about the physical and biotic environment and the human influence on the environment of Horseshoe Bend Park has been compiled for this document. The use of computerized mapping (known as Geographic Information Systems, or

GIS) aids visualization of the distribution and inter-relationships of resources**.**

Information sources include the Kingwood Township ERI (2009) and the Open Space and Recreation Plan (2011); the Internet; and federal, state, county and local databases and contacts. The most current GIS data has 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 61 GIS data layers from 14 sources were used for this report's 32 maps.

All digital inventory data will be submitted to Hunterdon Land Trust. The public can either use the New Jersey Department of Environmental Protection's i-MapNJ website or obtain relevant data layers (most are free on the internet), and download the free software, ArcExplorer (see **Internet Resources**, below).

References and related print and Internet resources 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 a search engine for the name of the document or information you want.

1.3 Limitations of the NRI

It should be noted that the NRI is not intended to produce original research and is not meant to replace the primary data sources upon which it is based. It is intended for preliminary assessments of projects and *cannot substitute for on-site testing and evaluations*. 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). GIS data from NJDEP and Hunterdon County are used with permission (see the Terms of Agreement in **Appendix A**), with the required disclaimer[1] printed on each map. **Appendix B** provides details of the GIS data used for this report, and where the data may be obtained.

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.

Common marsh-pink (Sabatia angularis)

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.

Management recommendations are not part of the NRI.

1.4 General Description of Horseshoe Bend Park

Horseshoe Bend Park was dedicated in July 2011 after a decade of efforts to bring together funding from many partners and negotiate with the landowners to prevent the parcels

[1] The NJDEP and Hunterdon County require the following disclaimer, which is printed on all the maps which use their data: "This map was developed using [NJDEP and/or Hunterdon County] GIS digital data, but this secondary product has not been verified by [NJDEP or Hunterdon County] and is not [NJDEP- or county-] authorized."

from becoming a 70-lot subdivision. The 237 acre property is owned by Kingwood Township and the State of New Jersey (106 acres owned by Kingwood and 131 owned by the State of New Jersey; **see Table 1**) and is managed by Kingwood Township. The purchase was funded by Kingwood Township, Hunterdon Land Trust (HLT), New Jersey Conservation Foundation (NJCF), NJDEP's Green Acres program, State Agriculture Development Committee (SADC) and the US Department of Agriculture (NJDEP, July 6, 2011).

Table 1: Open Space Parcels

Current Owner	Block	Lot	Acres	Minus private acres	Current owner of private property
Horseshoe Bend Park					
NJDEP	14	28.02	140	6	Oakes
Kingwood Township	14	30	119	15	Palopoli
NJDEP	14	35	123	18	Flagg
NJDEP	28	2	115	15	Kirkland
			497 acres total	**54 acres private**	
Preserved Properties Adjacent to Horseshoe Bend Park					
Copper Creek Preserve	12	31	24		
NJDEP (former Cooley)	14	27	138	N/A	
Church Farm (under contract)	12	35	106	N/A	
			268 acres total		

The park is located in Kingwood Township, in Hunterdon County, New Jersey (see **Figure 1a**). It is in the northwestern corner of Kingwood, about a mile south of Frenchtown Borough on Horseshoe Bend Road[2]. The property is irregularly shaped, and is roughly ¼ to 1 mile east to west and $^1/_3$ to 1.5 miles north to south. It extends nearly to the Delaware River, which is designated in this section as part of the National Wild and Scenic River System. According to the Hunterdon Land Trust, the park is "one of the most beautiful spots in western Hunterdon County, with rolling hills, lush forested ravines, and sweeping vistas of the Delaware River Valley. Its high meadows are home to meadowlarks, bobolinks, redwing blackbirds, and many other grassland species. Bald eagles and hawks are believed to nest here. Copper Creek and other small streams flow through the park before tumbling down the bluffs into the Delaware River." (Hunterdon Land Trust, 2013)

Kingwood Township entered into a Memorandum of Agreement with the State of New Jersey for managing the adjacent state-owned property, and these properties are combined for the purposes of this report.

Horseshoe Bend Park (including the state property) is approximately 450 acres of woods and open fields and is part of a greenway of over 800 acres of contiguous open space and preserved farms (see **Figure 1b**). Efforts are continuing to extend the greenway by preserving additional open space and farmland in the area.

Management of the open space adjoining Horseshoe Bend Park (**see Table 1**) will be coordinated with management of the park. These

Jill Stein Dodds

Dogs (and their owners) enjoy the leash-free fenced dog area.

[2] Vehicles with trailers should use Spring Hill Road, going straight across Horseshoe Bend Road to the Spring Hill Road entrance, or turning right, travel 0.18 miles and turn left into the north entrance of the park.

properties include the Hunterdon Land Trust-owned 24 acre Copper Creek Preserve; a 138 acre property to the west of the park, purchased by NJDEP in October 2013; and a 106 acre property known as the Church Farm, which is planned for "fee simple" purchase by Kingwood Township in March 2014.

Left: Dogs participating in the sport of lure coursing at Horseshoe Bend Park. Right: Trails are maintained to a width and height that makes them ideal for equestrian trail riding.

References: Introduction

Garie, Henry L. and Lawrence L. Thornton. New Jersey State Agency Partnership GIS Technical Mapping Standards: Enhancing GIS Technology for Multi-Agency Cooperation. September 1998. Standards Subcommittee State Mapping Advisory Committee: Trenton, NJ.

Hunterdon Land Trust. 2013. Horseshoe Bend Preserve. http://hunterdonlandtrust.org/portfolio/horseshoe-bend-preserve/

Kingwood Township Open Space Advisory Committee With the Assistance of: Banisch Associates, Inc. May 12, 2011. Open Space and Recreation Plan, Kingwood Township, Hunterdon County, NJ. 48 pages. http://www.kingwoodtownship.com/ktdocuments/environmental/Kingwood_OpenSpace&RecreationPlan_05-12-2011.pdf

Kratzer, Deborah J. January 2009. Environmental Resources Inventory for Kingwood Township, Hunterdon County, NJ. Prepared by Kratzer Environmental Services for the Kingwood Township Environmental Commission. 177 pages. http://www.kingwoodtownship.com/ktdocuments/ERI_Kingwood_2009_January.pdf

NJDEP. July 6, 2011. News Release: New 313-Acre Park In Hunterdon County Unveiled. http://www.nj.gov/dep/newsrel/2011/11_0081.htm

Internet Resources: Introduction

Aerial photography and online mapping:

- Google Earth[3]: http://www.google.com/earth/index.html (free download)
- HistoricAerials.com[4]: 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)

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

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

Environmental Education NJDEP SEEDS: http://www.state.nj.us/dep/seeds/index.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

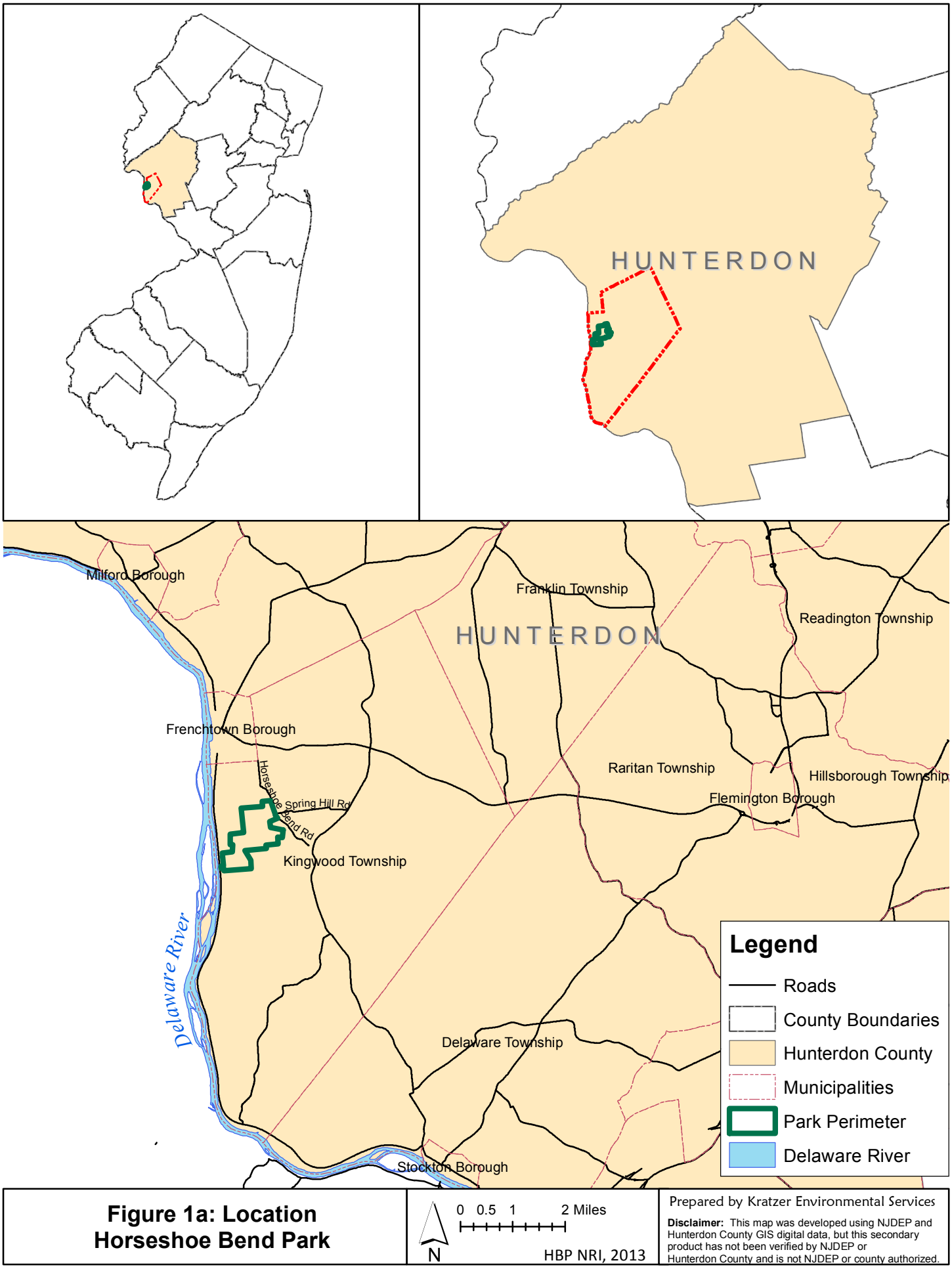


Figure 1a: Location
Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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

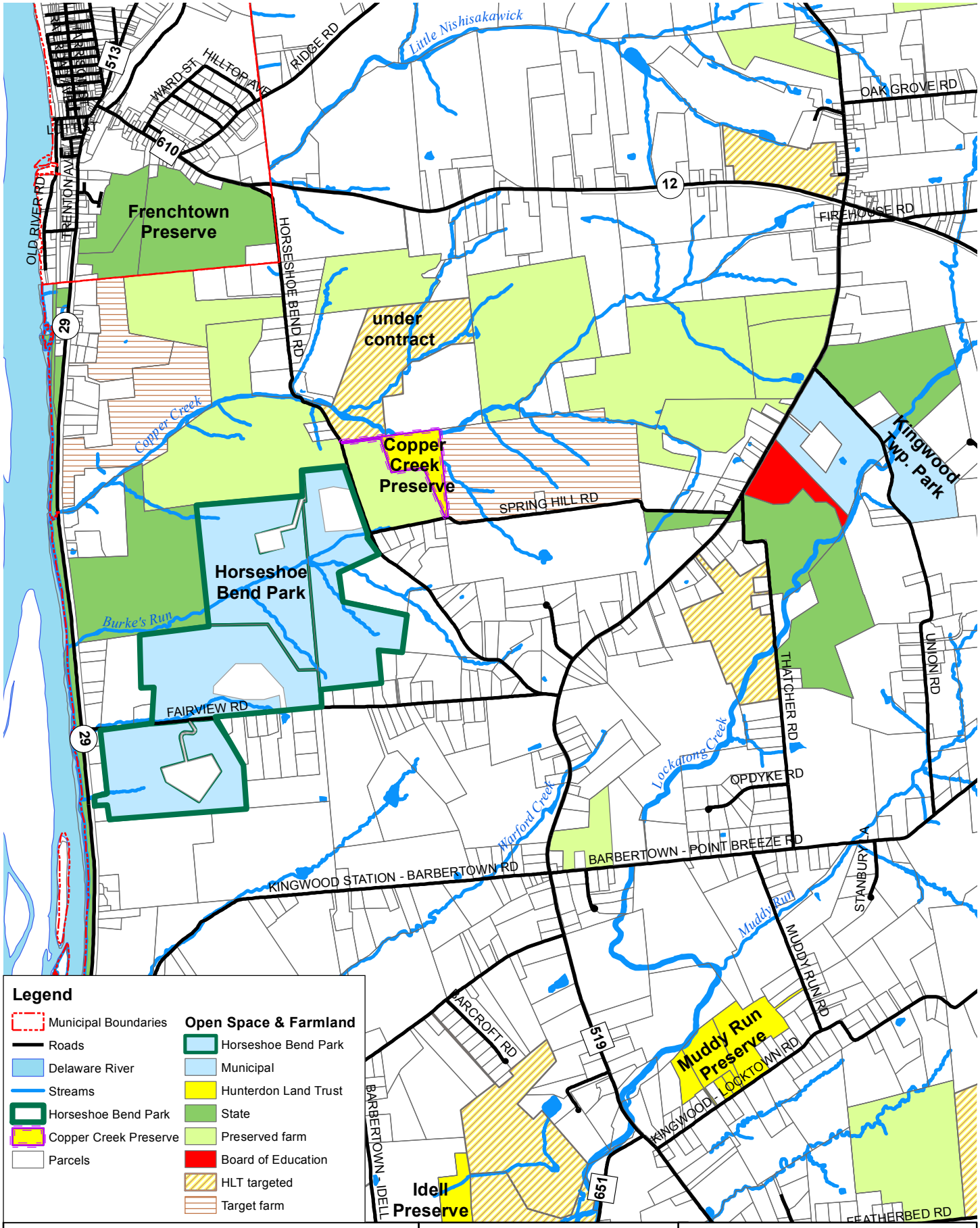


Figure 1b: Preserved Land Surrounding Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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

2: LAND USE

2.1 Aerial Photography

Aerial photographs of Horseshoe Bend Park and the surrounding areas taken in 1930[5], 2007 and 2012 are shown in **Figures 2a, 2b and 2c,** respectively[6]. In 1930, most of the area was farmed, with forests generally confined to narrow stream corridors and steep slopes. The four farms that are private property within the outline of the park were in existence prior to 1930. By 2007, most of the farm fields had grown into forests and only about 100 acres of fields remained. A tornado had touched down on the property, downing more than 10 acres of trees, visible as the prominent tan region in the center of what is now the park. The 2007 aerial photographs are notable for this report because other data layers, such as land use/land cover, wetlands and Landscape Project, are derived from them.

The 2012 aerial photos are depicted in **Figure 2c**. The tornado damaged area shows some growth and succession is occurring in the field where the proposed Red Trail passes (see **Figure 2e**).

Other options for viewing aerial photos online are listed in **Section 1 Internet Resources**.

2.2 Land Use

The New Jersey Department of Environmental Protection (NJDEP) used aerial photographs taken in 2007 to determine land use (see **Figure 2d**). 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.

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

Table 2: 2007 Land Use Type

Land Use Type	Acres	Percent
Agriculture	127.3	25.6
Barren Land	15.2	3.1
Forest	323.8	65.2
Urban/Residential	16.3	3.3
Water	1.2	0.2
Wetlands	13.2	2.7
Total:	497.0	100.0
Source: NJDEP, July 12, 2010		

[5] The 1930 aerial photographs are not high resolution and are not georeferenced. Georeferencing involves defining the location of something in physical space using map coordinates and assigning a coordinate system. This is the strength of GIS, because features can be defined in relation to other features.

[6] More detail can be seen when the data is mapped at a larger scale than that used in this report (the 2007 and 2012 data have pixels of 1 square foot).

Figure 2a: 1930 Aerial Photography
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

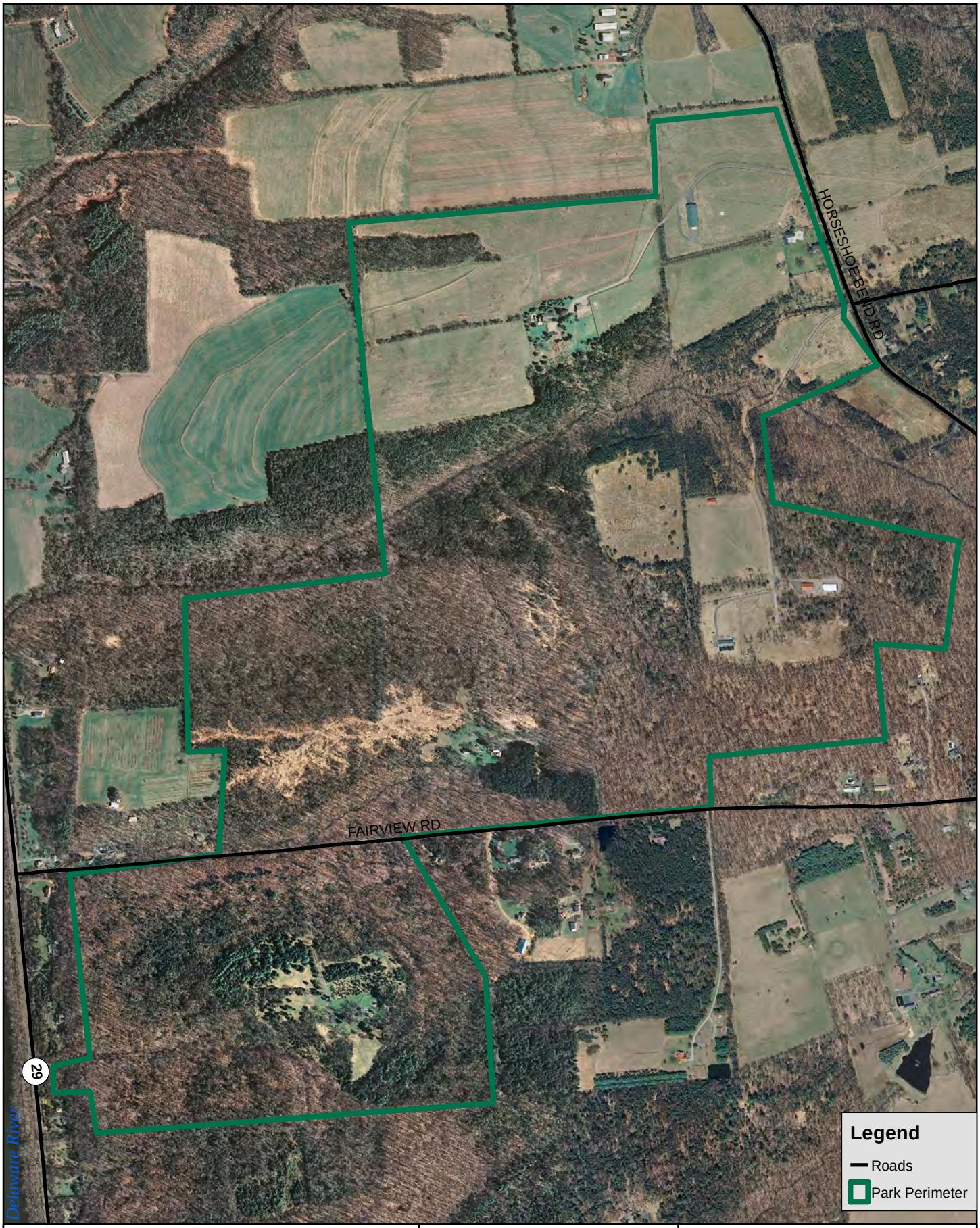


Figure 2b: 2007 Aerial Photos
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

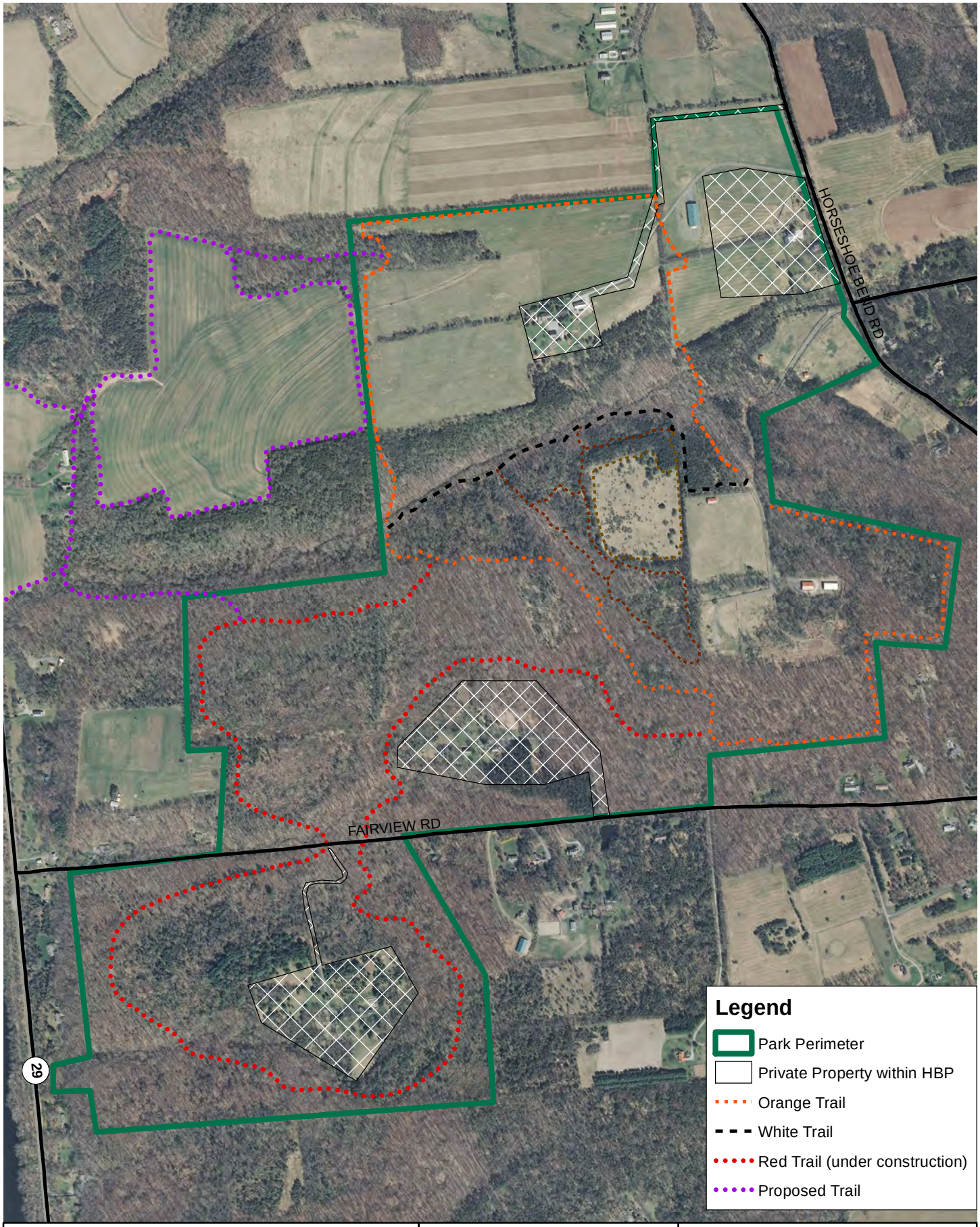


Figure 2c: 2012 Aerial Photography
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

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 6.8** 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.

The majority of Horseshoe Bend Park is forested (65%), followed by agriculture (26%). Small portions of the property are urban (3%), barren (3%), wetlands (3%) and water (>1%) (see **Table 2**). Details of these categories (e.g. deciduous forest or coniferous forest) are shown in **Section 7.1** and **Figure 7a**.

2.3 Trails

When Horseshoe Bend Park was preserved in 2011, the property had approximately 5 miles of existing trails. Prior to preservation, a great deal of ATV use had degraded some trails. Trails may now be used for all non-motorized activities, including hiking, mountain biking and horseback riding.

Trail maintenance is performed by volunteers. Various storms, such as the October snowstorm in 2011 and Hurricane Sandy in 2012, felled many trees, blocking trails. Several floods caused Burke's Run to overflow its banks and erode some sections of trails. A 2012 NJDEP grant is providing materials for rehabilitating some eroded sections of trails and for building boardwalks in some wet sections.

At the time of this writing, trails have been focused in the Kingwood Township-owned portion of the park (see **Figure 2e**). The Orange and the White Trails are open and marked with their respective color trail markers. Descriptions of the trails are below:

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Boardwalk for foot traffic over a wet area on the Orange Trail

- **Orange Trail** – a 2.7 mile loop trail, mostly following the perimeter of the northern portion of the park, through woods and fields. There are orange numbered markers every $^{1}/_{10}$ mile to aid rescue efforts in case of emergency. The path crosses a tributary of Copper Creek near mile marker 0.9. There are two steep portions of the trail (>30% slope); one about 200 feet and the other about 400 feet in length.

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Left: The One of the $^{1}/_{10}$ mile markers on the Orange Trail. Center: The Orange Trail through deciduous forest. Right: Part of the Orange Trail traverses open fields.

- **White Trail**- a 0.6 mile connector trail through coniferous (red cedar) forest and deciduous forested wetland along Burke's Run. There are white numbered markers every $^{1}/_{10}$ mile to aid rescue efforts in case of emergency.



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Left: A kiosk marks the entrance to the White Trail on the Spring Hill Road entrance driveway. Center: Red cedar forest. Right: Burke's Run (low flow).

- **Ravine Trail** - consists of several trails which can be used as a loop from the south parking area or to connect to the White, Orange or Open Field Loop. However, some of the connectors may be blocked by downed trees. The paths traverse deciduous and coniferous forest and portions follow an intermittent tributary of Burke's Run. Parts of this trail are fairly steep.



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Left: The entrance to the Ravine Trail, by the south parking area. An information kiosk and dog waste bags are available. Center: Common blue wood aster (Symphyotrichum cordifolium) is a common native wildflower in the park. Right: Ravine Trail.

- **Open Field Loop Trail** – approximately ½ mile loop around the perimeter of a former pasture. The native little bluestem grass and a number of native wildflowers and scattered Virginia pine grow in this field, as well as the invasive autumn olive. It can be accessed from the White or Ravine Trail, or by crossing the adjacent open field.



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Left: Open Field Loop Trail, with the invasive shrub, autumn olive (Elaeagnus umbellate). Center: Virginia pine (Pinus virginiana). Right: Another view of the field, showing the dominance of the native little bluestem grass (Schizachyrium scoparium).

- Additional trails are expected to be added as volunteer time allows.

2.4 Facilities

Horseshoe Bend Park already had several buildings at the time it was preserved. These included a large Morton building which is used for many group activities, a Morton building used for storage, a hay storage building and three horse sheds. One of the fenced fields is designated as an off-leash dog area. There are two entrance roads and miles of fences.

The Morton building near the north entrance is used for many activities, such as cheerleading practice and dog shows. It has a bathroom and a cement floor.

The largest of three horse sheds in the park

The Morton building near the south entrance is used for storage.

