ALEXANDRIA TOWNSHIP ENVIRONMENTAL COMMISSION

RESOLUTION NO. 2015 – _____

RESOLUTION OF THE ALEXANDRIA TOWNSHIP ENVIRONMENTAL COMMISSION APPROVING AND ADOPTING THE TOWNSHIP OF ALEXANDRIA ENVIRONMENTAL RESOURCE INVENTORY, JULY 2014.

WHEREAS, the Highlands Water Protection and Planning Act ("Highlands Act," N.J.S.A. 13:20-1 et seq.) was enacted by the State Legislature on August 10, 2004 for the purpose of protecting, enhancing, and restoring the natural resources of the New Jersey Highlands Region, in particular the water resources, which provide drinking water to over 5 million New Jersey residents; and

WHEREAS, Alexandria Township is located in the Highlands Region including lands lying within the both the Preservation Area and Planning Area, as defined by section 7 of the Highlands Act; and

WHEREAS, on November 11, 2009 the Alexandria Township Committee, held a noticed public meeting during which it adopted "A Resolution Authorizing Submission of A Petition for Plan Conformance to the Highlands Water Protection and Planning Council for Land in the Preservation Area and in the Planning Area Portions of Alexandria Township", which resolution noticed the municipal intent to Petition the Highlands Council for Plan Conformance with respect to that portion of the municipality located within the Preservation Area and Planning Area; and

WHEREAS, on April 11, 2012the Alexandria Township Committee did hold a public meeting at which it discussed conformance with the Regional Master Plan and did adopt Resolution No. 2012-136 petitioning the Highlands Council for approval of its Petition for Plan Conformance, prepared *with respect only to* the Preservation Area; and

WHEREAS, an updated Environmental Resources Inventory is included among the municipal Plan Conformance requirements under Plan conformance for the Highlands Preservation Area portion of Alexandria Township; and

WHEREAS, in cooperation with the NJ Highlands Council Planning Staff, Alexandria Township has prepared the Township of Alexandria Highlands Environmental Resource Inventory (ERI), dated July 2014, and

WHEREAS, the Alexandria Township Environmental Commission reviewed the Township of Alexandria Highlands ERI, dated July 2014, and met on September

22, 2014, at which time the Commission discussed approval and adoption of the Township of Alexandria Highlands ERI, and

WHEREAS, on October 28, 2014 the Alexandria Township Environmental Commission considered a motion and verbal resolution to approve and adopt the Township of Alexandria Highlands ERI, which passed unanimously by the members present;

NOW, THEREFORE, BE IT RESOLVED, by the Alexandria Township Environmental Commission that this resolution hereby memorializes the October 28, 2014 approval and adoption of the Township of Alexandria Highlands Environmental Resource Inventory, dated July 14.

Michelle Carey

Chair, Alexandria Township Environmental Commission

Secretary, Alexandria Township Environmental Commission

Date: January 12, 2015

Township of Alexandria Highlands Environmental Resource Inventory

July 2014

Table of Contents

Purpose and Scope 1
Highlands Region 2
Land Use Capability Map Series 3
Highlands Subwatersheds 6
Forest Resources 7
Highlands Open Waters and Riparian Areas 9
Steep Slope Protection Areas 13
Critical Habitat 15
Land Preservation and Stewardship 18
Carbonate Rock Areas 21
Water Resources Availability 22
Prime Ground Water Recharge Areas 24
Water Quality 26
Wellhead Protection 29
Septic System Yield 30
Agricultural Resources 33
Historic, Cultural, and Archaeological Resources 35
Scenic Resources 36
Contaminated Sites 37
Infrastructure 38
Water and Wastewater Utilities 38
Roadway and Transit 39

List of Figures

Figure 1. Preservation Area
Figure 2. Land Use Capability Map Zones
Figure 3. HUC 14 Boundaries
Figure 4. Forest Resource Area
Figure 5. Total Forest Area
Figure 6. Forest Subwatersheds
Figure 7. Highlands Open Waters
Figure 8. Highlands Riparian Areas
Figure 9. Watershed Values
Figure 10. Riparian Integrity
Figure 11. Steep Slope Protection Areas
Figure 12. Critical Wildlife Habitat
Figure 13. [Reserved]
Figure 14. Vernal Pools
Figure 15. Preserved Lands
Figure 16. Highlands Conservation Priority Areas
Figure 17. [Reserved]
Figure 18. Carbonate Rock Areas
Figure 19. [Reserved]
Figure 20. Net Water Availability
Figure 21. Prime Ground Water Recharge Areas
Figure 22. HUC 14s on NJDEP Impaired Waters List
Figure 23. Wellhead Protection Areas
Figure 24. Agricultural Resource Area
Figure 25. Agricultural Priority Area
Figure 26. Preserved Farms, SADC Easements, All Agricultural Uses
Figure 27. Important Farmland Soils
Figure 28. Historic, Cultural, and Archaeological Resources Inventory
Figure 29. Baseline Scenic Resources Inventory
Figure 30. Highlands Contaminated Site Inventory
Figure 31. Public Community Water Systems
Figure 32. [Reserved]
Figure 33. Highlands Roadway Network
Figure 34. Highlands Transit Network

Purpose and Scope

An Environmental Resource Inventory (ERI), sometimes called a Natural Resource Inventory, identifies and depicts the natural and cultural resources present in a community. Natural resources maps and accompanying narrative provide the basis for inventorying a community's natural resource components and provide the base source for resource conservation. Identifying a community's natural resources is the first step toward establishing mechanisms for their protection. As an integral component of a master plan, an ERI functions as the basis for development of natural resources protection ordinances.

The purpose of the Highlands Environmental Resource Inventory (ERI) is to provide a framework that supports the efforts of Alexandria to bring its planning documents, including the ERI, into conformance with the Highlands Regional Master Plan (RMP). The ERI is one requirement for Plan Conformance. It provides critical support to the Conservation Plan Element of the municipal master plan and to implementation of resource protection requirements in the land use ordinance and health codes of Alexandria.

Highlands Region

In the Highlands Water Protection and Planning Act (Highlands Act) the Legislature designated specific boundaries within the Highlands Region as the Preservation Area and the Planning Area. These boundaries were delineated by the Legislature in the Highlands Act, and as a legislative enactment, are not subject to modification through the Conformance Process.

The fundamental distinction between the Preservation and Planning Areas is that municipal and county conformance with the RMP is required in the Preservation Area and is voluntary in the Planning Area. The Preservation Area consists of 415,000 acres of the Highlands Region's 859,288 acres, and is located in 52 municipalities within the seven Highlands Counties. The lands within the Preservation Area were subject to the immediately effective standards in the Highlands Act and are governed by rules and regulations subsequently adopted by the NJDEP. The Planning area consists of 444,268 acres and is located in 83 municipalities. There are five municipalities located entirely within the Preservation Area, 47 municipalities that have land in both the Preservation and Planning Areas, and 36 municipalities that have land only in the Planning Area.

Through passage of the Highlands Act, the New Jersey Highlands Water Protection and Planning Council (Highlands Council) was created and charged with the important task of developing the RMP to restore and enhance the significant values of the abundant and critical resources of the Highlands Region. Through conformance by municipalities and counties, the RMP will provide for the protection and preservation of significant values of the Highlands Region for the benefit of its residents.

Alexandria Township includes both the Preservation and Planning Areas. The Preservation Area is located in the northern most portion of the Township and consists of 2,721 acres, or 15% of the total lands, while the Planning Area covers the remaining 15,038 acres (85% of total), as depicted in Figure 1.

Land Use Capability Map Series

The Highlands Act requires that the RMP include a land use capability map and a comprehensive statement of policies for planning and managing the development and use of land based upon the results of the Council's resource assessment and smart growth analysis. The RMP requires that future land use in the Highlands Region be guided by the RMP's Land Use Capability Map (LUCM) Series. The LUCM Series includes components necessary to protect the natural, scenic and other Highlands resources, including but not limited to, agriculture, forests, wetlands, stream corridors, steep slopes, and critical habitat for flora and fauna.

The Land Use Capability Zone map depicts overlay zones to establish areas that address distinguishing circumstances or landscape features. The overlay zones are superimposed over existing municipal zoning and are intended to provide a means to address issues of special public interest (e.g. watershed management area, open space preservation, historic preservation, urban enterprise zone) that the underlying base zoning may not otherwise take into consideration. The Land Use Capability Zone Map is one of the five capability maps that support the RMP. The LUCM Series also includes: Water Availability Map; Public Community Water Systems Map; Domestic Sewerage Facilities Map, and the Septic System Yield Map.

In the Highlands Region, overlay zones will provide all levels of government (federal, State, county and municipal) and the public with an indication of areas where special consideration is required to protect regionally significant resources. Overlay zones also indicate where and how development initiatives may occur based on the ability of areas to accommodate growth. The Highlands LANDS model was designed to develop the overlay zones each with their own purpose, application, and minimum standards as generally discussed below and these will collectively be referred to as overlay designations.

These overlay zones distinguish between resource constrained lands, where development will be limited (Protection Zone), and those lands characterized by existing patterns of human development where, dependent on municipal planning, land or capacity constraints, additional growth may or may not be appropriate (Existing Community Zone). The Conservation Zone identifies those areas with a high concentration of agricultural lands and associated woodlands and environmental features, where development potential may exist to the extent it is not limited by available infrastructure to support development (e.g. water availability, the existence of concentrated environmental resources that are easily impaired by development, the protection of important agricultural resources).

The four sub-zones represent regionally significant sensitive environmental features, in most of which development is subject to stringent limitations on the extension or creation of water and wastewater services; however, they do not incorporate all environmental constraints and other factors that may be considered during local development review and Highlands Project Review. Of the four sub-zones, the Lake Community Sub-Zone is the only one where the provision of public wastewater or water supply services is not restricted in the Planning Area. Preservation Area restrictions on the creation or extension of public wastewater or water supply services apply in all zones and sub-zones.

The Land Use Capability Zones include the following:

The Protection Zone (PZ) consists of high resource value lands that are important to maintaining water quality, water quantity, and sensitive ecological resources and processes. Land acquisition is a priority in the

Protection Zone and development activities will be extremely limited; any development will be subject to stringent limitations on consumptive and depletive water use, degradation of water quality, and impacts to environmentally sensitive lands. The LANDS model uses a 75 acre minimum mapping threshold for the delineation of the Protection Zone.

The Wildlife Management Sub-Zone (WM) consists of all National Wildlife Refuges managed by the United States Fish and Wildlife Service and Wildlife Management Areas administered by the NJDEP Division of Fish & Wildlife's Bureau of Land Management, within the Highlands Region. These areas are part of a network of lands and waters for conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats and permit compatible wildlife-dependent recreational uses, such as hunting, fishing, wildlife observation and photography, and environmental education and interpretation. There is no minimum mapping threshold for the delineation of the Wildlife Management Sub-Zone.

The Conservation Zone (CZ) consists of areas with significant agricultural lands and interspersed with associated woodlands and environmental features that should be preserved when possible. Non-agricultural development activities will be limited in area and intensity due to infrastructure constraints and resource protection goals. The LANDS model uses a 75 acre minimum mapping threshold for the delineation of the Conservation Zone.

The Conservation Zone – Environmentally Constrained Sub-Zone (CZ-EC) consists of significant environmental features within the Conservation Zone that should be preserved and protected from non-agricultural development. Development activities will be constrained through restrictions on the extension or creation of water supply and wastewater services. The LANDS model uses a 10 acre minimum mapping threshold for the delineation of the Conservation Zone – Environmentally Constrained Sub-Zone.

The Existing Community Zone (ECZ) consists of areas with regionally significant concentrated development signifying existing communities. These areas tend to have limited environmental constraints due to previous development patterns and may have existing infrastructure that can support development and redevelopment provided that such development is compatible with the protection and character of the Highlands environment, at levels that are appropriate to maintain the character of established communities. The LANDS model used a 75 acre minimum mapping threshold for the delineation of the Existing Community Zone.

The Existing Community Zone – Environmentally Constrained Sub-Zone (ECZ-EC) consists of significant environmental features within the Existing Community Zone that should be protected from further fragmentation. They serve as regional habitat "stepping stones" to larger contiguous critical habitat and forested areas. As such, they are not appropriate for significant development and are best served by land preservation and protection. Development is constrained through restrictions on the extension or creation of water supply and wastewater services. The LANDS model used a 2 acre minimum mapping threshold for the delineation of the Existing Community Zone – Environmentally Constrained Sub-Zone.

The Lake Community Sub-Zone (LCZ) consists of patterns of community development around lakes that are within the Existing Community Zone and within 1,000 feet of lakes. The LANDS model focuses on lakes 10 acres or greater and delineates this zone as consisting of an area of up to 1,000 feet (depending on the protection focus) from the lake shoreline in order to protect water quality, resource features, shoreline development recreation, scenic quality and community character. A future management area is planned,

encompassing the full lake watershed, for protection of the lake water quality. This sub-zone has unique policies to prevent degradation of water quality and watershed pollution, harm to lake ecosystems, and promote natural aesthetic values within the Existing Community Zone. The LANDS model used a 2 acre minimum mapping threshold for the delineation of the Lake Community Sub-Zone.

Alexandria includes four Land Use Capability Zones, as listed below and illustrated in Figure 2:

- 6,941 acres of land in the Conservation Zone – 6,389 acres in the Planning Area and 552 acres in the Preservation Area

- 7,408 acres of land in the Conservation Zone-Environmentally Constrained Sub-Zone – 6,904 acres in the Planning Area and 504 acres in the Preservation Area

- 2,895 acres of land in the Protection Zone – 1,275 acres in the Planning Area and 1,620 acres in the Preservation Area

- 41 acres of land in the Existing Community Zone - fully in the Planning Area

The other Land Use Capability Zones do not occur within the Township. The remaining LUCM Series Maps are included in their respective sections within the ERI. The Net Water Availability Map Figure 20 is described in the Water Availability Section. The Public Community Water Systems Map Figure 31 and the Domestic Sewerage Facilities Map Figure 32 are described in the Utilities Section.

Highlands Subwatersheds

For many of the Region's natural resources, the Highlands Council utilized a watershed-based assessment to evaluate resource integrity and protection needs. A watershed describes an area of land from which all water, above ground (e.g., rain and snowmelt) and below ground (e.g. ground water), drains to the same point. Nearly all watersheds in New Jersey are part of larger watersheds, and may range in size from a few acres to thousands of square miles.

Water moves through a network of drainage pathways, both underground and on the surface, and these pathways converge into streams and rivers, which become progressively larger in size (i.e., higher order) as the water moves downstream and the size of the contributing drainage area increases. The connectivity of streams is the primary reason for doing assessments at the watershed level. Because water moves downstream, any activity that affects the water quality, quantity, or rate of movement at one location can affect locations downstream. The watershed boundaries used for the analysis in the RMP were 14-digit Hydrologic Units (i.e., subwatersheds or HUC14s). There are 183 HUC14 subwatersheds that are located partially or entirely within the Highlands Region.

The Township includes portions, or the entirety of nine HUC14 subwatersheds, as depicted in Figure 3.

HUC 14 Subwatersheds	HUC 14 Subwatershed Name
2030105020030	Mulhockaway Creek
2030105020060	Cakepoulin Creek
2030105020070	Raritan R SB(River Rd to Spruce Run)
2040105160050	Musconetcong R (I-78 to 75d 00m)
2040105160060	Musconetcong R (Warren Glen to I-78)
2040105170020	Hakihokake Creek
2040105170030	Harihokake Creek (and to Hakihokake Ck)
2040105170040	Nishisakawick Creek (above 40d 33m)
2040105170050	Nishisakawick Creek (below 40d 33m)

Forest Resources

The forests of the Highlands Region provide essential ecosystem functions, including surface water filtration, which is important to protecting essential drinking water supplies for the Highlands Region, and air filtration, which helps to reduce the effects of global warming through carbon sequestration. Forests also serve as habitat for animal and plant species and are critically important to maintenance of biodiversity in the Highlands Region. In addition, properly managed, they provide an important renewable source of wood products.

Historically, forests were the predominant land cover of the Highlands. Today, more than half of the Highlands Region consists of upland and wetland forested communities (approximately 453,941 acres or 53% of the total of land area). Despite increasing forest loss due to land development patterns, the Highlands Region still includes extensive areas of relatively intact forested tracts. More than half of the existing forests in the Highlands Region consist of contiguous forested tracts greater than 500 acres in size.

Protecting the integrity of Highlands forests is dependent on maintaining large contiguous forested areas and healthy forest stands. Large contiguous forest tracts have a higher degree of interior, or core, forest. Interior or core forests provide important ecological values. Core forest habitat is defined as a forest located more than 300 feet from altered land or a road. Approximately 43% of the total Highlands Region forest area is core forest habitat. It is important to note, however, that even these large contiguous areas may consist of many smaller parcels under individual ownership. This presents a significant challenge in efforts to manage forest for sustained ecological and water quality benefits.

Increased fragmentation of forest tracts is occurring due to land use alterations. This fragmentation results in quantifiable landscape level changes which include increased edge, reduced forest interior, increased number of patches, forest patch isolation, and reduced habitat area. Historical and current forest losses due to changes in land development patterns and poor management activities threaten the protection of the region's wildlife, water quality, air quality, and overall ecosystem health.

Sustainable forestry becomes more difficult as woodlot sizes decrease, particularly with increased suburbanization occurring around larger properties. Deer overabundance and introduction of non-native pest species are of significant threat to the region's forest. An overabundance of white tailed deer, in particular, is detrimental to forest health and regeneration due to over-browsing.