The hay storage building

Deborah J. Kratzer

References: Land Use

NJDEP. July 12, 2010. NJDEP 2007 Land use/Land cover Update, Central Delaware Watershed Management Area, WMA-11. GIS data. http://www.state.nj.us/dep/gis/digidownload/zips/lulc07/w11lu07.zip

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: Land Use

Kingwood Township Parks: http://www.kingwoodtownship.org/parks

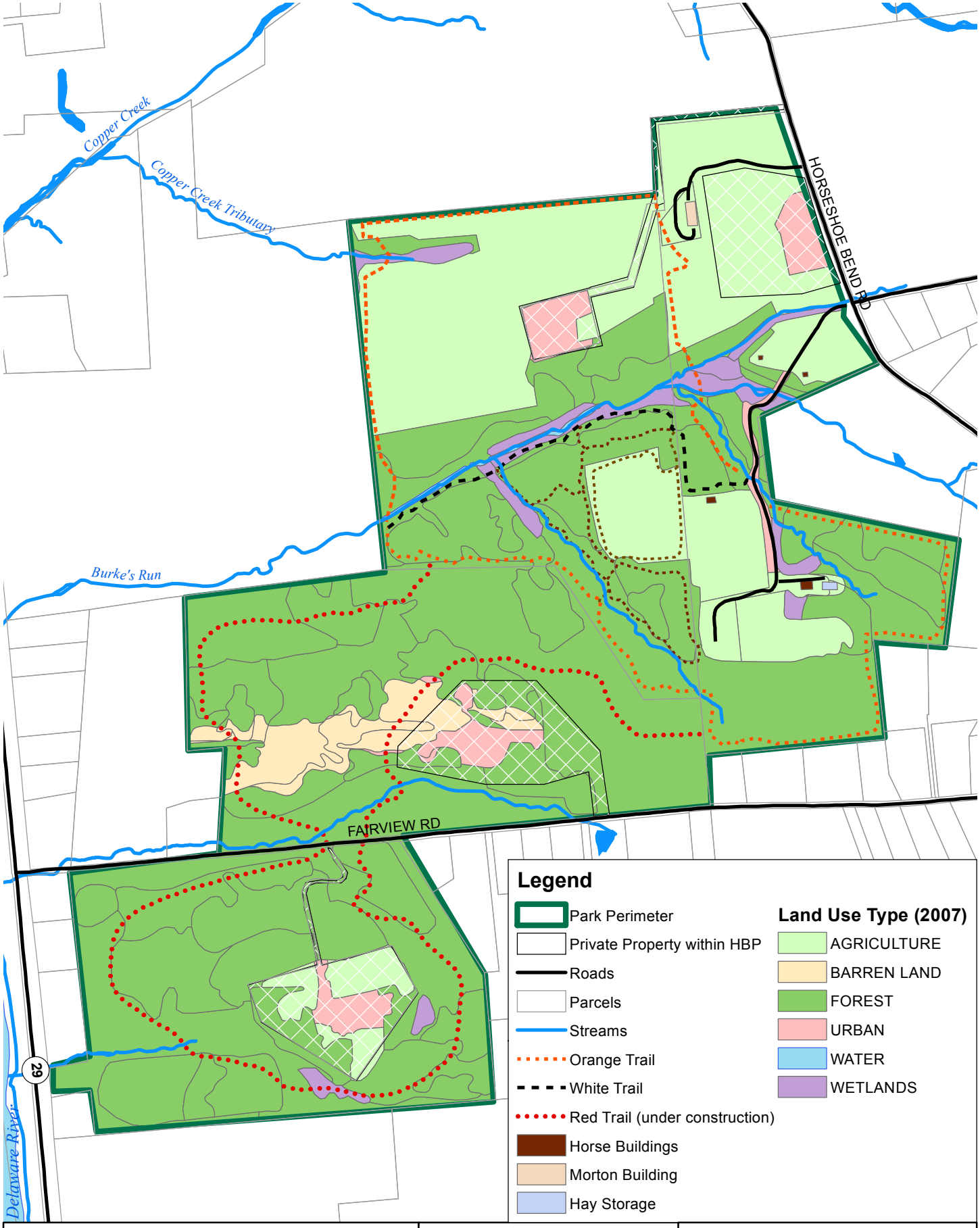

Figure 2d: Land Use Type
Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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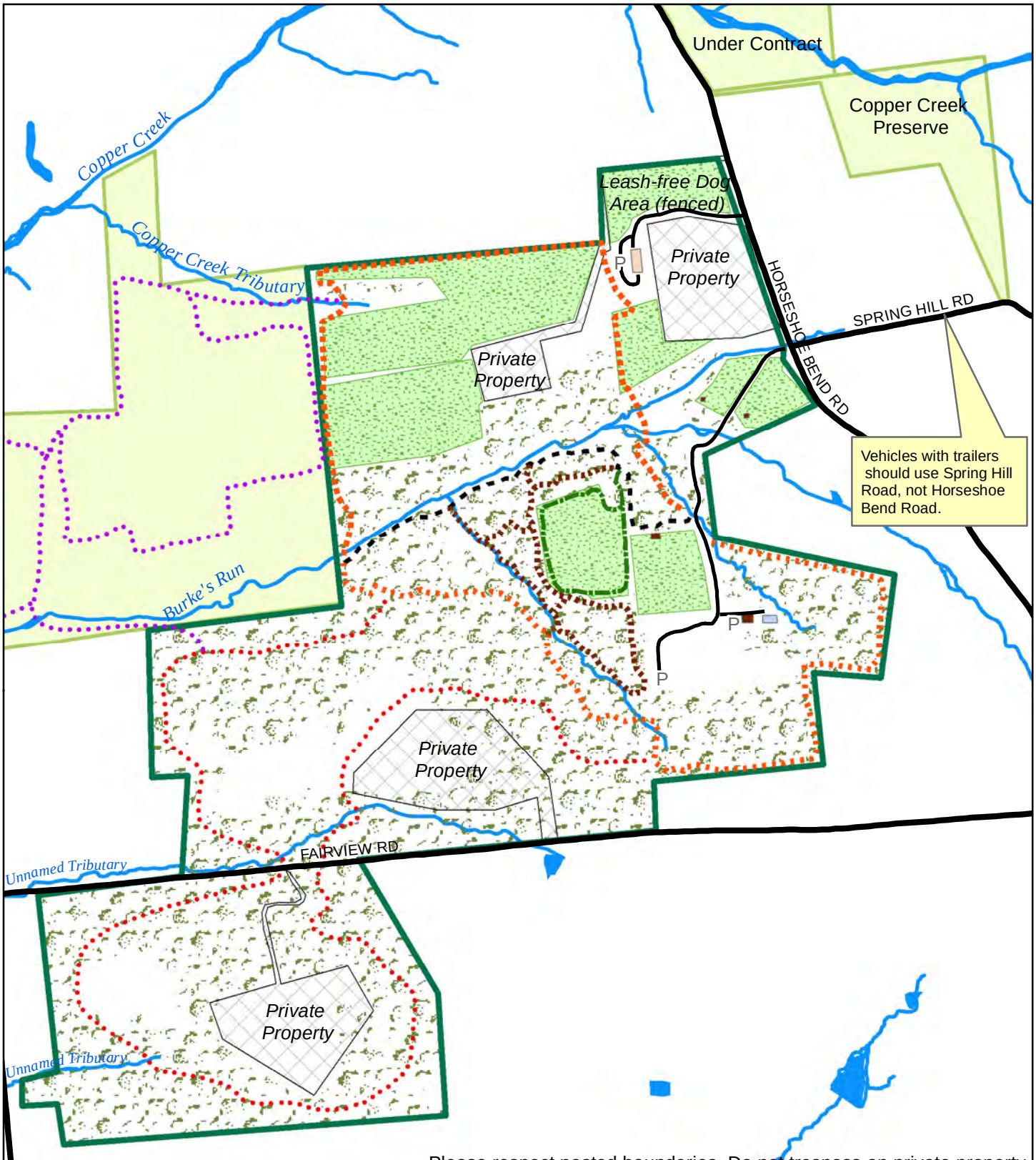

Figure 2e: Trails
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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3: GEOLOGY, PHYSIOGRAPHY AND TOPOGRAPHY

3.1 Geology

Geologic history

Five hundred million years ago, the land that is now New Jersey was at the bottom of the sea, close to the equator. About 400 million years ago, Europe and North America collided, forming the Appalachian Mountains, which were far higher and more rugged than the Rocky Mountains are now.


Deborah J. Kratzer

Mud cracks are preserved in the rocks

Flashfloods eroded the mountains to the east and south of what is now Kingwood, dropping mud and silt in extensive floodplain deposits, gradually filling the valleys. This is known as the "Newark episode," which lasted between about 15 and 23 million years. The rate of deposition averaged between 215 and 325 millimeters per 1,000 years, keeping pace with the rate of basin sinking. Shallow lakes formed at the bottom of the desert basin (known as playa lakes). The sediments became rock under the pressure of each successive layer of mud, silt or sand. Dinosaurs walked on these mudflats, leaving footprints that occasionally became fossilized. Fossils of coelacanths and other fish have also been found in Lockatong argillite rocks (although not necessarily in Kingwood).

Roughly 200 million years ago, the supercontinent broke apart, and the Atlantic Ocean was born. This was accompanied by volcanic activity, which resulted in magma flowing at or near the surface. These exist today as the erosion resistant basalt and diabase outcrops found in the Byram area of Kingwood (other examples are the Watchung Mountains, the Palisades, and the Sourland Mountains). When the diabase intruded, the surrounding sedimentary rocks were hardened by heat and pressure, and are known as hornfels rocks, or traprock, which was quarried commercially. These have properties similar to the Lockatong argillite rocks.

Within the past two million years, the climate alternated between cold and warm. During periods of glaciation, the glaciers never came as far south as Kingwood, although this area became a cold tundra. At times, the shoreline of the Atlantic Ocean may have been nearby, while at other times, it may have receded a hundred miles from the present shore (Gallagher, 1997.).

Bedrock Geology

Bedrock is the solid rock beneath the soil and surficial rock. The bedrock geologic formations that exist in what is now Horseshoe Bend Park were formed during the Mesozoic Era (Triassic and Jurassic periods), and belong to a geologic group called the "Late Triassic Newark Group" (See **Table 3.1** and **Figure 3a).** If additional sediments were laid down after that time, they have since been eroded away**.**

The Late Triassic Newark Group lies in a southwest-trending basin that extends from Rockland County, New York, to northeastern Lancaster County, Pennsylvania. This is the

Passaic Formation shale

largest of the Triassic rift valleys that extend from Nova Scotia to North Carolina. The Newark Group consists of non-marine sedimentary rocks 16,000-20,000 feet thick, and associated intrusions of volcanic rocks. Older rocks, which lie beneath the Newark Group, are exposed to the north in the Highlands and Ridge and Valley Provinces. Younger strata overlap the Newark Group in the Coastal Plain Province to the southeast. The layers generally dip 10 – 20° northwest, and are locally broken by many small normal faults (Van Houten, 1969).

Table 3.1: Characteristics of Bedrock Types Found in Horseshoe Bend Park

Abbreviation and Bedrock Name	When Formed	Approximate Thickness	Lithology (physical character of rocks)	Acres in HBP	Percent of HBP
JTrp - Passaic Formation[7]	Lower Jurassic and Upper Triassic	6,234 ft. (1,900m)	siltstone and shale	377.58	75.97%
JTrpg – Passaic Formation Gray bed			sandstone, siltstone and shale	119.45	24.03%
			Totals:	497.03	100%
Source: NJDEP NJGS, May 10, 2007; Van Houten, 1969.					

Surficial Geology

Surficial materials are the unconsolidated sediments that overlie bedrock formations, and that are the parent material for agricultural soils. In Hunterdon County they include stream, wetland, glacial, windblown, and hillslope sediments and weathered bedrock material. The weathered bedrock material may be as much as 200 feet thick, although most are generally less than 20 feet thick. The size of particles in the surficial materials ranges from coarse gravel to clay and peat. They affect the movement of ground water from the surface into underlying bedrock aquifers, and some are aquifers themselves (See **Figure 3b** and **Table 3.2**).

Table 3.2: Types of Surficial Geology Found in Horseshoe Bend Park

Abbre-viation	Deposit Type	Age	Definition
Qal	Alluvium	Holocene & late Pleistocene	Sand, gravel, silt, clay, organic matter. Deposited in modern floodplains and channels. As much as 20 feet thick.
Qcal	Colluvium	Holocene & late Pleistocene	Interbedded alluvium and colluvium in headwater areas of valleys. As much as 20 feet thick.
Qcs	Shale, Mudstone & Sandstone Colluvium	Pleistocene	Sandy silt to clayey silt with shale, mudstone, or sandstone fragments. As much as 30 feet thick.
Qws	Weathered Shale, Mudstone & Sandstone	Pleistocene	Silty sand to silty clay with shale, mudstone, or sandstone fragments. As much as 10 feet thick on shale and mudstone, 30 feet thick on sandstone.
sbo	Scattered Bedrock Outcrop		Surficial material thin and patchy.
Source: Stanford, Scott D. and Ron W. Witte, 1999			

[7] Passaic Formation was previously called the Brunswick Formation.

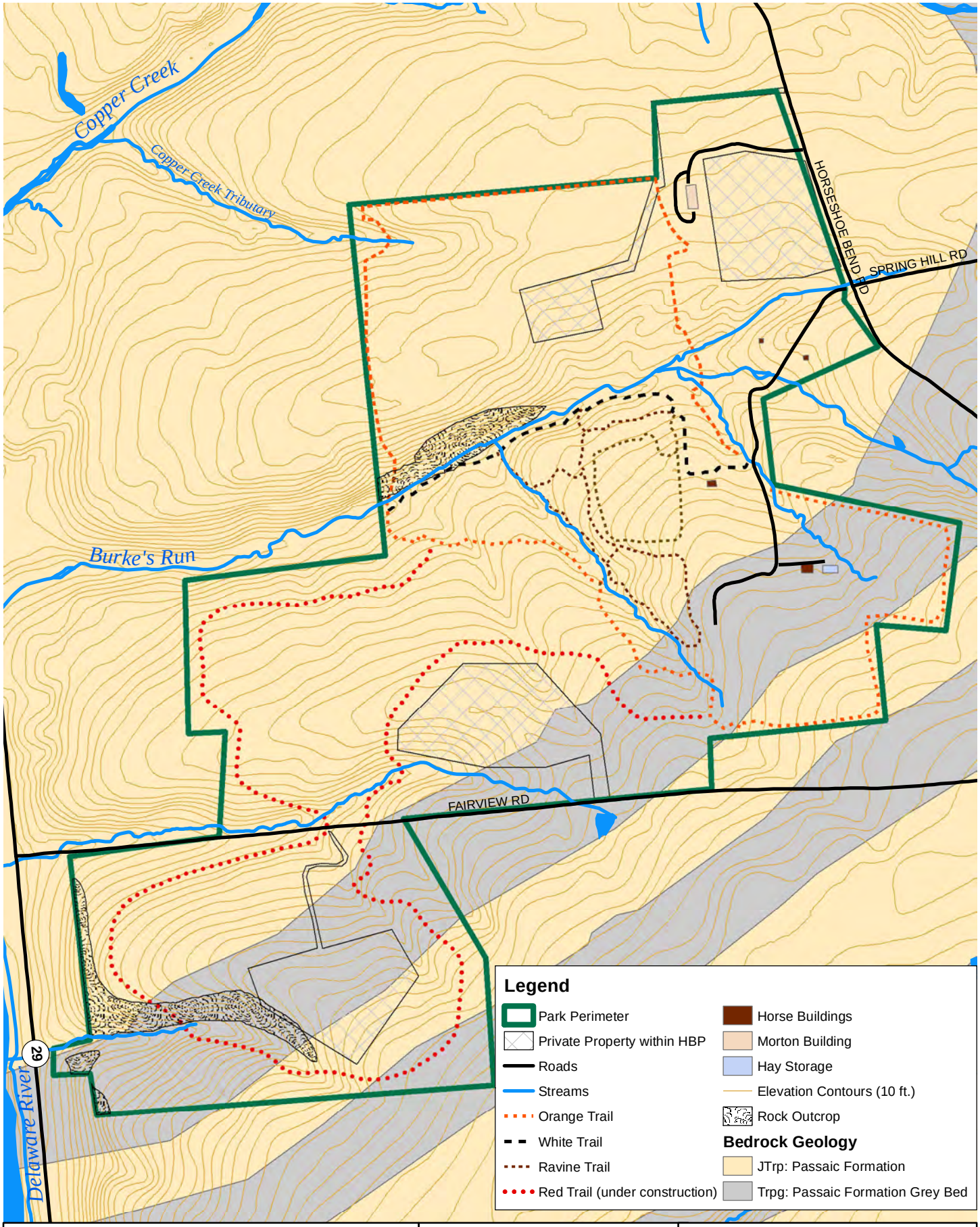

Figure 3a: Bedrock Geology
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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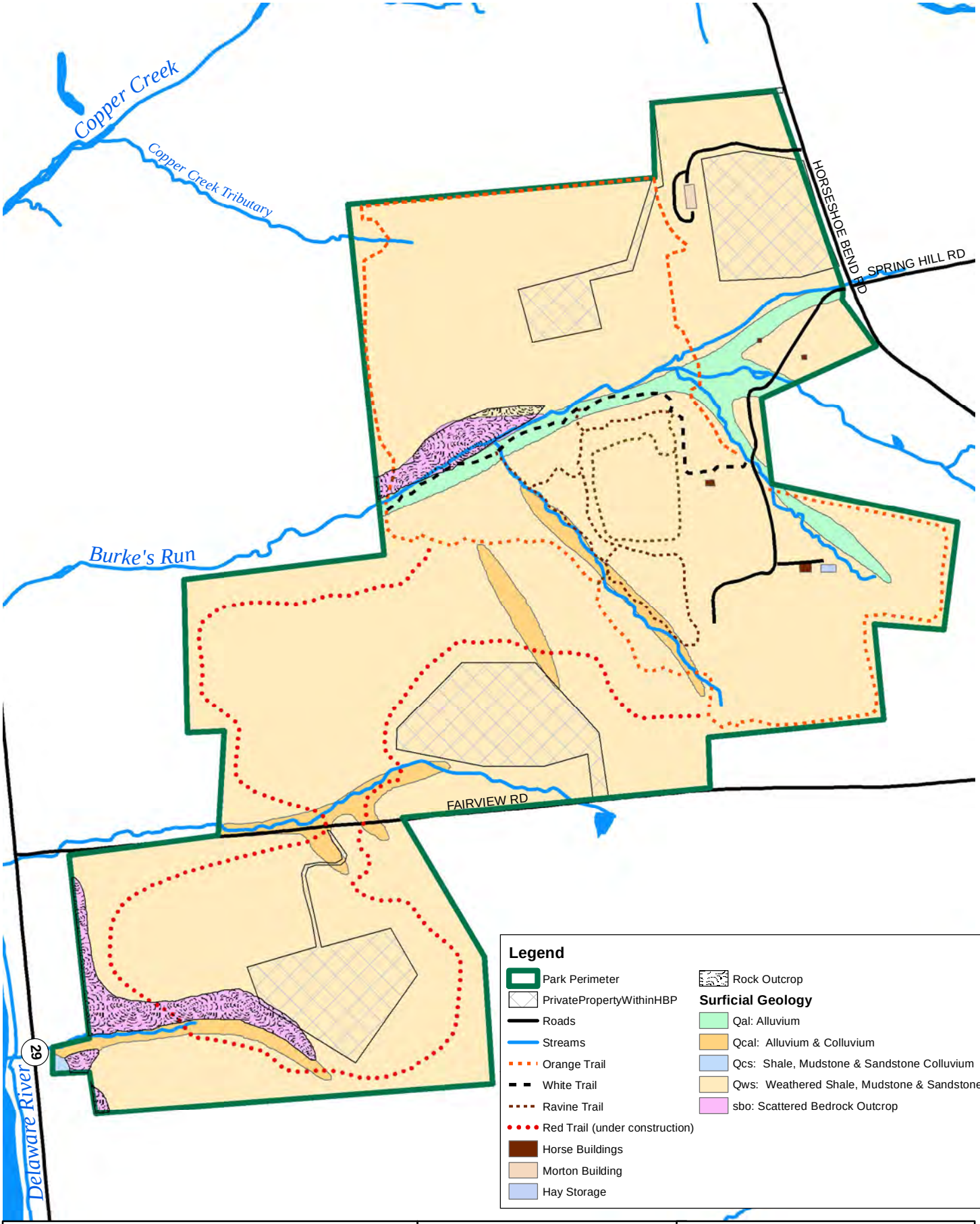

Figure 3b: Surficial Geology Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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3.2 Physiography

New Jersey can be divided into four regions, known as *physiographic provinces*, which are areas with similar sequences of rock types, geologic structures and a common geologic history. The northwestern section of New Jersey is part of the *Valley and Ridge Province*, which is characterized by long, parallel ridges and valleys formed by folded and faulted limestones, shales and sandstones of early and middle Paleozoic age. Erosion-resistant sandstone and siltstone bedrock lie beneath the ridges of the Appalachian Mountains while shale and limestone underlie the valleys.

Bordering the Valley and Ridge Province to the southeast, the *Highlands Province* consists of metamorphic rocks of Precambrian age. The granites and gneisses are resistant to erosion and create a hilly upland with deep, steep-sided valleys carved by streams.

The Highlands Province is separated from the *Piedmont Province* by a series of major faults, reaching the Delaware River near Milford. The rocks of the Piedmont are of Late Triassic and Early Jurassic age. As sediments eroded from adjacent uplands, and were deposited along rivers and lakes within the basin, they became compacted and cemented to form conglomerate, sandstone, siltstone and shale. Overlapping the Piedmont Province to the southeast lies the relatively flat terrain of the *Coastal Plain Province*, which consists of unconsolidated sedimentary formations, such as sands, clays, and marls (Dalton, 2006).

Horseshoe Bend Park is in the Piedmont Province.

3.3 Topography

Today's topography resulted from relatively recent erosion from a nearly flat plain. The elevation ranges from 140 to 450 feet above mean sea level within Horseshoe Bend Park. The lowest elevation is found near the southeastern corner of the property, where the boundary reaches Route 29 (also known as River Road or Daniel Bray Highway). Beyond the park, the slope continues down to 90 feet at the Delaware River. The high elevation of 560 feet is located at an eastern corner of the property, near Fairview Road. Elevation contours, shown in **Figure 3c**, are lines drawn to follow the contour of the land, and each line represents ten feet of elevation.

The closer the lines are spaced to each other, the steeper the topography is. Slopes greater than 10 or 15% are generally considered "steep slopes." 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).

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

Deborah J. Kratzer

Bedrock is exposed in Burke's Run

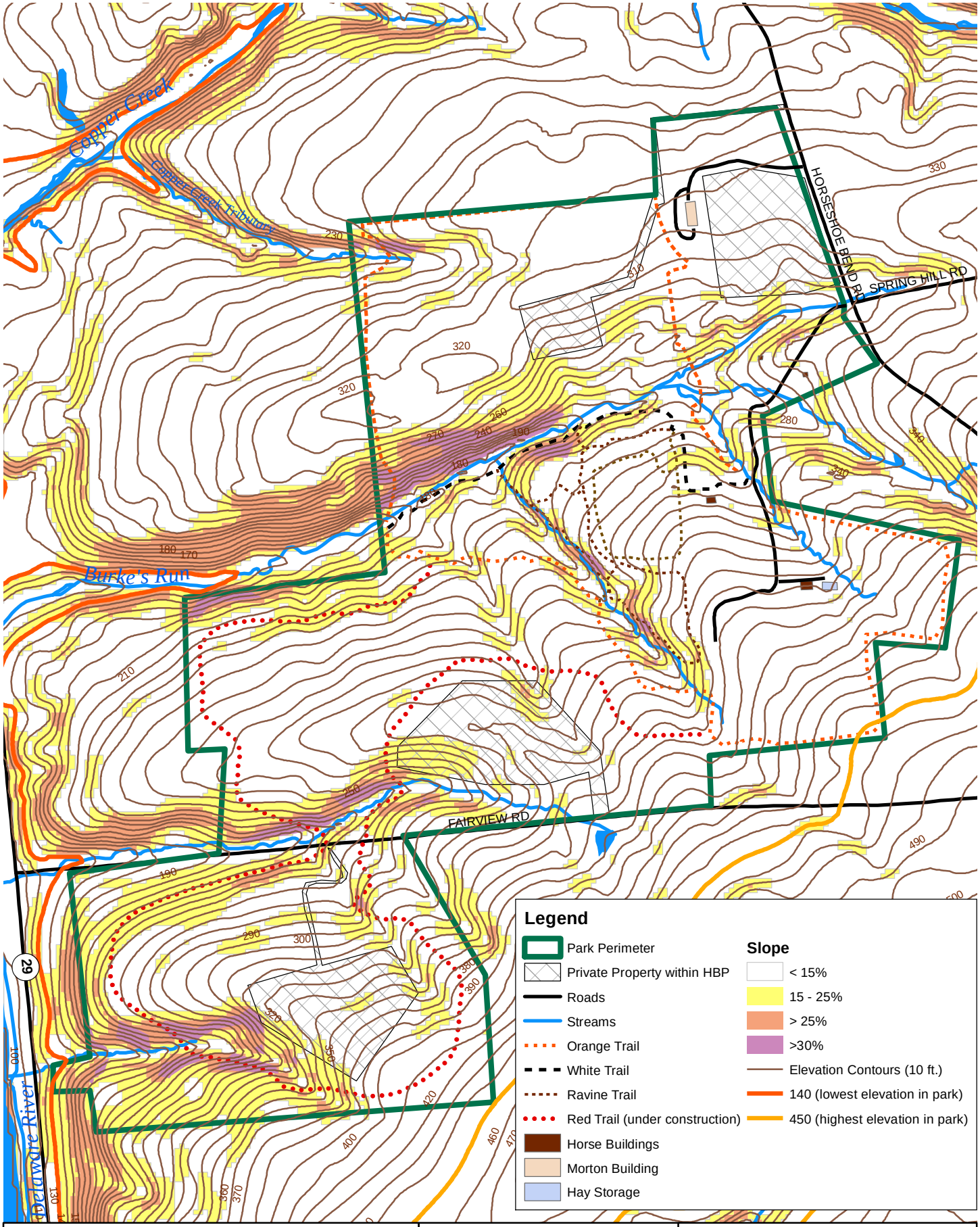

Figure 3c: Elevation Contours & Steep Slopes Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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many ways. The sediments may bury fish eggs, reduce light available to aquatic plants, and reduce recreational quality and aesthetics.

Steep topography can be seen in **Figure 3c**. Slopes over 30% occur on stream banks.

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Internet Resources

USGS programs in NJ: http://water.usgs.gov/pubs/FS/FS-030-96/

The Geology of New Jersey (NJGS): http://www.state.nj.us/dep/njgs/index.html

The Physiographic Provinces of NJ (NJGS): http://www.state.nj.us/dep/njgs/enviroed/infocirc/provinces.pdf

4: SOILS

4.1 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.

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This open field has Penn Channery Silt Loam soil (PeoB) (a channery soil has >15% thin, flat rock fragments).

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 (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, September 7, 2010).

The NRCS made soil surveys in 1974 to determine soil characteristics and capabilities and to help people understand soils and their uses (Jablonski, 1974). The soil survey was updated in 1986 and digitized into GIS in 1999.

Beginning in 2005, the NRCS made its soil surveys available online (USDA NRCS, September 7, 2010). This provides the means for keeping the information current and available to the public. For this report, the SSURGO (Soil Survey Geographic Database) spatial data and

tabular data for Hunterdon County were downloaded for use in the GIS (USDA NRCS, September 7, 2010)[8].

4.2 Soil Series and Map Units

The soil characteristics vary from place to place in slope, depth, drainage 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, 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 12 soil series' found in Horseshoe Bend Park, such as Abbotstown, Klinesville and Penn. A total of 16 different map units are present in the park. These map units are listed in **Table 4.2** and shown on **Figure 4a**. Several important characteristics of these soils are listed in **Table 4.2**, while **Figures 4b – 4h** illustrate the distribution of some soil characteristics.

4.3 Map Unit Descriptions[9]

Map unit: AbrB - Abbottstown silt loam, 2 to 6 percent slopes

The Abbottstown series consists of deep, somewhat poorly drained soils on uplands. They formed in material weathered mainly from shale, siltstone, and sandstone. Typically these soils have a dark reddish gray silt loam surface layer 10 inches thick. The subsoil layers from 10 to 20 inches are reddish brown and reddish gray silt loam. A very firm and brittle fragipan from 20 to 39 inches is weak red channery loam. The lower layer of subsoil from 39 to 48 inches is weak red channery silt loam. Partly weathered shale is at 48 inches. Slopes range from 0 to 15 percent.

Map unit: BhnB - Birdsboro silt loam, 2 to 6 percent slopes

The Birdsboro series consists of very deep, well to moderately well drained soils on terraces and alluvial fans. They formed in stream deposits washed from uplands underlain by red sandstone, shale and siltstone. Typically these soils have a dark brown silt loam surface layer about 10 inches thick. The subsoil between 10 and 46 inches is reddish brown and brown silty clay loam, loam and sandy clay loam. The substratum from 46 to 70 inches is reddish brown very gravelly clay loam. Slopes range from 0 to 15 percent.

Map unit: ChcB - Chalfont silt loam, 2 to 6 percent slopes

The Chalfont series consists of deep, somewhat poorly drained soils on uplands. They formed in loess and the underlying residuum. Typically these soils have a brown silt loam surface layer 10 inches thick. The mottled subsoil from 10 to 21 inches is brown silt loam and

[8] The maps in this report are the most recent available as of September 2013 (Publication Date 09/07/2010; SSURGO version 2; Template database version 36, 09/10/2012).

[9] Nontechnical description/SOI-5 Report, Survey Area Version: 8, Survey Area Version Date: 09/07/2010

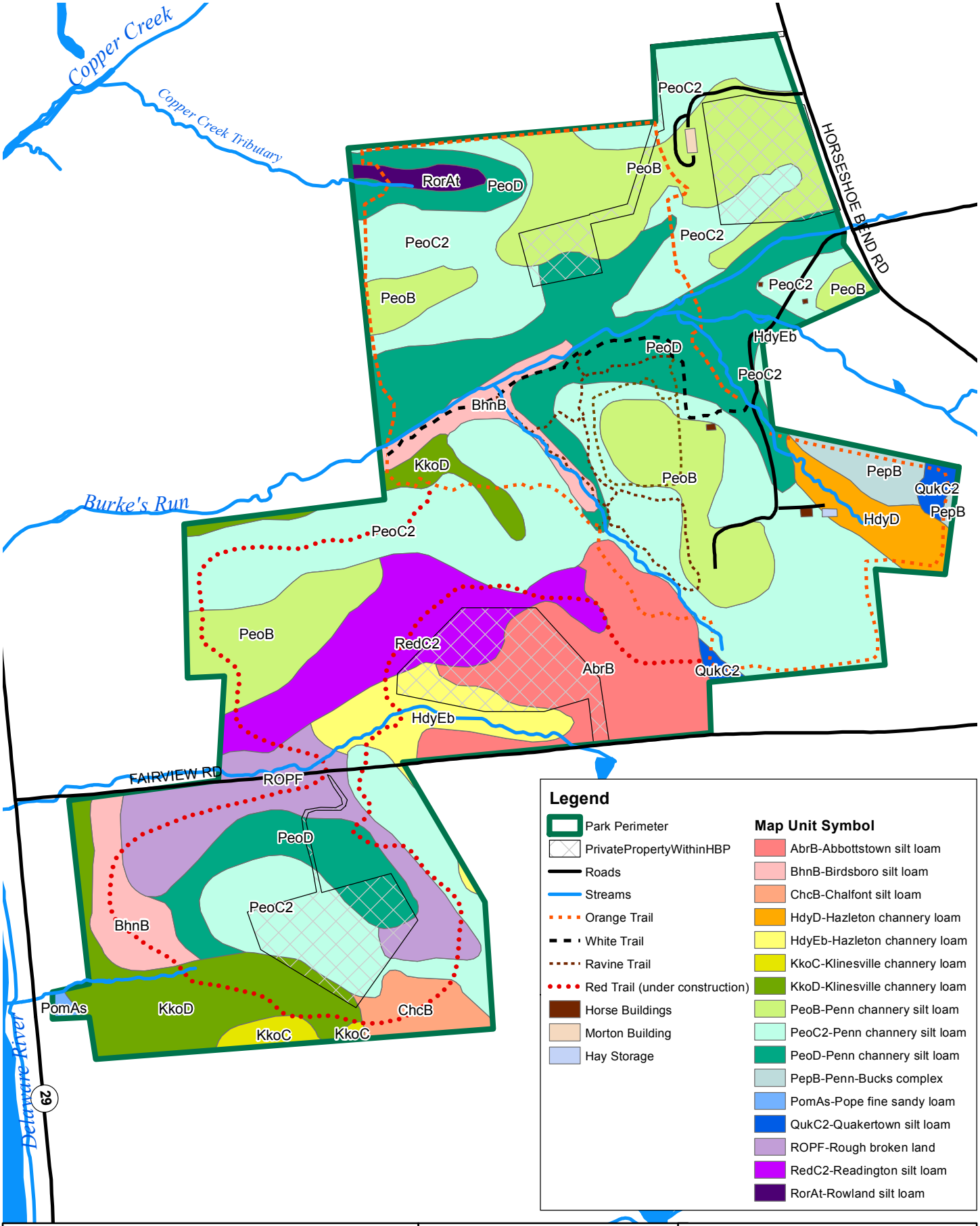

Figure 4a: Soils
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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silty clay loam. From 21 to 57 inches is a firm, brittle, silt loam and channery silt loam fragipan. The substratum from 57 to 70 inches is brown channery silt loam. Slopes range from 0 to 15 percent.

Map unit: HdyD - Hazleton channery loam, 12 to 18 percent slopes
Map unit: HdyEb - Hazleton channery loam, 18 to 40 percent slopes, very stony

The Hazleton series consists of moderately deep well drained soils on piedmont hills. They formed from acidic gray and brown loamy residuum weathered from sandstone. Bedrock is at about 44 to 56 inches. Slopes range from 12 to 40 percent.

Map unit: KkoC - Klinesville channery loam, 6 to 12 percent slopes
Map unit: KkoD - Klinesville channery loam, 12 to 18 percent slopes

The Klinesville series consists of shallow, somewhat excessively drained soils on uplands. They formed in material weathered from shale, siltstone, and sandstone. Typically these soils have a dark reddish brown very channery silt loam surface layer 5 inches thick. The subsoil from 5 to 15 inches is reddish brown very channery silt loam. The substratum from 15 to 19 inches is weak red weathered shale fragments. Bedrock is at 19 inches. Slopes range from 0 to 80 percent.

Map unit: PeoB - Penn channery silt loam, 2 to 6 percent slopes
Map unit: PeoC2 - Penn channery silt loam, 6 to 12 percent slopes, eroded
Map unit: PeoD - Penn channery silt loam, 12 to 18 percent slopes

The Penn series consists of moderately deep, well drained soils on uplands. They formed in materials weathered from red shale, siltstone and fine grained sandstone. Typically these soils have a dark reddish brown channery silt loam surface layer about 8 inches thick. The subsoil between 8 and 21 inches is reddish brown and weak red friable and firm channery silt loam. The substratum from 21 to 34 inches is weak red very channery silt loam. Bedrock is at about 34 inches. Slopes range from 0 to 60 percent.

Map unit: PepB - Penn-Bucks complex, 2 to 6 percent slopes

The Penn series consists of moderately deep, well drained soils on uplands. They formed in materials weathered from red shale, siltstone and fine grained sandstone. Typically these soils have a dark reddish brown channery silt loam surface layer about 8 inches thick. The subsoil between 8 and 21 inches is reddish brown and weak red friable and firm channery silt loam. The substratum from 21 to 34 inches is weak red very channery silt loam. Bedrock is at about 34 inches. Slopes range from 0 to 60 percent.

The Bucks series consists of deep, well drained soils on uplands. They formed in a silt mantle over weathered red shale, siltstone or fine grained sandstone. Typically these soils have a dark yellowish brown or dark brown silt loam surface layer 15 inches thick. The subsoil between 15 and 35 inches is a reddish brown silt loam. The substratum from 35 to 44 inches is dark reddish brown channery silt loam. Red shale bedrock is at a depth of 44 inches. Slopes range from 0 to 25 percent.

Map unit: PomAs - Pope fine sandy loam, high bottom, 0 to 2 percent slopes, occasionally flooded

The pope series consists of deep, well drained soils on flood plains. They formed in acid alluvial material. Typically these soils have a brown fine sandy loam surface layer 8 inches thick. The subsoil from 8 to 42 inches and the substratum from 42 to 85 inches are dark yellowish brown fine sandy loam. Slopes range from 0 to 4 percent.

Map unit: QukC2 - Quakertown silt loam, 6 to 12 percent slopes, eroded

The Quakertown series consists of deep, well drained soils on uplands. They formed in materials weathered from fine grained sandstone, sandy siltstone and thinly bedded argillite. Typically these soils have a dark grayish-brown silt loam surface layer 12 inches thick. The subsoil from 12 to 32 inches is dark brown silt loam and silty clay loam. The substratum from 32 to 48 inches is dark yellowish-brown channery silt loam and shattered siltstone overlying sandstone bedrock. Slopes range from 0 to 18 percent.

Map unit: RedC2 - Readington silt loam, 6 to 12 percent slopes, eroded

The Readington series consists of very deep and deep, moderately well drained soils on uplands. They formed in material weathered from red shale, siltstone, and sandstone. Typically these soils have a dark grayish brown silt loam surface layer 8 inches thick. The subsoil layers from 8 to 29 inches are reddish brown silt loam and silty clay loam. A firm to very firm brittle fragipan between 29 to 50 inches is mottled reddish brown and weak red channery silt loam. Bedrock is at 50 inches. Slopes range from 0 to 15 percent.

Map unit: ROPF - Rough broken land, shale

Soft rock outcrop consists of exposures of bare soft bedrock other than rock-lined pits. They consist mainly of unweathered sedimentary rock. Slopes range from 0 to 200 percent.

Map unit: RorAt - Rowland silt loam, 0 to 2 percent slopes, frequently flooded

The Rowland series consists of very deep, moderately well to somewhat poorly drained soils on floodplains. They formed in alluvial sediments. Typically these soils have a dark reddish brown silt loam surface layer 10 inches thick. The subsoil from 10 to 28 inches is reddish brown silt loam mottled in the lower part. The substratum from 28 to 44 inches is weak red silty clay loam. Below 44 inches is stratified sand and gravel. Slopes range from 0 to 3 percent.

4.4 Characteristics of Horseshoe Bend Park Soils

Depth to Bedrock (Figure 4b)

According to NJDEP (August 15, 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.

The depth to bedrock in Horseshoe Bend Park ranges from 0 to 55.9 inches (see **Figure 4b)**. The areas with depth to bedrock less than 18 inches are mostly on the sections known as the Flagg and Kirkland properties. Most of the park has 30 or more inches depth to bedrock.

In some cases, a fragipan layer is encountered with or without the presence of shallow bedrock. A *fragipan* is a subsoil layer, typically high in clay, which is a higher density than the soil above it. A fragipan layer becomes cemented and very hard when dry, and brittle when moist. The layer is low in organic matter and slowly or very slowly permeable to water and also restricts root growth (NRCS, August 2013). When present in Horseshoe Bend Park, the fragipan layer varies in depth between 15 and 36 inches in depth (see **Table 4.2**).

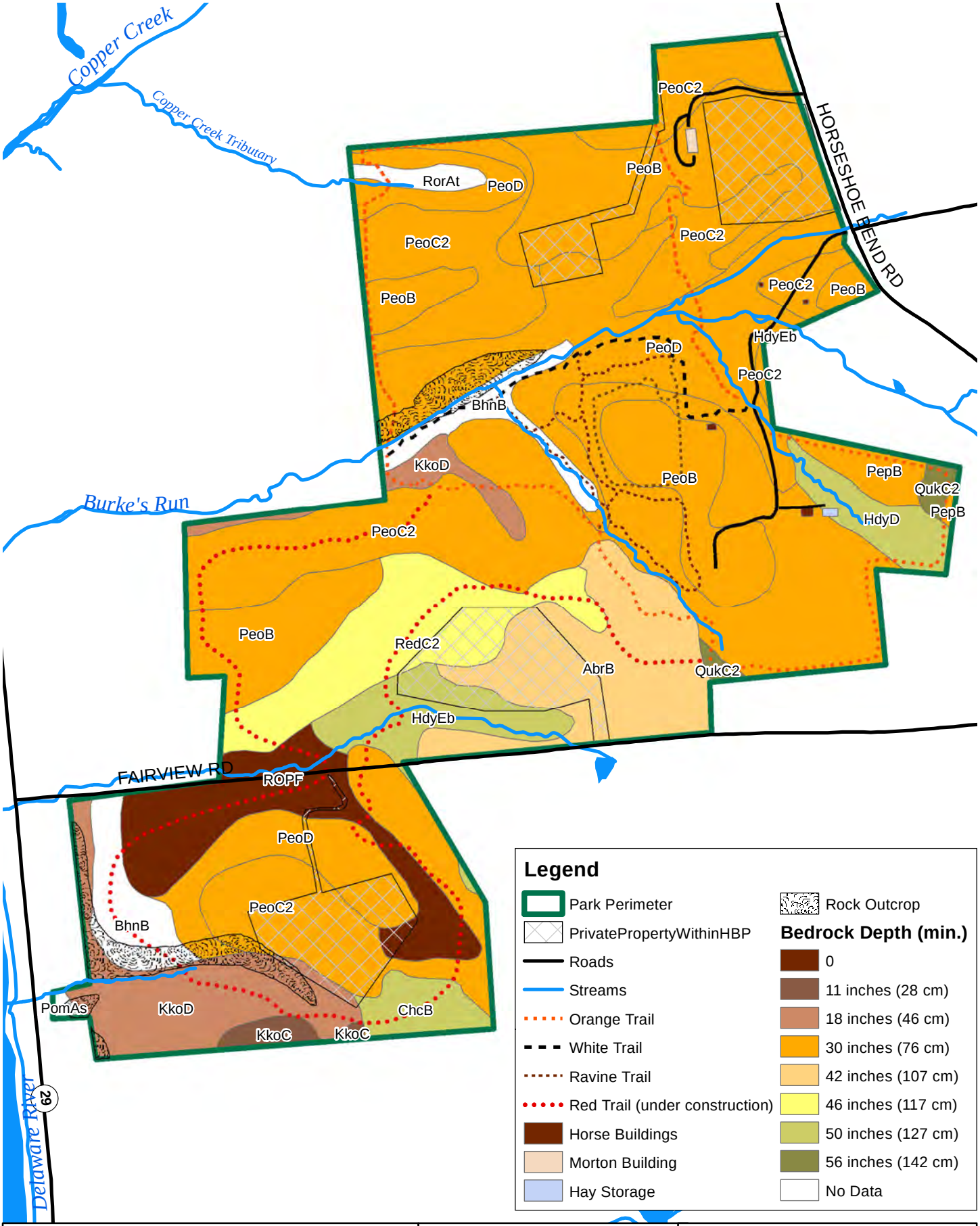

Figure 4b: Soils Depth to Bedrock
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

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 an aquifer. A SHWT of less than one foot severely constrains development, while SHWT between 1 and 3 feet also provides obstacles to development. 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 Horseshoe Bend Park lacks data for SHWT, while some areas have between 6 and 27 inches (see **Figure 4c**).

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 would runoff compared to the rate that water would infiltrate into the ground). Horseshoe Bend Park has moderate to very slow 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	

Soil 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 (which allows effluent to percolate to ground water too rapidly); presence of water (including depth to high water table, flooding, and hydric soils); depth to restrictive layer (bedrock or restrictive substratum) and steep grades over 25%. N.J.A.C 7:9A prohibits septic systems in soils subject to flooding; 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, August 15, 1999).

In the majority of Horseshoe Bend Park, the suitability of soils for septic tank absorption fields is somewhat to very limited. Portions of some soil units have areas where septic system disposal fields would not be permitted due to flooding, while bedrock outcrop areas (ROPF) were not rated. Birdsboro silt loams (2-6% slope) have no technical limitations. These general suitability guidelines would need to be used in combination with on-site testing, the SSURGO interpretation report "Sewage Disposal (NJ)," and N.J.A.C.7:9A subchapter 10 to determine what types of disposal field installations would be appropriate in any given situation. In soils with more than one limiting factor, a disposal field must be a type approved as an acceptable option for each of the soil suitability classes which apply (NJDEP, August 15, 1999).

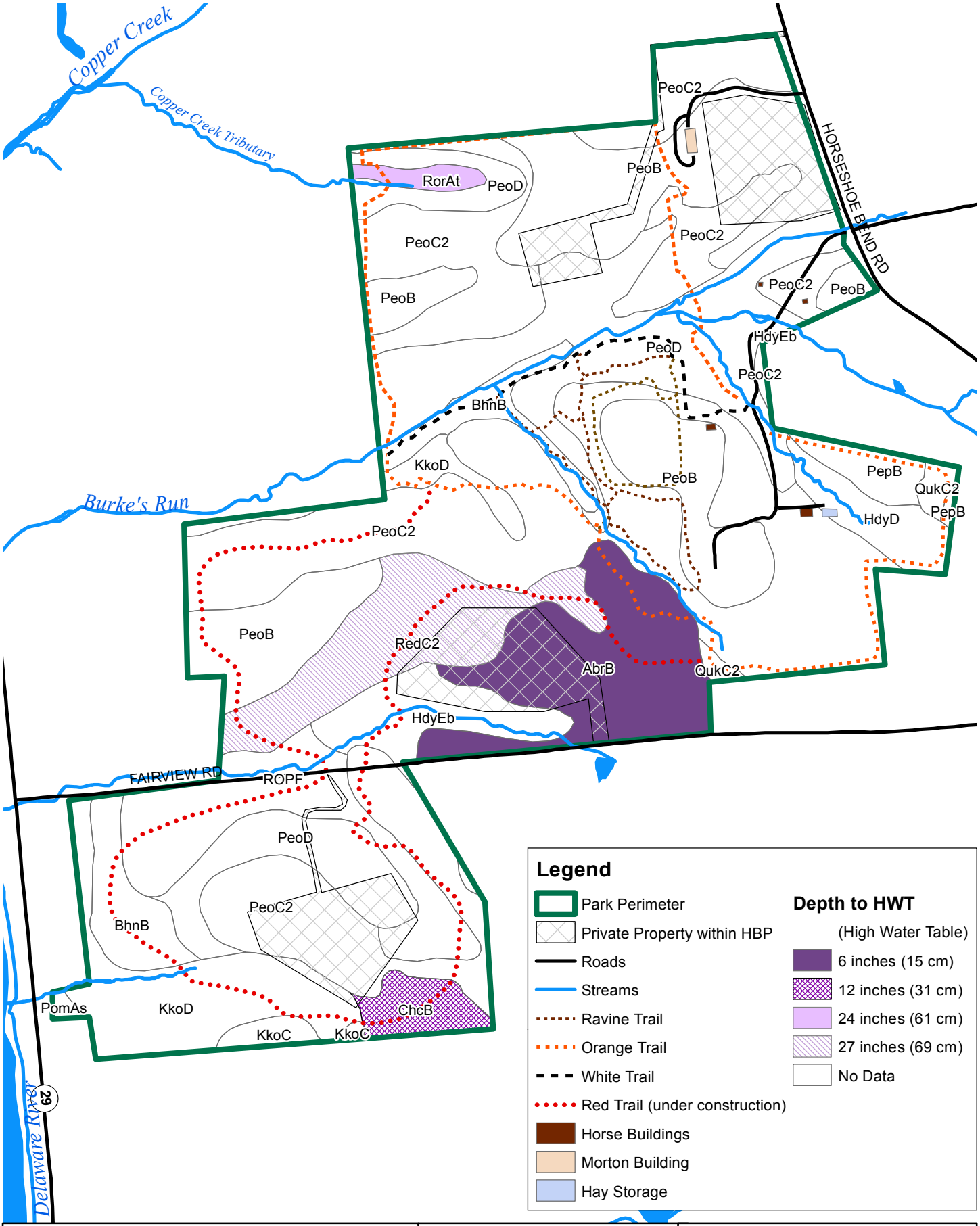

Figure 4c: Soils Depth to High Water Table Horseshoe Bend Park

Prepared by Kratzer Environmental Services

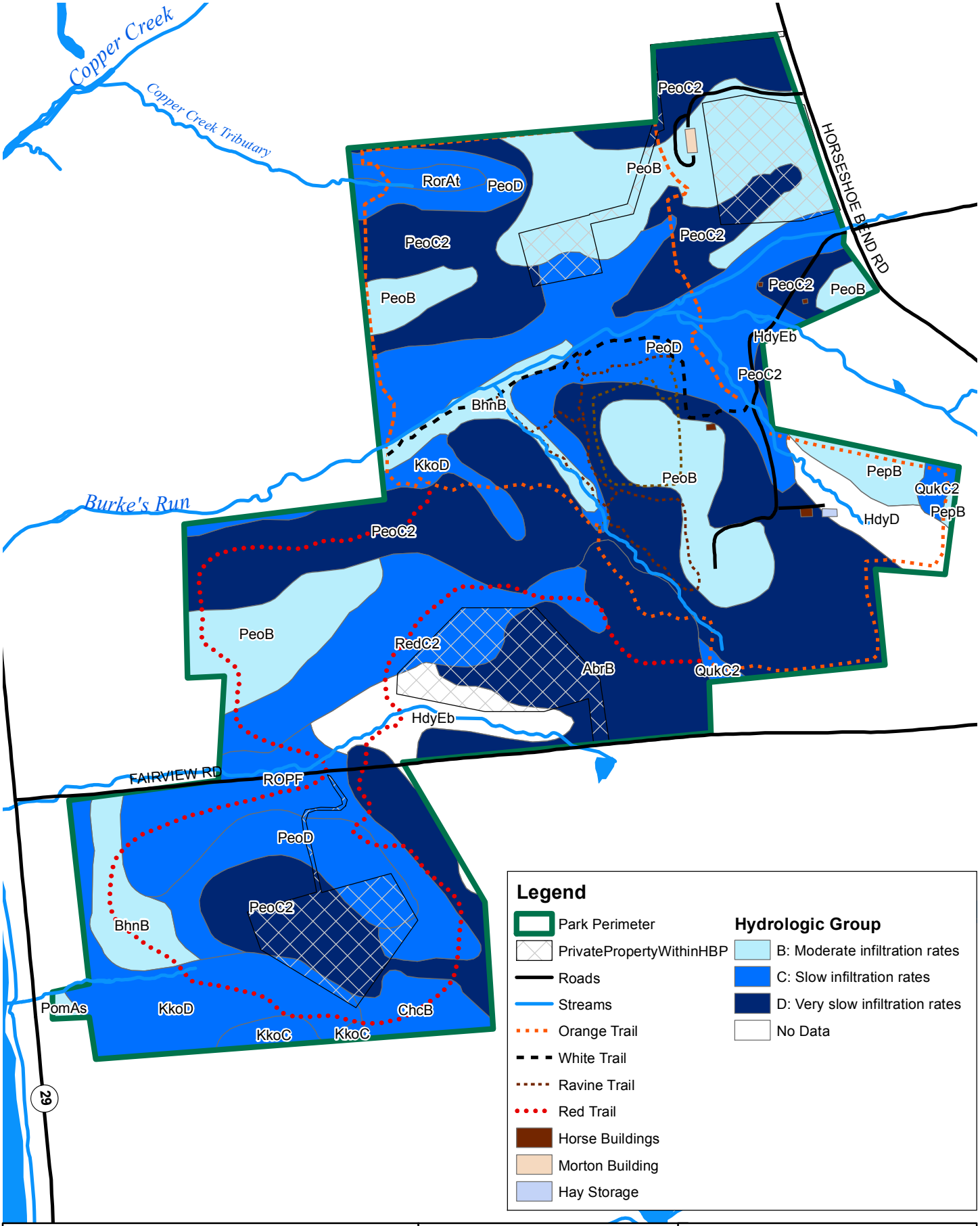

Figure 4d: Soils Hydrologic Group
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

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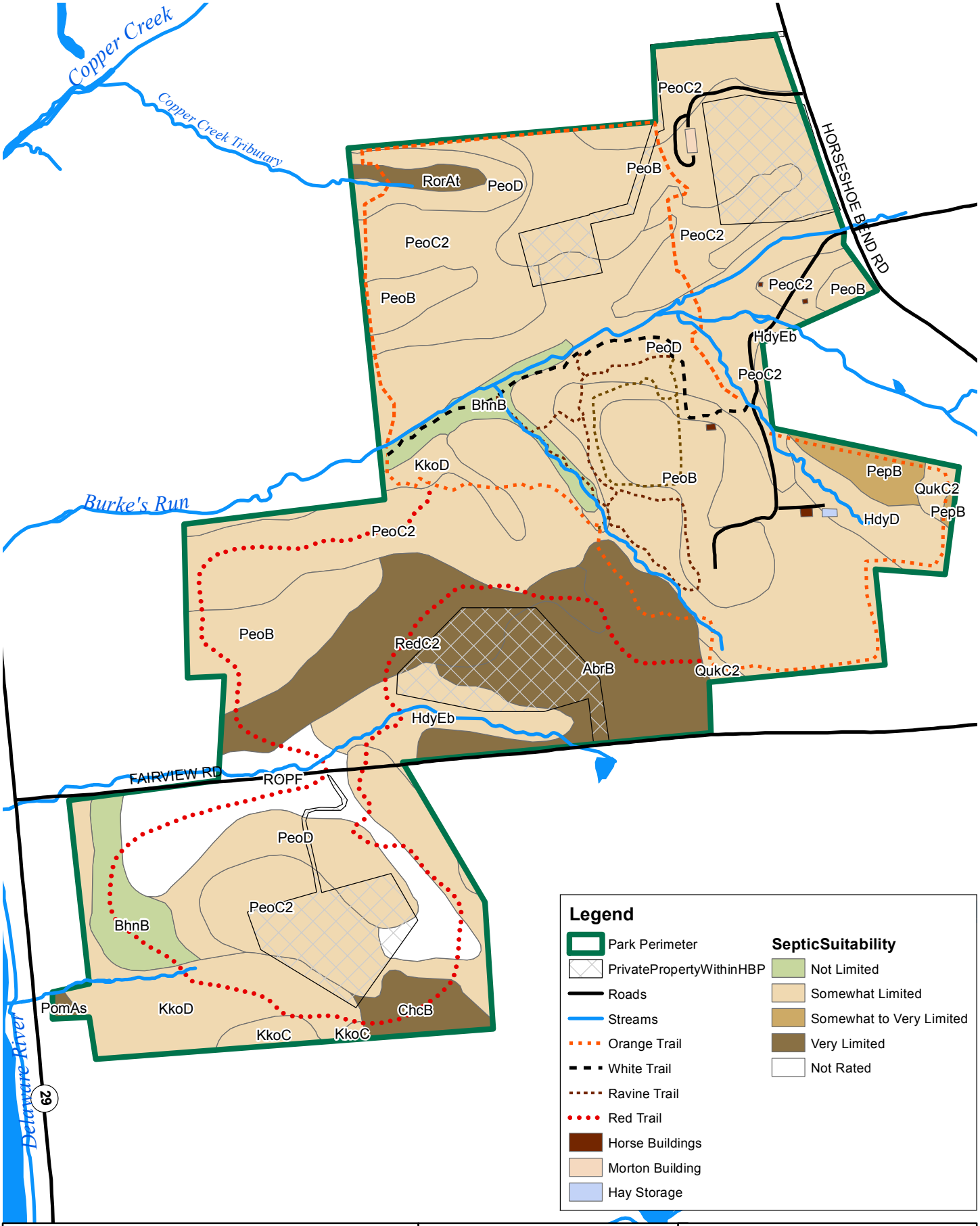

Figure 4e: Soils
Septic Suitability (NJ)
Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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

Soil Drainage Class (permeability) (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: excessively drained, somewhat excessively drained, well drained, moderately well drained, poorly drained, and somewhat poorly drained. The largest portion of Horseshoe Bend Park has well drained soils. Poorly drained soils most likely coincide with wetlands. The steeper slopes and rocky soils tend to be somewhat excessively drained, while some areas are moderately well drained (see **Figure 4f).**

Prime Farmland Soils (Figure 4g)

Prime Farmland Soils include soils that have the best combination of physical and chemical characteristics for economically producing sustained high yields of crops when treated and managed according to acceptable farming methods and is also available for these uses. These soils have the soil quality, growing season, and moisture supply needed; they are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding (NRCS, August 2013).

Farmlands of statewide importance include those soils with characteristics that are nearly Prime Farmland. They economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce yields as high as Prime Farmland if conditions are favorable (NRCS, August 2013). Horseshoe Bend Park's soils are nearly all agricultural soils; some are prime farmland soils, while others are farmlands of statewide importance (see **Figure 4g).**

Potential Frost Action (Figure 4h)

Potential Frost Action is an interpretation rating of the susceptibility of the soil to frost heaving. Most soils within Kingwood are moderately susceptible to frost action, while the Klinesville soils have a low potential and several (Abootsville, Readington, Rowland and Quakertown) are highly susceptible (except gravel pits and rough broken land, which is rated "none") (see **Figure 4h).**

Other

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. For those soils which experience frequent or occasional flooding, duration of annual flooding in a normal year and the months during which flooding occurs in a normal year are also noted.

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. Hydric Soils are marked **Y** for yes, when they meet the requirements for a hydric soil. Hydric soils are shown with wetlands in **Figure 6c**.

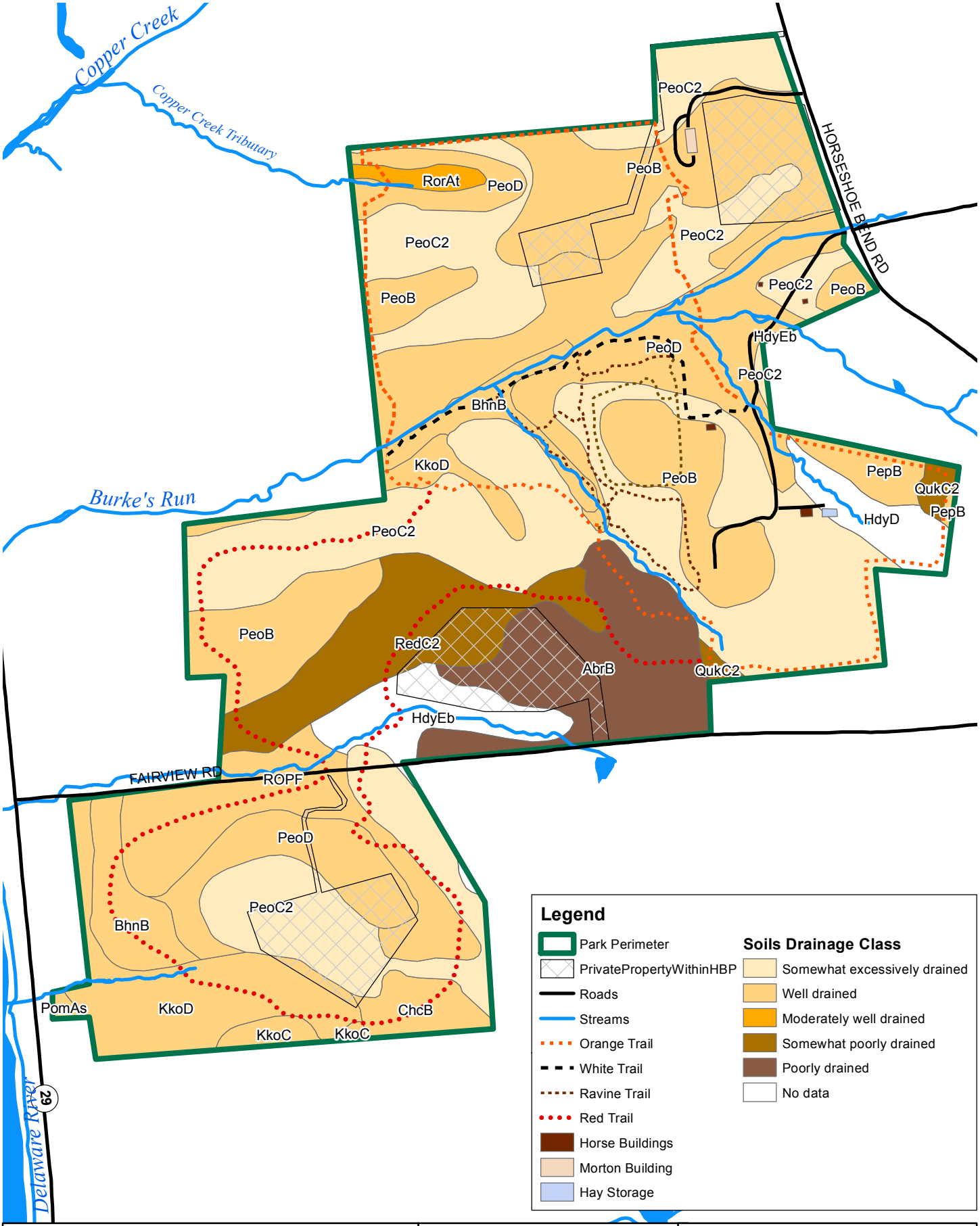

Figure 4f: Soils Drainage Class Horseshoe Bend Park

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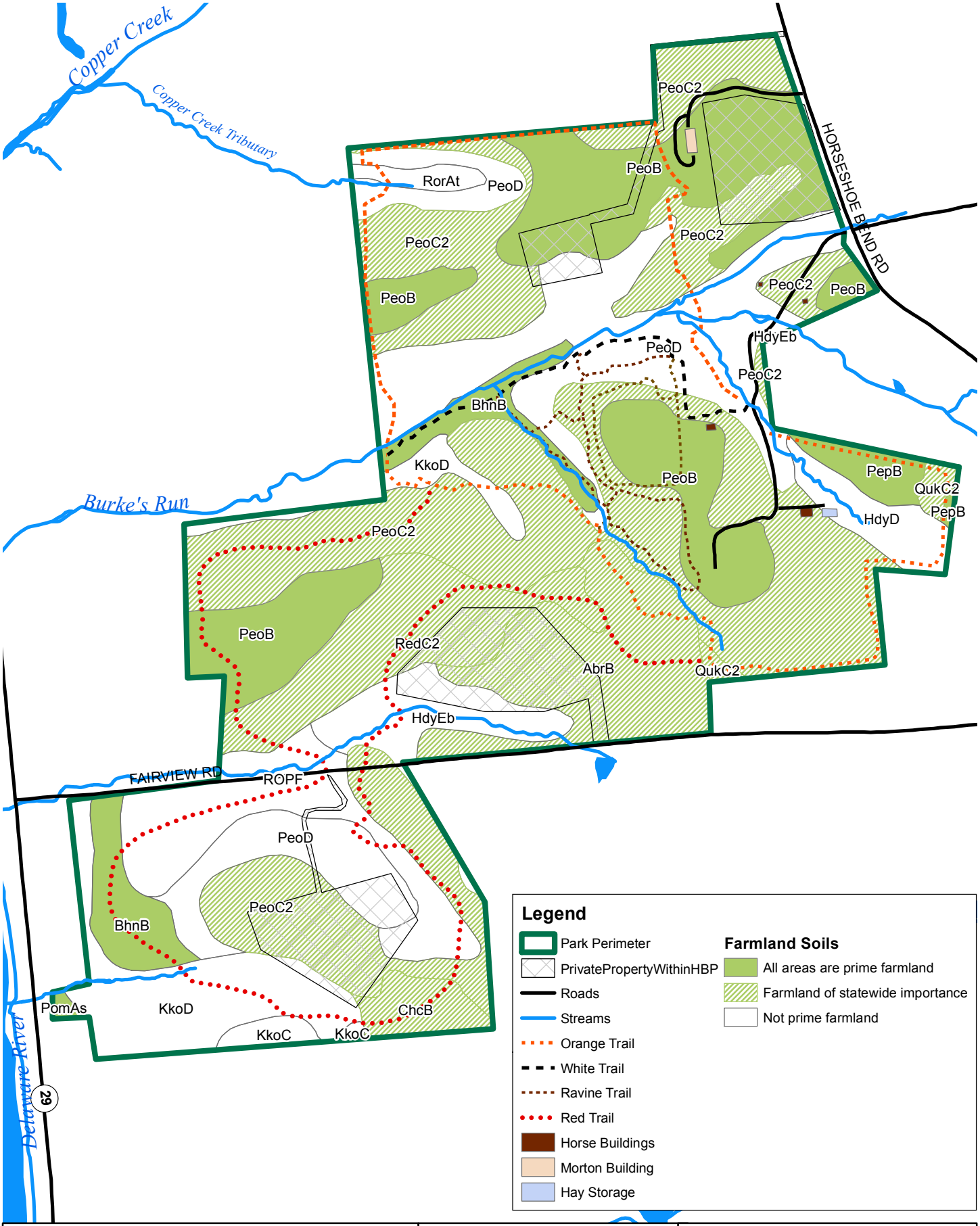