The Highlands Council assessed the ecological integrity of forests through the examination of landscape level characteristics at both the forest patch and subwatershed (HUC14) level, utilizing measures of forest fragmentation, to identify where regionally significant forests are located in the Highlands Region. These are the forests that are most suited to support ecological processes. The result of this assessment is the spatial delineation of the Forest Resource Area within the Highlands Region. The Forest Resource Area includes high ecological value forest areas including those forested areas that exhibit the least fragmentation and are vital for the maintenance of ecological processes.

The Highlands Council spatially delineated the Forest Resource Area by including those forested areas that express one or more of the following indicators – a contiguous forest patch of equal to or greater than 500 acres in size, an area consisting of >250 acres of core forest area greater than 300 feet from an altered edge, or areas that include >45% of mean total forest cover, and mean distance to nearest patch (HUC14 only).

In addition, the Highlands Council assessed forest cover integrity in the Highlands Region at the watershed level. Forests are important for the protection of water quality and quantity. To assess forest cover integrity at a subwatershed level, the Highlands Council assigned a value class to each of the 183 HUC14 subwatersheds in the Highlands Region as follows:

- High Integrity Forest Area – Predominantly forested, including a high proportion of forest cover consisting of high core area, large patch size, and a low distance to nearest patch.
- Moderate Integrity Forest Area – Predominantly forested, but do not exhibit a high proportion of forest cover, core area or patch size and an increase in distance to nearest patch.
- Low Integrity Forest Area – Predominantly non-forested or include low values for proportion of forest cover and patch size, or a high distance to nearest patch.

Each subwatershed within the Highlands Region was evaluated, using these indicators of forest watershed integrity to identify forested subwatersheds that provide important water quality benefits. The Forest Resource Area and the Forest Integrity Indicators are used in the Highlands RMP to achieve the protection of forest areas in the Highlands Region.

Alexandria contains 5,769 acres of Forest Resource Areas (3,176 acres in the Planning Area and 2,593 acres in the Preservation Area), as depicted in Figure 4. The Township contains 6,584 acres of Total Forest (4,864 acres in the Planning Area and 1,720 acres in the Preservation Area), as depicted in Figure 5. The HUC14 subwatershed scores for forest integrity for Alexandria are outlined in the table below and depicted in Figure 6.

HUC 14 Subwatersheds	HUC 14 Subwatershed Name	Forest Integrity Score
2030105020030	Mulhockaway Creek	High
2030105020060	Cakepoulin Creek	Low
2030105020070	Raritan R SB(River Rd to Spruce Run)	Low
2040105160050	Musconetcong R (I-78 to 75d 00m)	Moderate
2040105160060	Musconetcong R (Warren Glen to I-78)	Moderate
2040105170020	Hakihokake Creek	High
2040105170030	Harihokake Creek (and to Hakihokake Ck)	Low
2040105170040	Nishisakawick Creek (above 40d 33m)	Low
2040105170050	Nishisakawick Creek (below 40d 33m)	Low

Highlands Open Waters and Riparian Areas

Highlands Open Waters are a critical public trust resource and an essential source of drinking water for New Jersey. These waters and the associated Riparian Areas provide protection against floods and help to ameliorate the affects of prolonged droughts. They are also important habitat for numerous plant and animal species including many endangered and threatened in the State. Highlands Open Waters also provide a wealth of agricultural, recreational and aesthetic uses for both residents and visitors alike, helping to contribute to a vibrant regional economy.

Highlands Open Waters include all springs, wetlands, intermittent or ephemeral streams, perennial streams, and bodies of surface water, whether natural or artificial, located wholly or partially within the boundaries of the Highlands Region. Specific definitions for the various types of Highlands Open Waters follow:

- **Stream** – A surface water drainage channel with definite bed and banks. A stream can be perennial, intermittent, or ephemeral. Perennial streams have a permanent flow of water. Many perennial streams are shown as "blue line" watercourses on United States Geological Survey Quadrangle Maps. Intermittent and ephemeral streams do not have a permanent flow of surface water. Surface water flow in an intermittent stream generally occurs for several weeks or months, due to seasonal precipitation and/or ground water discharge to the channel. Surface water flow in an ephemeral stream generally occurs after rain events, and typically lasts a few hours to days following the rain event.
- **Lake/Pond** - Any impoundment of water, whether naturally occurring, or created in whole or in part by the building of structures for the retention of surface water.
- **Seep** – The natural movement of water from below ground to the ground surface, many times forming a pool.
- **Spring** – A point where ground water flows from the ground to the surface creating a flow of water, representing the point where an aquifer meets the ground surface. Springs may be ephemeral or perennial.
- **Vernal Pool** – NJDEP defines vernal habitat as the following (N.J.A.C. 7:7A-1.4): 1) occurs in a defined basin depression without a permanent flowing outlet; 2) features evidence of breeding by one or more species of fauna adapted to reproduce in ephemeral aquatic conditions as identified in N.J.A.C. 7:7A; 3) maintains ponded water for at least two continuous months between March and September of a normal rainfall year; and 4) is free of fish throughout the year, or dries up at some time during a normal rainfall year.
- **Wetland** – NJDEP defines a freshwater wetland as an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation; provided, however, that the Department, in designating a wetland, shall use the three-parameter approach (that is, hydrology, soils, and vegetation) enumerated in the 1989 Federal Manual as defined in N.J.A.C. 7:7A-1.4.

The Highlands Council prepared a Highlands Open Waters Inventory using three primary GIS-based spatial data sets: 1) NJDEP 2007 Land Use/Land Cover (LU/LC); 2) NJDEP 2002 Hydrography (HYDRO) mapping; and 3) the Highlands Council Supplemental Headwater Stream Delineation.

The Highlands RMP requires a 300 foot protection area buffer around all Highlands Open Waters. Key functional values that Highlands Open Waters buffers provide or contribute to include, but are not limited to, habitat, stormwater and flood water retention and filtration, water quality protection, temperature moderation, aquatic ecosystem integrity and channel integrity. The RMP features a mitigation requirement, which requires demonstration of no net loss of functional value of a protection area buffer through the conduct of a Highlands Open Waters buffer functional value assessment. The functional value assessment entails analysis of the following Highlands Open Waters buffer functions:

- **Habitat** – No net loss of instream food sources and no net loss of terrestrial and aquatic habitat functional value due to a shift to a less valuable overall vegetative condition in the protection buffer based on the following continuum from highest to lowest: forest or wetland, scrub/shrub, pasture or meadow, agriculture, maintained lawn, unpaved impervious surface, and other structures;
- **Water Quality** – A degradation of this functional value will occur if, as a result of the proposed land conversions, pollutant loads increase to the Highlands Open Waters;
- **Temperature Moderation** – A loss in temperature moderation functional value will occur if changes to the existing vegetation result in reduced shading of the Highlands Open Waters or stormwater that discharges to Highlands Open Waters. Further, a loss in temperature moderation functional value may occur with the heating of stormwater by new structures and other impervious surface. Mitigation approaches include removing or relocating impervious surfaces away from the Highlands Open Water or ensuring that stormwater temperature is reduced through shading or other techniques; and
- **Channel Integrity** – A loss of channel integrity functional value will occur if the project will result in: the loss of bank stabilizing vegetation; the placement of infrastructure that can be feasibly located outside the stream corridor; an increase in the peak rate of stream flow generated, or in localized scour potential, that will increase stream bank and stream bed erosion; or the removal or burial of aquatic habitat in any substantial part of a stream bed or for threatened or endangered species.

Riparian Areas are hydrologically connected to surface water through overland surface runoff, hydric soils, wetlands, or subsurface flow. They serve as an interface between surface water bodies (e.g., streams, rivers, lakes, or reservoirs) and terrestrial ecosystems. Riparian areas moderate fluctuations in water temperature, help maintain ground water recharge and stream base flow, stabilize stream banks, and provide flood storage areas. During high flow or overland runoff events, riparian areas reduce erosion and sediment loads to surface water and remove excess nutrients and contaminants from flood water. Riparian areas also provide habitat and for a variety of animal species and support terrestrial and aquatic food webs through deposition of woody debris.

Riparian areas in the Highlands Region were defined and mapped by the Highlands Council using hydrologic properties of land cover, soil, and evidence of periodic inundation or saturation. Riparian areas include the integration of Highlands Open Waters with their associated flood prone areas, riparian soils, and wildlife corridors. A single riparian GIS coverage was created by joining flood prone area, riparian soil, wetland and stream, and wildlife corridor coverages to create a combined riparian area map. Each is described in more detail below.

- **Highlands Open Waters** – Defined as all mapped rivers, lakes, streams and wetlands that are adjacent to and hydraulically interconnected with a river or stream as identified in the Highlands Open Water Inventory.
- **Flood Prone Areas** – Defined as NJDEP documented and undocumented flood prone areas and Federal Emergency Management Agency (FEMA) 100-year floodplain.
- **Riparian Soils** – Defined as a hydric soil, a soil exhibiting a shallow depth to seasonal high water table, or alluvial soil.
- **Wildlife Corridors** – Defined as a 300-foot corridor on each mapped stream bank or from the stream centerline if no stream bank is mapped.

Highlands Open Waters and Riparian Areas located within Alexandria are depicted in Figures 7 and 8, respectively. They include 91 miles of streams (80 miles in the Planning Area and 11 miles in the Preservation Area), 1,714 acres of wetlands, lakes, and ponds (1,508 acres in the Planning Area and 206 acres in the Preservation Area), 9,538 acres of open water protection areas (8,423 acres in the Planning Area and 1,115 acres in the Preservation Area), and 9,097 acres of riparian areas (8,197 acres in the Planning Area and 900 acres in the Preservation Area).

The Highlands Council utilized a watershed-based assessment to evaluate the integrity and protection needs of Highlands Open Waters at the HUC14 subwatershed level. The Highlands Council assigned a watershed value class to each HUC14 subwatershed in the Highlands Region based on a cumulative assessment of selected watershed indicators. The Council created the following watershed value classes for the Highlands subwatersheds:

- **High Resource Value Watershed** – A high resource value watershed contains predominantly forest lands and includes a significant portion of the watershed that is high quality habitat. A high value watershed typically consists of limited pre-existing developed land within the watershed;
- **Moderate Resource Value Watershed** – A moderate resource value watershed contains forest lands and some habitat suitable for rare, threatened, or endangered species, but typically also contains developed lands; and
- **Low Resource Value Watershed** – A low resource value watershed contains a low proportion of forest lands, a low proportion of habitat suitable for rare, threatened, or endangered species, and typically consists of higher levels of developed lands.

The Highlands Council's characterization of Riparian Area integrity entailed the examination of existing land use conditions within Riparian Areas, or those lands that are proximate to a surface water feature. The Council assigned a Riparian Area integrity value class to each HUC14 subwatershed in the Highlands Region, based on a cumulative assessment of selected watershed indicators, as follows:

- **High Integrity Riparian Area** – These areas include subwatersheds with Riparian Areas that exhibit predominantly natural vegetation, including high quality habitat for water/wetland dependent species, and a generally low incidence of impervious area, agricultural uses, and/or road crossings;

- **Moderate Integrity Riparian Area** – These areas include subwatersheds with Riparian Areas that contain a higher incidence of impervious area, agricultural uses, and road crossings, and a reduced

proportion of natural vegetation, including high quality habitat for water/wetland dependent species; and

- **Low Integrity Riparian Area** – These areas include subwatersheds with Riparian Areas that contain a high proportion of impervious area, agricultural uses, and road crossings, and minimal natural vegetation, including high quality habitat for water/wetland dependent species.

Watershed Values for subwatersheds located within Alexandria Township are depicted in Figure 9 while Riparian Integrity values are depicted in Figure 10.

Steep Slope Protection Areas

Steep slopes within the Highlands Region play an important ecological, recreational, scenic, and functional role. Steep slopes and rocky ridgelines provide specialized habitats that are home to rare plant and animal species. Areas of steep slope provide popular recreational opportunities including hiking, climbing and wildlife observation. Ridgelines, hillsides, and steep slopes provide scenic views and vistas, which contribute to the rural character of the Highlands Region and help to define the landscape.

Disturbance of areas containing steep slopes can trigger erosion and sedimentation, resulting in the loss of topsoil. Silting of wetlands, lakes, ponds and streams damages and degrades wetland and aquatic habitats, especially trout streams that are found throughout the Highlands and receive the State's highest water quality protections. Steep slope disturbance can also result in the loss of habitat quality, degradation of surface water quality, silting of wetlands, and alteration of drainage patterns. These processes, when severe, can also result in land slumping and landslides that can damage both developed property and ecosystems. The severity and extent of slopes, soil characteristics and land cover all affect the potential for damages from the disturbance of steep slopes. The identification and classification of steep slopes is important to effectively manage critical natural resources in the Highlands Region.

In order to address the requirements and goals of the Highlands Act, the Highlands Council conducted an analysis by classifying and mapping steep slopes within the Highlands Region to identify areas that are significantly constrained by steep slopes and to ensure that the level of protection for these areas is appropriate. The establishment of steep slope protection requirements is intended not to simply protect steep slope resources, but to ensure the protection of the natural, scenic, and other resources of the Highlands Region.

The Highlands Council spatially examined slopes in the Highlands Region using 2007 Light Detection and Ranging (LiDAR) elevation data. A Digital Elevation Model (DEM) was then generated from the LiDAR dataset. The DEM includes records of terrain elevations for ground positions at regularly spaced horizontal intervals. The Council examined areas of slope in the Highlands Region based on the LiDAR derived DEM that exhibited one of the following grade classifications. These grades were established as steep slope protection areas:

- Grades of slopes of 20 percent or greater;
- Grades of slope between 15 percent and 20 percent; and
- Grades of slope between 10 percent and 15 percent that occur within the Riparian Area.

All lands with slopes of 20% or greater and lands within Riparian Areas with slopes of 10% and greater are considered as Severely Constrained Slopes. All non-Riparian lands having a slope of 15% to less than 20% which are forested are considered Moderately Constrained Slopes. All non-Riparian Area lands having a slope of 15% to less than 20% which are non-forested with one or more of the following characteristics are considered Constrained Slopes: a) highly susceptible to erosion; b) shallow depth to bedrock; or c) a Soil Capability Class indicative of wet or stony soils. All non-Riparian Area lands having a slope of 15% to less than 20%, which are non-forested, are not highly susceptible to erosion, and do not have a shallow depth to bedrock or a Soil Capability Class indicative of wet or stony soils, are considered Limited Constrained Slopes.

Alexandria Township includes 346 acres of Moderately Constrained Slopes (152 acres in the Planning Area and 195 acres in the Preservation Area) and 3,188 acres of Severely Constrained Slopes (2,413 acres in the Planning Area and 775 acres in the Preservation Area). Each of the steep slope protection classifications within Alexandria Township is depicted in Figure 11.

Critical Habitat

Biodiversity is the variety of plant species, animal species, and all other organisms found in a particular environment and is a critical indicator of ecological viability. The protection of habitats that are critical to maintaining biodiversity contributes to the protection of rare, threatened and endangered plant and animal species of the Highlands Region.

The Highlands RMP defines three categories of Critical Habitat in the Highlands Region:

- **Critical Wildlife Habitat** – Habitats of animal species identified as endangered, threatened, of special concern, or of regional conservation priority in the Highlands Region;
- **Significant Natural Areas** – Regionally significant ecological communities, particularly for protection of endangered and rare plant species; and
- **Vernal Pools** – Confined, ephemeral wet depressions that support distinctive, and often endangered, species that are specially adapted to periodic extremes in water pool levels.

Critical Wildlife Habitat and Significant Natural Areas are designated based on the presence of species of concern. Vernal pools are certified by the NJDEP, and to protect and promote the biodiversity of Vernal Pools, the Highlands Council has determined that a terrestrial habitat protection buffer of 1,000 feet around Vernal Pools will generally address the habitat requirements of vernal pool-breeding wildlife.

The Highlands Council utilized NJDEP's Endangered and Nongame Species Program Landscape Project data to delineate suitable critical wildlife habitat for species of concern within the Highlands Region. A Landscape model (Version 3) was developed as a landscape level approach for the Highlands Region to identify areas of habitat based upon documented occurrences of rare, threatened and endangered wildlife species. It identifies the locations and types of critical wildlife habitat that are critically important to maintaining biological diversity in the Highlands Region.

The Landscape Project ranks habitat according to the status and distribution of wildlife species of concern. Landscape Ranks include the following:

- Federally Listed (5) – A wildlife species listed by the U.S. Fish and Wildlife Service as threatened or endangered.
- State Endangered (4) – A species listed on the official endangered wildlife list that the NJDEP promulgates pursuant to the Endangered and Nongame Species of Wildlife Conservation Act of 1973 (ENSCA).
- State Threatened (3) – A species designated as "threatened" on the list of nongame wildlife species that the NJDEP promulgates pursuant to ENSCA.
- Special Concern (S3) (2) – Nongame wildlife that are considered by the NJDEP to be species of special concern as determined by a panel of experts or S3 according to NatureServe methodology.
- Suitable (1) – Meets minimum habitat suitability requirements.

A Highlands Conservation Rank index was also assigned to each species occurrence based upon how critical the Highlands Region is to the continued existence of the species within the state. Following are the Highlands Conservation Ranks that were used:

- Critically Significant (3) – If habitats in the Highlands Region were lost, that species would not exist in the state.
- Significant (2) – Highlands Region habitats play a significant role for that species' existence in the state.
- Low Significance (1) – Highland Region habitats do not play an important role for that species' existence in the state.