Figure 4g: Agricultural Soils
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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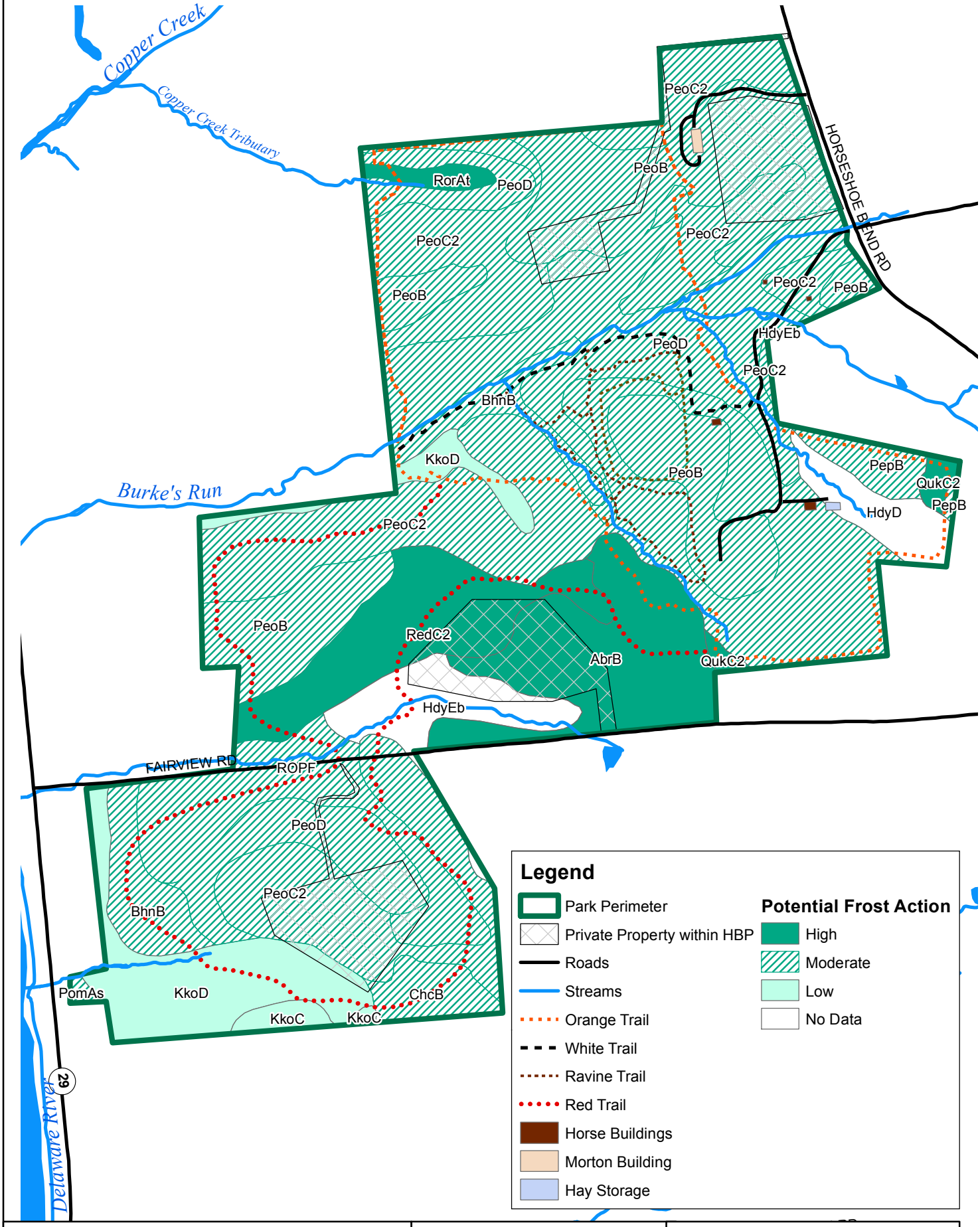

Figure 4h: Soils Frost Action
Horseshoe Bend Park

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

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Internet Resources: Soils

Hunterdon Soil Conservation District: http://www.nj.gov/agriculture/divisions/anr/nrc/conservdistricts.html

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/

Table 4.2: Characteristics of Soil Types Found in Horseshoe Bend Park

Map Unit Symbol	Map Unit Name	Depth to Restrictive Layer (inches)	Seasonal High Water Table Depth	Annual Flood Frequency	Hydrologic Group	Potential Frost Action	Drainage Class	Hydric Soil?	Prime Farmland?	Septic Suitability	Reason(s) for Septic Suitability Limit
AbrB	Abbottstown silt loam, 2 to 6 percent slopes	B: 40-60 F: 15-30	6	NONE	C	HIGH	SP	Y	SI	VL	Depth to perched zone of saturation, Restrictive substratum, Restrictive horizon, Excessively coarse substratum
BhnB	Birdsboro silt loam, 2 to 6 percent slopes	none	>60	NONE	B	MOD	W		P	N	not limited
ChcB	Chalfont silt loam, 2 to 6 percent slopes	B: 42-72 F: 15-30	12	NONE	C	HIGH	SP		SI	VL	Depth to perched zone of saturation, Restrictive substratum, Restrictive horizon, Excessively coarse substratum
HdyD	Hazleton channery loam, 12 to 18 percent slopes	44-56	>60	NONE	B	MOD	W			SL	Depth to massive bedrock
HdyEb	Hazleton channery loam, 18 to 40 percent slopes, very stony	48-60	>60	NONE	B	MOD	W			SL	Depth to massive bedrock
KkoC	Klinesville channery loam, 6 to 12 percent slopes	10-20	>60	NONE	D	LOW	SE			SL	Excessively coarse substratum
KkoD	Klinesville channery loam, 12 to 18 percent slopes	10-20	>60	NONE	D	LOW	SE			SL	Excessively coarse substratum
PeoB	Penn channery silt loam, 2 to 6 percent slopes	20-40	>60	NONE	C	MOD	W		P	SL	Excessively coarse substratum
PeoC2	Penn channery silt loam, 6 to 12 percent slopes, eroded	20-40	>60	NONE	C	MOD	W		SI	SL	Excessively coarse substratum
PeoD	Penn channery silt loam, 12 to 18 percent slopes	20-40	>60	NONE	C	MOD	W			SL	Excessively coarse substratum

PepB	Penn-Bucks complex, 2 to 6 percent slopes	40-60	>60	NONE	C	MOD	W		P	SL to VL	Excessively coarse substratum, Restrictive substratum
PomAs	Pope fine sandy loam, high bottom, 0 to 2 percent slopes, occasionally flooded	none	>60	Occasional; Brief Duration; Jan-May	B	MOD	W		P	VL	Not Permitted - Flooding
QukC2	Quakertown silt loam, 6 to 12 percent slopes, eroded	40-60	>60	NONE	C	MOD	W		SI	SL	Excessively coarse substratum
RedC2	Readington silt loam, 6 to 12 percent slopes, eroded	B: 40-60 F: 24-36	27	NONE	C	MOD	MW		SI	VL	Restrictive substratum, Restrictive horizon, Excessively coarse substratum, Depth to perched zone of saturation
ROPF	Rough broken land, shale	0	>60	NONE	D	NONE	W			-	-
RorAt	Rowland silt loam, 0 to 2 percent slopes, frequently flooded	none	24	FREQUENT; Brief Duration; Nov-Mar	C	HIGH	MW			VL	Not Permitted - Flooding, Depth to apparent zone of saturation

Notes: See preceding text for descriptions of these various characteristics.
Depth to Restrictive Layer measured in inches from surface: **B**=Depth to Bedrock; **F**=Depth to Fragipan
Hydrologic Group explanations see **Table 4.1**.
Potential Frost Action: **HIGH**=high; **MOD**=Moderate; **NONE**=none
Drainage Class: **W**=well drained; **MW**=moderately well drained; **E**=excessive; **SE**=somewhat excessively; **P**=poorly; **SP**=somewhat poorly.
Hydric Soils: **Y**=yes
Prime Farmland: **Y**=yes; **SI**=Statewide Importance
Septic Suitability: **SL**=somewhat limited; **VL**=very limited; **N**=not limited

Source: US Department of Agriculture, Natural Resources Conservation Service (NRCS). September 7, 2010. Soil Survey Geographic (SSURGO) database for Hunterdon County, New Jersey. nj019. http://websoilsurvey.nrcs.usda.gov.

5: GROUND WATER

5.1 The Aquifer in Horseshoe Bend Park

Ground water is defined as the 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.

Horseshoe Bend Park is located in Kingwood Township, which relies exclusively on ground water from individual wells. Nearby Frenchtown Borough also relies on ground water, from three municipal wells.

The aquifer beneath Horseshoe Bend Park is the Brunswick Aquifer (also known as the Passaic Aquifer), which is part of the Late Triassic Newark Group of sedimentary rocks (see **Figure 5a** and **Table 5.1**).

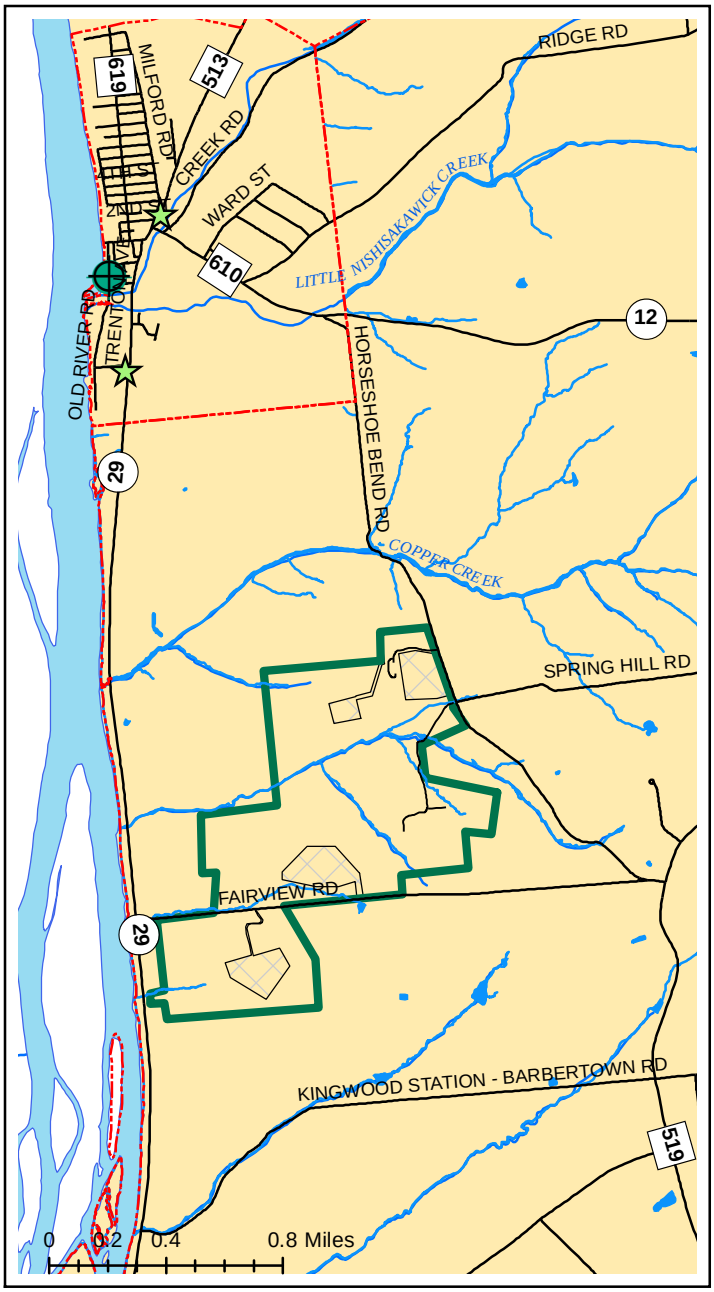
Table 5.1: Characteristics of the Aquifer in Horseshoe Bend Park

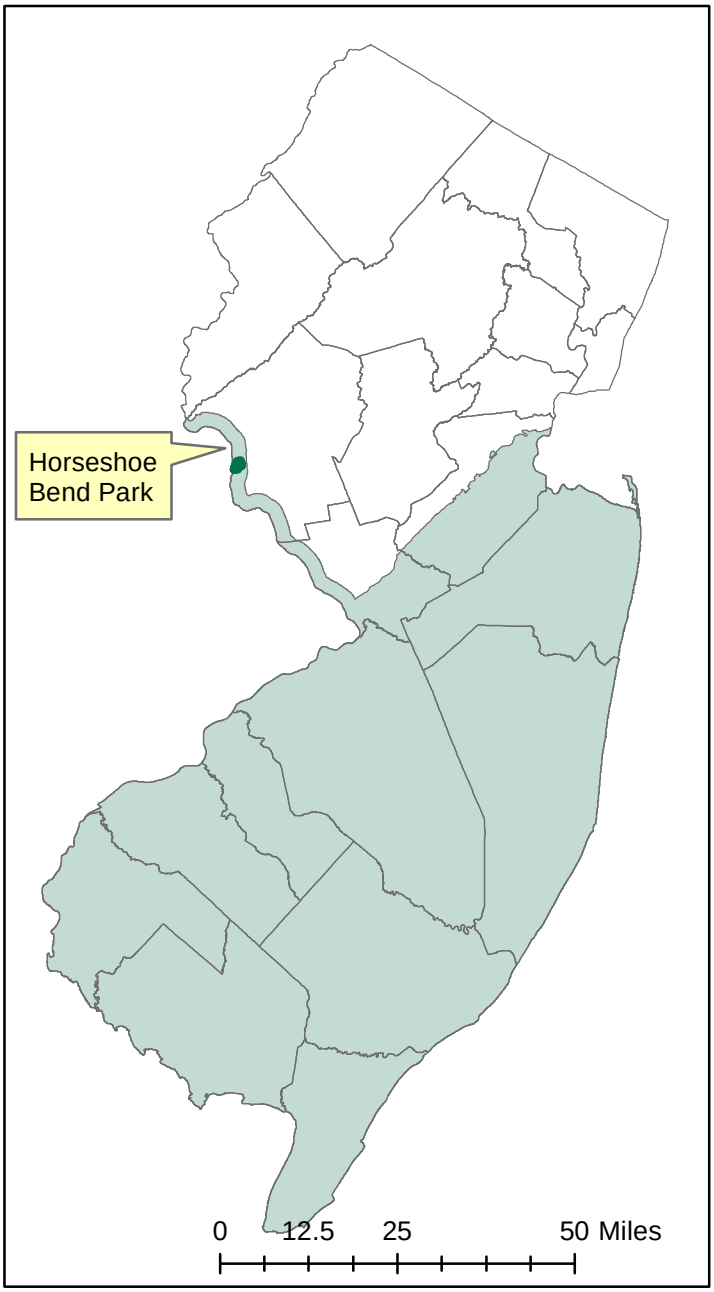
Aquifer	State Rank*	Characteristics	Common Range		Percent of Township
			Depth (ft)	Yield (gpm)	
Brunswick (Passaic) aquifer (ba)	C	Sandstone, siltstone, and shale. Ground water stored and transmitted in fractures. Water is normally fresh, slightly alkaline, non-corrosive and hard. Calcium-bicarbonate type waters dominate. Subordinate calcium-sulfate waters are associated with high total dissolved solids.	30-1,500	10-500	71.30
*** State Rank** 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&b					

The Late Triassic Newark Group consists of dense, almost impermeable, bedrock that yields water mostly from *secondary porosity*[10] and permeability provided by fractures. Therefore, the distribution and orientation of these fractures controls the rates and directions of ground water flow. 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. Rocks below the weathered zone, which is usually about 75 feet thick, have no primary porosity (Lewis-Brown and Jacobsen, 1995). *Unconfined* conditions commonly exist above this level 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.

The Passaic formation is 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

[10] *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.





Legend

- Park Perimeter
- Private Property within HBP
- Roads
- River & Streams
- Brunswick aquifer
- AGWQN
- NJGS Site

Legend

- Park Perimeter
- Counties

Sole Source Aquifer

- Coastal Plain

Figure 5a: Aquifer
Horseshoe Bend Park

N

HBP NRI, 2013

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Figure 5b: Sole Source Aquifer
Horseshoe Bend Park

N

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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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 500 feet (Houghton, 1990 in Lewis-Brown and Jacobsen, 1995). For this reason, wells extended beyond 500 feet 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 aquifer consists of the whole 500 foot thick sequence of water bearing units and confining units.

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 Horseshoe Bend Park, because it is present in fractures, 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 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.

Water that flows to pumped wells generally is derived mostly from the water bearing units intersected by the well opening. Other water-bearing units provide water by leakage through confining units. 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). Wells located near surface water often have higher yields (Vecchioli and Palmer, 1962 in Lewis-Brown and Jacobsen, 1995), but could be vulnerable to pollution, if the surface water carries pollutants.

Kingwood Township has a well ordinance which applies to all new or increased water uses (Township of Kingwood Administrative Code Chapter 153).

5.2 Sole-Source Aquifer

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. 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* and its *stream-flow source zone*. The recharge zone is the area through which water recharges the aquifer. The stream-flow source zone is the upstream area that contributes recharge water to the aquifer. Horseshoe Bend Park is within the area designated as part of the stream-flow source zone for the Coastal Plain SSA (see **Figure 5b**) (NJGS, May 19, 1998).

5.3 Recharge

Ground water *recharge* is defined as water added to an aquifer (for example, precipitation that seeps into the ground). 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 coincide with, or are slightly offset from, surface water divides (Lewis-Brown and Jacobsen, 1995)(watersheds are described in **Section 6.1** 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.

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). Evaporation likewise, is higher during the warmer months. Therefore, most recharge occurs during late fall, winter, and early spring, when plants are dormant and evaporation rates are minimal (Heath, 1983).

Recharge rates are expressed in terms of the amount of precipitation that reaches the aquifer per unit of time (e.g. inches per year). Recharge rates vary from year to year, depending on the amount of precipitation, its seasonal distribution, air temperature, land use and other factors. 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.

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, surface runoff, and evapotranspiration. This method was then applied by NJGS to create a GIS coverage (see **Figure 5c**). There were a number of assumptions made for the calculations and model inputs which limit the accuracy of the method: 1.) the calculated ground water recharge includes any water entering the ground (lesser amounts actually enter the aquifer); 2.) assumes that all water which migrates below the root zone recharges the aquifer (which doesn't 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); and 5.) stream baseflows used may not be representative of local streams (Charles et. al., 1993). 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).

Keeping these limitations in mind, the method estimated recharge rates from 7 to 11 inches per year in Horseshoe Bend Park, for estimated average annual subsurface recharge during a drought year (see **Figure 5c)**. This represents 14 to 22% of precipitation[11].

For comparison, in 1966, the State Geologist estimated recharge to be 10 to 15% of precipitation for areas similar to Kingwood Township (Kasabach, 1966), while a typical figure for recharge in the sandy coastal areas of New Jersey is approximately 50% of rainfall.

As previously mentioned, only a portion of water entering the ground actually recharges the aquifer, but the GSR-32 did not attempt to quantify this amount. According to Lewis-Brown and Jacobsen (1995), of the US Geological Survey, "…only about 6% of the recharge at land

[11] "New normal" annual precipitation is 49.37 inches based on values from 1981-2010 and are preliminary (Office of the NJ State Climatologist, September 3, 2013).

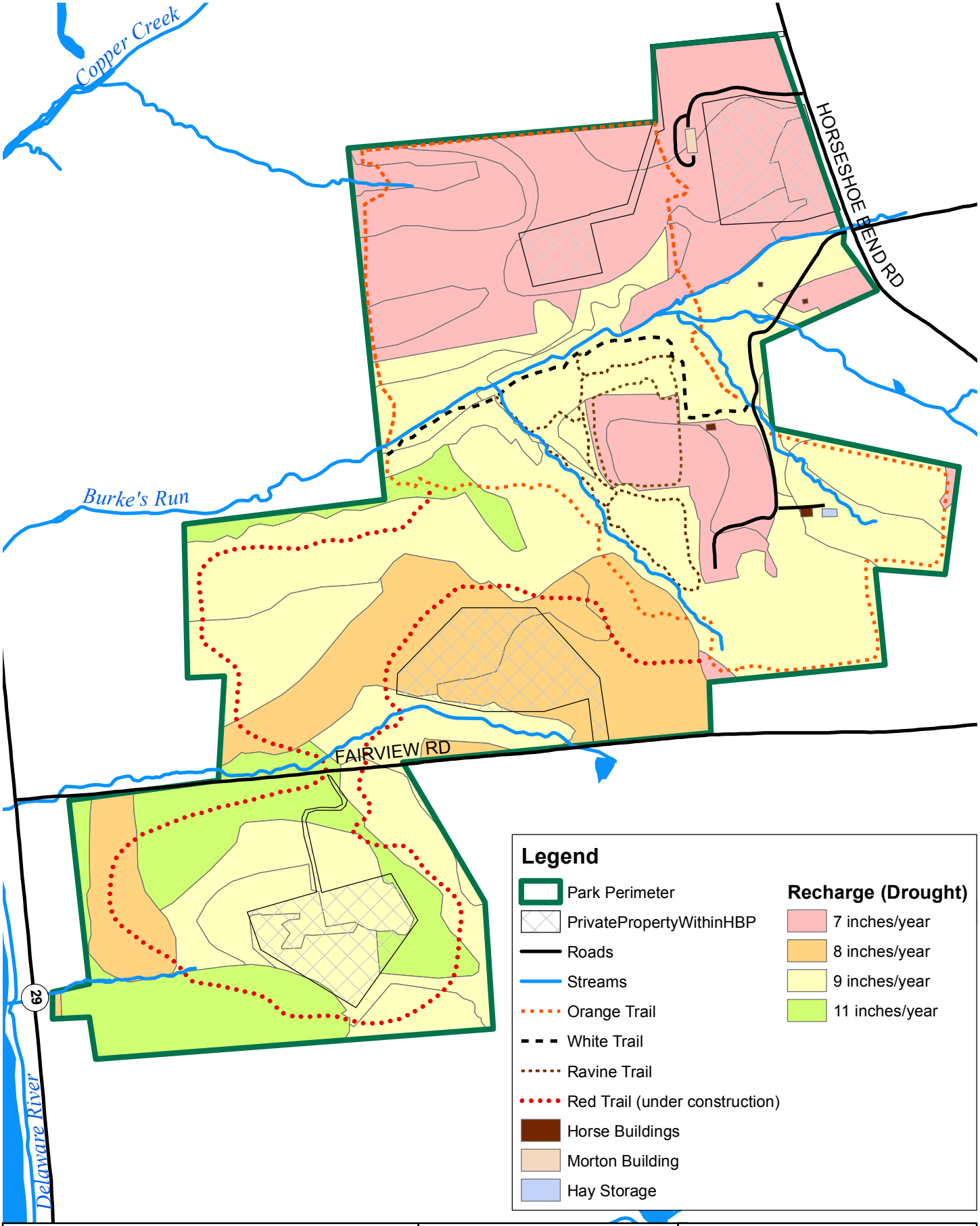

Figure 5c: Recharge Horseshoe Bend Park

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surface reaches depths greater than 75 feet below land surface." In contrast, 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). Using the 6% figure, Horseshoe Bend Park may have usable recharge of 0.42 to 0.66 inch. If assuming that 20% of ground recharge is aquifer recharge, 1.4 to 2.2 inches are added to ground water per year. While it is unknown at this time which figure is closer to actual conditions in this area, the general principle is this: Recharge is limited. Therefore, if withdrawals of ground water are greater than the recharge amounts, the aquifer would experience a continuous net reduction in the available water supply.

5.4 Ground Water Quality Standards

The New Jersey Ground Water Quality Standards (GWQS; N.J.A.C. 7.9-6) specify the quality criteria and designated uses for ground water, and serve as the basis for setting ground water discharge standards under the New Jersey Pollutant Discharge Elimination System program, 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 6.3** 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. 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, and encompass all areas that are not designated as Class I or Class II. 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 (NJDEP Bureau of Water Quality Standards and Assessment, December 5, 2011).

The groundwater of Horseshoe Bend Park is designated Class II.

5.5 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 (including discharge pipes), 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, nitrates, and waterborne pathogens.

The New Jersey Private Well Testing Act (N.J.S.A. 58:12A-26 et seq.) became effective in September 2002. The PWTA requires mandatory statewide private well testing upon the sale of a house. The well water must be tested for Primary Contaminants[12] (bacteria, Volatile

[12] Primary contaminants are contaminants that may a cause potential health risk if consumed on a regular basis above the established maximum contaminant levels (MCLs).

Organic Compounds, arsenic, lead and nitrates) and Secondary Contaminants[13] (pH, iron and manganese). Beginning March 16, 2004, gross alpha particle activity is also required in Hunterdon County. Based on data collected between 2002 and 2009 throughout Kingwood Township, 46% of tested wells exceeded the arsenic standard of 5 µg/l; 7% exceeded the gross alpha particle activity standard of 15 pCi/L**;** and no wells exceeded the standards for nitrate or VOCs. A PWTA report concluded that: 1.) certain geologic formations in the Piedmont region contain layers that may leach arsenic into the ground water as it passes through, and 2.) wells drilled into bedrock aquifers are more susceptible to fecal coliform contamination than wells in the coastal plain (NJDEP Division of Water Supply / Bureau of Safe Drinking Water and Division of Science, Research and Technology, July 2008).

The NJ Geological Survey analyzed data from 150 wells in the Newark Basin in order to characterize the natural range of ground water quality parameters. While no sites were located within Horseshoe Bend Park, 5 sites were situated nearby (well numbers 20 and 21 were located nearby in Frenchtown Borough, see **Figure 5a**, well numbers 22, 23 and 24 were located in Kingwood Township). 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, 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. In addition, the water may have large concentrations of iron and sulfate (USGS, January 14, 2013; Serfes, 1994).

NJGS/USGS Ambient Ground-Water-Quality Network (AGWQN) monitoring wells in New Jersey is maintained jointly by the New Jersey Geological Survey (NJDEP) and the United States Geological Survey. The AGWQN is designed to monitor the quality of ground water at or near the water table throughout the State. Each of the 150 sites in the network is sampled every 5 years. One site is located nearby in Frenchtown, also in the Passaic Aquifer (**Figure 5a)**.

5.6 Ground Water Level Monitoring

The *ground water level* is the distance from the land surface (i.e. top of well casing) 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 (current drought declarations are based on reservoir levels, which may not correlate with local ground water stress). 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, as well as causing a decrease in the baseflows of adjacent streams. Ground water level varies seasonally, due to the seasonality of recharge (see Recharge section, above). Wells do occasionally fail in Kingwood, demonstrating the vulnerability of these aquifers to over-withdrawal.

The nearest US Geological Survey well level monitoring site that is drilled in the Passaic (Brunswick) Formation is located in Readington Township (see **Internet Resources**, below).

[13] Secondary parameters are regulated by the State for aesthetic or other concerns (taste, odor, staining, scaling of home fixtures) rather than health effects. Whether or not these natural water quality parameters are a problem depends on the amount of the substance present.

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Internet Resources: Ground Water

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

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

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6: SURFACE WATER

6.1 Watersheds

Surface water is water that is visible above the ground surface, such as creeks, rivers, ponds, lakes, and wetlands. 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. *Sub-watersheds* are those smaller drainage areas that make up a larger watershed.

Horseshoe Bend Park is within the Delaware River watershed. The Delaware River drains portions of Pennsylvania, New York, New Jersey and Delaware. It is the second longest un-dammed river in the United States (after the Mississippi), flowing 330 miles from Hancock, NY to the mouth of the Delaware Bay, where it joins the Atlantic Ocean (DRBC, February 27, 2013).

Jill Stein Dodds

Burke's Run in Horseshoe Bend Park

The northern portion of Horseshoe Bend Park is within the Copper Creek sub-watershed. Over a dozen small unnamed streams join to form Copper Creek, which covers about 2,100 acres in Kingwood Township. Copper Creek joins the Delaware River about 0.9 miles south of Frenchtown. South of Copper Creek, Burke's Run (recently named, but unnamed on USGS and NJDEP maps) drains most of the park, and is roughly 800 acres in size, entering the Delaware River about ¼ mile from the park boundary. South of this stream, two even smaller unnamed tributaries of the Delaware River, encompassing about 350 acres total, drain the southern half of the park (see **Figure 6a).**

6.2 Hydrologic Unit Codes (HUC)

The classification system used by the NJDEP assigns each sub-watershed a *14-digit Hydrologic Unit Code (HUC14[14])*. 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 "0204" is in the Delaware River major drainage basin (USGS, May 13, 2013). The Delaware River upstream of Trenton (in this instance, called the Upper Delaware) has a HUC6 of "020401". The "Middle Delaware-Musconetcong" is assigned a HUC8 of "02040105," and every sub-watershed within this area has a HUC that starts with "02040105" (perhaps confusingly, in this instance dubbed "Middle Delaware").

All of Horseshoe Bend Park is within the Delaware River Basin, Middle Delaware. The park is entirely within the HUC14 of "02040105170060," which is called "Kingwood Twp (Warford-Little Nishisakawick)." This HUC14 encompasses 3,729 acres, and includes Copper Creek, Burke's Run and several small unnamed tributaries and direct drainage to the Delaware River. This sub-watershed lies between the Little Nishisakawick Creek, to the north, and

[14] 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.

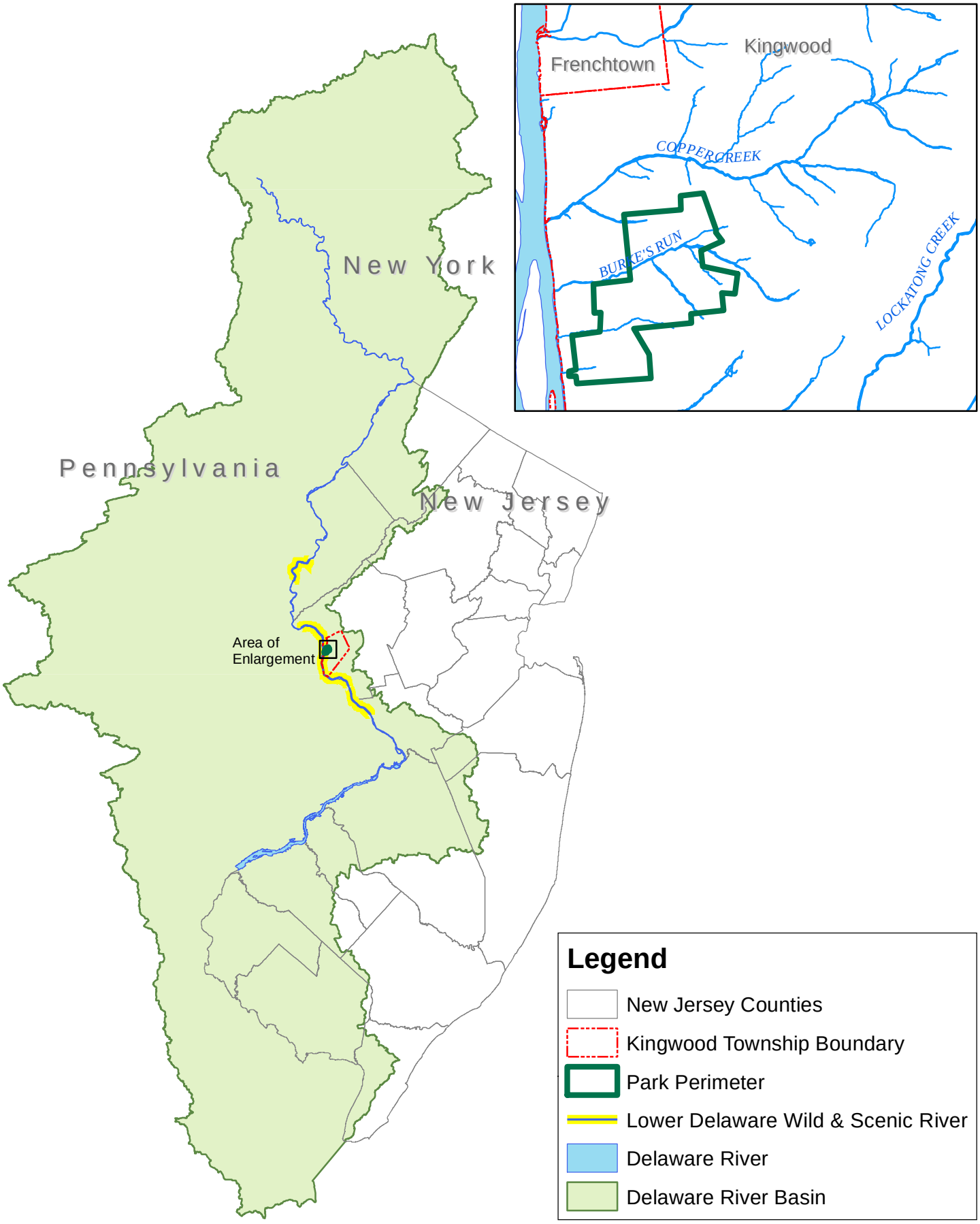


Figure 6a: Watershed
Horseshoe Bend Park

N

0 5 10 20 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

Warford Creek, to the south. HUC14 sub-watersheds encompassing and surrounding the park are shown in **Figure 6b**.

6.3 Surface Water Quality Standards

Surface Water Quality Standards (SWQS) are the rules in chapter N.J.A.C. 7:9B which 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.

> "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).

Surface water classifications are names assigned by the NJDEP to group waters according to designated uses (designated uses include potable water, propagation of fish and wildlife, recreation, agricultural and industrial supplies, and navigation) and water quality criteria. 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. **Table 6.1** describes the definitions of the categories, while **Figure 6b** illustrates the stream categories within and surrounding Horseshoe Bend Park. In **Figure 6b**, "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, its antidegradation status and its trout water status.

The streams found within Horseshoe Bend Park are all designated FW2-NT (Freshwater 2, Non-Trout). As illustrated in **Figure 6b**, the streams surrounding the park are all labeled Category One (C1)[15]: The Nishisakawick and Little Nishisakawick Creeks are just north of Copper Creek, Lockatong Creek is to the east, and Warford Creek (which has the additional designation of Trout Production) is directly to the south of the park.

6.4 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) are attained, and improving the quality of surface waters that do not attain their designated uses (NJDEP Water Monitoring and Standards, June 2012).

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

[15] Waterways can be designated *Category One* because of exceptional ecological significance, exceptional water supply significance, exceptional recreational significance, exceptional shellfish resource, or exceptional fisheries resource. The Category One designation provides additional protections that help prevent water quality degradation and discourage development where it would impair or destroy natural resources and environmental quality.

HUC14 sub-watershed) by labeling the results of each designated use assessment as *Fully Supporting*, *Not Supporting*, or *Insufficient Information* (see **Table 6.2**).

Table 6.1: 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	

The NJDEP is required to use all existing and readily available data to assess water quality for the Integrated List. Only one site is used to assess the water quality in this HUC14 (02040105170060): site 01458710, which is on Copper Creek and is part of the NJDEP Ambient Stream Quality Monitoring Program, and under the site name AN0084, the biomonitoring program (NJDEP Water Monitoring and Standards, July 2012; NJDEP BFBM, November 20,

2008; NJDEP, BFBM, November 2010). This HUC14 is *Fully Supporting* the uses of Drinking Water, Industrial Water Supply and Agricultural Water Supply; *Not Supporting* the uses of Aquatic Life and Recreation; and there is *Insufficient Information* to evaluate Fish Consumption.

Table 6.2: Integrated Water Quality Assessment

Use	Attain-ment	Cause	First on 303(d) List	TMDL Priority*	Source
02040105170060: Kingwood Twp(Warford-Little Nishisakawick)					
Agricultural Water Supply	F				• Package Plant or Other Permitted Small Flows Discharges • Agriculture • Urban Runoff/Storm Sewers
Aquatic Life	N	Phosphorus (total)	2006	Medium	
Fish Consumption	I				
Industrial Water Supply	F				
Primary Contact Recreation	N	Fecal Coliform	2006	Completed	
Public Water Supply	F				

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

*Medium priority = NJDEP expects to complete TMDL in the near future, but not within the next two years.

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)

Sources: NJDEP Water Monitoring and Standards, July 2, 2012; NJDEP Water Monitoring and Standards June 2012.

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[16] 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).

Excessive phosphorus was noted in Copper Creek, which can lead to eutrophication – the excessive growth of algae and/or macrophytes. When this happens, 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). While this TMDL is needed to address phosphorus, it is not scheduled for completion at least in the next two years.

A TMDL has been completed to address fecal coliform loads in 28 streams in WMA 1, WMA 2 and WMA 11, including the Copper Creek sub-watershed. Nonpoint and stormwater point sources are the primary sources of fecal coliform loads in these streams. Contributors include wildlife, farms, farm animals and domestic pets and failing or inappropriately located septic systems. Fecal coliform from these sources can reach waterbodies directly, through overland runoff, or through sewage or stormwater conveyance pipes. Implementation of pollution reduction strategies are being addressed through the NJDEP stormwater rules (N.J.A.C. 7:8), and include education, preventing illicit connections to stormwater, and ordinances

[16] 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).

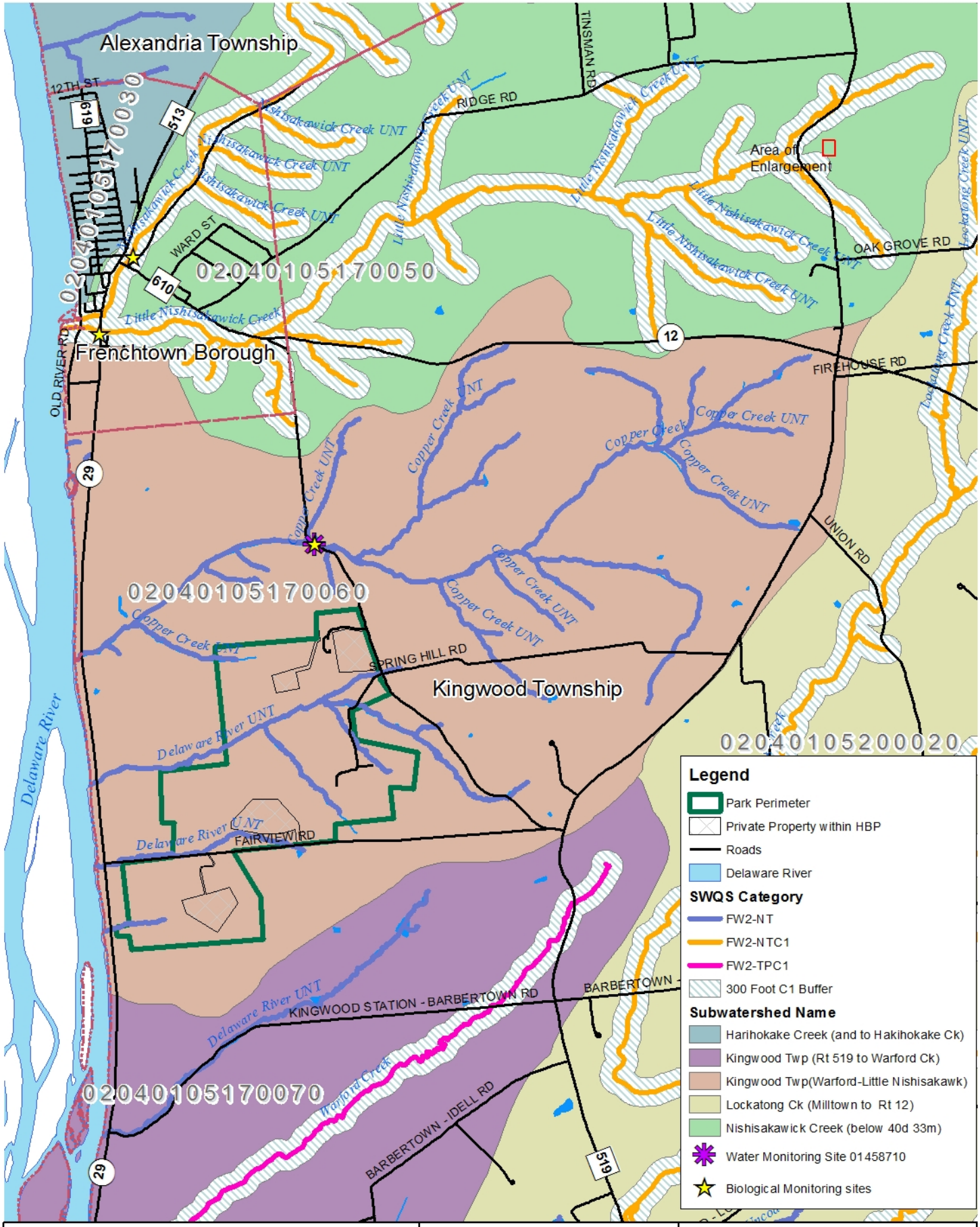


Figure 6b: HUC14 & SWQS Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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

addressing pet waste and prohibiting feeding of wildlife on public property. Agricultural sources are addressed through the Hunterdon County Soil Conservation Service, and include strategies such as filter strips, riparian buffers, and animal waste management (NJDEP Division of Watershed Management, 2003).

Since there is no known water quality data for Burke's Run or the unnamed streams in Horseshoe Bend Park, no conclusions can be discussed for these waters.

6.5 Watershed Management Areas

Jill Stein Dodds

Burke's Run in Horseshoe Bend Park

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.

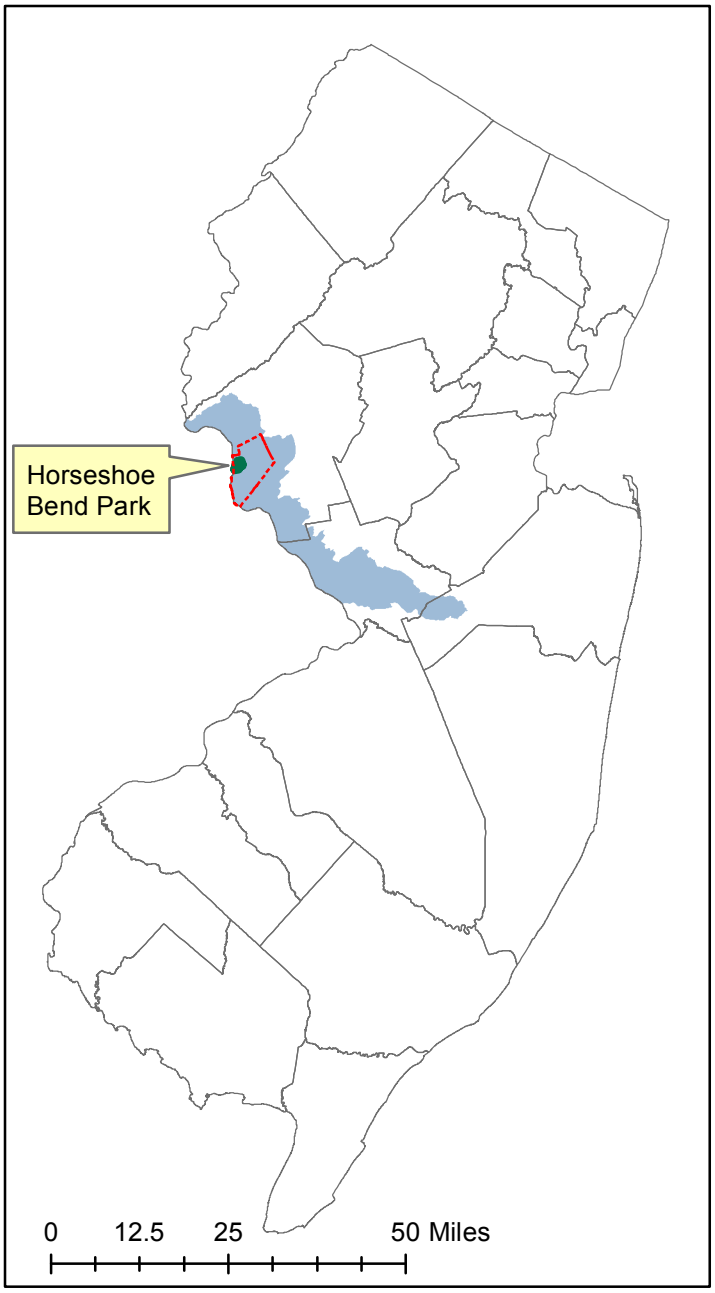
NJDEP has divided the state's watersheds into 20 *Watershed Management Areas (WMAs)*. The Delaware River basin is divided into ten WMAs. Horseshoe Bend Park falls within *WMA 11: Central Delaware* (see **Figure 6c**).

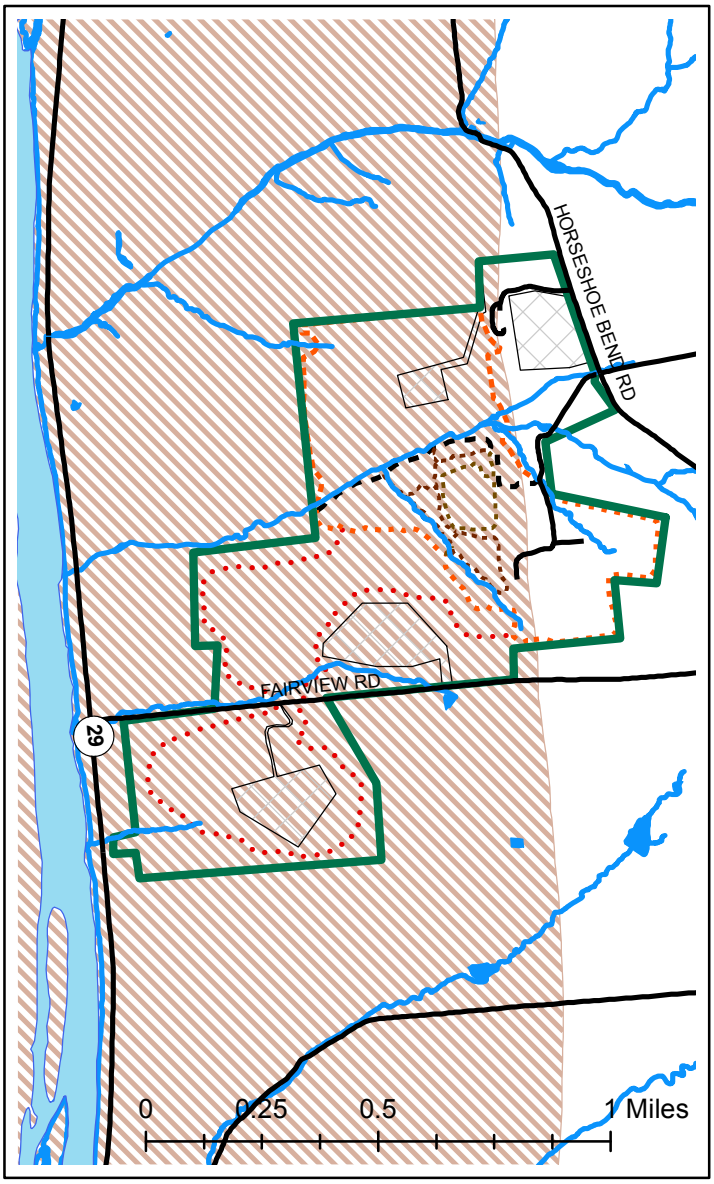
6.6 Lower Delaware Wild & Scenic River

Segments of the Delaware River between the Delaware Water Gap and Washington Crossing were designated into the National Wild and Scenic River System in 2000 (see **Figure 6a**). With this addition of about 65 miles of the Delaware, ¾ of the non-tidal Delaware River is now included in the national system. The Delaware River is the longest free flowing river east of the Mississippi River. The Delaware River has the longest water quality anti-degradation policy of any river in the United States of America (Lower Delaware Wild and Scenic River, July 17, 2013).

The management area for the Lower Delaware Wild and Scenic River extends from the river to the prominent ridgelines, about a mile from the river, which roughly follows Route 519 within Kingwood Township (see **Figure 6d** for approximate boundary). Kingwood Township joined others in their support of the designation.

The Management Plan recommends actions to maintain and improve the Lower Delaware River, its tributaries and surrounding natural, historic and cultural resources. While each level of government retains its existing level of authority, designation requires federal agencies to make decisions compatible with the plan. Despite the national designation, the area is not administered by the National Park Service. The *Lower Delaware River Wild and Scenic Management Committee* was formed for the purpose of providing oversight and guidance to participating agencies and reminding partners of the Management Plan goals (Lower Delaware River Wild and Scenic River Study Task Force, 1997).





Legend

- Counties
- Kingwood Township Boundary
- Park Perimeter
- Watershed Mgmt Area 11: Central Delaware

Legend

- Park Perimeter
- Private Property within HBP
- Roads
- Delaware River
- Streams
- Wild & Scenic River Corridor (approximate)

Figure 6c: Watershed Management Area 11
Horseshoe Bend Park

N

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

Figure 6d: Lower Delaware Wild & Scenic River Corridor
Horseshoe Bend Park

N

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

6.7 Floodplains/Flood Prone Areas

A *floodplain* is the land along a river or stream that is subject to periodic flooding when the river or stream overflows its banks. The Federal Emergency Management Administration (FEMA) is responsible for delineating floodplains. Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures may include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances. Community involvement is an important element in making flood insurance available to home and businesses owners. Flood Zones in the vicinity of Horseshoe Bend Park are shown in **Figure 6e**. Areas along the Delaware River (including some portions of Route 29), Copper Creek and Burke's Run experience periodic flooding. However, no delineated Flood Zones occur within the park.

6.8 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:

- 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).

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

Note: 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. The maximum transition area width of 150 feet is shown, but will not apply to all wetlands.

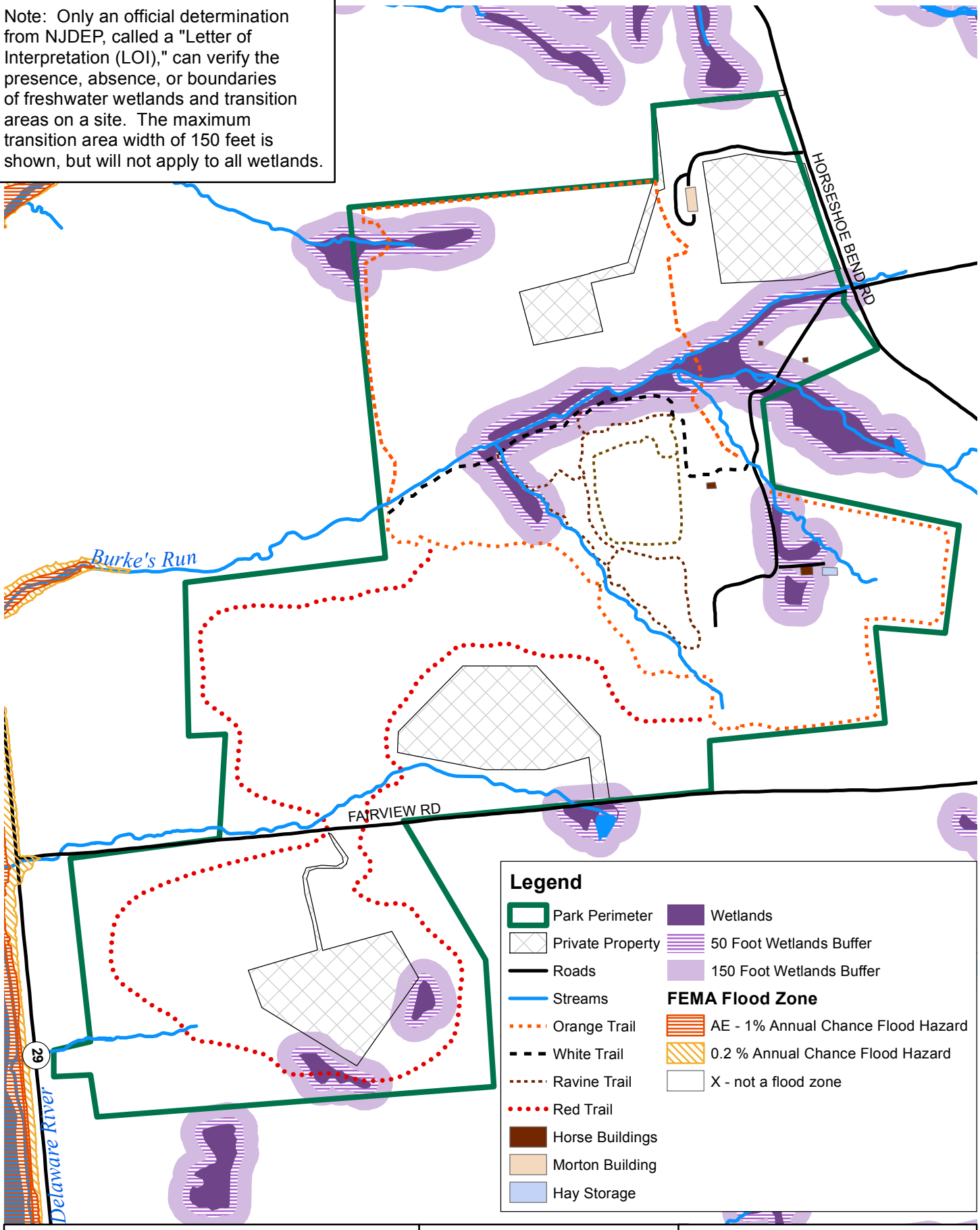


Figure 6e: Flood Zones & Wetlands
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

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.

The regulations define the transition area width according to the value of the wetland. *Ordinary Value* wetlands, such as swales, have a 0 foot buffer; *Intermediate Value* wetlands have a 50 foot buffer; while *Exceptional Value* wetlands have a 150 foot buffer width. Exceptional Value wetlands include wetlands which provide habitat for endangered and threatened species and those contiguous with C1 classified streams.

The New Jersey freshwater wetlands maps (see **Figure 6e**) provide guidance on where wetlands are found in the state, based on aerial photographs. In **Figure 6e**, the transition area widths of 50 and 150 feet are mapped, because the GIS data does not distinguish wetland values. 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.

There are several wetland areas within Horseshoe Bend Park. Two types of freshwater wetlands are found, including deciduous wooded wetlands and mixed wooded wetlands (coniferous dominating) (see **Figure 7a** for wetland types).

6.9 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 much of the park is forested, 97% of the park has less than 10% impervious surfaces, while 2% has 15 to 20% impervious and less than 1% of the park has 25% impervious

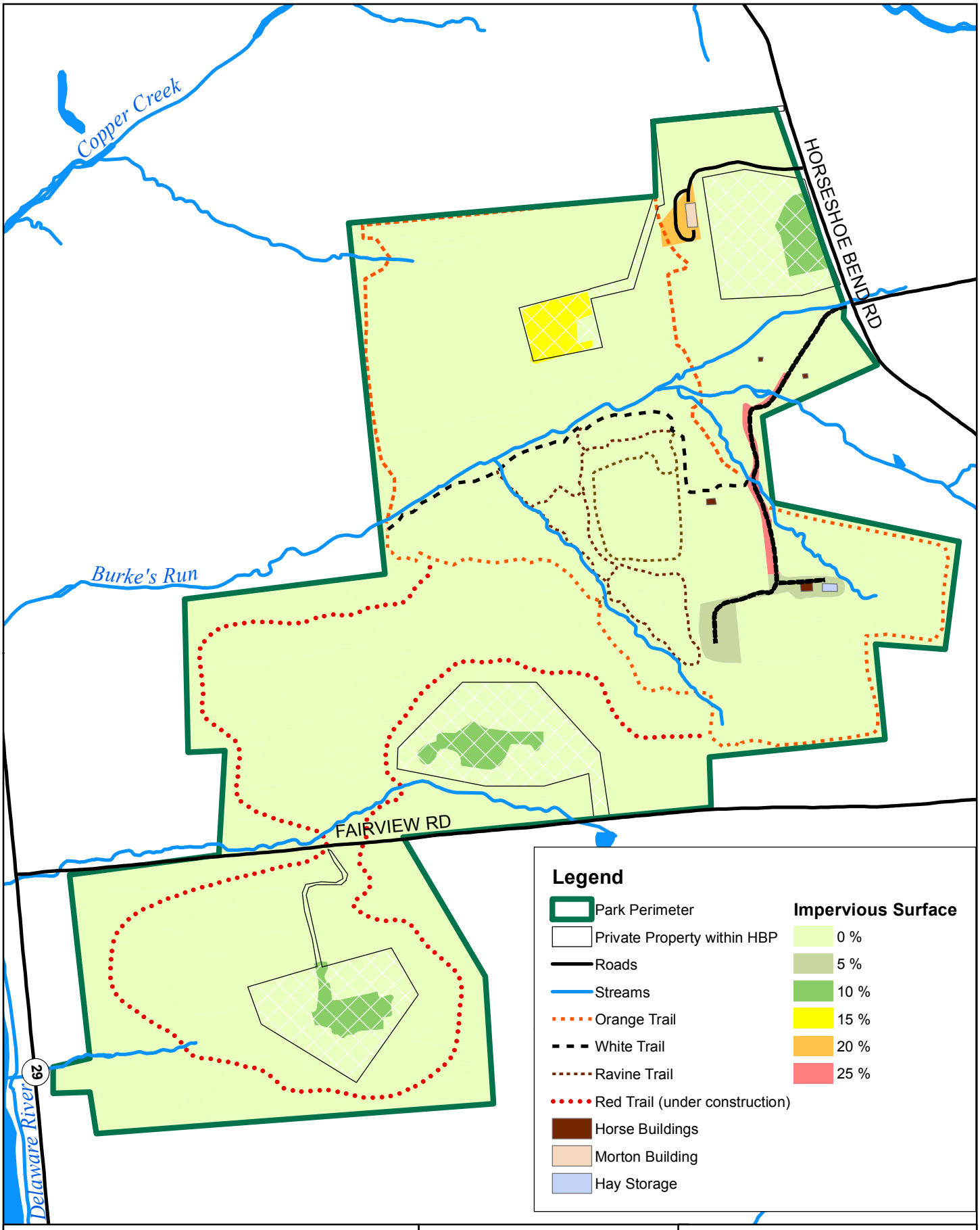


Figure 6f: Impervious Surface
Horseshoe Bend Park

Prepared by Kratzer Environmental Services

surfaces (see **Figure 6f**). Nonetheless, as discussed in **Section 6.4**, nonpoint pollution is a problem in some streams.

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) or Tier B (less developed and non-coastal, including Kingwood) (NJDEP Bureau of Nonpoint Pollution Control, December 4 2006).