Critical Wildlife Habitat in the Highlands Region is the acreage of rare, threatened and endangered species habitat (Landscape Rank 2 through 5 in the Preservation Area; Landscape Rank 3 through 5, and Rank 2 with a Highlands Conservation Rank of 2 or 3 in the Planning Area) in the Region. Of the Highlands Region's approximately 860,000 acres, there are approximately 529,271 acres (or 61% of the Region) that function as habitat for rare, threatened, or endangered species.

Significant Natural Areas are those Natural Heritage Program (NHP) Priority Sites within the Highlands Region that are regionally significant due either to the presence of rare or endangered plant species or unusual or exemplary natural ecological communities. The Highlands Council reviewed Priority Site boundaries using 2007 color orthophotography and the 2007 Land Use/Land Cover data to identify land use and land cover within and adjacent to NHP delineated Priority Sites. Where land use or land cover indicated a habitat disturbance or feature constraint, boundary lines were revised. Final revised boundaries of Priority Sites were identified as Highlands Significant Natural Areas. The Highlands Council may add Significant Natural Areas over time based on additional field survey results.

Vernal pools are unique ecosystems that:

- Provide critical breeding habitat for a variety of amphibian and invertebrate species;
- Contribute significantly to local biodiversity by supporting plants, animals, and invertebrates that would otherwise not occur in the landscape; and
- Contribute significant amounts of food to adjacent habitats.

Protecting vernal pools and adjacent habitat is important for maintaining ecological integrity and providing amphibian and invertebrate breeding habitat. Lands adjoining vernal pools are also important to protect the ecological integrity of these sites and provide for the life requisites of amphibians during the breeding and non-breeding season. Because of their complicated lifecycle, many amphibian species require open access to both terrestrial and aquatic environments. Because some salamanders (such as the Jefferson salamander, which is known to occur in the Highlands Region and is a State Species of Concern) appear to move farther from ponds, occasionally in excess of 1,900 feet, an even larger protected area or buffer zone around vernal pools would be necessary to protect these species. The Highlands RMP established a buffer of 1,000 feet surrounding each vernal pool.

For projects in the Highlands Preservation Area, definitions for endangered species, threatened species, and rare species are provided in NJDEP Preservation Area rules at N.J.A.C. 7:38-1.4.

Alexandria Township contains 8,205 acres of Critical Wildlife Habitat (6,289 acres in the Planning Area and 1,917 acres in the Preservation Area) suitable to support populations of rare, threatened, and endangered species, as depicted in Figure 12. These lands include habitat that supports species listed in the table below.

Species	Landscape Rank
Bog Turtle	5
Bobcat	4
Northern Harrier	4
Bobolink	3
Cooper's Hawk	3
Grasshopper Sparrow	3
Longtail Salamander	3
Savannah Sparrow	3
Wood Turtle	3
Eastern Meadowlark	2
Great Blue Heron Forage	2

The Township does not contain Significant Natural Areas, but includes 82 acres of vernal pool protection buffer (all within the Preservation Area), as depicted in Figure 14.

Land Preservation and Stewardship

Highlands Preserved Lands

The Highlands RMP and the *Land Preservation and Stewardship Technical Report* describe how the Highlands Council evaluated the status of land preservation in the Highlands Region. The technical report records the public and private resources that provide existing recreation and preserved lands for the Highlands Region. This inventory presents a catalog of the public and private land and water areas that have been preserved for conservation and recreation or are presently protected as open space and recreation facilities. The inventory considers significant recreation and conservation resources in the Highlands Region including:

- Public and private land and water areas available for active and passive recreation;
- Public and private land and water areas maintained as conservation areas dedicated to the preservation of natural and cultural resources;
- Lands that provide access to inland water bodies; and
- Other public or private lands that may not be directly accessible to the public but that enhance the open space system in the Highlands Region.

The inventory also includes preserved farmland in the Highlands Region, which generally is not available for public access except where used as part of agri-tourism.

Since the preserved lands data were acquired from numerous sources and measured at different scales, there may be discrepancies in the attribution of some sections of preserved open space or preserved farmland. Additionally, certain assumptions were made in the creation of the figures. After analyzing the available data the following statistics represent the status of open space and preserved farmland in the 859,268 acre Highlands Region.

Highlands Land Use/Land Cover of Preserved Lands by Acres

Of the total of 288,330 acres of open space and farmland known to be preserved in the Highlands Region as of 2011, 33,845 acres are in agriculture, 181,014 acres are forested, 18,394 acres are water bodies, 40,952 acres are wetlands, 13,693 acres are classified as urban, and 432 acres are barren. Urban land includes categories such as, buildings on open space, parking lots, military installations, county facilities, transportation, communication and utilities facilities, and cemeteries. Barren land includes bare exposed rock, rock slides, and disturbed lands. Of the 288,330 acres, 196,611 acres are in the Preservation Area and the remaining 91,719 acres are located in the Planning Area. NJDEP 2007 Land Use/Land Cover data were used to determine these statistics.

Ownership of Highlands Preserved Lands by Acres

Of the total of 288,330 acres of preserved open space and preserved farmland in the Highlands Region as of 2011, 9,283 acres are in federal ownership, 108,106 acres are in State ownership, 33,682 acres are in county ownership, 37,488 acres are in municipal ownership, 35,793 acres are preserved farmland, 17,809 acres in nonprofit/private ownership, 45,989 acres are water supply watershed lands, and 173.8 acres are Highlands TDR-Preserved Lands. Highlands TDR-Preserved Lands consist of Preservation Area lands from which development rights have been retired through the Highlands Transfer of Development Rights (TDR)

program. See the figure "Highlands Preserved Lands" and the table in the *Land Preservation and Stewardship Technical Report* Appendix A, "Highlands Preserved Lands."

Alexandria Township has reviewed the municipal data provided by the Highlands Council and updated the information as necessary, in support of the municipal build-out process as part of Plan Conformance Module 1 and 2. The municipality contains 2,818 total acres of Highlands Preserved Lands, as depicted in Figure 15. Preserved Farms are depicted in Figure 26 in the Agricultural Resources section. Preserved Lands are categorized as indicated in the following table.

Preserved Land Category	Acres
Preserved Farmland	1,919
Highlands TDR-Preserved Lands	0
Preserved Open Space	
Federal	0
State	595
County	336
Municipal	79
Non-Profit/Private	167
Water Supply Watershed Lands	0
Conservation Easements (where known)	0
Total Preserved Lands	3,096

Conservation Priority Areas

In addition to inventorying existing recreation and open space properties, the Highlands Council seeks to identify additional lands in the Region that should be protected in order to preserve their ecological and water supply value. To determine these priority areas for land preservation, the Highlands Council used the results of the Resource Assessment to identify those lands within the Highlands Region which have the highest ecological resource values. These values are based upon a combination of 33 ecological indicators which measure the quantity and quality of the following regional resource values: forests, watershed condition, critical habitat, prime ground water recharge areas, open waters and riparian areas, and steep slopes. The resources are not weighted, but rather are scored as an additive process (i.e., an area containing three resources would receive a score of three).

The Conservation Priority Areas displays a scale of the relative value of these resources in order to provide an initial prioritization mechanism for future land preservation activities in the Highlands Region that is consistent with the resource protection goals of the RMP. Because the priority system is GIS-based, it is possible to use the same data layers in different combinations, and to ascertain which resources resulted in a score for any area of land. The highest value areas contained a maximum of 31 criteria/indicators. The Conservation Priority Area consists of priority areas established by the Highlands Council in coordination with the NJDEP Green Acres Program. The Highlands Council acknowledges that municipalities may have

different mechanisms for setting priorities regarding future land preservation activities in the Highlands Region.

The 33 criteria used to determine the Conservation Priority Area are defined in detail in the *Land Preservation and Stewardship Technical Report*: Alexandria contains 2,041 acres of *Conservation Priority Areas* (1,204 acres in the Planning Area and 837 acres in the Preservation Area), as defined by the Highlands Council and depicted in Figure 16.

Carbonate Rock Areas

The term karst describes a distinctive topography that indicates dissolution of underlying carbonate rocks (such as limestone and dolomite) by surface water or ground water over time. This dissolution process causes surface depressions and the development of such features as sinkholes, sinking streams, enlarged bedrock fractures, caves, and underground streams. Sinking streams range in size from intermittent streams to perennial rivers. They may sink through a segment of the stream bed or through a discrete opening such as a fracture or cave entrance, and then reappear further downstream. Sinkholes function as funnels, directing surface water runoff into karst aquifers with little or no attenuation of any transported contaminants. Stormwater basins, septic system leaching fields, sewers, agricultural runoff, lawn runoff, underground pipelines, and soil disturbance may also contribute contaminants directly to ground water through karst features. Soils in sinkhole bottoms may be thin or non-existent. In addition to ground water concerns, communities in karst areas must contend with safety concerns. Sinkholes present a geologic hazard as they may undermine such infrastructure as stormwater basins, roads, sewer lines, septic systems, and natural gas lines.

Beyond the potential deleterious effects of karst areas with respect to ground water and public safety, karst features provide natural, scenic, and recreational resource values. Karst aquifers are high yielding, particularly where carbonate rock is overlain by permeable materials such as glacial sands and gravels. These prolific aquifers have significance as water supplies and are extremely vulnerable to contamination. Karst areas often offer unique topographic features and opportunities for outdoor recreation. They typically occupy valley bottoms, producing dramatic contrasts in relief and valuable scenic vistas, especially when viewed from the higher elevations of ridges. Carbonate rock areas also offer unique habitats that contribute to the Region's biodiversity

The Highlands Council utilized existing New Jersey Geologic Survey and United States Geological Survey data to map areas of the Highlands Region that are underlain by carbonate rocks. These areas collectively are referred to as Carbonate Rock Areas. Because changes in the quantity, quality, and rate of discharge of surface water runoff from upslope lands can impair ground water resources in the Carbonate Rock Area, lands that drain surface water into the Area will be delineated by the Council using LiDAR topographic analyses or other topographic data where LiDAR data are not available.

Management of development activities in Carbonate Rock Areas is necessary to address the potential problems that are common to karst areas. The site assessment and design process can be modified for karst areas to allow applicants, municipalities and the Council to identify any karst concerns at a site and to incorporate appropriate design features in order to minimize future sinkhole (or other karst feature) formation, damage to development, and the potential for ground water contamination.

Alexandria Township contains approximately 43 acres of Carbonate Rock Areas (1 acre in the Planning Area and 42 acres in the Preservation Area), as depicted in Figure 18.

Water Resources Availability

The availability of water for human use is a critical factor in determining the capacity for growth and continued economic vitality for both existing development and agriculture within and outside the Highlands Region. The availability of water for ecological purposes is critical to sustaining the aquatic ecosystems of streams, ponds and lakes. The Highlands RMP provides a Net Water Availability analysis for identifying the quantity of available water resources in the region, which is used to identify areas where water resources are, or are not sufficient to support existing human and ecological uses, and to support future uses.

The Net Water Availability analysis examines stream base flows as a surrogate for water sustainability because the protection of base flow is critical to maintaining healthy aquatic ecosystems and protecting potable surface water supplies, particularly during periods of drought. Overuse of water can reduce base flows, impair ecological function and integrity, and reduce the reliability of potable water supplies.

The Highlands Council selected the Low Flow Margin (LFM) method for this analysis, which considers the severity and duration of low flows as a reasonable surrogate for ecosystem and water supply impacts. The Low Flow Margin yields a value called Ground Water Capacity, expressed in million gallons per day (MGD), for each HUC14 subwatershed. The HUC14 subwatershed, which generally is between 10 and 20 square miles, was selected as the smallest drainage area available for application of the method.

A key issue for water availability is to what extent the estimated Ground Water Capacity should be made "available" for both current and future human uses, factoring in the nature of the environmental resources and conservation objectives of the RMP and respective zone goals of Land Use Capability Map. The resulting quantity, defined as Ground Water Availability, must be conservative and sensitive to varied ecological needs within the region, among other factors. In more ecologically sensitive HUC14 subwatersheds, this amount should be limited in order to protect aquatic ecosystems and the related terrestrial ecosystems. The RMP sets Ground Water Availability thresholds of 5%, 5% and 20% percent for Protection Zone, Conservation Zone and Existing Community Zone, respectively, plus a 10% availability threshold dedicated only for agricultural uses in the Conservation Zone. When Ground Water Capacity is multiplied by the appropriate threshold, Ground Water Availability is derived.

Ground Water Availability = (Ground Water Capacity * % Water Availability Threshold)

After Ground Water Availability has been calculated, the amount of water currently being used must be factored in, as this will reduce the amount remaining for future uses. A significant amount of water use is either consumptive (not returned as recharge) or depletive (exported out of the watershed). Both consumptive and depletive water uses reduce the amount of water available to sustain human activity and the integrity of water resources. The RMP calculated maximum monthly consumptive and depletive use that are not supported by reservoir storage or safe yields for each HUC14. Wastewater discharges were identified and estimated to account for returns to the subwatershed. When consumptive and depletive demands are subtracted from Ground Water Availability, the remainder is called Net Water Availability. The formula for Net Water Availability is as follows:

Net Water Availability = (Ground Water Availability) – (Consumptive/Depletive Water Use)

Where Net Water Availability is positive, it is assumed there is water available beyond existing demands. This availability must not be exceeded, so that new deficits are avoided in the future. Where Net Water

Availability is negative, existing uses are exceeding sustainable supplies and the subwatershed is deemed to be a Current Deficit Area. In addition, maintenance of stream flows within any HUC14 subwatersheds upstream of a Current Deficit Area is necessary without further impairing the ecological health of the stream. These areas, classified as Existing Constrained Areas, have their Ground Water Availability threshold adjusted to 5% more than the existing consumptive/depletive uses or the default threshold for the Zone, whichever is lower. Where water resources are stressed, additional planning and mitigation is necessary.

Net Water Availability volumes for Highlands subwatersheds is illustrated in Figure 20 in millions of gallons per day (MGD). Alexandria is located within nine different subwatersheds, as depicted in Figure 3. Of these, four are calculated to be in deficit, as indicated by a negative value for volume of net water availability.

HUC 14 Subwatersheds	HUC 14 Subwatershed Name	Net Water Availability (MGD)
2030105020030	Mulhockaway Creek	0.07098
2030105020060	Cakepoulin Creek	0.02105
2030105020070	Raritan R SB(River Rd to Spruce Run)	0.1992
2040105160050	Musconetcong R (I-78 to 75d 00m)	0.07355
2040105160060	Musconetcong R (Warren Glen to I-78)	**-0.1654**
2040105170020	Hakihokake Creek	**-0.1166**
2040105170030	Harihokake Creek (and to Hakihokake Ck)	**-0.1947**
2040105170040	Nishisakawick Creek (above 40d 33m)	0.03962
2040105170050	Nishisakawick Creek (below 40d 33m)	**-0.0211**

Prime Ground Water Recharge Areas

In the hydrologic cycle, when precipitation occurs over the land surface a majority of it will be returned back to the atmosphere through evaporation. Some of it will flow over the surface in a process known as overland flow or runoff, to lakes and other open water bodies which then flow into streams and eventually to the ocean where the cycle begins again. A small percentage of precipitation that reaches the land surface will find its way into the subsurface in a process known as infiltration. Where infiltration reaches the water table, it is considered ground water recharge, and the overlying land areas are classified as ground water recharge areas. Ground water recharge areas can be defined as locations within a drainage basin where meteorological, ecological, geological and hydrogeological factors are conducive to infiltration of water from the surface into the subsurface. The factors that determine recharge potential are:

- **Precipitation**: The primary meteorological factor controlling infiltration. The amount of precipitation and its characteristics such as intensity and duration control the overall volume of water that is available for infiltration.
- **Evapotranspiration**: The combined evaporation from streams, open water bodies and land surfaces, and transpiration from plants. Of all the precipitation that falls within a drainage basin, a majority will be returned back to the atmosphere as evapotranspiration. Evapotranspiration rates are controlled by a combination of meteorological factors such as temperature, relative humidity and wind speed, and ecological factors such as type of vegetation, soil type and the size and volume of a water body.
- **Anthropogenic**: Development and land use factors such as the extent of urbanization, suburban areas, industrial zones, the presence of sewer service areas, public and private water supply wells, reservoirs, and septic system densities, cultural and historical and agricultural activities. Anthropogenic factors are the primary non-meteorological factor affecting infiltration.
- **Ecological Factors:** The types of vegetation, the density of forested areas, wetlands, vernal pools, critical habitat and riparian buffer zones.
- **Geological Factors:** Soil type and characteristics, depth to bedrock, rock type and its characteristics, rock outcroppings, faulting, and topography.
- **Hydrogeological Factors:** Depth to ground water, soil permeability, rock type porosity, the presence or absence of fractures and wellhead protection areas.

Once into the subsurface, the infiltrated water under the pull of gravity will move down through the soil root zone to zones of saturation to become ground water. A portion of this ground water will become ground water runoff or ground water base flow which is ground water that migrates horizontally along zones of lower permeability soil or along the soil-bedrock interface and more quickly exits the drainage basin as stream flow. Some ground water will move further downward to enter an aquifer system where it can be used as a water-supply resource, or will eventually migrate to surface waters and again exit the drainage basin as stream flow.

The Highlands Council defines Prime Ground Water Recharge Areas as those lands within a HUC14 subwatershed that most efficiently provide 40 percent of total drought recharge volume for that HUC14 subwatershed, as defined using a GSR-32 analysis available based upon the 2002 land use/land cover and 1964-1966 drought of record precipitation.

Prime Ground Water Recharge Areas are not stand alone features, but instead are totally interrelated to local anthropogenic, ecological, geological and hydro-geological conditions which function as constraints that

control the degree of infiltration and hence the volume of water that is recharged to ground water base flow and aquifer systems. Changes in anthropogenic factors, particularly land use, greatly affect the degree of infiltration and water quality within a ground water recharge area by changing the ecological, geological and hydro-geological constraining factors. These changes can be controlled through the land development regulatory process.

Alexandria Township contains 5,462 acres of Prime Ground Water Recharge Areas (4,180 acres in the Planning Area and 1,282 acres in the Preservation Area), as depicted in Figure 21.

Water Quality

Water quality affects drinking water, recreation, ecosystems, and aesthetic beauty. The most commonly found parameters that indicate poor surface and ground water quality are fecal coliform bacteria, phosphorus, temperature, arsenic, and nitrate-nitrogen. These and other contaminants can either cause health risks if ingested or harm native biota, resulting in non-attainment of designated water uses for the water body.

Water quality is influenced by the type and intensity of land use adjacent to and upstream of the water body. Pollutants are contributed to the environment from a wide variety of nonpoint sources (NPS) including human development (through stormwater and residential runoff, septic systems, fertilizer applications on lawns, and Brownfields or contaminated sites), domestic or captive animals, agricultural practices (crop farming, livestock, and manure applications), and wildlife (large populations). Pollutants from these sources can reach water bodies directly, through overland runoff, or through stormwater conveyance facilities. Point sources also exist, primarily wastewater treatment plants serving communities or industrial facilities. Each potential source will respond to one or more management strategies designed to eliminate or reduce that source of pollution. Each management strategy has one or more entities that can take lead responsibility to effect the strategy. Various funding sources are available to assist in accomplishing the management strategies.

Section 303(d) of the Federal Water Pollution Control Act (33 U.S.C. 1313(c)), commonly known as the Clean Water Act, requires states to identify "Impaired Waters" where specific designated uses are not fully supported. Known as the 303(d) list, this list identifies the name of the water body and the pollutant or pollutants causing the water body to be listed as impaired. Section 305(b) of the Clean Water Act also requires states to periodically assess and report on the overall quality of their waters. With guidance from USEPA, in 2002 the NJDEP integrated the 303(d) report with the 305(b) report into one report titled the New Jersey Water Quality Monitoring and Assessment Report (Integrated Report).

The 2006 Integrated Report identifies river segments and lakes of attainment of each of several designated uses. Designated Uses include Aquatic Life (general), Aquatic Life (trout), Primary Contact Recreation, Secondary Contact Recreation, Drinking Water Supply, Agricultural Water Supply, Industrial Water Supply, Shellfish Harvest, and Fish Consumption. The Integrated List lists the attainment of HUC14s of designated uses based on six categories as follows:

- Sublist 1: The designated use is assessed and attained AND all other designated uses in the assessment unit are assessed and attained. (Note: The fish consumption use is not used for this determination based on USEPA guidance).
- Sublist 2: The designated use is assessed and attained BUT one or more designated uses in the assessment unit are not attained and/or there is insufficient information to make a determination.
- Sublist 3: Insufficient or no data are available to determine if the designated use is attained.
- Sublist 4: The designated use is not attained or is threatened; however, development of a TMDL (Total Maximum Daily Load) is not required for one of the following reasons:

    a. A TMDL has been completed for the pollutant causing non-attainment.
    b. Other enforceable pollution control requirements are reasonably expected to result in the conformance with the applicable water quality standard(s) in the near future and the designated use will be attained.
    c. Non-attainment is caused by something other than a pollutant (e.g. "pollution"), such as natural conditions.

- Sublist 5: The designated use is not attained. The waterbody is impaired or threatened for the designated use by a pollutant(s), and requires a TMDL.
- N/A: Designated use does not apply.

Sublist 4 and Sublist 5 indicate that a water body is not attaining the designated use. The Water Resource Technical Report Volume 1: Watersheds and Quality Appendix B contains a table of Designated Use attainment in the Highlands Region, and Appendix D of the Technical Report displays the Spatial Extent of Designated Uses.

The 2006 Integrated Report also categories Impaired Waters by HUC14. The List of Impaired Waters identifies the parameters that a HUC14 does not attain with Priority Ranking from high to low. Parameters listed include metals, nutrients, pathogens, etc. Appendix E of the Water Resource Technical Report Volume 1: Watersheds and Quality identifies the spatial extent of parameters not meeting water quality standards.

Section 303(d) of the Clean Water Act requires TMDLs to be developed for water bodies that cannot meet surface water quality standards after the implementation of technology-based effluent limitations. A TMDL defines the pollutant load that a water body can assimilate without causing violations of water quality standards, and allocates the loading between contributing point sources and source categories. It is a mechanism for identifying all contributors to surface water quality impacts and setting pollutant load reduction goals to meet surface water quality standards. TMDLs may also be established to help maintain or improve water quality in waters that are not impaired. New Jersey's TMDL regulations are in N.J.A.C. 7:15-7 (Water Quality Management Planning rules). The RMP figure *Impaired Waters Overall Assessment by HUC 14* displays the status of designated uses for waterbodies by the subwatersheds (HUC14) within the Highlands Region. Water Resource Technical Report Volume 1: Watersheds and Quality Appendix H outlines TMDLs that have been established by NJDEP divided by Watershed Management Areas.

Appendix B of the Highlands Council Water Resource Technical Report Volume 1 (http://www.highlands.state.nj.us/njhighlands/master/tr_water_res_vol_1.pdf) includes a table that lists Designated Use Support status by HUC14 subwatershed and is organized by Watershed Management Areas (WMA). This table identifies HUC14s and lists, in columns, the use and HUC14 attainment status for each use.

The individual pollutants responsible for the non-attainment of the designated uses in Appendix B are identified in NJDEP's Integrated Water Quality Monitoring and Assessment Report 2006 (http://www.nj.gov/dep/wms/bwqsa/2006IntegratedReport.pdf) Appendix B "303(d) List of Impaired Waterbodies with Priority Ranking". This list is organized numerically. The pollutant is listed if known or "pollutant unknown" or "toxic unknown" is used when the pollutant is not known.

Appendix H of the Highlands Council Water Resource Technical Report Volume 1 (http://www.highlands.state.nj.us/njhighlands/master/tr_water_res_vol_1.pdf) identifies TMDLs that are established within the Highlands Region. Appendix H is organized WMA and within each WMA the report is organized by parameter (e.g., fecal coliform, phosphorus, temperature, etc).

Information regarding designated use status, pollutants responsible for non-attainment, and TMDL status is summarized in the table below for Alexandria regarding the HUC14 subwatersheds that are located entirely or partially within the municipality.

The table below clarifies which HUC14 subwatersheds in the Township have impairments (depicted in Figure 22).

HUC 14s Located Entirely or Partially in the Municipality	Designated Use Support Status								Parameters Not Attained	TMDL(s)
	Drinking Water	Primary Recreation	Aquatic Life	Trout Support	Industrial	Agricultural	Fish Consumption	Secondary Recreation		
02030105020030 Mulhockaway Creek	2	4A	5	5	2	2	3	3	Temperature	Fecal Coliform
02030105020060 Cakepoulin Creek	2	3	5	5	2	2	3	2	DDX, Phosphorus	N/A
02030105020070 Raritan R SB(River Rd to Spruce Run)	2	3	2	2	2	2	3	3	N/A	N/A
02040105160050 Musconetcong R (I-78 to 75d 00m)	2	4A	2	2	2	2	3	3	N/A	Fecal Coliform
02040105160060 Musconetcong R (Warren Glen to I-78)	2	4A	2	2	2	2	3	3	N/A	Fecal Coliform
02040105170020 Hakihokake Creek	2	4A	2	2	2	2	3	3	N/A	Fecal Coliform
02040105170030 Harihokake Creek (and to Hakihokake Ck)	2	3	5	5	2	2	3	3	Phosphorus	N/A
02040105170040 Nishisakawick Creek (above 40d 33m)	2	4A	5	N/A	2	2	3	3	pH	Fecal Coliform
02040105170050 Nishisakawick Creek (below 40d 33m)	2	4A	5	N/A	2	2	3	3	pH	Fecal Coliform

Wellhead Protection

Residents of Alexandria Township rely on ground water supplies as a primary source of drinking water. To protect the health, safety and welfare of Alexandria Township residents, to ensure a supply of safe and healthful drinking water, and to protect the ground water resources that provide water to potable water supply wells are the primary goals of Alexandria Township.

Achieving this goal requires the establishment of a Wellhead Protection Ordinance. An effective Wellhead Protection Ordinance establishes Wellhead Protection Areas (WHPAs) around public community wells, defined as public water supply wells serving at least 15-service connections used by year-round residents regularly serving at least 25-year round residents, and non-community water supply wells defined as public water supply wells that are not public community wells and regularly service at least 25-individuals for at least 60-days in any given calendar year. WHPAs are mapped areas that delineate the horizontal extent of ground water captured by pumping at a specific rate. Once a well is located on the New Jersey Department of Environmental Protection's Geographic Information System database, a WHPA is mapped based upon time of travel, which is the amount of time it will take for ground water to flow to the well. In New Jersey, well head protection ordinances use three tiers based upon a 2-year, 5-year and 12-year time of travel.

- Tier 1 is a two-year time of travel to reflect the potential for bacterial and viral contaminant movement.
- Tier 2 is equivalent to a five-year time of travel based upon limitations on technological options for preventing long-lived contaminants from reaching a well without interfering with well function.
- Tier 3 is equivalent to a twelve-year time of travel, the longest times of travel customarily seen in New Jersey for plumes of long-lived contaminants.

Alexandria Township includes 4 Public Community Water Supply wells (all located in the Planning Area) and 12 Public Non-community Water Supply wells (11 located in the Planning Area and 1 in the Preservation Area) for which Wellhead Protection Areas have been delineated, as depicted in Figure 23.

Septic System Yield

Septic system yield is used as a method for minimizing the potential for contamination of ground water. Discharges to ground water from septic systems have the potential to damage the quality of aquifers, reducing their utility as drinking water supplies. They also can damage surface water quality, through the flow of contaminated ground water to natural discharge points such as springs, seeps or stream baseflow. Because septic systems are closely associated with the non-point source effects of non-sewered development, septic system yield is a useful indicator of the potential impacts to ground water quality. Protection of ground water quality requires appropriate septic system yields to ensure that future development utilizing septic systems provide for sufficient dilution of effluent discharges.

To this end, the RMP outlines a methodology for computing appropriate septic system yields within the Planning Area portion of the municipality. Within the Preservation Area portion, NJDEP establishes specific regulatory approaches applicable to Major Highlands Development, including an objective of nondegradation for ground water regarding new septic systems. NJDEP Highlands' regulations have established septic system densities of one unit per 88-acres and 25-acres for forested and non-forested Preservation Area lands, respectively. The Highlands RMP adopts these standards as well for application to Major Highlands Development in the Preservation Area.

Within the Planning Area of the municipality, the Highlands Council's methodology applies. This methodology relies upon a number of different modeling approaches and analytical techniques that estimate at the subwatershed scale: 1) annual drought ground water recharge rate; 2) septic system density required for sufficient septic system effluent dilution, and 3) an estimate of the total number of allowable septic system units (septic system yield) from developable land within each Land Use Capability zone in the municipality. For application to non-Major Highlands Development in the Preservation Area, the same methodology applies but only at the project scale – no septic system yield is calculated within the Preservation Area.

Since Alexandria Township is not conforming to the Planning Area RMP standards, the Highlands Council's methodology for calculating septic system yield does not strictly apply in the Planning Area portion of Alexandria Township as indicated in septic system density calculations below.

Target Nitrate Concentrations

Computing appropriate septic system densities requires setting target nitrate concentrations in ground water at the subwatershed scale. Nitrate serves as a target indicator contaminant not only for septic systems, but also as a surrogate for other contaminants of concern that can affect ground water quality. Nitrates are stable in ground water, can travel long distances within the septic system plume, are a commonly measured contaminant with inexpensive sampling, and have been shown to have a good association with other contaminants (i.e., where the other contaminants are found, nitrate levels tend to be elevated above natural levels). The Highlands Council has established the following target nitrate concentrations in each of the following Land Use Capability zones:

Existing Community Zone: 2 mg/L (used on a case-by-case basis, only)
Conservation Zone: 1.87 mg/L
Protection Zone: 0.72 mg/L

Septic System Density

From a water quality protection perspective, appropriate septic system density is necessary for ensuring that over a regional planning area, septic system effluent does not produce median nitrate concentrations in ground water that exceed a specific target nitrate concentration. Septic system density essentially estimates the area required to provide enough natural recharge that will dilute septic system effluent to the target nitrate concentration.

To calculate appropriate septic system density, the RMP utilizes the Trela-Douglas nitrate dilution model factoring in the target nitrate concentrations, septic system nitrate loads, and estimated annual drought recharge rates. Annual recharge is calculated in each subwatershed using NJGS's GSR-32 method, which uses local climate, soil type, and land cover characteristics to estimate annual ground water recharge. In order to be protective of ground water quality, New Jersey drought of record was used to predict extreme climatic conditions. With the conversion factors of 245 and 94.3 included, the Trela-Douglas equation (shown below) can be used to calculate the unique Protection Zone and Conservation Zone septic system density within each subwatershed:

Protection Zone Septic System Density (acres) = 245 ÷ (HUC14 annual drought recharge rate in inches)

Conservation Zone Septic System Density (acres) = 94.3 ÷ (HUC14 annual drought recharge rate in inches)

Alexandria is located within subwatersheds depicted in Figure 3. The septic system density is computed by using the drought recharge rate in the Trela-Douglas equation, as previously explained. The estimated drought recharge rates and resulting Protection Zone and Conservation Zone septic system densities are shown in the following table.

HUC 14 Subwatersheds	HUC 14 SW Name	Drought Recharge Rate (inches/year)	Septic System Density (acres/unit)	
			Protection Zone	Conservation Zone
2030105020030	Mulhockaway Creek	9.5	25.8	9.9
2030105020060	Cakepoulin Creek	7.9	31.0	11.9
2030105020070	Raritan R SB (River Rd to Spruce Run)	9.0	27.2	10.5
2040105160050	Musconetcong R (I-78 to 75d 00m)	8.9	27.5	10.6
2040105160060	Musconetcong R (Warren Glen to I-78)	7.8	31.4	12.1
2040105170020	Hakihokake Creek	7.6	32.2	12.4
2040105170030	Harihokake Creek (and to Hakihokake Ck)	8.2	29.9	11.5
2040105170040	Nishisakawick Creek (above 40d 33m)	8.2	29.9	11.5
2040105170050	Nishisakawick Creek (below 40d 33m)	7.5	32.7	12.6

Septic System Yield

Following computation of an appropriate septic system density, the number of additional allowable septic systems in the municipality is calculated based upon the existing developable land area. For the calculation of

septic system yield, the developable land area consists of two general classes: undeveloped parcels and over-sized (underdeveloped) parcels. Assuming they have sufficient land area, these latter parcels have the potential to accommodate an additional septic system if subdivided. When the amount of developable land is divided by the septic system density (while respecting the unique septic system density and recharge in each subwatershed and each Land Use Capability Zone), the septic system yield is computed. Alexandria will calculate the septic system yield values after a municipal build-out is performed.

Agricultural Resources

The Highlands RMP and the *Sustainable Agriculture Technical Report* describe the Agricultural Resource Area (ARA) and the resource values used to define the ARA. The ARA consists of those areas of the most concentrated, contiguous agricultural uses, using Important Farmland Soils as a critical factor in the Highlands Region.

A healthy agricultural environment and an agricultural land base are necessary to promote long-term sustainability of agricultural resources and the viability of the agricultural industry in the Highlands Region. The Highlands RMP promotes preservation in the ARA and limits non-agricultural uses within the ARA to those that support the preservation of farmland, avoid conflicts with agriculture, maintain and enhance the sustainability and continued viability of the agricultural industry, protect Important Farmland Soils, and meet resource management and protection requirements of the RMP. Where it is not feasible to preserve agricultural lands within the ARA by such methods as fee simple acquisition, easement acquisition, or a TDR Program, the Highlands RMP requires mandatory clustering for residential development in an ARA. Clustering is mandatory for residential development within the ARA regardless of the underlying Land Use Capability Zone. However, the majority of the ARA is within the Conservation Zone and the Conservation Environmentally Constrained Sub-Zone.

In order to identify critical agricultural lands in the Highlands Region, the Highlands Council examined the Region's agricultural resources and evaluated them specifically considering the realities of farming in the Highlands Region. The Council then utilized the following criteria to assess the Region's farmland and identify the Region's most important agricultural resources: contiguous farming landscapes; farms that include Important Farmland Soils; the extent of lands adjoining a farm that are in agricultural use; and concentrations of existing preserved farmland. An examination of these factors permitted the Highlands Council to spatially delineate areas in the Highlands Region, with a prevalence of active farms to develop the ARA. The categories mapped within the ARA are defined below.

Preserved Farmland

The New Jersey Department of Agriculture (NJDA) State Agriculture Development Committee (SADC) Farmland Preservation Program provides spatial files to the Highlands Council, which include farms that are preserved, farms that have final approval from the SADC, and farms under the eight year easement program.

All Agricultural Uses

All agricultural uses were derived from the NJDEP 2007 Land Use/Land Cover spatial files.

Important Farmland Soils and Soil Quality

The Highlands RMP considers the four soil types of Prime, Statewide Importance, Unique, and Locally Important soils as Important Farmland Soils which are critical agricultural resources of the Highlands Region. The primary factor used in determining important farmland is soil quality, which is measured based on land capability classes, important farmland classes, and soil productivity rating. Soil data are prepared by the United States Department of Agriculture (USDA), Natural Resources Conservation

Service (NRCS) and are used as the reference to identify soil quality. Usually a percentage figure for each of these four soil categories is calculated for the entire farm targeted for preservation.