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WMA
NJDEP Office of Environmental Planning. January 1997. Draft Statewide Watershed Management Framework Document for the State of New Jersey. http://www.nj.gov/dep/watershedrestoration/docs/frame97fixed.pdf

Lower Delaware Wild and Scenic River
Lower Delaware Wild and Scenic River Home Page. July 17, 2013. http://www.lowerdelawarewildandscenic.org/

Lower Delaware River Wild and Scenic River Study Task Force with assistance from the National Park Service, Northeast Field Office. 1997. Lower Delaware River Management Plan. 106 pages.
http://www.lowerdelawarewildandscenic.org/Files/ManagementPlan.pdf

Wetlands
Fair, Abigail. 2004. Freshwater Wetlands Protection in New Jersey: A Manual for Local Officials. Third Edition. Association of New Jersey Environmental Commissions. 52 pages.
http://www.anjec.org/WaterFreshwaterWetlands.htm

NJDEP Division of Land Use Management. July 16, 1998. Freshwater Wetlands Protection Act N.J.S.A. 13:9B (last amended July 1998) 22 pages. http://www.nj.gov/dep/landuse/download/13_9b.pdf

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Nonpoint Pollution
Hasse, John and Richard G. Lathrop. 2008. Tracking New Jersey's Dynamic Landscape: Urban Growth and Open Space Loss 1986-1995-2002 (Final Report). 66 pages.
http://www.crssa.rutgers.edu/.../HasseLathrop_njluc_final_report_07_14_08.pdf

Kaplan, Marjorie and Mark Ayers. April 5, 2000. Impervious Surface Cover Concepts and Thresholds. NJDEP and USGS. 10 pages. Cached copy:
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=3&cad=rja&ved=0CDoQFjAC&url=http%3A%2F%2Fmss3.libraries.rutgers.edu%2Fdlr%2Foutputds.php%3Fpid%3Drutgers-lib%3A37001%26ds%3DPDF-1&ei=BOr7UdjbB_e34APUhoCQCg&usg=AFQjCNEcfJXaTLYIl4pf1tG4GedUWvTgmA&sig2=hhz-DuRu2u8jFmIheg3btg

NJDEP Bureau of Nonpoint Pollution Control. December 4, 2006. Tier Assignment List.
http://www.state.nj.us/dep/dwq/pdf/municipal_tier_list.pdf

NJDEP. April 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

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

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

Surface Water Quality:
USEPA STORET Database: http://www.epa.gov/storet

Internet Resources: Lower Delaware Wild and Scenic River
Lower Delaware National Wild and Scenic River PA, NJ: http://www.nps.gov/lode/index.htm
Maps: http://www.nps.gov/lode/planyourvisit/maps.htm

Lower Delaware Wild and Scenic River Management Committee: http://www.lowerdelawarewildandscenic.org/

Partnership Lower Delaware W&S River: http://www.nps.gov/ncrc/programs/pwsr/lowerdelaware_pwsr_sub.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

7.1 Land Cover (Dominant Vegetation)

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

This open field is categorized as Agriculture: Cropland and Pastureland

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 (2007 aerial photos are shown in **Figure 2b**) 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 **Figure 7a**. The number of acres of each kind within Horseshoe Bend Park is tabulated in **Table 7.1** (NJDEP, July 12, 2010).

The largest portion of land in Horseshoe Bend Park is Deciduous Forest (>50% Crown Closure), which comprises approximately 30.5 % of the land area, followed by Cropland and Pastureland, 23.19%, followed by Coniferous Forest (>50% Crown Closure), 11.44%.

A preliminary list of plant species found in Horseshoe Bend Park is in **Appendix C.1**. This list will be updated when further surveys add additional species.

Table 7.1: 2007 Land Use/Land Cover

Land Use Type	Code	Land Use/Land Cover	Acres	Percent
Urban	1140	Residential, Rural, Single Unit	13.60	2.74
Urban	1400	Transportation/Communication/Utilities	2.04	0.41
Urban	1700	Other Urban or Built-Up Land	0.71	0.14
		Total of all Urban Land Uses	**16.34**	**3.29**
Agriculture	2100	Cropland and Pastureland	117.73	23.69
Agriculture	2200	Orchards/Vineyards/Nurseries/Horticultural Areas	3.44	0.69
Agriculture	2400	Other Agriculture	6.15	1.24
		Total of all Agriculture Land Uses	**127.32**	**25.62**
Forest	4110	Deciduous Forest (10-50% Crown Closure)	23.19	4.67
Forest	4120	Deciduous Forest (>50% Crown Closure)	151.58	30.50

Land Use Type	Code	Land Use/Land Cover	Acres	Percent
Forest	4210	Coniferous Forest (10-50% Crown Closure)	21.82	4.39
Forest	4220	Coniferous Forest (>50% Crown Closure)	56.86	11.44
Forest	4311	Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	7.91	1.59
Forest	4312	Mixed Forest (>50% Coniferous With >50% Crown Closure)	14.40	2.90
Forest	4321	Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	15.05	3.03
Forest	4322	Mixed Forest (>50% Deciduous With >50% Crown Closure)	9.58	1.93
Forest	4420	Deciduous Brush/Shrubland	6.08	1.22
Forest	4430	Coniferous Brush/Shrubland	0.03	0.01
Forest	4440	Mixed Deciduous/Coniferous Brush/Shrubland	17.30	3.48
		Total of all Forested Land Uses	**323.80**	**65.15**
Water	5100	Streams And Canals	1.20	0.24
		Total of all Water Land Uses	**1.20**	**0.24**
Wetlands	6210	Deciduous Wooded Wetlands	12.34	2.48
Wetlands	6252	Mixed Wooded Wetlands (Coniferous Dom.)	0.85	0.17
		Total of all Wetland Land Uses	13.20	2.66
Barren Land	7500	Transitional Areas	15.17	3.05
		Total of all Barren Land Uses	**15.17**	**3.05**
		Total	**497.03**	**100.00**
Source: NJDEP, July 12, 2010				

7.2 Wildfire Fuel Hazard

The New Jersey Forest Fire Service (NJFFS), a division of NJDEP, assessed *Wildfire Fuel Hazard* (WFH) throughout New Jersey (see **Figure 7b**). 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, April 17, 2009).

Trees downed by a storm add to the wildfire fuel hazard (although not officially part of this data layer)

The largest percentage of Horseshoe Bend Park is Low Wildfire Fuel Hazard (30%). These are the areas with mature forests, which are actually lower fire hazard because of less undergrowth. Almost as much area (29%) is an Extreme Wildfire Fuel Hazard, which includes the brush/shrubland areas and coniferous forests that have a greater amount of fuel. Smaller areas are very high (1%), high (5%) and moderate (9%) Wildfire Fuel Hazard. The agricultural and urban areas were not rated.

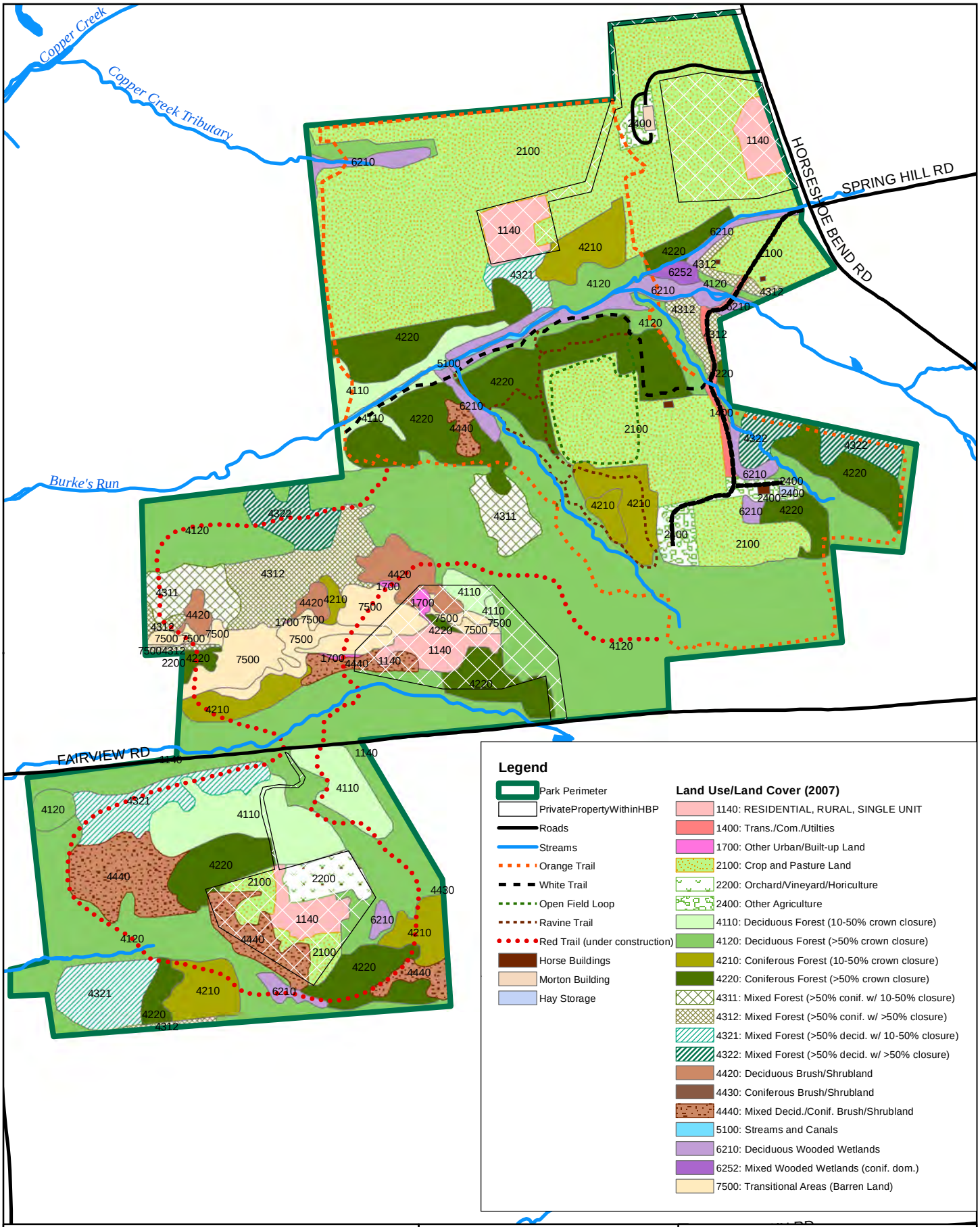


Figure 7a: Land Cover (2007) Horseshoe Bend Park

Prepared by Kratzer Environmental Services

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

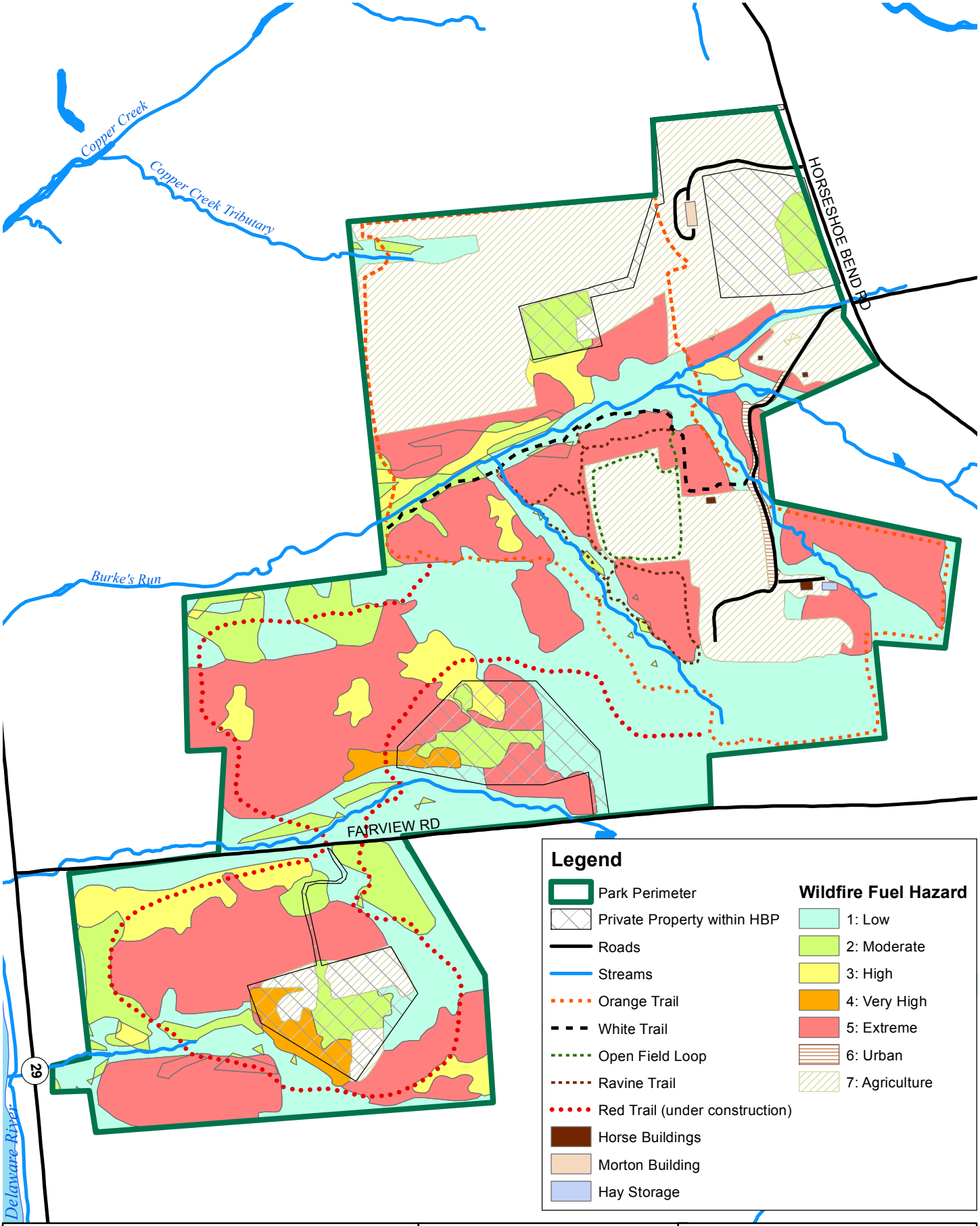


Figure 7b: Wildfire Fuel Hazard
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

7.3 Wildlife

General

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, amphibians and freshwater fish of New Jersey; with notes on the status of each (e.g. common or rare) (see **Internet Resources**). The Hunterdon County Division of Parks and Recreation has developed wildlife checklists for Hunterdon County (see **Internet Resources**). The North Jersey Butterfly Club offers a list of butterflies seen in northern New Jersey (see **Internet Resources**).

A variety of animal species enjoy Horseshoe Bend Park's diversity of habitat types. Lists of bird and butterfly species sighted in the park have been developed, but are preliminary and will be revised with additional sightings (see **Appendices C.2 and C.3**). Lists of mammals, herptiles, fish or invertebrates (other than butterflies) are not available specifically for the park.

White-tailed Deer

The white-tailed deer (*Odocoileus virginianus*), the largest herbivore living wild in New Jersey, is seen frequently in Horseshoe Bend Park. 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.

Documentation of deer population numbers is not available for Horseshoe Bend Park or Kingwood Township, 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. Horseshoe Bend Park is within DMZ 11 (NJDEP Division of Fish and Wildlife, September 9, 2013). In order to balance deer hunting with safety

and other recreational activities, hunting is allowed only by special permit within Horseshoe Bend Park, which is obtained through a lottery system (Kingwood Township, 2013).

Black Bears

Black bears (*Ursus americanus*), the largest land mammals in the state, are occasionally seen in or around Horseshoe Bend Park. They 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. Black bears 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. The Division of Fish and Wildlife offers information and techniques for damage and nuisance prevention (see **Internet Resources** below).

Coyotes

The population of eastern coyotes (*Canis latrans*) was reduced to 100 in the state in 1975, but has rebounded to the current population of 3,000 spread throughout 96% of the state. This wild canid was first noted in Kingwood Township between 1990 and 1994. The coyote is the largest wild canine found in NJ, primarily nocturnal, and extremely wary of humans. The coyote closely resembles a small German shepherd, except that its snout is longer, and its tail is bushier, black-tipped, and held horizontally or lower. They are not pack animals, although the young may remain with the parents for 1½ years. Coyotes are opportunistic predators, feeding on small animals, carrion, insects, fruit and other vegetable matter. They occasionally kill and eat small livestock (e.g. chickens, sheep) and pets, and raid garbage. Sightings alone should not cause alarm but are a signal to take measures to make a property less hospitable to the coyotes and to safeguard children, pets and livestock (McBride, 2006). NJDEP receives reports of approximately 6 to 20 coyote sightings annually in the vicinity of Horseshoe Bend Park (NJ Division of Fish and Wildlife, July 1, 2012).

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).

Based on NJDEP's potential vernal habitat data, one potential vernal pool is located on property adjacent to Horseshoe Bend Park and the 1,000 foot radius potential vernal habitat extends into the park (see **Figure 7c**).

Table 7.2: Vernal Pool Amphibians and Reptiles

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 Kingwood Township or their ranges include Hunterdon County; species in grey have ranges which do not include Hunterdon County, therefore it would be unlikely to find them in Kingwood.		
Sources: Tesauro, no date; Gessner and Stiles, February 2001; N.J.A.C 7:7A, Appendix 1.		

Butterflies

In July, August and September 2013, the North Jersey Butterfly Club performed a survey of butterflies sighted in Horseshoe Bend Park. No netting or collecting was performed, since this practice is detrimental to the health of the butterflies. A total of 44 species were seen, including the very rare Gray Comma (*Polygonia progne*). Of these species, 37 are resident and 7 are non-resident[17]. A butterfly species list is provided in **Appendix C.3**. This list is preliminary and will be updated when further surveys add additional species (Wander, October 24, 2013).

Christopher T. Kratzer

Eastern Tailed Blue (female) (Everes comyntas) is tiny, <1" in size.

Christopher T. Kratzer

Monarch (Danaus plexippus), one of the largest butterflies, at 3.8" is a non-resident.

Christopher T. Kratzer

Pearl crescent (Phyciodes tharos) is 1.3" in size.

[17] Resident species are known to overwinter in New Jersey at some stage in their life cycle. A non-resident species might be either an immigrant (repopulating the state from the south each summer) or vagrant (rarely straying into New Jersey and are not expected to occur every year).

7.4 Endangered, Threatened and Special Concern Wildlife


Jill Stein Dodds

American Kestrel (Falco sparverius)

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.

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 7.3 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.2 and D.3)**


Jill Stein Dodds

Grasshopper sparrow (Ammodramus savannarum)

Table 7.3: 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	

A search of NJDEP Division of Parks and Forestry *Natural Heritage Database*[18] in September 2013 for rare species presently recorded in Horseshoe Bend Park revealed the documented presence of one State Endangered bird (bald eagle), 2 State Threatened birds (bobolink and grasshopper sparrow) and 5 special concern bird species. No species known to occur in Horseshoe Bend Park are found on the Federal endangered species list. In the immediate vicinity of the park, there is a record of the Federal and State Endangered fish, Atlantic sturgeon, a special concern bird (cliff swallow) and a special concern damselfly (cobra clubtail). **Table 7.4** lists these endangered, threatened and special concern species, their conservation status and habitat.

Fact sheets, including photos, for some of the threatened or endangered animals listed below are presented in **Appendix D.4** to **D.7**.

Table 7.4: Species Presently Recorded in the NJ Natural Heritage Database for Horseshoe Bend Park

Common Name	Scientific Name	Feature Type	LP Rank*	State Protection	Global Rank	State Rank	Habitat
Bald Eagle★	*Haliaeetus leucocephalus*	foraging	4	State endangered	G5	S1B, S2N	Near lakes and rivers
Bald Eagle★	*Haliaeetus leucocephalus*	Nest	4	State endangered	G5	S1B, S2N	Near lakes and rivers
Bobolink★	*Dolichonyx oryzivorus*	Breeding sighting	3	State threatened	G5	S2B, S3N	Nest in hayfields and pastures; perch on saplings and fence posts

[18] Information on whether or not endangered or threatened species have been documented on a specific piece of land can be obtained by requesting a search of the Natural Heritage Database from the Office of Natural Lands Management (ONLM). Some areas have never been surveyed, but may also contain endangered or threatened species.

Common Name	Scientific Name	Feature Type	LP Rank*	State Protection	Global Rank	State Rank	Habitat
Cooper's hawk	*Accipiter cooperii*	Breeding sighting	2	Special concern	G5	S3B, S4N	Forests and forested wetlands
Eastern Meadowlark	*Sturnella magna*	Breeding sighting	2	Special concern		S3B, S3N	Nest in farm fields and wet grasslands; sing from trees and fence posts
Grasshopper Sparrow★	*Ammodramus savannarum*	Breeding sighting	3	State threatened	G5	S2B,S3N	Open grasslands with patches of bare ground
Great Blue Heron	*Ardea herodias*	foraging	2	Special Concern	G5	S3B, S4N	Forage in any water, also in grasslands and agricultural fields; gather in colonies (heronries) to breed
Veery	*Catharus fuscescens*	Breeding sighting	2	Special Concern	G5	S3B	Deciduous forested wetlands
Wood Thrush	*Hylocichla mustelina*	Breeding sighting	2	Special Concern	G5	S3B	Deciduous and mixed forests with plenty of leaf litter for foraging
Additional Species in the Vicinity of Horseshoe Bend Park							
Cliff Swallow	*Petrochelidon pyrrhonota*	Breeding sighting - confirmed	2	Special Concern	G5	S3B, S3N	Nest in vertical cliff faces, bridges, culverts; feed over water
Cobra clubtail	*Gomphus vastus*	Exuviae sighting	2	Special Concern	G5	S3	Large rivers
Cobra clubtail	*Gomphus vastus*	Territorial Display	2	Special Concern	G5	S3	Large rivers
Shortnose Sturgeon★	*Acipenser brevirostrum*	Summer-ing Area – Adult sighting	5	Fed & State endangered	G3	S1	River mouths, tidal rivers, estuaries, bays
* Landscape Project Rank – see **Section 7.6.** ★Species reports included in **Appendix D.4** to **D.7.**							
Sources: NJDEP ONLM, September 4, 2013; Cornell Lab of Ornithology, September 29, 2013							

7.5 Rare Plants & Natural Heritage Grid

A September 2013 search of the Natural Heritage Program database of rare plant species and ecological communities revealed one rare plant in the vicinity of Horseshoe Bend Park. The eastern green violet (*Hybanthus concolor)* is Critically Imperiled in NJ (NJDEP ONLM, September 4, 2013). In addition, the imperiled (S2) plant, yellow giant hyssop (*Agastache nepetoides*) was found in Horseshoe Bend Park by the author and reported to the Natural Heritage Program. These species are described in **Table 7.5**.

The Office of Natural Lands Management (ONLM) has developed the *Natural Heritage Grid Map* (see **Figure 7c**), which provides a general representation of the locations of rare plant species and natural communities. The purpose of the Grid Map is to document rare plant species locations (both historical and recently documented) and natural community habitat to inform decision-makers who need to address the conservation of natural resources. 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 2002).

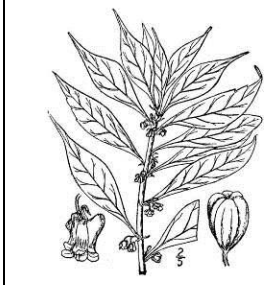
Three grid areas intersect with Horseshoe Bend Park, indicating the generalized location(s) of the state endangered eastern green violet (see **Table 7.5**).

Because the plant inventory could be incomplete, a list of Hunterdon County rare plant species and natural communities is included in **Appendix D.1**. If suitable habitat is present in Horseshoe Bend Park, these species also have potential to be present.

Table 7.5: Rare Plants

Natural Heritage Database Plant Species

Scientific Name	Common Name	Federal Status	State Protection
Hybanthus concolor	green violet		E
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
LP, HL	G5	S1	1974-05-18



Description:
Violet family (Violaceae)
1½–3' tall, hairy stem, usually unbranched
alternate leaves ≤6" long x 1½" wide
elliptic in shape, smooth margins or a few teeth
one to three ¼" nodding light green flowers in the upper axil of each leaf
blooms mid-spring to early summer

Habitat:
moist to mesic deciduous woodlands, wooded slopes, shaded stream terraces and damp ravines, particularly where calcareous rocky material is close to the surface of the ground, normally found in undisturbed woodlands

Note: For status and rank definitions, refer to **Table 7.3.**

Sources: NJDEP ONLM, March 21, 2013; Description from Encyclopedia of Life, 2013; Illustrations from: Tropicos.org. Missouri Botanical Garden. 28 Sep 2013 http://www.tropicos.org/Image/100150023; USDA-NRCS PLANTS Database / Britton and Brown, 1913

Other

Scientific Name	Common Name	Federal Status	State Protection
Agastache nepetoides	Yellow giant hyssop		
Regional Status	**Global Rank**	**State Rank**	**Last Observed**
HL	G5	S2	2013-10-01

Description:
Mint Family (Lamiaceae)
4-7' tall with a few branches
central stem square in cross section
leaves are opposite, lance to oval shaped, 6" x 3", serrated margins
blooms mid-summer to early fall
pale yellow flowers are densely crowded on each 4-16" long x ¾ - 1" wide spike
individual flowers are short-lived

Habitat:
deciduous woodlands, woodland borders and openings

Note: For status and rank definitions, refer to **Table 7.3.**

Sources: Description from Encyclopedia of Life, 2013; Photos: Deborah J. Kratzer.

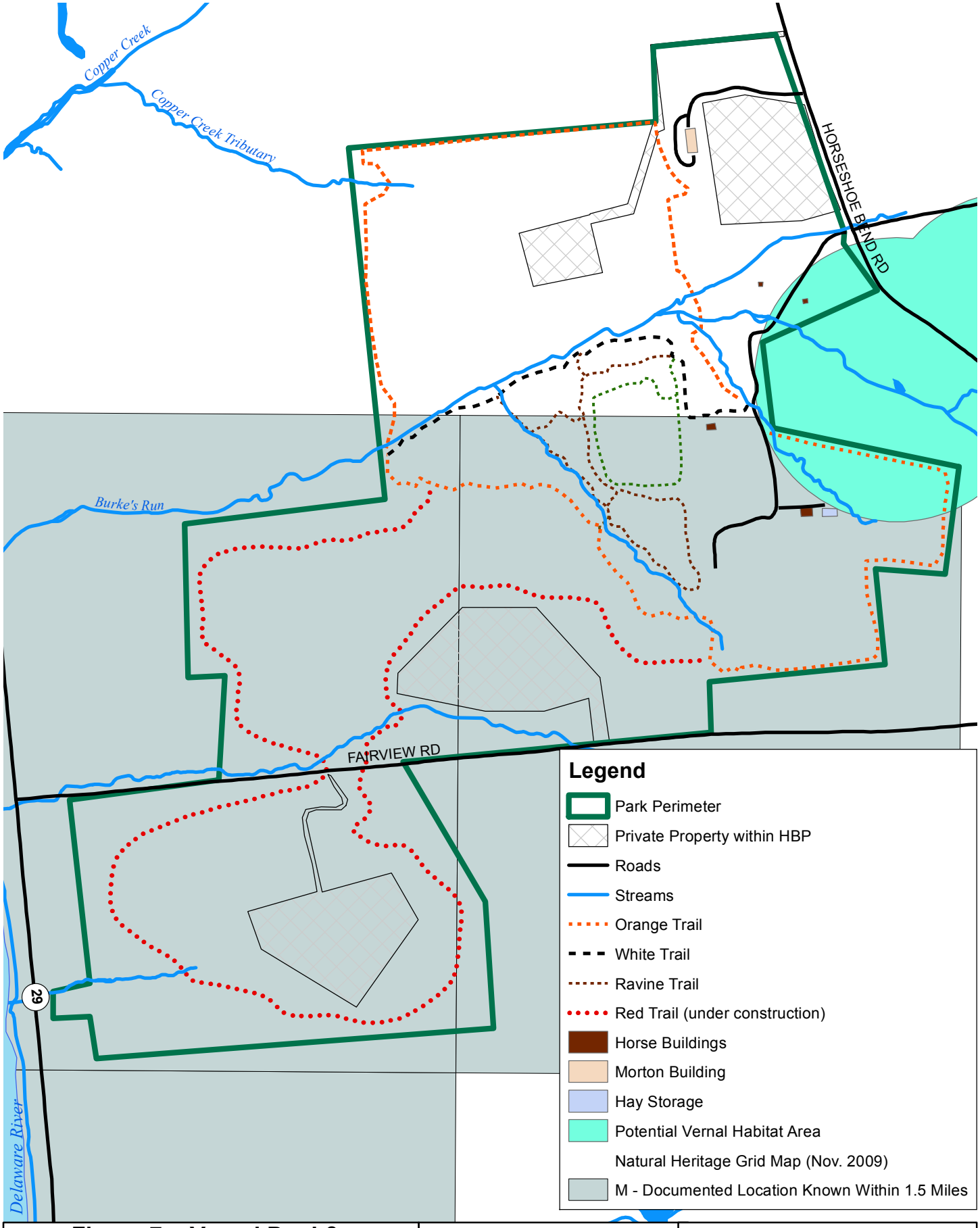


Figure 7c: Vernal Pool & Natural Heritage Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

7.6 The Landscape Project

The state's *Landscape Project* (see **Figure 7d**) 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).

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 7.6** lists rank definitions. Each habitat patch is coded for the number of special concern, state threatened, state endangered and federally listed species present.

Table 7.6: 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	

About 88% of Horseshoe Bend Park is ranked as habitat for priority animal species (special concern, threatened or endangered) according to the Landscape Project Version 3.1. Thirty percent of the park is Rank 4 for the presence of state endangered species; 18% is Rank 3 for state threatened species; 40% is Rank 2 for special concern species; and >1% is Rank 1 for suitable habitat (see **Table 7.7** and **Figure 7d)**.