Prime farmland soil has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to produce high yields of crops when treated and managed according to acceptable farming methods. Prime farmland soils 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.

Farmland of Statewide Importance soils are similar to Prime farmland soils and produce high yields of crops when treated and managed according to acceptable farming methods. This soil may support yields as high as Prime farmland if conditions are favorable. Farmland of Locally Important soils include those soils that are not Prime or Statewide Importance and are used for the production of high value food, fiber, or horticultural crops.

Unique farmland soils are soils used for special crops (such as cranberries in the New Jersey Pinelands). Unique soils are determined on a statewide basis by the State Soil Conservation Committee. Locally Important soils are generally defined through county ranking processes, rather than by the NRCS.

The USDA, NRCS, Soil Survey Geographic (SSURGO) Database for farmland soil quality including Prime, Statewide, Unique, and Locally Important farmland soils can be found at the following link: http://soildatamart.nrcs.usda.gov/SSURGOMetadata.aspx

Agricultural Priority Areas

In order to determine the priority areas for farmland preservation, the Highlands Council, in coordination with the NJDA and the SADC, utilized the results of the agricultural resource assessment to identify those lands within the Highlands Region that have the highest agricultural resource values. The Agricultural Priority Area (APA) displays the relative value of these agricultural resources in order to provide a prioritization mechanism for future farmland preservation activities in the Highlands Region. The seven indicators used to determine the APA are: ARAs; Important Farmland Soils – Undeveloped; Preserved Farms; Contiguous Farms greater than 250 acres; Agricultural Uses 10 acres or greater; 50% or greater Prime Soils; and ¼ mile proximity to Preserved Farms. The *Land Preservation and Stewardship Technical Report* describes the seven indicators and the development of the APA. The APA consists of priority areas established by the Highlands Council in coordination with the NJDA and the SADC Farmland Preservation Program. The Highlands Council acknowledges that municipalities may have different mechanisms for setting priorities regarding future farmland preservation activities in the Highlands Region.

Alexandria contains 17,698 acres of Agricultural Resource Areas (14,977 acres in the Planning Area and 2,721 acres in the Preservation Area) and 11,037 acres of Agricultural Priority Areas, (10,309 acres in the Planning Area and 728 acres in the Preservation Area), as depicted in Figures 24 and 25, respectively. Alexandria contains 1,919 acres of Preserved Farms (all within the Planning Area); 7,092 acres designated All Agricultural Uses (6,626 acres in the Planning Area and 465 acres in the Preservation Area) and 10,854 acres of Important Farmland Soils (10,053 acres in the Planning Area and 801 acres in the Preservation Area), as depicted in Figures 26 and 27, respectively.

Historic, Cultural, and Archaeological Resources

The Highlands RMP identifies protection and preservation of the historic, cultural and archaeological resources of the Highlands as a resource protection goal. In compliance with the directive of the Highlands Act, to assess the "scenic, aesthetic, cultural, historic, open space, farmland, and outdoor recreation resources of the region, together with a determination of overall policies required to maintain and enhance such resources;" the RMP requires every conforming municipality and county to include a historic preservation plan element as part of their local master plan.

From the first Native American settlements over ten thousand years ago, to the colonial period and Revolutionary War, to the early industrial age and up to the modern day, the Highlands Region has enjoyed a rich historical and cultural heritage. Many buildings, archaeological sites, ruins and artifacts remain. Examples include Native American settlements in the Ramapo Mountains, Washington's encampment in Morristown, the furnaces in Oxford, Wawayanda, Norton and Andover, the Morris Canal, the mines in Ogdensburg and Franklin, the Picatinny Arsenal, the Hibernia School House and many, many others. Cultural resources are part of the character of the Highlands Region and protecting these resources is vital to protecting that essential character. They preserve the Region's history and provide a link to its past. They provide evidence of significant human and environmental events, and they provide vital information about how the people in this Region lived, worked and recreated.

The Highlands Region Cultural Resources Inventory includes 8,289 historic sites and districts within the Region as of June 2011. The Inventory also lists four National Park Service National Historic Landmarks and 70 recorded archaeological sites. The Historic and Cultural Resource Inventory includes: 1) all properties listed on the State or National Register of Historic Places; 2) all properties which have been deemed eligible for listing on the State or National Register; and 3) all properties for which a formal State Historic Preservation Office (SHPO) opinion has been issued. The Highlands Region Historic and Cultural Resource Inventory is a dynamic inventory and will automatically be updated according to SHPO's additions or deletions.

The Highlands Region Historic, Cultural, and Archaeological Resources data layer for the Township of Alexandria as of June 2011 is depicted in Figure 28. SHPO lists nine Historic, Cultural and Archaeological resources for the Township, all included in the Highlands Historic, Cultural, and Archaeological Resources Inventory, as follows:

1) Abbott Taylor Farmstead, 45 Mt. Salem Road (SHPO ID #4762)
2) Curtis Paper Mill Historic District , Frenchtown Road (SHPO ID #4197)
3) Everittstown Historic District, Intersection of NJ Routes 12 & 15, and Palmyra Rd (SHPO ID #1558)
4) Little York Historic District, County Rte 614 & Sweet Hollow Rd (SHPO ID #1559)
5) Little York Historic District Addendum, Old York Rd (SHPO ID #4213)
6) Mount Pleasant Historic District, County Rte 519 & Rick Rd (SHPO ID #1561)
7) Mount Salem Methodist Episcopal Church, County Rte 579(SHPO ID #1562)
8) Pittstown Historic District, Pittstown & Quakertown Roads & Race St (SHPO ID #1589)
9) St. Thomas Episcopal Church, Sky Manor Rd (SHPO ID #1563)

Sites that are also of interest to the municipality and possibly suited for nomination for inclusion in the Highlands Inventory include: Martin Mine, Petty Mine, Wright Mine, and three unnamed mines.

Scenic Resources

Protection of the scenic resources of the Highlands is one of the goals of the Highlands Act. Among the goals for the Preservation Area of the Highlands, the Act calls for the Regional Master Plan to "protect the natural, scenic, and other resources of the Highlands Region, including but not limited to contiguous forests, wetlands, vegetated stream corridors, steep slopes, and critical habitat for fauna and flora;" and "preserve farmland and historic sites and other historic resources;" (section 10 (b) (3&4)). In the Planning Area, the Act calls for the regional master plan to "protect and maintain the essential character of the Highlands environment;" and to "preserve farmland and historic sites and other historic resources;" (section 10 (c) (3&4)).

The goals associated with protecting scenic resources are to maintain the visual integrity and scenic beauty of noteworthy viewsheds and natural and cultural features of regional significance in the Highlands Region. Toward addressing these goals, the Highlands Council identified a baseline of scenic resources, totaling 131 scenic resource areas. These include National Park Service National Historic Landmarks and publicly-owned parks, forests, and recreation areas. The compilation is meant to serve as a baseline from which to begin to refine a complete list of scenic resources. The Highlands Council also adopted a Procedure for Nomination, Evaluation and Inventory of Highlands Regionally Significant Scenic Resources which establishes the process for formal nomination and inclusion of additional scenic resources into the Highlands Scenic Resource Inventory.

The Highlands Region baseline scenic resources data layer for Alexandria is depicted in Figure 29. There are four (4) scenic resource areas identified on the Highlands Scenic Resource Inventory, including:

1. Delaware and Raritan Canal State Park
2. Musconetcong River Greenway
3. Schick Reservation
4. Sweet Hollow Preserve

Contaminated Sites

Inclusion of contaminated sites in the Highland ERI provides a municipality with a large-scale perspective about its contaminated sites locations and the potential impact of the contamination regarding on-site or adjacent natural resources, neighborhoods and economic potential. Awareness of contaminated sites locations and details provides a municipality with additional planning tools in terms of natural resources protection and planning for future remedial actions. Contaminated sites associated with prior development may qualify as brownfields under the Highlands Act, and be eligible for formal designation as Highlands Redevelopment Areas by the Highlands Council.

The Highlands Council utilized portions of NJDEP's Known Contaminated Sites in New Jersey (KCS-NJ) database, the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database, and the Resource Conservation and Recovery Act (RCRA) database for contaminated sites listings. For further information regarding data selection, refer to the Highlands Council *Regional Land Use Conditions and Smart Design Technical Report*. Sites become listed if contamination of soil or ground water has been confirmed.

The contaminated site inventory will be updated to include additions and deletions as needed based upon input from local, county, state, and non-profit stakeholders beginning during the Plan Conformance process. The contaminated site inventory indicates that in the Highlands Region, there are 589 contaminated sites in the Highlands Region covering 13,786 acres in 82 Highlands communities. Two tiers of contaminated sites were created based upon information gleaned from KCS-NJ, the CERCLIS database, and the RCRA database. Tier 1 sites are considered to have somewhat more complex contamination issues than Tier 2.

Tier 1 consists of:

- All Final and Deleted Superfund sites (CERCLIS);
- All RCRA identified sites;
- All sites with a Remedial Level of C3 or D (KCS-NJ); and
- Remaining sites with a Remedial Level of C2 located in the Preservation Area (KCS-NJ).

Tier 2 consists of:

- Remaining sites with a Remedial Level of C2 located in the Planning Area (KCS-NJ).

The inventory includes two categories, Tier 1 and 2. There are two (2) Tier 1 Contaminated Sites (both within the Planning Area) and one (1) Tier 2 Contaminated Site (within the Planning Area) identified in Alexandria as shown in Figure 30. Municipal awareness of these sites is the first step toward learning more about them, including such information as the nature, extent and characterization of on-site contamination, past uses, and redevelopment and restoration potential.

Infrastructure

The Highlands ERI includes three sections on infrastructure (i.e., water and water utilities, and roadway/transit), as these three elements contribute to, or are a significant basis for, the Highlands Land Use Capability Zones. Additionally, water and wastewater utilities rely upon significant volumes of ground water or surface water, and thus are intrinsically linked to those natural resource components for which the Highlands RMP provides protection policies. Incorporation of the following three elements into the Highlands ERI provides for support of RMP protection policies and long-term planning goals.

Water and Wastewater Utilities

Water Supply Utility

Future development within the Highlands Region at densities consistent with smart growth principles will generally require access to public water supply utilities. A Public Community Water System is a public water system that pipes water for human consumption to at least either 15 service connections or one that regularly serves at least 25 year-round residents. They may be owned and operated by governmental entities (either as municipal operations or utility authorities) or investor-owned utilities. These community systems, whether their source consists of ground water or surface water withdrawals, may have the potential for inducing or supporting growth. The figure *Public Community Water Systems Map* in the RMP outlines their associated remaining capacity.

Alexandria has 7 acres of Water Utility Existing Area Served (all within the Planning Area) provided by the Milford Water Department to a small area located adjacent to Milford Borough (see Figure 31).

Wastewater Utility

The primary wastewater collection systems in the Highlands Region are regulated by NJDEP as Domestic Sewerage Facilities. Domestic Sewerage Facilities are wastewater treatment systems that serve more than an individual residential or non-residential customer and treat sanitary sewage. These systems are distinct from industrial treatment works (which treat industrial process wastes from individual manufacturing sites) and Individual Subsurface Disposal Systems (ISSDS, or septic systems, which handle sewage from individual homes). Domestic Sewage Facilities include municipal and regional sewage systems that are publicly-owned, similar systems that are investor-owned, and privately-owned systems (e.g., homeowners associations, mobile home parks) that provide sewage treatment. The *Highlands Domestic Sewerage Facilities* figure in the RMP outlines estimates of available treatment capacity.

The inventory of Highlands Domestic Sewerage Facilities Existing Areas Served is an important tool to identify areas where growth should or should not be encouraged and where land adjacent to this infrastructure is appropriate for growth. Additionally, this inventory will assist in the identification of areas of concern where dense development patterns without sewer service exist. Such situations may require the replacement of septic systems with community wastewater systems in order to safeguard public health.

Less than 1 acre of land in Alexandria Township is designated Highlands Domestic Sewerage Facilities Existing Areas Served (located fully within the Planning Area), with service provided by the Milford Borough Sewer Treatment Plant.

Roadway and Transit

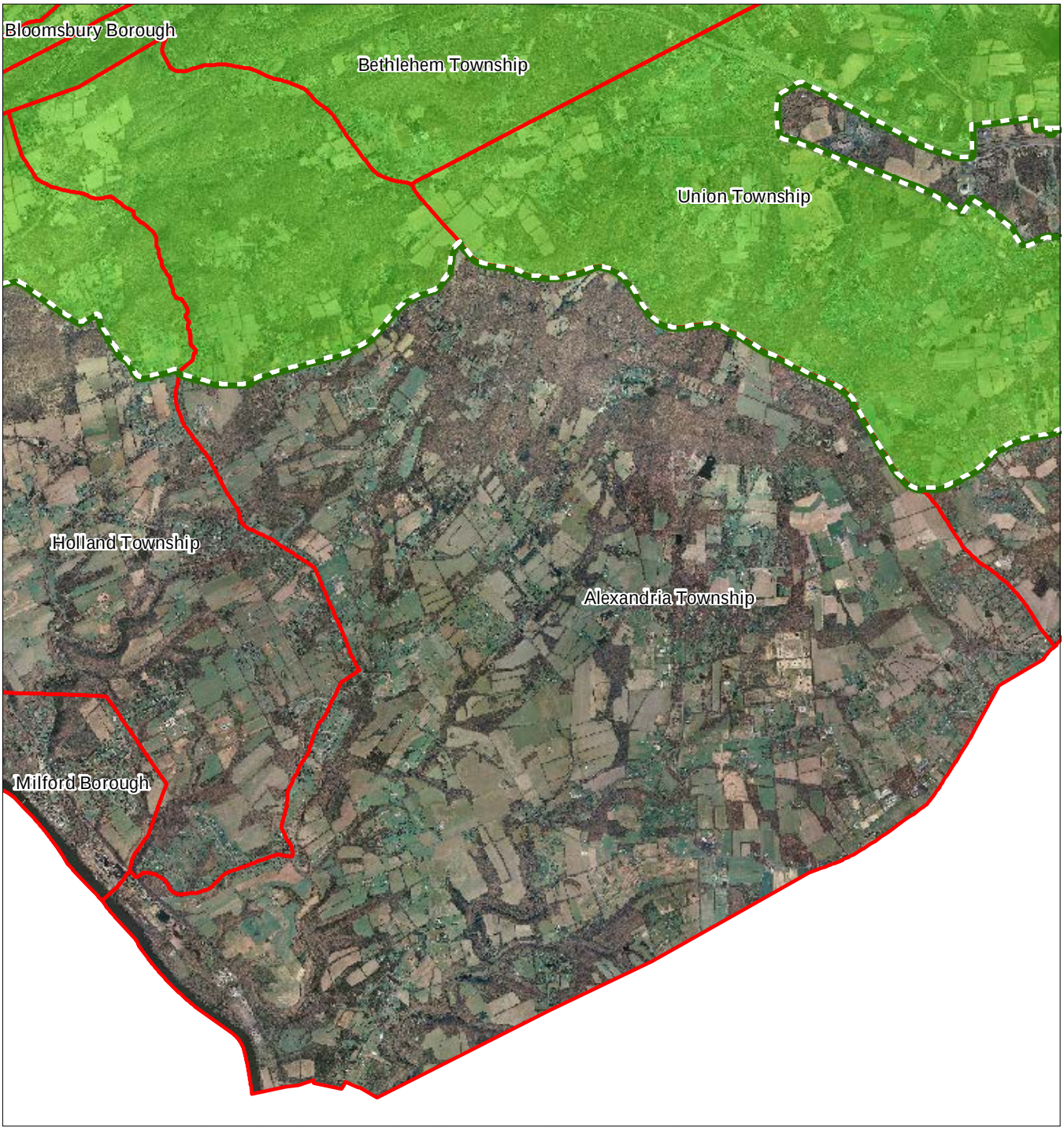
Future and existing development and redevelopment in the Highlands Region will rely on a complex network of roads, railways and bridges and various modes of transportation, including automobile, bus, rail, truck, bicycle and pedestrian, to carry people and move goods throughout the Region. Numerous factors including past development patterns of inefficient land use in the Region have led to an increased dependence on automobile travel, which has adverse impacts on natural resources and overall quality of life. By using smart growth principles and encouraging more efficient land use, the potential for an accessible, multi-modal transportation system will increase in the Region, while protection of environmentally sensitive areas can be improved.

The existing transportation and transit features for the Region support the Land Use Capability Zone Map with the goal of better understanding the movement of people and goods, and the relationship of these features to the resources and land use conditions of the Region. The nature and extent of the regional and local roadway and transit features provide a framework for evaluating environmental resources that are potentially affected by the presence of these features. Such impacts could involve habitat features that are bisected by road or transit networks, for example, or habitat that surrounds these networks and should be evaluated when planning for future development and redevelopment activities.

The RMP figure "Road Network" presents the Highlands road infrastructure by road category and the various administrative boundaries within the Region. The RMP figure "Transit Network" presents the Highlands transit and rail network infrastructure.

The roadway and transit networks for Alexandria are presented in Figures 33 and 34, respectively.

Figure 1: Preservation Area



Preservation Area
Municipal Boundaries

Alexandria Township

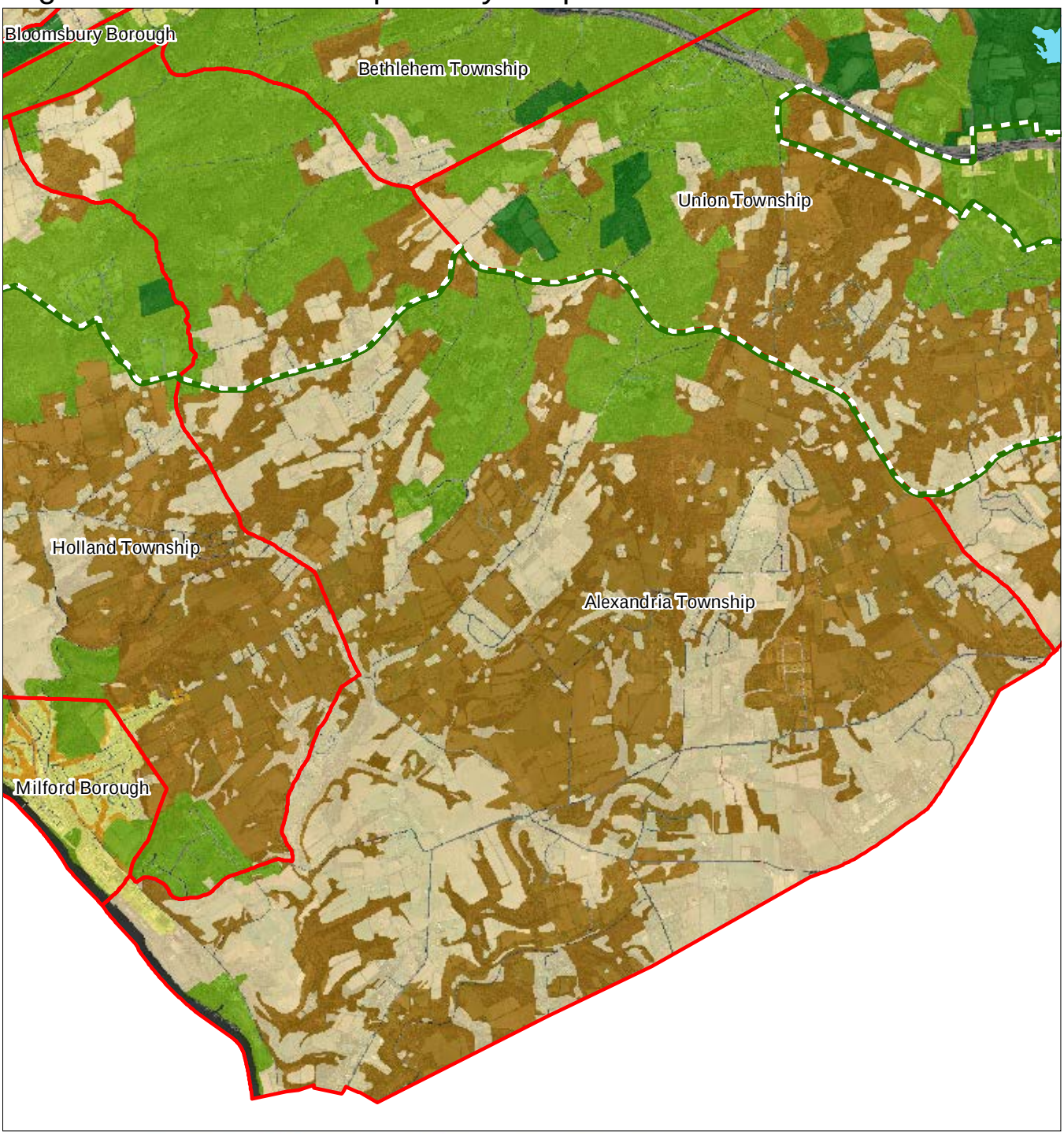
1 inch = 0.94 miles

Highlands Council
New Jersey

N

July 2014

Figure 2: Land Use Capability Map Zones



Regional Master Plan Overlay Zone Designation

Zone

- *Protection*
- *Conservation*
- *Existing Community*
- Lakes Greater Than 10 acres
- Preservation Area
- Municipal Boundaries

Sub-Zone

- *Existing Community Environmentally Constrained*
- *Conservation Environmentally Constrained*
- *Lake Community*
- *Wildlife Management*

Alexandria Township

1 inch = 0.94 miles

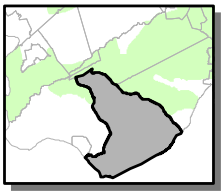
Highlands Council
New Jersey

N

Figure 3: HUC 14 Boundaries

HUC 14 Subwatersheds
Stream Centerlines
Preservation Area
Municipal Boundaries

Alexandria Township

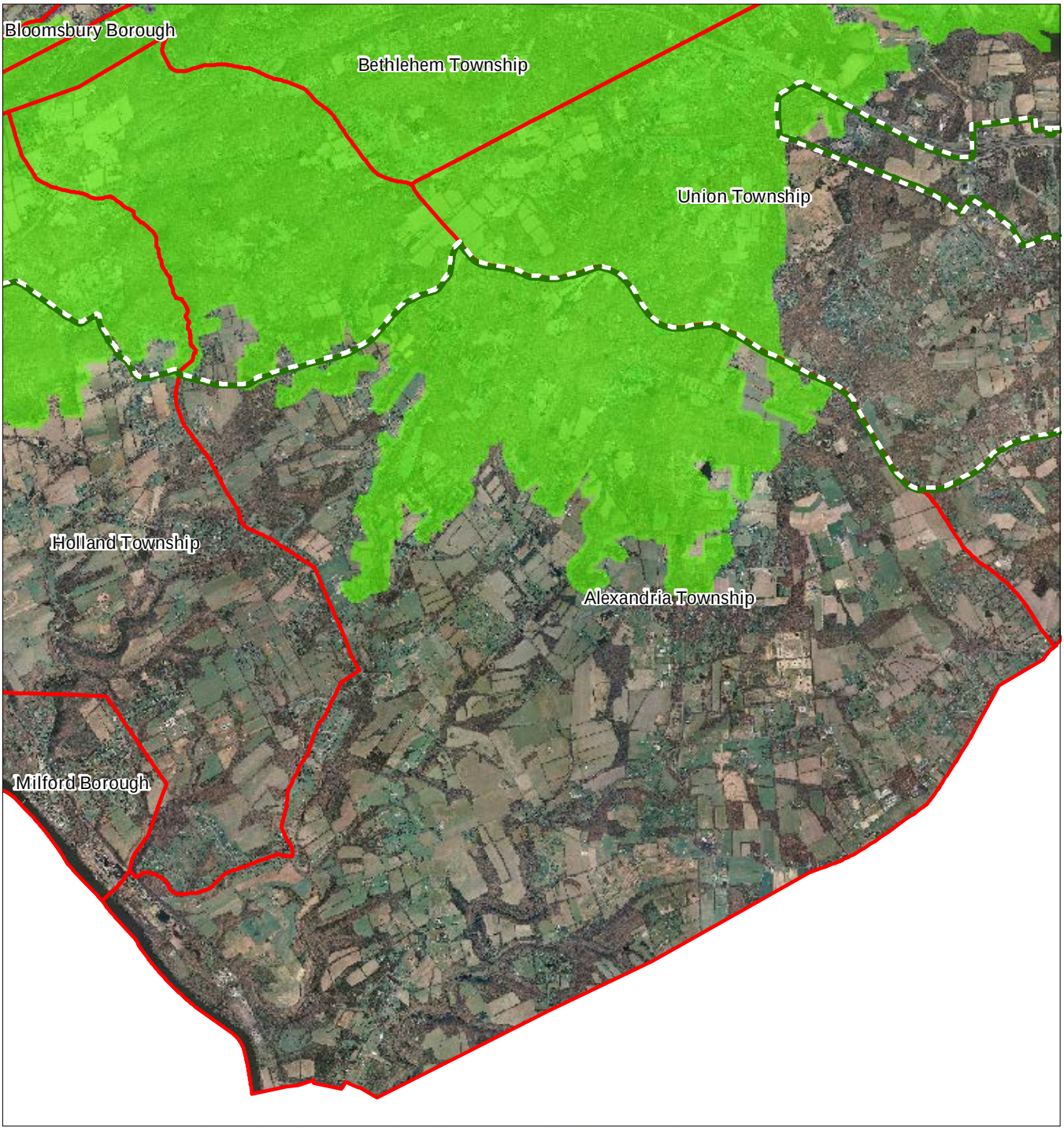


1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 4: Forest Resource Area



Forest Resource Area
Preservation Area
Municipal Boundaries

Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 5: Total Forest Area

Forested Areas
Preservation Area
Municipal Boundaries

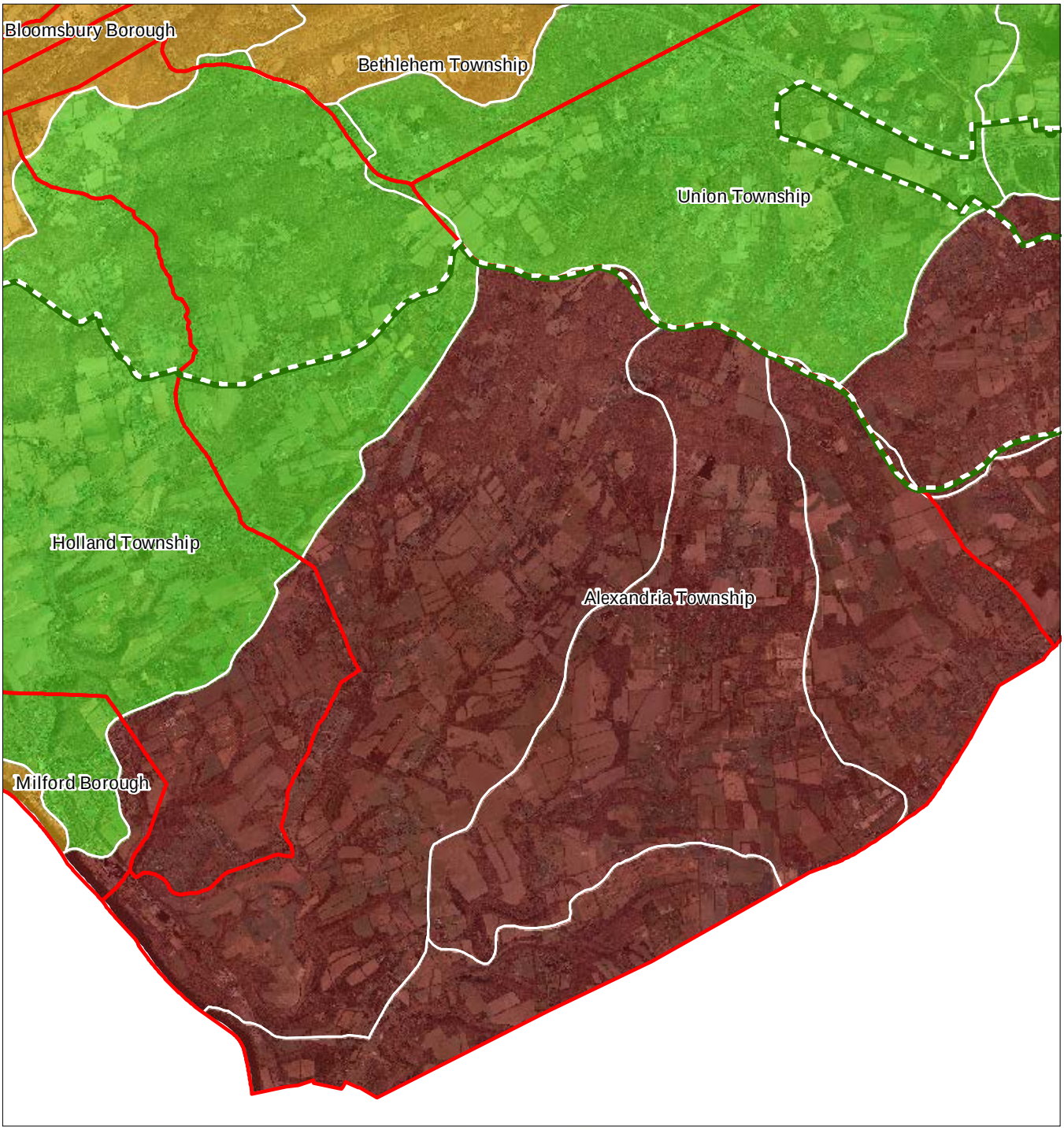
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 6: Forest Subwatersheds



Forest Integrity by HUC14 Subwatershed

- *Low*
- *Moderate*
- *High*
- Preservation Area
- Municipal Boundaries

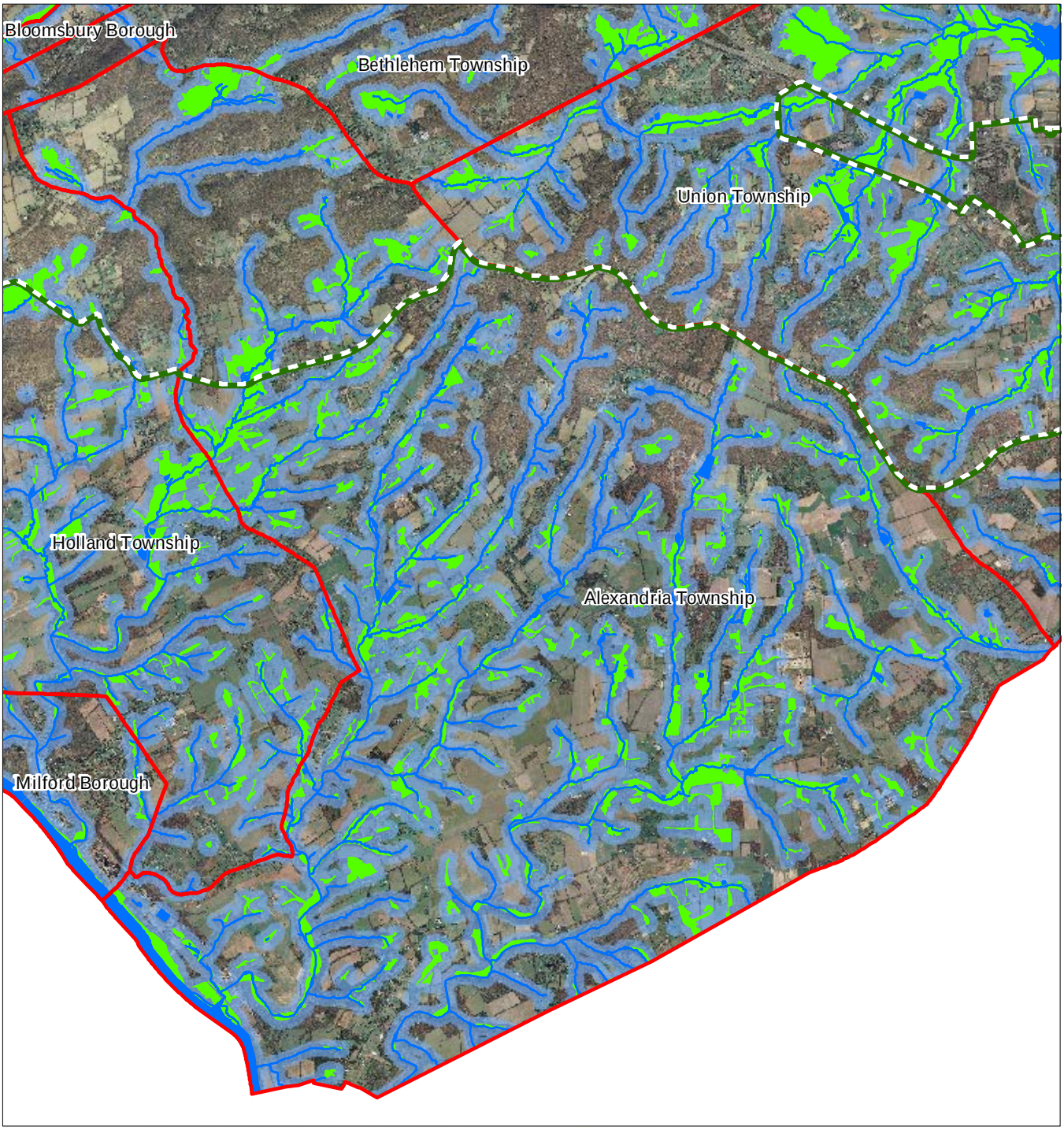
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 7: Highlands Open Waters



Highlands Open Water Buffers (300ft)
Streams
Wetlands
Lakes & Ponds
Preservation Area
Municipal Boundaries