Jill Sttein Dodds

Bobolink (Dolichonyx oryzivorus)

Table 7.7: Landscape Project v.3.1

Land Use Type	Acres	Percent
No rank	57.93	11.66
Rank 1	2.95	0.59
Rank 2	200.86	40.41
Rank 3	90.72	18.25
Rank 4	144.57	29.09
Total Acres	**497.03**	**100.00**
Source: NJDEP Division of Fish and Wildlife, February 21, 2012		

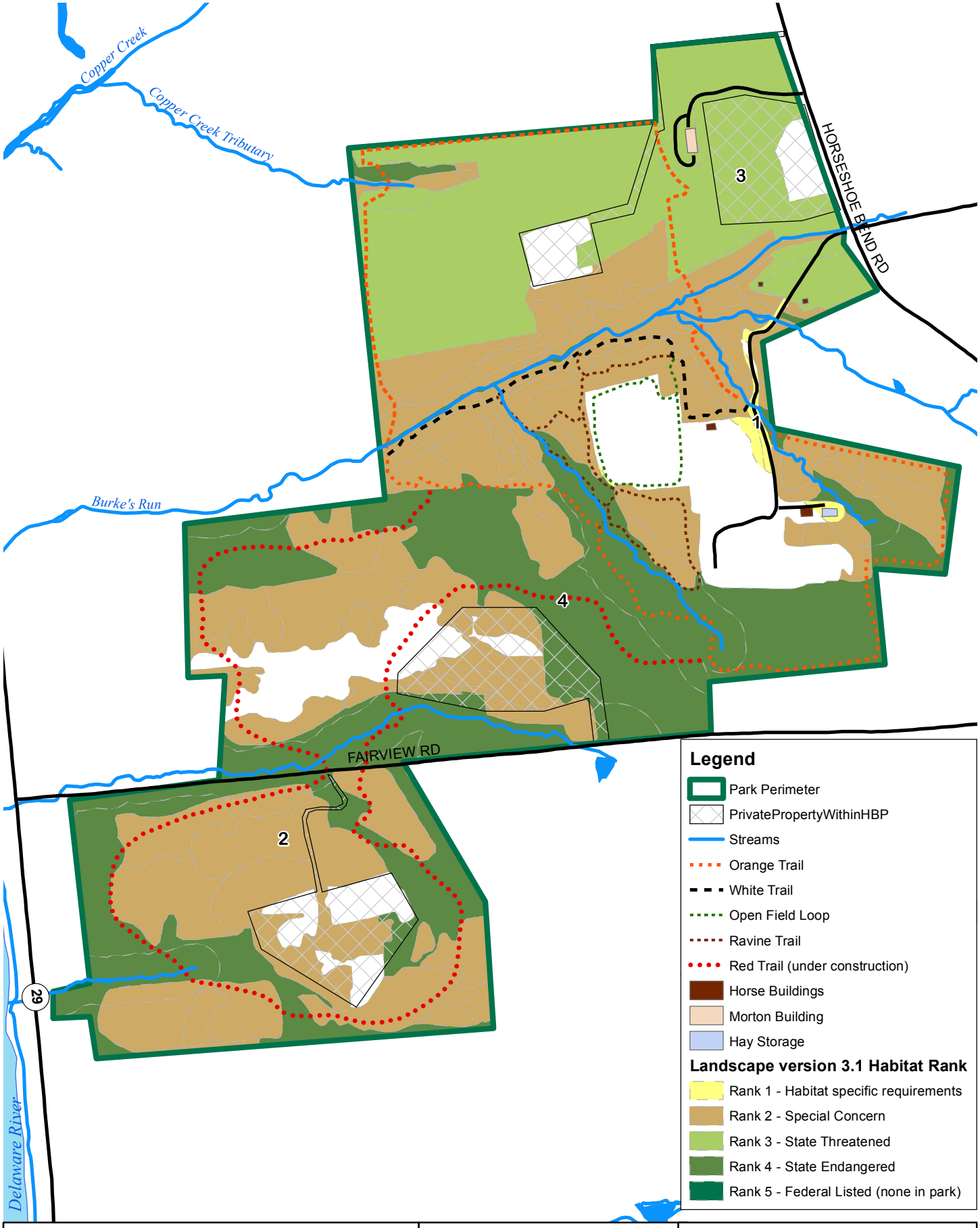


Figure 7d: Landscape Project v. 3.1
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

7.7 Invasive Non-native 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 and Kaufman, 2004). Preliminary research in NJ has documented over 1,200 species of non-native plant species, or as much as 62% of the state's total vascular flora (Snyder and Kaufman, 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 chestnut trees, once one of the dominant trees in the New Jersey landscape. Another introduced fungus, Dutch elm disease, destroyed the American elm.

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 with the potential to impact Horseshoe Bend Park's trees include the emerald ash borer, 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, 2013). 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).

An Overview of Nonidigenous Plant Species in New Jersey (Snyder and Kaufman, 2004) profiles 27 nonindigenous plant species that aggressively invade natural plant communities in New Jersey, a number of which are found in Horseshoe Bend Park. In 2012, a brief survey was performed by the New Jersey Invasive Species Strike Team (NJISST), a statewide cooperative effort to prevent the spread of emerging invasive species across New Jersey, and the Kingwood Environmental Commission. Some of the most problematic invasive exotic species in Horseshoe Bend Park include the widespread autumn olive, multiflora rose, mugwort, Japanese barberry and Japanese stiltgrass, as well as Chinese Bush Clover, an emerging invasive species (see **Table 7.8**).

Table 7.8: Invasive Non-native Plants in Horseshoe Bend Park

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Alliaria petiolata	garlic mustard	Aggressive in shady habitats, crowding out native plants.		Deborah J. Kratzer
Artemisia vulgaris	Mugwort or common wormwood	Crowds 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. Displaces the native American bittersweet.		Deborah J. Kratzer
Cirsium arvense	Canada thistle	Competes with crops and degrades pastures (inedible to livestock).		Deborah J. Kratzer
Elaeagnus umbellate	autumn olive	Sprouts vigorously in disturbed areas, produces shade, preventing sprouting of native trees.		Deborah J. Kratzer

Scientific Name	Common Name	Problems Caused	Illustration	Illus. Source
Lespedeza cuneata	Chinese Bush Clover	Crowds out native plants in fields, open woods and wetlands borders, reducing biodiversity. It may inhibit the growth of tree seedlings		Deborah J. Kratzer
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
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
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
Sources: Snyder and Kaufman, 2004; Swearingen et al., 2002; Courtney, 1997; Center for Invasive Species and Ecosystem Health (bugwood.org)				

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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

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- Endangered & Threatened Wildlife of NJ: http://www.njfishandwildlife.com/tandespp.htm
- Freshwater Fish Of NJ: http://www.njfishandwildlife.com/chkfish.htm
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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

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

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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: COMPOSITE MAP OF ENVIRONMENTALLY CRITICAL AREAS

8.1 Composite Map of Environmentally Critical Areas

Throughout this document, many environmental and natural features of Horseshoe Bend Park 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 8** 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 8 combines the following:

- Steep slopes greater than 30%
- Wetlands (from 2007 Land Use data; an LOI is necessary to determine actual boundary of wetlands)
- 150 foot wetlands buffers (from 2007 Land Use data; an LOI is necessary to determine actual buffer for wetlands – not all wetlands are given a 150 foot buffer)
- Landscape Project Vernal Habitat (potential)
- Landscape Project version 3.1: Rank 3 or 4 habitats (for threatened or endangered species)
- Natural Heritage Grid Map (for generalized locations of rare plants)
- Delaware River Wild and Scenic River Corridor (approximate)

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 3.3; Figure 3c
Wetlands & wetlands buffers: See Section 6.8; Figure 6e
Landscape Project Vernal Pools: See Section 7.3; Figure 7c
Natural Heritage Grid Map: See Section 75; Figure 7c
Landscape Project v3.1 Rank 3 or 4: See Section 7.6; Figure 7d
Delaware River Corridor: See Section 6.6; Figure 6d

Jill Stein Dodds

Red-tailed hawks are regularly seen in Horseshoe Bend Park.

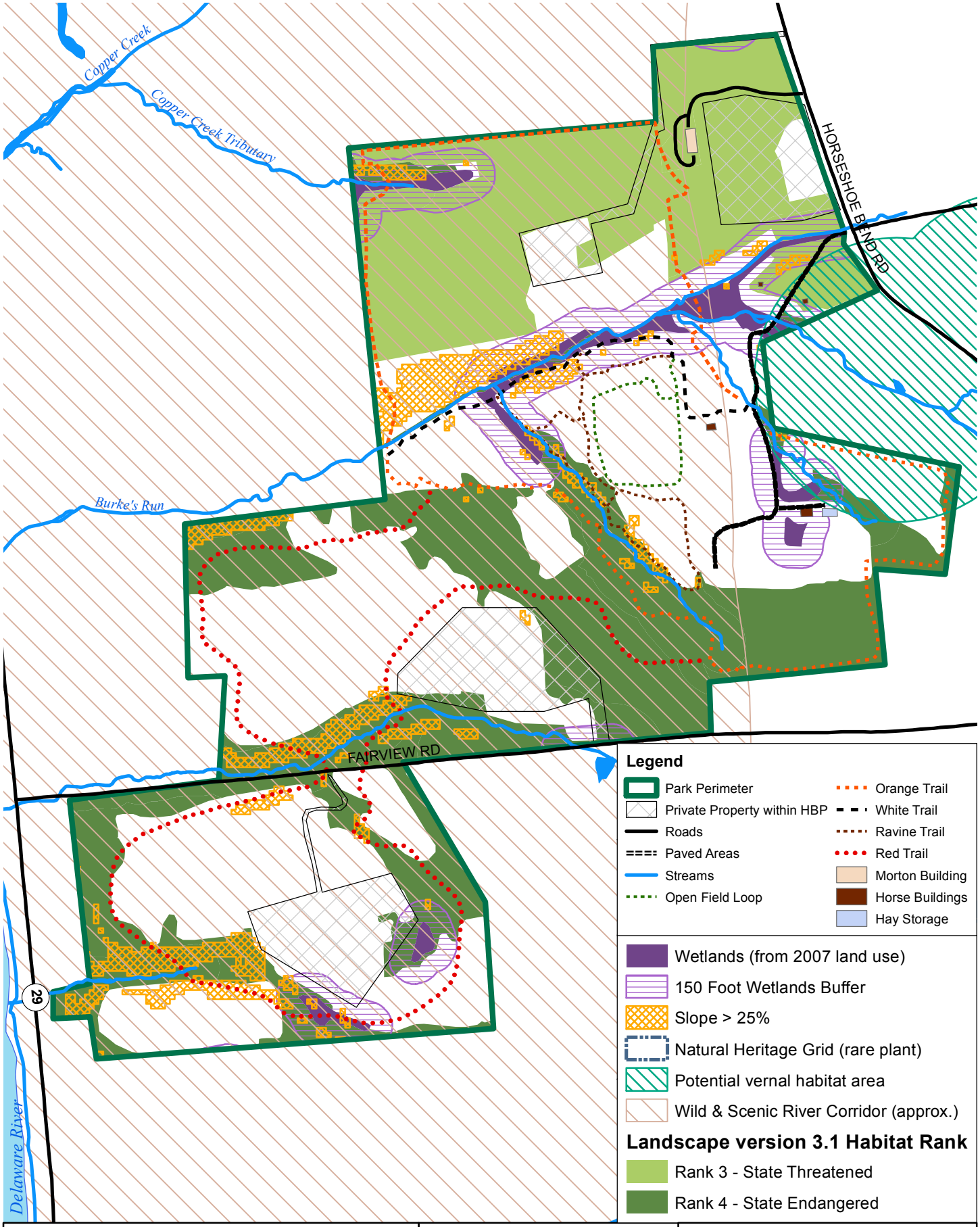


Figure 8: Environmentally Critical Areas
Horseshoe Bend Park

N

0 0.05 0.1 0.2 Miles

HBP NRI, 2013

Prepared by Kratzer Environmental Services

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

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 Spatial Data Distribution Agreement for use of Hunterdon County GIS Data

(Required by County of Hunterdon Division of Geographic Information Systems.)

- Digital data received from the County of Hunterdon is to be used solely for internal purposes in the conduct of daily affairs.

- The data is 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 remain intact.

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

- Any sale distribution is prohibited without prior approval from the County of Hunterdon.

- Users agree to hold the County of Hunterdon, New Jersey and all their employees, and agents harmless from any claim, suit, or proceeding arising out of the use of the data in accordance with this agreement, including indemnification of the County of Hunterdon and the State of New Jersey for reasonable expenses incurred in defending such claims.

- The reproduction of any hard copy products, as provided by the County of Hunterdon, with the intent to sell for a profit is prohibited without the written consent from the County of Hunterdon.

- Any maps, publications, reports, or other documents produced as a result of this project which utilize Hunterdon County digital data will credit the County's Geographic Information System as the source of the data with the following credit/disclaimer:

  > "This (map/publication/report) was developed using Hunterdon County, New Jersey, Geographic Information System digital data, but this secondary product has not been verified by Hunterdon County and is not county-authorized."

- Users shall require any independent contractor, hired to undertake work which will utilize digital data obtained from the County of Hunterdon, to agree not to use, reproduce, or redistribute Hunterdon County GIS digital data for any purpose other than the specified contractual work. All copies of Hunterdon County GIS digital 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 the terms and conditions have been read and that the user is bound by these criteria.

A.3 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.

Figure	Source of Data[1]	Data Title	Date	Scale	Name of File (original)	Name of File (used)
All	Dodds	Park Perimeter	8/1/2013	NA	HBP Basic.lpk	Park_Perimiter
Base	Dodds	PrivatePropertyWithinHBP	8/1/2013	NA	HBP Basic.lpk	PrivatePropertyWithinHBP
Base	Dodds	Paved Areas	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Ravine Trail	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Open Field Loop Trail	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Orange Trail	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	White Trail	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Horse Buildings	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Morton Building	8/1/2013	NA	HBP Basic.lpk	
Base	Dodds	Hay Storage	8/1/2013	NA	HBP Basic.lpk	
Most	NJDEP BGIS	NJDEP TIGER Roads 2000 in Hunterdon County, New Jersey	5/26/2448	1:24,000	hunrds00.shp	HuntRoads_King
Most	Hunterdon County	Hunterdon County Rivers	10/16/2000	1:1,000	HuntRivers.shp	HuntRivers_DelRiv
Most	Hunterdon County	Hunterdon County Lakes	10/13/2000	1:1,000	HuntLakes.shp	HuntLakes_King.shp
Most	NJDEP BGIS	National Hydrography Dataset (NHD) Streams 2002	11/1/2010	1:2,400	nhdstreams2002.shp	SWhydro02_King
Figure 1a: Location of Park	NJDEP	NJDEP Municipality Boundaries for the State of New Jersey	11/14/2007	1:24,000	stmun.shp	boundary_King.shp; boundary_KingwoodandFrenchtown.shp
	NJDEP BGIS	NJDEP County Boundary for Hunterdon County, New Jersey	5/26/2448	1:24,000	huncnb.shp	huncnb.shp
	NJDEP BGIS	NJDEP County Boundaries for the State of New Jersey	1/23/2003	1:24,000	stco.shp	stco.shp
Figure 1b: Surrounding Open Space	Hunterdon County	Hunterdon County Parcels (2010)	12/31/2010	NA	HunterdonCountyParcels.shp	joined to excel spreadsheet of preserved properties

[1] Full names of GIS data sources are listed at the end of this table.

Figure	Source of Data[1]	Data Title	Date	Scale	Name of File (original)	Name of File (used)
Figure 2a: 1930 Aerial Photography	NJOIT OGIS	1930s Aerial Photography of New Jersey Web Map Service (WMS)	10/1/2009	1:24,000	data on server	BlackWhite1930
Figure 2b: 2007 Aerial Photography	NJOIT OGIS	New Jersey 2007 - 2008 High Resolution Orthophotography, JPEG2000 5K Tiles (2009 revision)	11/1/2009	1:2,400	6 files (D9B2.sid; D9B3.sid; D8D10.sid; D8D11.sid; D8D14.sid; D8D15.sid:	6 files (D9B2.sid; D9B3.sid; D8D10.sid; D8D11.sid; D8D14.sid; D8D15.sid:
Figure 2c: 2012 Aerial Photography	NJOIT OGIS	New Jersey 2012 - 2013 High Resolution Orthophotography, NAD83 NJ State Plane Feet, MrSID Tiles	3/1/2013	1:2,400	data on server	data on server
Figure 2d: Land Use Type (2007)	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Central Delaware Watershed Management Area, WMA11	7/12/2010	1:2,400	w03lu07.shp	w11lu07_HBP.shp
Figure 2e: Trails/Facilities	Dodds	Open Fields	8/1/2013	NA	HBP Basic.lpk	Open Fields & HP Open Fields2
Figure 3a: Bedrock Geology	NJGS	Bedrock Outcrops of New Jersey	9/15/2006	1:24,000	njoutcrp.shp	njoutcrp_HBP.shp
	NJGS	Bedrock Geology for New Jersey 1:100,000 Scale	6/30/1999	1:100,000	geology.shp	geology_HBP.shp
	Hunterdon County	Elevation Contours - 10 foot	1/1/2003	1:24,000	contours_10ft_king.shp	contours_10ft_king.shp
Figure 3b: Surficial Geology	NJGS	Surficial Geology of New Jersey	1/1/2006	1:100,000	surf_geol.shp	surf_geol_HBP.shp
Figure 3c: Elevation Contours & steep slopes	Hunterdon County Division of GIS	NJDEP 10 Meter DEM Slopes and Steep Slopes	4/15/2003	NA	HC_steep_slopes_poly.shp	HC_steep_slopes_poly.shp
	Hunterdon County	Elevation Contours - 10 foot	1/1/2003	1:24,000	contours_10ft_king.shp	contours_10ft_king.shp
Figure 4a: Soil Map Units	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shp; joined to mutext
Figure 4b: Soils - Depth to Restrictive Layer	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and muaggatt.txt

Figure	Source of Data[1]	Data Title	Date	Scale	Name of File (original)	Name of File (used)
Figure 4c: Soils - Depth to High Water Table	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and muaggatt.txt
Figure 4d: Soils - Hydrologic Group	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and component.txt
Figure 4e: Soils - Septic Limitations	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and soils spreadsheet
Figure 4f: Soils - Drainage Class	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and component.txt
Figure 4g: Agricultural Soils	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and mapunit.txt
Figure 4h: Soils - Frost Action	USDA/NRCS	Soil Survey Geographic (SSURGO) database for Hunterdon (nj019)	9/7/2010	1:24,000	soilmu_a_nj019.shp	soils_2010_HBP.shpjoined to mutext.txt and component.txt
Figure 5a: Aquifer, W&S River corridor, GW Monitoring wells	NJGS	Aquifers of New Jersey	5/21/1998	1:24,000	baqfr250.e00	C:\arcgis\GIS-data-from-NJDEP\Ground Water\aquifers\aquifers-1998
	NJGS	DGS96-3 Ambient Ground Water Quality in the Newark Basin, NJ	12/12/1995	1:24,000	wells.e00; data at chemattr.dbf	wells.e00; data at chemattr.dbf
	NJGS	Ambient-Major Ions of New Jersey	5/24/2007	unknown	majions.shp;metals.shp; nutrient.shp; radio.shp; voc.shp;pest.shp	majions.shp;metals.shp; nutrient.shp; radio.shp; voc.shp;pest.shp
Figure 5b: Sole Source Aquifer	NJGS	NJDEP Sole-Source Aquifers in New Jersey	5/19/1998	1:24,000	njsolesrc.e00	njsolsrc_King.shp
Figure 5c: Ground Water Recharge (NJGS)	NJGS	Ground-Water Recharge for Hunterdon County, NJ	9/15/2005	1:24,000	huncmb.shp	huncmb_HBP.shp

Figure	Source of Data[1]	Data Title	Date	Scale	Name of File (original)	Name of File (used)
Figure 6a: Watersheds	DRBC	Wild and Scenic Designations			wildsandscenic_rivers_arc.shp	wildsandscenic_rivers_arc.shp
	DRBC	Delaware River Basin Boundary			drb_bnd_polygon.shp	drb_bnd_polygon.shp
Figure 6b: HUC14 & SWQS	NJGS	14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)	2/25/2011	1:2,400	dephuc14.shp	dephuc14_2011_HBP.shp
	NJDEP BFBM	NJDEP Surface Water Quality Standards of New Jersey (Version 201012)	10/1/2007	1:12,000	swqs.shp	SWQS_2010_HBP.shp
	NJDEP BFBM	NJDEP Ambient Biomonitoring Network (AMNET) Version 201011	11/1/2010	1:24,000	biopts.shp	biopts.shp
	NJDEP BFBM	Ambient Stream Quality Monitoring Sites (1998 - 2010)	11/20/2008	1:24,000	swpts.shp	swpts_CopperCkSite.shp
Figure 6c: WMA 11	NJGS	14 Digit Hydrologic Unit Code Delineations for New Jersey (Version 20110225)	2/25/2011	1:2,400	dephuc14.shp	dephuc14.shp
	NJDEP DWM	NJDEP Watershed Management Areas in New Jersey (Version 200901)	9/1/2009	1:24,000	depwmas.shp	depwmas_CentralDel.shp
Figure 6d: Del River Corridor (1 mile)	Hunterdon County	Hunterdon County Rivers [approximate W&S corridor of one mile buffer width calculated with ArcMap]	10/16/2000	1:1,000	HuntRivers.shp	HuntRivers_DelRiv_Buffer.shp
Figure 6e: Floodplains & Wetlands	FEMA	Digital Flood Insurance Rate Map Database, Hunterdon Co., NJ (DFIRM)	9/25/2009	NA	s_fld_haz_ar.shp	s_fld_haz_ar.shp
	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Central Delaware Watershed Management Area, WMA11	7/12/2010	1:2,400	w03lu07.shp	w11lu07_Kingwood_wetlands_dissolve2.shp
	NJDEP BGIS	[same as above; 50 foot wetlands buffer calculated with ArcMap]	7/12/2010	1:2,400	w03lu07.shp	w11lu07_Kingwood_wetlands_50ftbuffer_dissolve.shp
	NJDEP BGIS	[same as above; 150 foot wetlands buffer calculated with ArcMap]	7/12/2010	1:2,400	w03lu07.shp	w11lu07_Kingwood_wetlands_150ftbuffer_dissolve.shp
Figure 6f: Percent Impervious Surface	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Central Delaware Watershed Management Area, WMA11	7/12/2010	1:2,400	w03lu07.shp	w11lu07_HBP.shp

Figure	Source of Data[1]	Data Title	Date	Scale	Name of File (original)	Name of File (used)
Figure 7a: Land Cover (2007)	NJDEP BGIS	NJDEP 2007 Land use/Land Cover Update, Central Delaware Watershed Management Area, WMA11	7/12/2010	1:2,400	w03lu07.shp	w11lu07_HBP.shp
Figure 7b: Wildfire Fuel Hazard	NJDEP NJFFS	2002 NJFFS Wildfire Fuel Hazard for Hunterdon County, New Jersey	4/17/2009	1:12,000	hunfh02.shp	WildfireHazard_HBP.shp
Figure 7c: Vernal Pool Habitat & Natural Heritage Grid	NJDEP DFW ENSP	NJDEP Species Based Habitat, Vernal Habitat (Version 3.1, 20120221)	2/21/2012	1:12,000	vernal_habitat.shp	vernal_habitatas_HBP.shp
	NJDEP ONLM	NJDEP Natural Heritage Grid Map, Version 200911	11/1/2009	1:24,000	nhpgrid.shp	nhpgrid_2009_HBP.shp
Figure 7d: Landscape Project version 3.1	NJDEP DFW ENSP	NJDEP Species Based Habitat, Skylands Region (Version 3.1, 20120221)	2/21/2012	1:12,000	skylands_v3_1.shp	Landscape_v3_1_Sky_HBP.shp
Figure 8: Composite Map of Environmentally Sensitive Features	see above	Steep slopes-3c; W&S River Corridor-6d; Wetlands-6e; Vernal-7c; NH Grid-7c; Landscape Project-7d	see above	see above	see above	see above

GIS Data Sources	Full Name of Data Source	GIS Data Website
DRBC	Delaware River Basin Commission	http://www.nj.gov/drbc/basin/map/GIS.html
Dodds	Richard Dodds	NA
FEMA	Federal Emergency Management Agency	http://msc.fema.gov
Hunterdon County	Hunterdon County Division of GIS	currently offline
NJDEP BGIS	NJDEP BGIS	http://www.state.nj.us/dep/gis/listall.html
NJDEP BFBM	NJDEP Bureau of Freshwater Biological Monitoring	http://www.state.nj.us/dep/gis/listall.html
NJDEP DFW ENSP	NJDEP, Division of Fish Wildlife, Endangered Nongame Species Program	http://www.state.nj.us/dep/gis/listall.html
NJDEP DWM	NJDEP Division of Watershed Management	http://www.state.nj.us/dep/gis/listall.html
NJDEP NJFFS	NJDEP, New Jersey Forest Fire Service	http://www.state.nj.us/dep/gis/listall.html
NJOIT OGIS	NJ Office of Information Technology, Office of GIS	https://njgin.state.nj.us/NJ_NJGINExplorer/index.jsp
NJDEP ONLM	NJDEP, Office of Natural Lands Management	http://www.state.nj.us/dep/gis/listall.html
NJGIN	New Jersey Geographic Information Network	https://njgin.state.nj.us/NJ_NJGINExplorer/DataDownloads.jsp
NJGS	New Jersey Geological Service	http://www.state.nj.us/dep/njgs/geodata/index.htm
USDA/NRCS	USDA/NRCS	http://websoilsurvey.nrcs.usda.gov

APPENDIX C: SPECIES LISTS

Contents:

C.1 List of Plant Species of Horseshoe Bend Park

The following list is preliminary; additional field work will find additional species*.

Species Name	Common Name	Category	Growth Habit	National Wetland Indicator Status
Ageratina altissima	white snakeroot	Dicot	Forb/herb	UPL, FAC
Asclepias syriaca	common milkweed	Dicot	Forb/herb	
Chamaecrista fasciculata	partridge pea	Dicot	Forb/herb	
Desmodium paniculatum	panicledleaf ticktrefoil	Dicot	Forb/herb	UPL, FAC-
Erechtites hieraciifolia	American burnweed	Dicot	Forb/herb	FACU, FAC
Erigeron annuus	eastern daisy fleabane	Dicot	Forb/herb	FACU, FAC
Eupatorium altissimum	tall thoroughwort	Dicot	Forb/herb	
Eupatorium serotinum	lateflowering thoroughwort	Dicot	Forb/herb	FAC-, FAC+
Eurybia divaricata	white wood aster	Dicot	Forb/herb	
Impatiens capensis	jewelweed	Dicot	Forb/herb	FACW, FACW+
Oenothera biennis	common evening primrose	Dicot	Forb/herb	FACU-, FACU+
Oxalis stricta	common yellow oxalis	Dicot	Forb/herb	
Phytolacca americana	American pokeweed	Dicot	Forb/herb	FACU+, FAC
Pilea pumila	Canadian clearweed	Dicot	Forb/herb	FAC, FACW
Polygonum virginianum	jumpseed	Dicot	Forb/herb	FAC, FACW
Prenanthes altissima	tall rattlesnakeroot	Dicot	Forb/herb	UPL, FACU
Pseudognaphalium obtusifolium	rabbit-tobacco	Dicot	Forb/herb	
Pycnanthemum tenuifolium	narrowleaf mountainmint	Dicot	Forb/herb	FAC-, FACW
Pycnanthemum virginianum	Virginia mountainmint	Dicot	Forb/herb	FAC, FACW+
Rudbeckia hirta	blackeyed Susan	Dicot	Forb/herb	FACU-, FACU
Sabatia angularis	rosepink	Dicot	Forb/herb	FAC, FAC+
Solidago caesia	wreath goldenrod	Dicot	Forb/herb	FACU
Solidago canadensis	Canada goldenrod	Dicot	Forb/herb	FACU, FACU+
Solidago rugosa	wrinkleleaf goldenrod	Dicot	Forb/herb	FAC, FAC+
Symphyotrichum cordifolium	common blue wood aster	Dicot	Forb/herb	
Symphyotrichum lateriflorum	calico aster	Dicot	Forb/herb	

Species Name	Common Name	Category	Growth Habit	National Wetland Indicator Status
Symphyotrichum novi-belgii	New York aster	Dicot	Forb/herb	
Ribes sp.	gooseberry	Dicot	Shrub	
Symphoricarpos orbiculatus	coralberry	Dicot	Shrub	UPL, FAC-
Toxicodendron radicans	eastern poison ivy	Dicot	Shrub, Forb/herb, Subshrub	FACU, FACW
Viburnum acerifolium	mapleleaf viburnum	Dicot	Shrub, Subshrub	UPL, FACU
Rhus typhina	staghorn sumac	Dicot	Shrub, Tree	
Rubus allegheniensis	Allegheny blackberry	Dicot	Subshrub	UPL, FACW
Rubus occidentalis	black raspberry	Dicot	Subshrub	
Rubus ostryifolius	highbush blackberry	Dicot	Subshrub	
Agastache nepetoides	yellow giant hyssop	Dicot	Subshrub, Forb/herb	FACU, FAC
Galium circaezans	licorice bedstraw	Dicot	Subshrub, Forb/herb	UPL, FACU-
Acer rubrum	red maple	Dicot	Tree	FAC
Betula nigra	river birch	Dicot	Tree	FACW, OBL
Carya alba	mockernut hickory	Dicot	Tree	
Carya glabra	pignut hickory	Dicot	Tree	FACU-, FACU
Carya ovata	shagbark hickory	Dicot	Tree	FACU-, FACU+
Catalpa bignonioides	southern catalpa	Dicot	Tree	UPL, FAC-
Fagus grandifolia	American beech	Dicot	Tree	FACU
Juglans nigra	black walnut	Dicot	Tree	FACU
Liriodendron tulipifera	tuliptree	Dicot	Tree	FACU, FAC
Platanus occidentalis	American sycamore	Dicot	Tree	FAC, FACW
Quercus alba	white oak	Dicot	Tree	FACU-, FACU+
Quercus bicolor	swamp white oak	Dicot	Tree	FACW+, OBL
Quercus palustris	pin oak	Dicot	Tree	FAC, FACW
Quercus prinus	chestnut oak	Dicot	Tree	UPL, FACU-
Quercus rubra	northern red oak	Dicot	Tree	FACU-, FACU+
Quercus velutina	black oak	Dicot	Tree	
Ulmus rubra	slippery elm	Dicot	Tree	FAC
Acer saccharum	sugar maple	Dicot	Tree, Shrub	UPL, FACU
Carpinus caroliniana	American hornbeam	Dicot	Tree, Shrub	FAC
Celtis occidentalis	common hackberry	Dicot	Tree, Shrub	FACU, FAC
Cornus florida	flowering dogwood	Dicot	Tree, Shrub	FACU-, FACU
Hamamelis virginiana	American witchhazel	Dicot	Tree, Shrub	FACU, FAC-
Lindera benzoin	northern spicebush	Dicot	Tree, Shrub	FACW-, FACW
Maclura pomifera	osage orange	Dicot	Tree, Shrub	UPL, FACU

Species Name	Common Name	Category	Growth Habit	National Wetland Indicator Status
Sambucus racemosa	red elderberry	Dicot	Tree, Shrub	FACU, FACU+
Sassafras albidum	sassafras	Dicot	Tree, Shrub	FACU-, FACU
Viburnum dentatum	southern arrowwood	Dicot	Tree, Shrub	FAC
Viburnum prunifolium	blackhaw	Dicot	Tree, Shrub	FACU, FACU+
Parthenocissus quinquefolia	Virginia creeper	Dicot	Vine	FACU, FAC
Vitis labrusca	fox grape	Dicot	Vine	FACU, FAC+
Amphicarpaea bracteata	American hogpeanut	Dicot	Vine, Forb/herb	FACU, FACW
Polygonum sagittatum	arrowleaf tearthumb	Dicot	Vine, Forb/herb	OBL
Athyrium filix-femina	common ladyfern	Fern	Forb/herb	FAC, FAC+
Dryopteris marginalis	marginal woodfern	Fern	Forb/herb	FACU-, FACU
Onoclea sensibilis	sensitive fern	Fern	Forb/herb	FACW
Polystichum acrostichoides	Christmas fern	Fern	Forb/herb	UPL, FAC
Thelypteris noveboracensis	New York fern	Fern	Forb/herb	FAC, FAC+
Juniperus virginiana	eastern redcedar	Gymnosperm	Tree	FACU-, FACU
Pinus virginiana	Virginia pine	Gymnosperm	Tree	
Arisaema triphyllum	Jack in the pulpit	Monocot	Forb/herb	FAC, FACW
Polygonatum pubescens	hairy Solomon's seal	Monocot	Forb/herb	
Elymus hystrix	eastern bottlebrush grass	Monocot	Graminoid	
Schizachyrium scoparium	little bluestem	Monocot	Graminoid	FACU-, FACU+

* Observations made in September 2013 by Deborah Kratzer. This table is based on actual past observations. It is not inclusive of all species that occur in Horseshoe Bend Park.