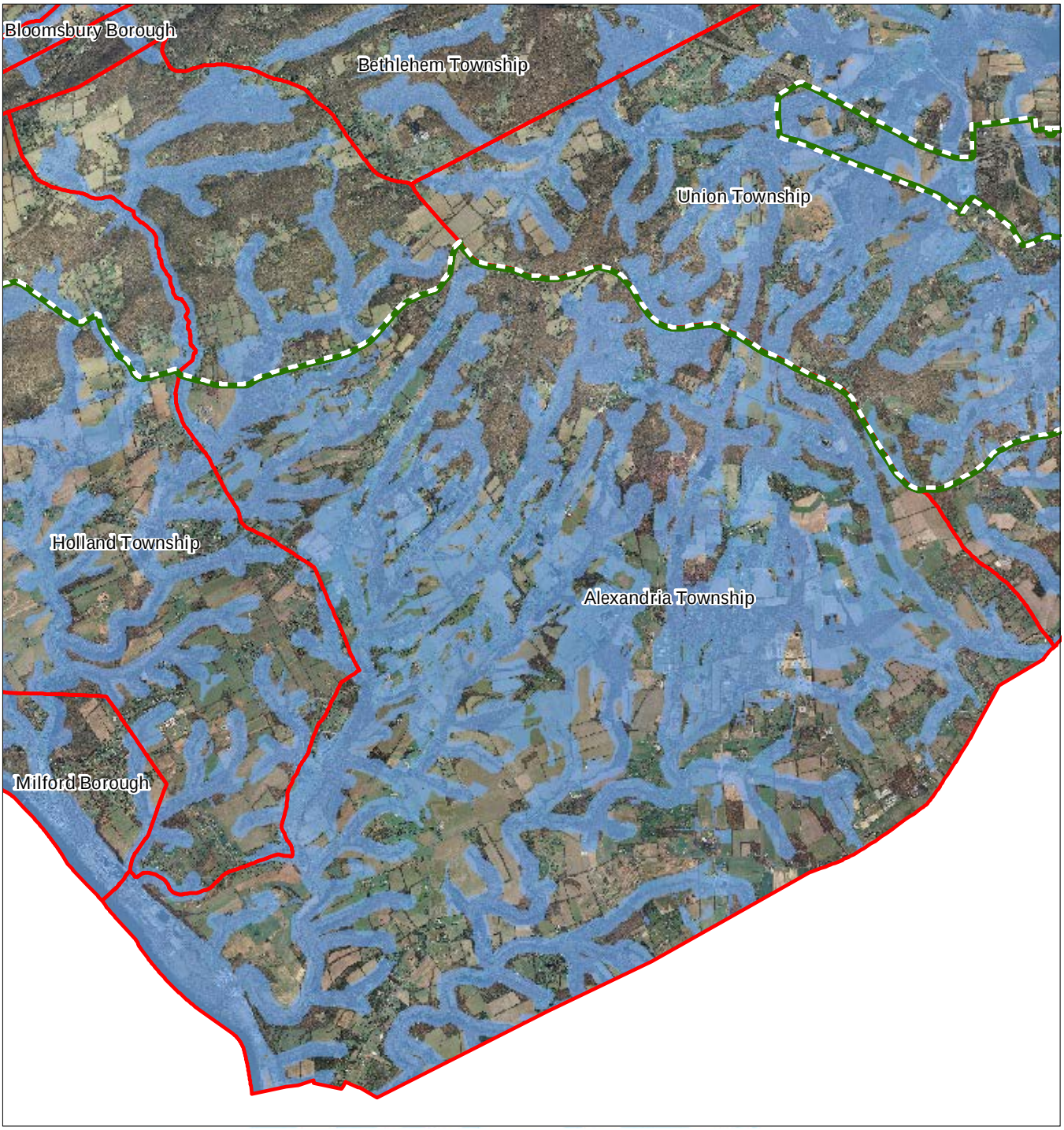
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

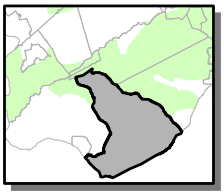
N

Figure 8: Highlands Riparian Areas



Riparian Area
Preservation Area
Municipal Boundaries

Alexandria Township

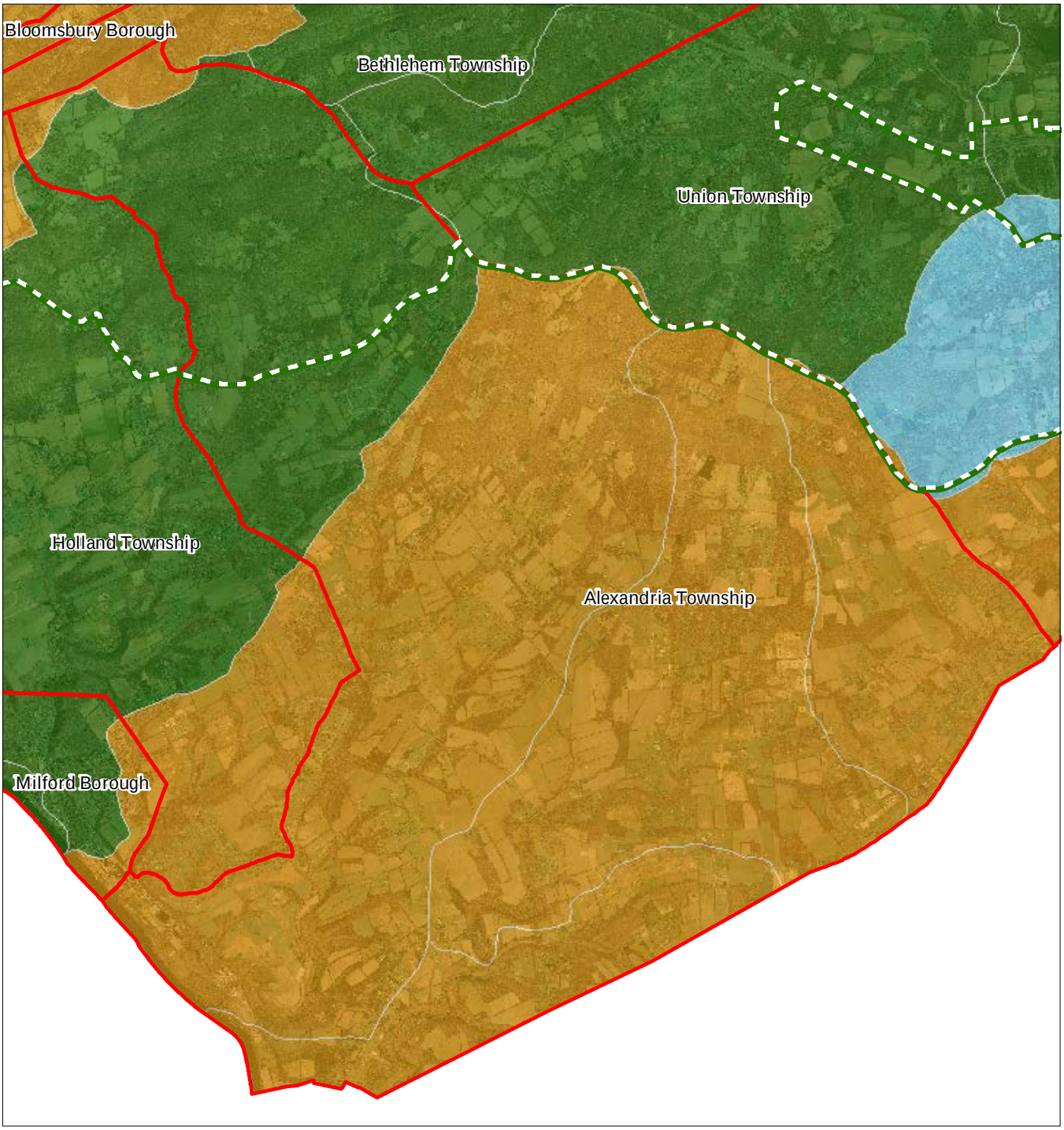


1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 9: Watershed Values



Watershed Values by HUC14 Subwatershed

- *Low*
- *Moderate*
- *High*
- Preservation Area
- Municipal Boundaries

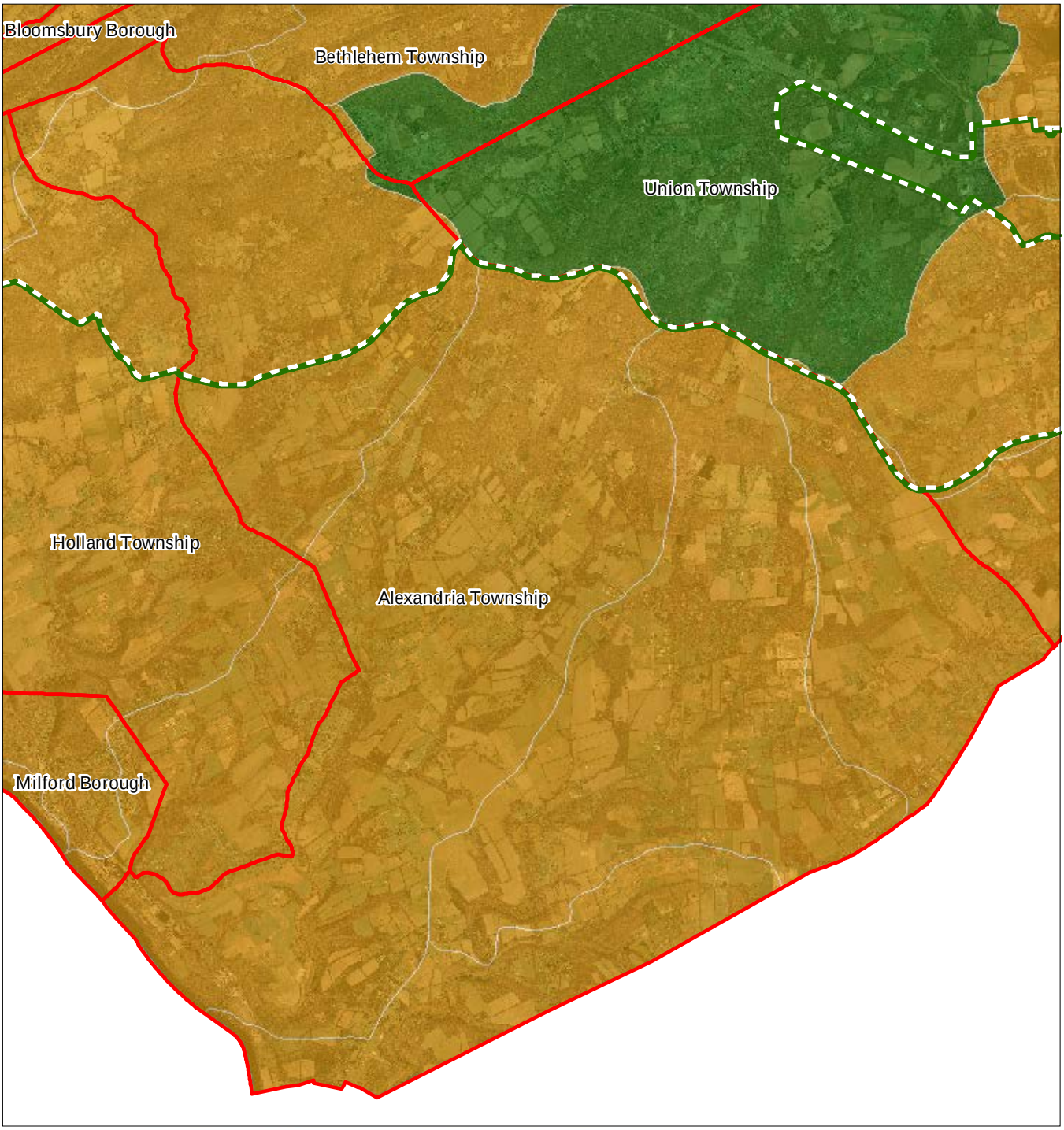
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 10: Riparian Integrity



Riparian Integrity by HUC14 Subwatershed

- *Low*
- *Moderate*
- *High*
- Preservation Area
- Municipal Boundaries

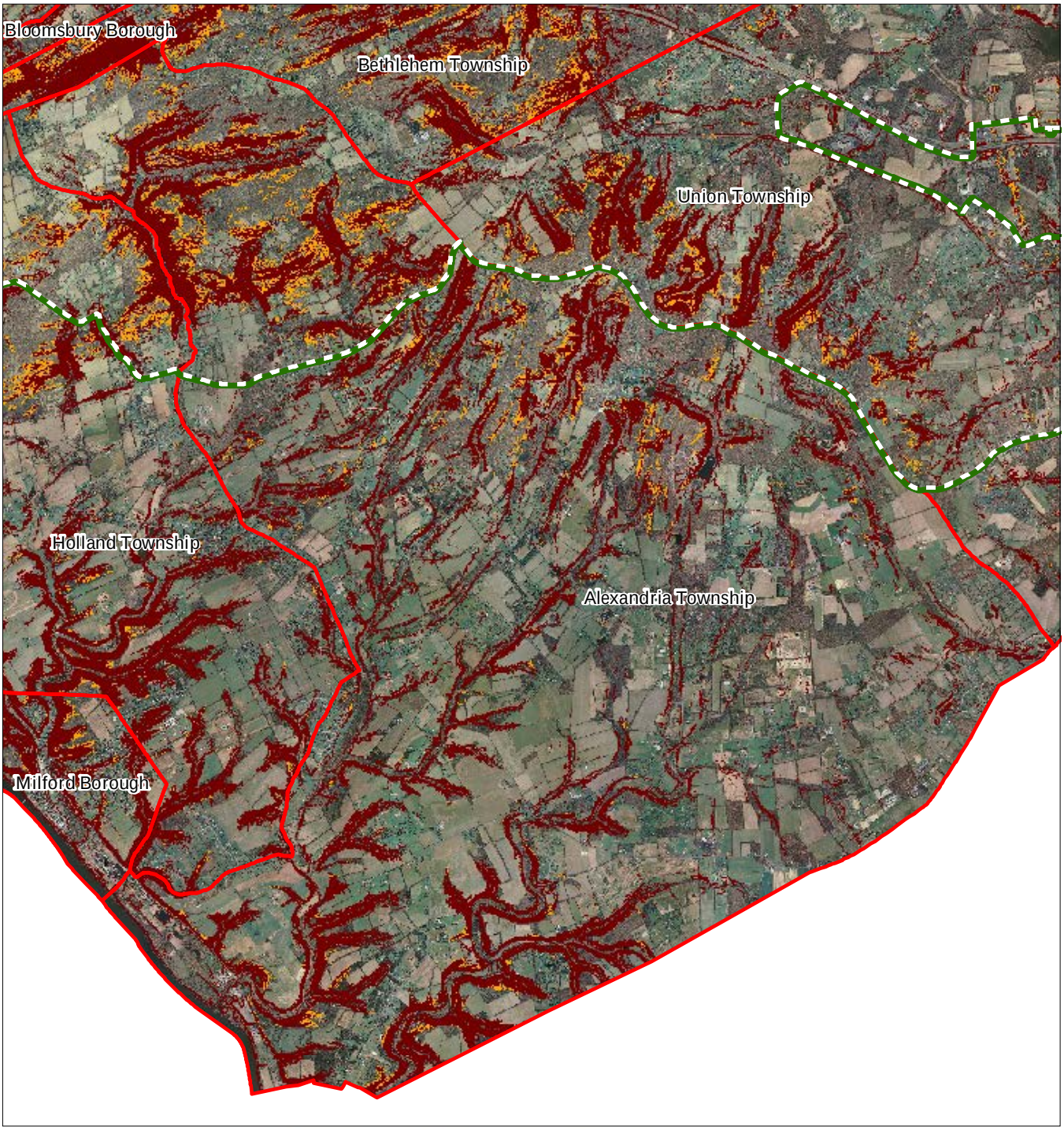
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 11: Steep Slopes Protection Areas



Steep Slopes
- *Moderate*
- *Severe*
- Preservation Area
- Municipal Boundaries

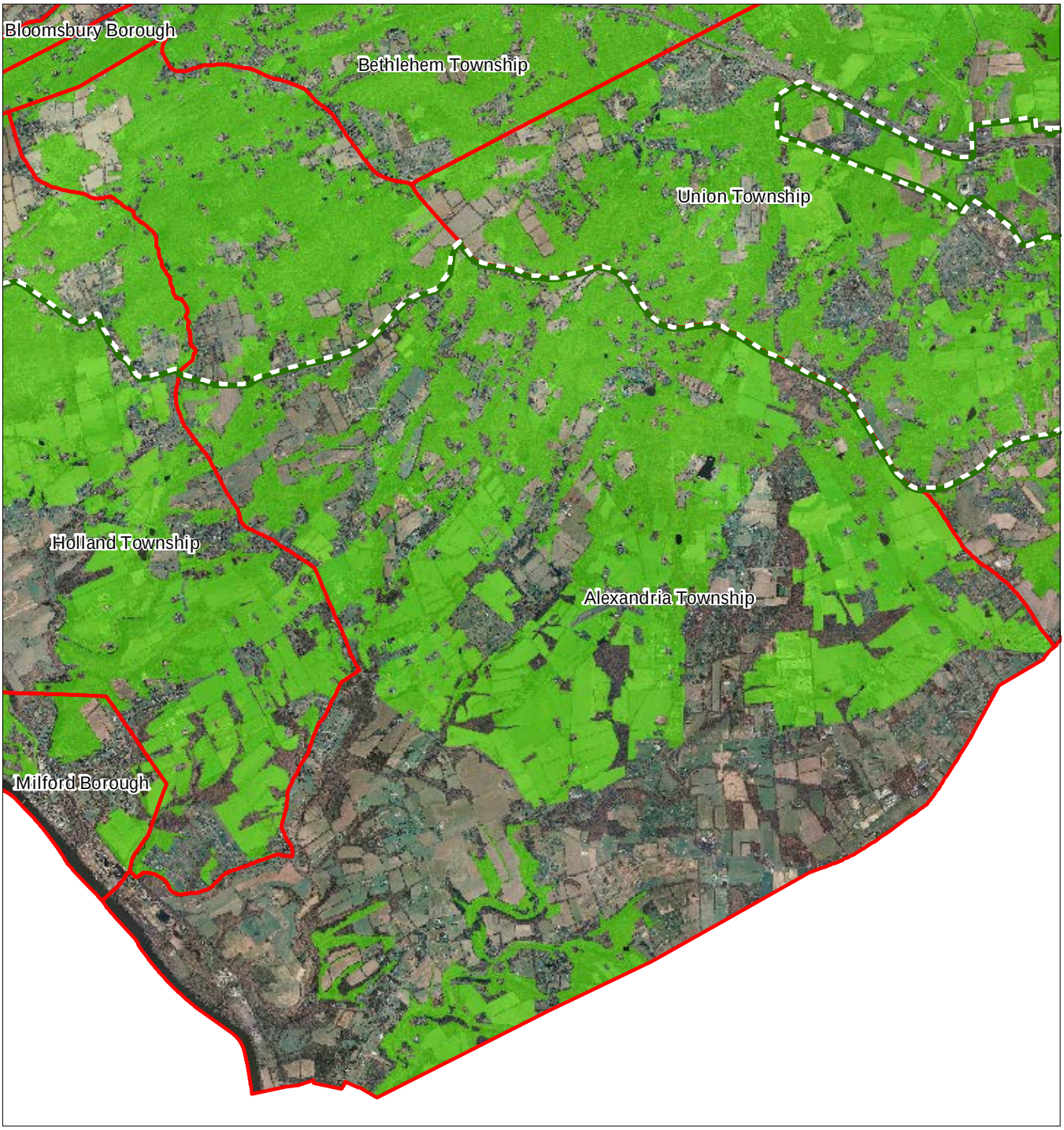
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