Reference for common name, category, growth habit and NWI status: Native Plant Society of NJ, Plants by NJ County, Hunterdon: http://www.npsnj.org/plant_lists/native_plants__Hunterdon.xls

National Wetland Indicator Status:

- **OBL - Obligate wetland:** Almost always occurs in wetlands (estimated probability > 99%) under natural conditions
- **FACW - Facultative wetland**: Usually occurs in wetlands (estimated probability 67% – 99%), but occasionally found in non-wetlands.
- **FAC – Facultative:** Equally likely to occur in wetlands (estimated probability 34% – 66%) or non-wetlands.
- **FACU - Facultative upland: U**sually occur in non-wetlands (estimated probability 67% – 99%), but occasionally found in wetlands (estimated probability 1% – 33%).
- **UPL - Obligate upland**: Occur almost always (estimated probability > 99% in non-wetlands under natural conditions.

The (+) sign indicates a frequency towards the wetter end of the category (more frequently found in wetlands) and the (−) sign indicates a frequency towards the drier end of the category (less frequently found in wetlands).

C.2 List of Bird Species Seen at Horseshoe Bend Preserve, Kingwood Township, Hunterdon County, NJ*

Common Name	Scientific Name	Breeding Status	Non-breeding Status
Canada Goose	*Branta canadensis*		
Turkey Vulture	*Cathartes aura*		
Black Vulture	*Coragyps atratus*		
Osprey	*Pandion haliaetus*	Threatened	
Cooper's Hawk	*Accipiter cooperii*	Special Concern	Stable
Bald Eagle	*Haliaeetus leucocephalus*	Endangered	Threatened
Red-tailed Hawk	*Buteo jamacensis*		
Mourning Dove	*Zenaida macroura*		
Chimney Swift	*Chaetura pelagica*		
Red-bellied Woodpecker	*Melanerpes carolinus*		
Downy Woodpecker	*Picoides pubescens*		
American Kestrel	*Falco sparverius*		
Eastern Phoebe	*Sayornis phoebe*		
Blue Jay	*Cyanocitta cristata*		
American Crow	*Corvus brachyrhynchos*		
Fish Crow	*Corvus ossifragus*		
Tree Swallow	*Tachycineta bicolor*		
Barn Swallow	*Hirundo rustica*		
Chickadee (species)	*Poecile sp.*		
Tufted Titmouse	*Baeolophus bicolor*		
White-breasted Nuthatch	*Sitta carolinensis*		
House Wren	*Troglodytes aedon*		
Carolina Wren	*Thryothorus ludovicianus*		
Blue-gray Gnatcatcher	*Polioptila caerulea*		
Eastern Bluebird	*Sialia sialis*		
Hermit Thrush	*Catharus guttatus*		
American Robin	*Turdus migratorius*		
Gray Catbird	*Dumetella carolinensis*		
Brown Thrasher	*Toxostoma rufum*	Special Concern	Stable
Northern Mockingbird	*Mimus polyglottos*		
European Starling	*Sturnus vulgaris*		
Cedar Waxwing	*Bombycilla cedrorum*		
Prairie Warbler	*Setophaga discolor*		
Yellow-rumped Warbler	*Setophaga coronata*		
Chipping Sparrow	*Spizella passerina*		
Field Sparrow	*Spizella pusilla*		
Grasshopper Sparrow	*Ammodramus savannarum*	Threatened	Special Concern
Song Sparrow	*Melospiza melodia*		

Common Name	Scientific Name	Breeding Status	Non-breeding Status
Dark-eyed Junco	*Junco hyemalis*		
Northern Cardinal	*Cardinalis cardinalis*		
Bobolink	*Dolichonyx oryzivorus*	Threatened	Special Concern
Red-winged Blackbird	*Agelaius phoeniceus*		
Eastern Meadowlark	*Sturnella magna*	Special Concern	Special Concern
Common Grackle	*Quiscalus quiscula*		
Brown-headed Cowbird	*Molothrus ater*		
Orchard Oriole	*Icterus spurius*		
American Goldfinch	*Spinus tristis*		

* Observations made in 2012 - 2013 by Sandra McNicol. This table is based on actual past observations. It is likely not inclusive of all species that occur in Horseshoe Bend Park.

References for Breeding and Non-breeding status:

New Jersey's Endangered and Threatened Wildlife (2/23/12). http://www.nj.gov/dep/fgw/tandespp.htm

NJ Endangered and Nongame Species Program Special Concern – Species Status Listing (2/21/2012). http://www.state.nj.us/dep/fgw/ensp/pdf/spclspp.pdf

Species of butterflies seen at Horseshoe Bend Preserve, Kingwood Township, Hunterdon County, NJ*

Common name	Scientific name	Status**
Black Swallowtail	*Papilio polyxenes*	R
Eastern Tiger Swallowtail	*P. glaucus*	R
Spicebush Swallowtail	*P. Troilus*	R
Cabbage White	*Pieris rapae*	R
Clouded Sulphur	*Colias philodice*	R
Orange Sulphur	*C. eurytheme*	R
Cloudless Sulphur	*Phoebis sennae*	NR
Sleepy Orange	*Eurema nicippe*	NR
American Copper	*Lycaena phlaeas*	R
Red-banded Hairstreak	*Calycopis cecrops*	R
Juniper Hairstreak	*Callophrys gryneus*	R
White M Hairstreak	*Parrhasius m-album*	R
Gray Hairstreak	*Strymon melinus*	R
Eastern Tailed Blue	*Everes comyntas*	R
Spring Azure	*Celastrina ladon*	R
American Snout	*Libythaena carinenta*	NR
Great Spangled Fritillary	*Speyeria cybele*	R
Meadow Fritillary	*Boloria bellona*	R
Pearl Crescent	*Phyciodes tharos*	R
Question Mark	*Polygonia interrogationis*	R
Eastern Comma	*P. comma*	R
Gray Comma	*P. progne*	R
American Lady	*Vanessa virginiensis*	R
Painted Lady	*V. cardui*	NR
Common Buckeye	*Junonia coenia*	NR
Red-spotted Purple	*Limenitis arthemis*	R
Hackberry Emperor	*Asterocampa celtis*	R
Northern Pearly Eye	*Enodia anthedon*	R
Common Wood Nymph	*Cercyonis pegala*	R
Monarch	*Danaus plexippus*	NR
Silver-spotted Skipper	*Epargyreus clarus*	R
Horace's Duskywing	*Erynnis horatius*	R
Wild Indigo Duskywing	*E. baptisiae*	R
Common Checkered-Skipper	*Pyrgus communis*	R
Common Sootywing	*Pholisora catullus*	R
Swarthy Skipper	*Nastra iherminier*	R
Least Skipper	*Anclyoxpha numitor*	R
Peck's Skipper	*Polites peckius*	R

Common name	Scientific name	Status
Tawny-edged Skipper	*P. themistocles*	R
Crossline Skipper	*P. origenes*	R
Little Glassywing	*Pompeius verna*	R
Sachem	*Atalopedes campestris*	NR
Zabulon Skipper	*Poanes zabulon*	R
Dun Skipper	*Euphyes vestris*	R

* Observations made in July, August, September, and October 2013 by members of
the North Jersey Butterfly Club (www.naba.org/chapters/nabanj).

** R = Resident (meaning that at least one life stage overwinters here)
NR = Nonresident

APPENDIX D: ENDANGERED SPECIES

Contents:

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: **Hunterdon**						
Subterranean Community - Other Classification						
Cave aquatic community	Cave Aquatic Community				G4?	S2
Cave terrestrial community	Cave Terrestrial Community				G4?	S2
Terrestrial Community - Other Classification						
Shale cliff/rock outcrop community	Shale Cliff/rock Outcrop Community				G3	S2?
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
Agrimonia microcarpa	Small-fruit Grooveburr			HL	G5	S2
Aristolochia serpentaria	Virginia Snakeroot			HL	G4	S3
Asimina triloba	Pawpaw		E	LP, HL	G5	S1
Asplenium pinnatifidum	Lobed Spleenwort		E	LP, HL	G4	S1
Aster praealtus	Willow-leaf Aster		E	LP, HL	G5T5?	S1
Botrychium oneidense	Blunt-lobe Grape Fern			HL	G4Q	S2
Cacalia atriplicifolia	Pale Indian Plantain		E	LP, HL	G4G5	S1
Callitriche palustris	Marsh Water-starwort			HL	G5	S2
Cardamine angustata	Slender Toothwort			HL	G5	S3
Carex albursina	White Bear Lake Sedge		E	LP, HL	G5	S1
Carex amphibola var. amphibola	Narrow-leaf Sedge		E	LP, HL	G4Q	S1
Carex bushii	Bush's Sedge		E	LP, HL	G4	S1
Carex deweyana	Dewey's Sedge		E	LP, HL	G5T5	S1

County: **Hunterdon**

Carex frankii	Frank's Sedge		HL	G5	S3
Carex hitchcockiana	Hitchcock's Sedge		HL	G5	S2
Carex jamesii	James' Sedge	E	LP, HL	G5	S1
Carex leptonervia	Fine-nerve Sedge	E	LP, HL	G4	S1
Carex meadii	Mead's Sedge		HL	G4G5	SX.1
Carex oligocarpa	Few-fruit Sedge	E	LP, HL	G4	S1
Carex pallescens	Pale Sedge		HL	G5	S2
Carex prairea	Prairie Sedge		HL	G5?	S2
Carex willdenowii var. willdenowii	Willdenow's Sedge		HL	G5T5	S2
Castilleja coccinea	Scarlet Indian-paintbrush		HL	G5	S2
Cercis canadensis	Redbud	E	LP, HL	G5T5	S1
Cheilanthes lanosa	Hairy Lipfern		HL	G5	S2
Chenopodium simplex	Maple-leaf Goosefoot		HL	G5	S2
Crataegus calpodendron	Pear Hawthorn	E	LP, HL	G5	S1
Crataegus dodgei	Dodge's Hawthorn		HL	G4	S2
Crataegus holmesiana	Holmes' Hawthorn		HL	G5	S1
Crataegus succulenta	Fleshy Hawthorn	E	LP, HL	G5	S1
Cuphea viscosissima	Blue Waxweed		HL	G5?	S3
Cuscuta cephalanthi	Buttonbush Dodder	E	LP, HL	G5	S1
Cynoglossum virginianum var. virginianum	Wild Comfrey		HL	G5T5	S2
Cystopteris protrusa	Lowland Fragile Fern		HL	G5	S2
Desmodium humifusum	Trailing Tick-trefoil	E	LP, HL	G1G2Q	S1
Dicentra canadensis	Squirrel-corn	E	LP, HL	G5	S1
Dirca palustris	Leatherwood		HL	G4	S2
Doellingeria infirma	Cornel-leaf Aster		HL	G5	S2

County: **Hunterdon**

Draba reptans	Carolina Whitlow-grass		E	LP, HL	G5	SH
Ellisia nyctelea	Aunt Lucy		E	LP, HL	G5	S1
Epilobium angustifolium ssp. circumvagum	Narrow-leaf Fireweed			HL	G5T5	S1
Eragrostis frankii	Frank's Love Grass			HL	G5	S2
Gymnocarpium dryopteris	Oak Fern			HL	G5	S1
Hybanthus concolor	Green Violet		E	LP, HL	G5	S1
Hydrophyllum canadense	Broad-leaf Waterleaf		E	LP, HL	G5	S1
Hypericum pyramidatum	Great St. John's-wort			HL	G4	S3
Isotria medeoloides	Small Whorled Pogonia	LT	E	LP, HL	G2	S1
Jeffersonia diphylla	Twinleaf		E	LP, HL	G5	S1
Kuhnia eupatorioides	False Boneset		E	LP, HL	G5T5	S1
Lathyrus venosus	Veiny Vetchling		E	LP, HL	G5	SX
Lechea intermedia var. intermedia	Large-pod Pinweed			HL	G5T4T5	S2
Lemna valdiviana	Pale Duckweed		E	LP, HL	G5	S1
Linum sulcatum	Grooved Yellow Flax		E	LP, HL	G5T5	S1
Lysimachia hybrida	Lowland Loosestrife			HL	G5	S3
Monarda clinopodia	Basil Beebalm		E	LP, HL	G5	SH
Monarda didyma	Oswego-tea			HL	G5	S2
Obolaria virginica	Virginia Pennywort			HL	G5	S2
Onosmodium virginianum	Virginia False-gromwell		E	LP, HL	G4	S1
Panax quinquefolius	American Ginseng			HL	G3G4	S2
Panicum oligosanthes var. oligosanthes	Few-flower Panic Grass			HL	G5T5?	S1S2
Penstemon laevigatus	Smooth Beardtongue		E	LP, HL	G5	S1
Phaseolus polystachios var. polystachios	Wild Kidney Bean			HL	G4TNR	S2
Phlox maculata var. maculata	Spotted Phlox			HL	G5TNR	S2

County: **Hunterdon**

Phlox pilosa	Downy Phlox	E	LP, HL	G5T5	SH
Pinus pungens	Table Mountain Pine	E	LP, HL	G4	S1.1
Porteranthus trifoliatus	Indian Physic		HL	G4G5	S2
Prunus alleghaniensis	Allegheny Plum	E	LP, HL	G4T4	SH
Prunus pumila var. depressa	Low Sand Cherry		HL	G5T5	S1
Ptelea trifoliata	Wafer-ash	E	LP, HL	G5T5	S1
Pycnanthemum clinopodioides	Basil Mountain-mint	E	LP, HL	G2	S1
Pycnanthemum torrei	Torrey's Mountain-mint	E	LP, HL	G2	S1
Quercus muehlenbergii	Yellow Oak		HL	G5	S3
Ranunculus ambigens	Water-plantain Spearwort		HL	G4	S2
Ranunculus flabellaris	Yellow Water Buttercup		HL	G5	S3
Ranunculus micranthus	Rock Buttercup		HL	G5	S2
Ranunculus trichophyllus var. trichophyllus	Thread-leaf Water Buttercup		HL	G5T5	S2
Rhynchospora globularis	Coarse Grass-like Beaked-rush	E	LP, HL	G5?	S1
Ribes missouriense	Missouri Gooseberry	E	LP, HL	G5	S1
Rudbeckia fulgida	Orange Coneflower	E	LP, HL	G5T4?	S1
Salix lucida ssp. lucida	Shining Willow		HL	G5T5	S1
Scutellaria nervosa	Veined Skullcap		HL	G5	S2
Sedum telephioides	Allegheny Stonecrop		HL	G4	SX.1
Selaginella rupestris	Rock Spike-moss		HL	G5	S2
Solidago rigida	Prairie Goldenrod	E	LP, HL	G5T5	S1
Sphenopholis pensylvanica	Swamp Oats		HL	G4	S2
Spiranthes lucida	Shining Ladies'-tresses		HL	G5	S2
Sporobolus compositus var. compositus	Long-leaf Rush-grass		HL	G5T5	S2
Stachys tenuifolia	Smooth Hedge-nettle		HL	G5	S3

County: **Hunterdon**

Stellaria pubera	Star Chickweed	E	LP, HL	G5	SH
Triosteum angustifolium	Narrow-leaf Horse-gentian	E	LP, HL	G5	SH
Valerianella radiata	Beaked Cornsalad	E	LP, HL	G5	S1
Verbena simplex	Narrow-leaf Vervain	E	LP, HL	G5	S1
Vicia caroliniana	Carolina Wood Vetch	E	LP, HL	G5	S1
Viola canadensis	Canadian Violet	E	LP, HL	G5TNR	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 _____

☐ I'm 18 or over and all information contained on this form and in the supporting documentation is true and accurate to the best of my knowledge.

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
P.O. Box 420
Mail Code 501-03
Trenton, NJ 08625-0420
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/imagnj/imagnj.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.

Source: http://www.nj.gov/dep/fgw/tandespp.htm

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

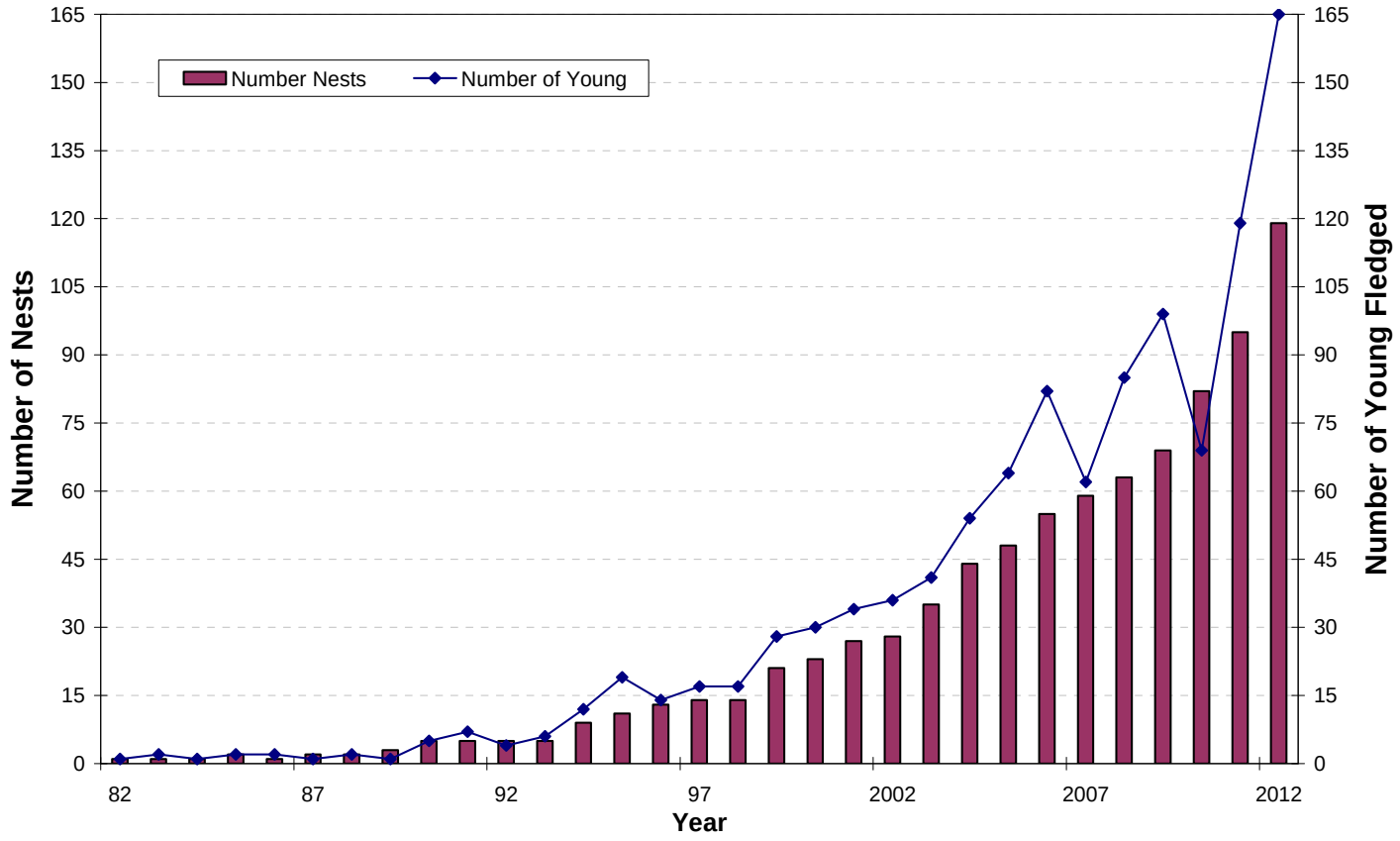
The ENSP receives no funding from state tax dollars. You can help support New Jersey's bald eagles by:

- 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



Source: http://www.nj.gov/dep/rgw/tandeepp.htm

To learn where you can view eagles in the state, purchase the NJ Wildlife Viewing Guide, available from the CWF

Bobolink, *Dolichonyx oryzivorus*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

Photo by S. Maslowski, courtesy US FWS

Amid a sea of agriculture, the bubbly "bobo-o-link!" song of the bobolink echoes from within an overgrown weedy field. On a fall day at Cape May, a chorus of "plink" notes is heard overhead as a flock of bobolinks passes above a fallow grassland. These are the song and call of the bobolink, a sparrow-sized member of the blackbird family.

Bobolinks exhibit sexual dimorphism (gender differences) in plumage during the breeding season. The nuptial male is black overall with a creamy nape and hindneck, a white rump, and white scapulars (feathers at the base of the wing). The plumage of the female, which camouflages her during nesting, is relatively drab. The female is buffy with dark brown streaking on the back, sides, and rump and has dark stripes on the head. In non-breeding plumage, adult males resemble females. Immature bobolinks also resemble adult females but are more yellow and lack streaking on the sides of the body. All ages and sexes have a short, finch-like bill and pointed tail feathers.

Habitat

Bobolinks inhabit low-intensity agricultural habitats, such as hayfields and pastures, during the breeding season. In addition, lush fallow fields and meadows of grasses, forbs, and wildflowers are occupied. Bobolink nests are often placed in areas of greatest vegetative height and density. Although small numbers of bobolinks may nest in grasslands of 2 to 4 hectares (5-10 acres), larger sized fields support higher densities of nesting pairs (Jones and Vickery 1997a).

Similar habitats are occupied by bobolinks throughout their annual cycle. During migration, bobolinks inhabit fallow and agricultural fields, as well as coastal and freshwater marshes. On their South American wintering grounds, they occur in grasslands, marshes, rice fields, and farm fields.

Status and Conservation

Historic clearing of forests in the eastern United States during the 1700s and 1800s enabled numerous grassland species to expand their ranges, inhabiting the growing agricultural landscape. As a result, the bobolink became a common breeding species in the hayfields and pastures of New Jersey. However, by the early 1900s, bobolink

population declines were noted in the Northeast. The slaughter of migrant bobolinks in rice fields of the southern United States, market hunting, and modernized farming techniques likely caused this decline. During the 1960s and 1970s, changing agricultural practices, the conversion of fallow fields to forests, and the development of agricultural lands further shrunk bobolink populations in New Jersey.

Modern farming techniques, including frequent rotation of hayfields, early mowing of hay, decreased vegetative diversity, and the change from warm-season to cool-season grasses, have rendered agricultural fields less favorable for nesting bobolinks. In addition, alfalfa (Medicago sativa) fields, which offer poor nesting habitat for bobolinks, have replaced many timothy (Phleum spp.) and clover (Fabaceae) fields. The area of land cultivated as hay fields in the northeastern United States declined from 12.6 to 7.1 million hectares (31.1 to 17.5 million acres) from 1940 to 1986 (Martin and Gavin 1995). During the same period, the percentage of sites where alfalfa replaced hay increased from 20% to 60% (Bollinger and Gavin 1992). Habitat loss is largely responsible for the decline of bobolink populations in the United States and New Jersey detected by the Breeding Bird Survey from 1966 to 1999 (Sauer et al. 2000).

Due to population declines and habitat loss, the bobolink was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers the bobolink to be “demonstrably secure globally,” yet “imperiled in New Jersey because of rarity” (Office of Natural Lands Management 1992).

Grasshopper Sparrow, *Ammodramus savannarum*

Status: ***State:*** Threatened ***Federal:*** Not listed

Identification

© M. Patrikeev/ VIREO

A small, secretive songbird, the grasshopper sparrow is more often heard than seen as its insect-like melody emits from dense grasses. Its song consists of one to two chips followed by a buzzy trill reminiscent of a grasshopper. This sparrow also sings a series of buzzy notes.

The grasshopper sparrow has a stocky body that is brown above with buff streaking. On adults, the breast and sides are solid buff and the belly is white. The buff breast and sides of juveniles are marked with dark brown vertical streaking. Grasshopper sparrows have flat heads with relatively large bills. The crown is dark brown with light central stripes atop the head and behind the eye. The lores (between the eyes and the bill) are orange or golden. The tail is short and brown.

Habitat

Grasshopper sparrows breed in grassland, upland meadow, pasture, hayfield, and old field habitats. Nesting grasshopper sparrows may occur on agricultural lands and airports where such habitats occur. Although grasshopper sparrows may use small grasslands, open areas of over 40 hectares (100 acres) are favored. Optimal habitat for these sparrows contains short- to medium-height bunch grasses interspersed with patches of bare ground, a shallow litter layer, scattered forbs, and few shrubs. Clumped grasses, such as poverty grass (Danthonia spicata) and broom-sedge (Andropogon virginicus), provide cover and foraging areas and are consequently favored over sod or matting grasses. In addition, orchardgrass (Dactylis glomerata), alfalfa (Medicago sativa), red clover (Trifolium pratense), lespedeza (Lespedeza spp.), and dewberry (Rubus spp.) provide sparrow habitat. Shrubs, fence posts, and tall forbs are used as song perches. However, habitats may become unsuitable for nesting grasshopper sparrows if shrub cover becomes too dense. Consequently, the presence and density of grasshopper sparrows at breeding sites varies annually due to habitat changes. Habitat use during the nonbreeding season is similar, although less restrictive, to that of the breeding season, as these sparrows may inhabit thickets, weedy lawns, vegetated landfills, fence rows, open fields, or grasslands.

Source: http://www.nj.gov/dep/fgw/tandespp.htm

Status and Conservation

In the eastern United States, the historic distribution of grasshopper sparrows was restricted to natural grasslands created by fires or flooding. However, the boom in agriculture during the late 1800s and early 1900s enabled this species to spread its range and increase in numbers, making it a fairly common breeder in New Jersey. By the 1950s and 1960s, expanding development of open areas, coupled with dwindling acreage of land devoted to farming or pasture, led to decreases in grasshopper sparrow populations. Continued declines in the northeast were noted in the 1970s and 1980s, when the species was considered locally distributed and uncommon. The number of grasshopper sparrows detected on Breeding Bird Survey routes in New Jersey, the eastern United States, and throughout the country declined from 1966 to 1999 (Sauer et al. 2000).

As the result of population declines and severe habitat loss, the grasshopper sparrow was listed as a threatened species in New Jersey in 1979. The New Jersey Natural Heritage Program considers this species to be “apparently secure globally,” yet “imperiled in New Jersey because of rarity” (Office of Natural Lands Management 1992). Currently, grasshopper sparrows occur in small, localized, and unstable populations in the Northeast. Consequently, other nearby states have listed this species as endangered (Maine, Connecticut), threatened (Massachusetts, Rhode Island), or of special concern (New York). In New Jersey, the survival of grasshopper sparrows is critically linked with management practices for grassland birds on airports, agricultural lands, and pastures.

Shortnose Sturgeon, *Acipenser brevirostrum*

Status: ***State:*** Endangered ***Federal:*** Endangered

Identification

Joshua D. Ingram, courtesy John C. O'Herron, II

The shortnose sturgeon has a short and bluntly rounded snout, wide mouth, barbels, numerous dorsal, lateral and ventral scutes (bony or horny plates), and a heterocercal tail (the upper lobe of the tail fin is larger and contains the upturned end of the spinal column). Typically, the body is yellowish brown to nearly black on the head, back and sides level to lateral plates, and whitish to yellowish below. Length at initial maturity for this species occurs between 45-55 cm fork length, from the snout to the middle of the tail (18-22 in.) for males and females (Dadswell *et al*. 1984). Maximum known fork lengths are nearly 49 in. for a female and nearly 39 in. for a male. In New Jersey, 28 tagged males ranged between 21 in. to nearly 35 in. fork length.

Habitat

River mouths, tidal rivers, estuaries, and bays serve as prime habitat for the shortnose sturgeon. In addition, individuals occasionally enter the open ocean. A significant portion of New Jersey's shortnose sturgeon occurs in the upper tidal Delaware River (Dadswell *et al* 1984).

Status and Conservation

The shortnose sturgeon has been federally listed as endangered since the inception of the Endangered Species Act in 1973, when it was also considered endangered in New Jersey. The Office of Natural Land's Management ranks the species as "rare in N.J." and "either very rare and local throughout its range or found locally in a restricted range or because of other factors making it vulnerable to extinction throughout its range."

This species is afforded protection under both federal and state Endangered Species acts, Clean Water acts, fishing regulations, and environmental review of proposed development projects.