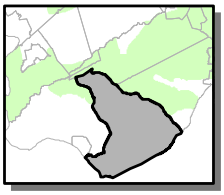
N

Figure 12: Critical Wildlife Habitat



Critical Wildlife Habitat
Preservation Area
Municipal Boundaries

Alexandria Township

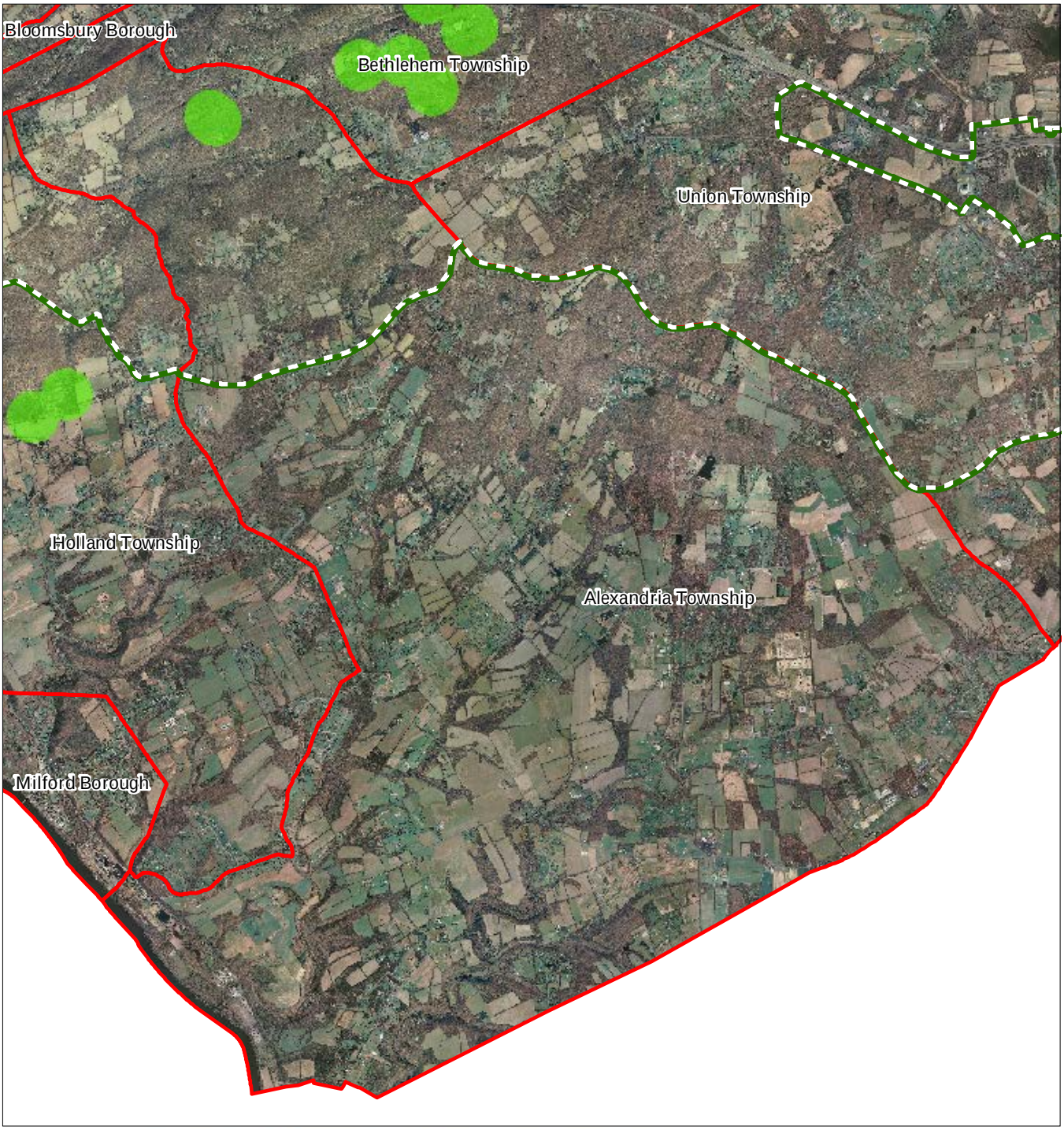


1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 14: Vernal Pools



Vernal Pools + 1000ft Buffer
Preservation Area
Municipal Boundaries

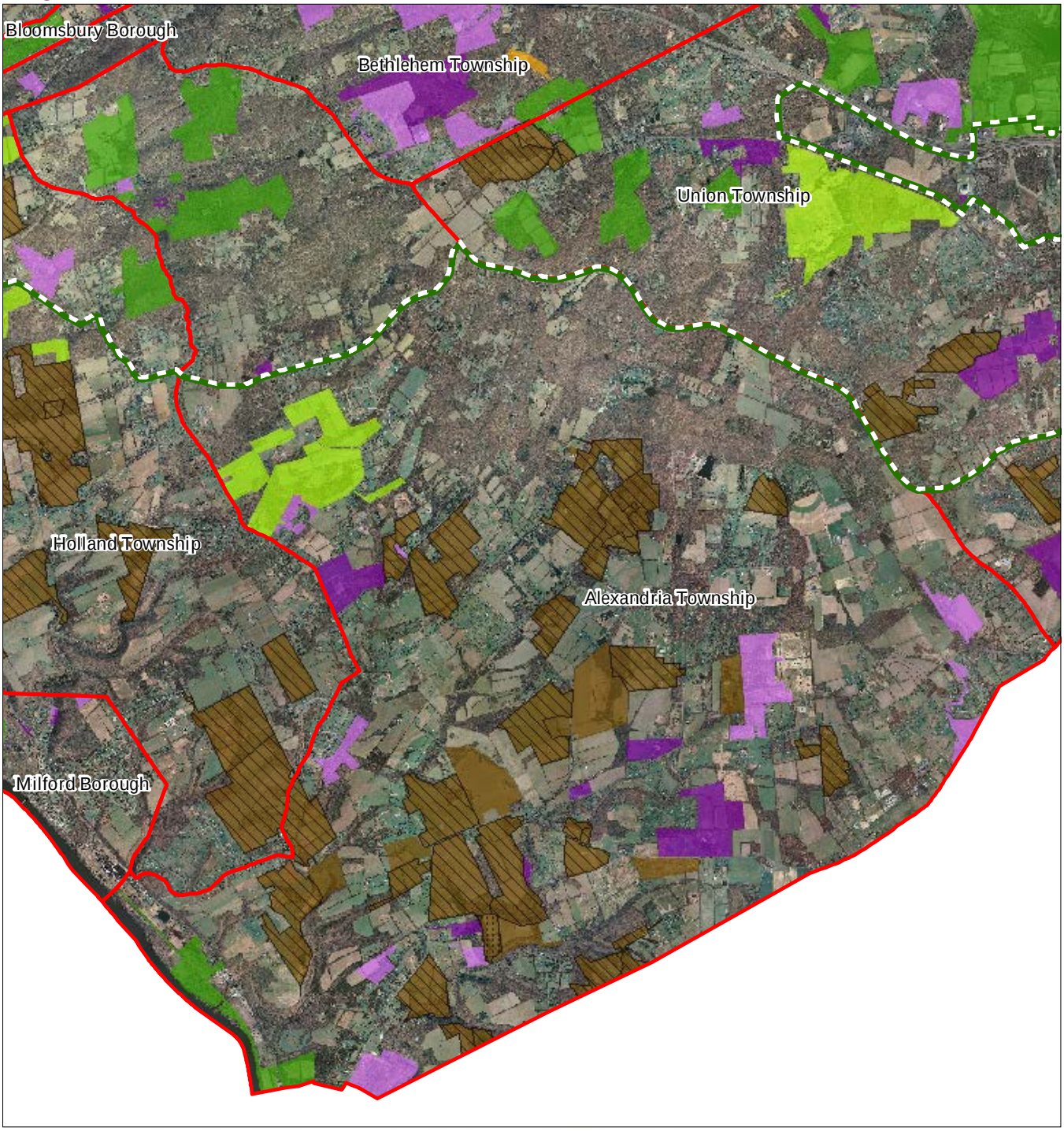
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 15: Preserved Lands



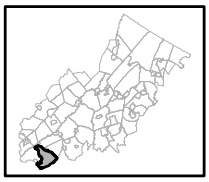
Preserved Lands
- Federal Open Space
- State Open Space
- County Open Space
- Municipal Open Space
- Non-Profit/Private Open Space
- Water Supply Watershed Lands
- Preserved Farmland
- Highlands Transfer of Development Lands

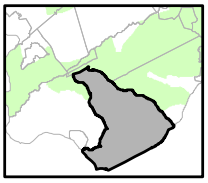
Conservation Easements
- Green Acres

SADC Easements
- SADC Final
- SADC Preserved

- Municipal Boundaries
- Preservation Area

Alexandria Township



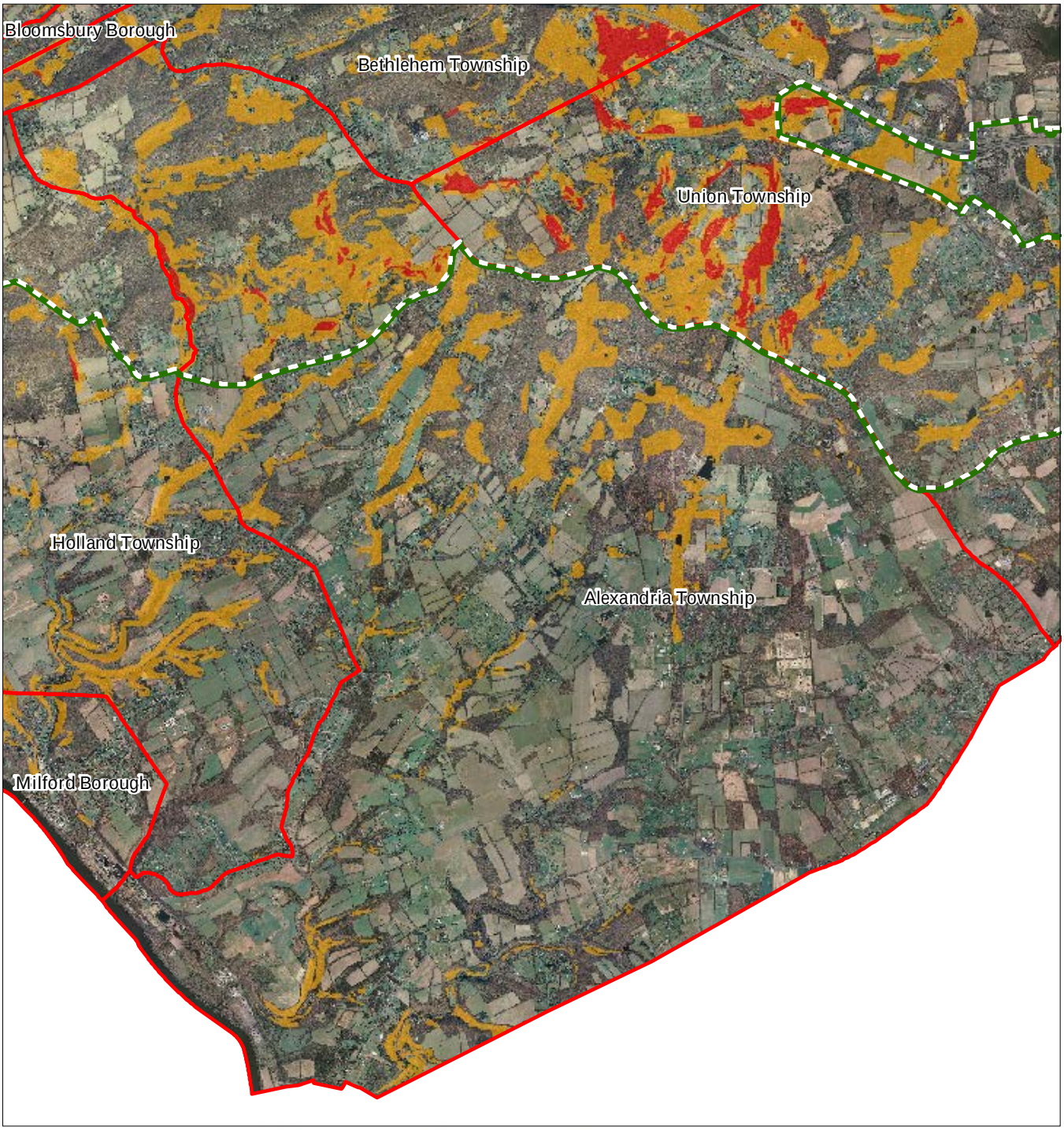


1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 16: Highlands Conservation Priority Areas



Conservation Priority Area
- *Moderate*
- *High*
- Preservation Area
- Municipal Boundaries

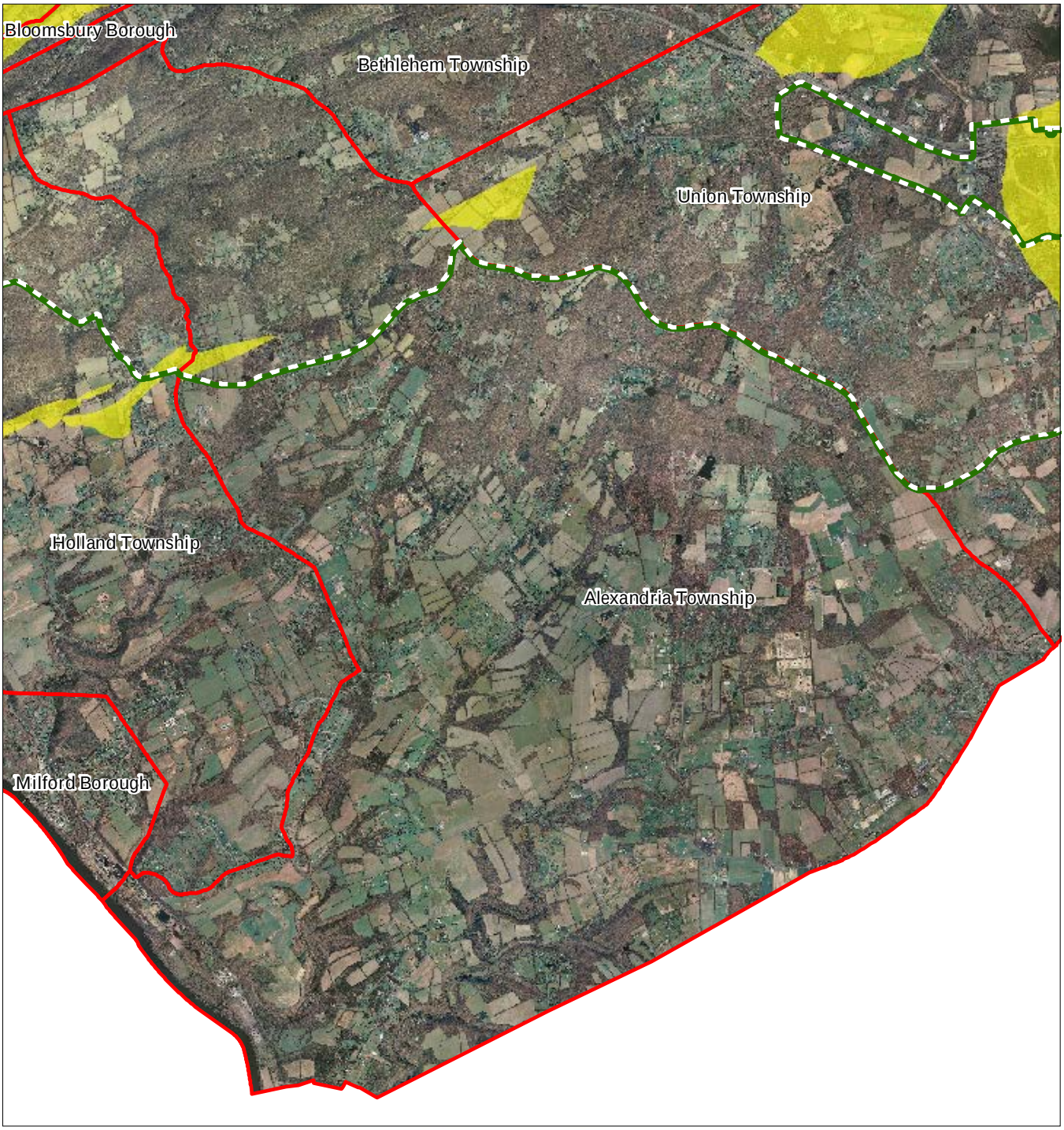
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 18: Carbonate Rock Areas



Carbonate Rock Areas
Preservation Area
Municipal Boundaries

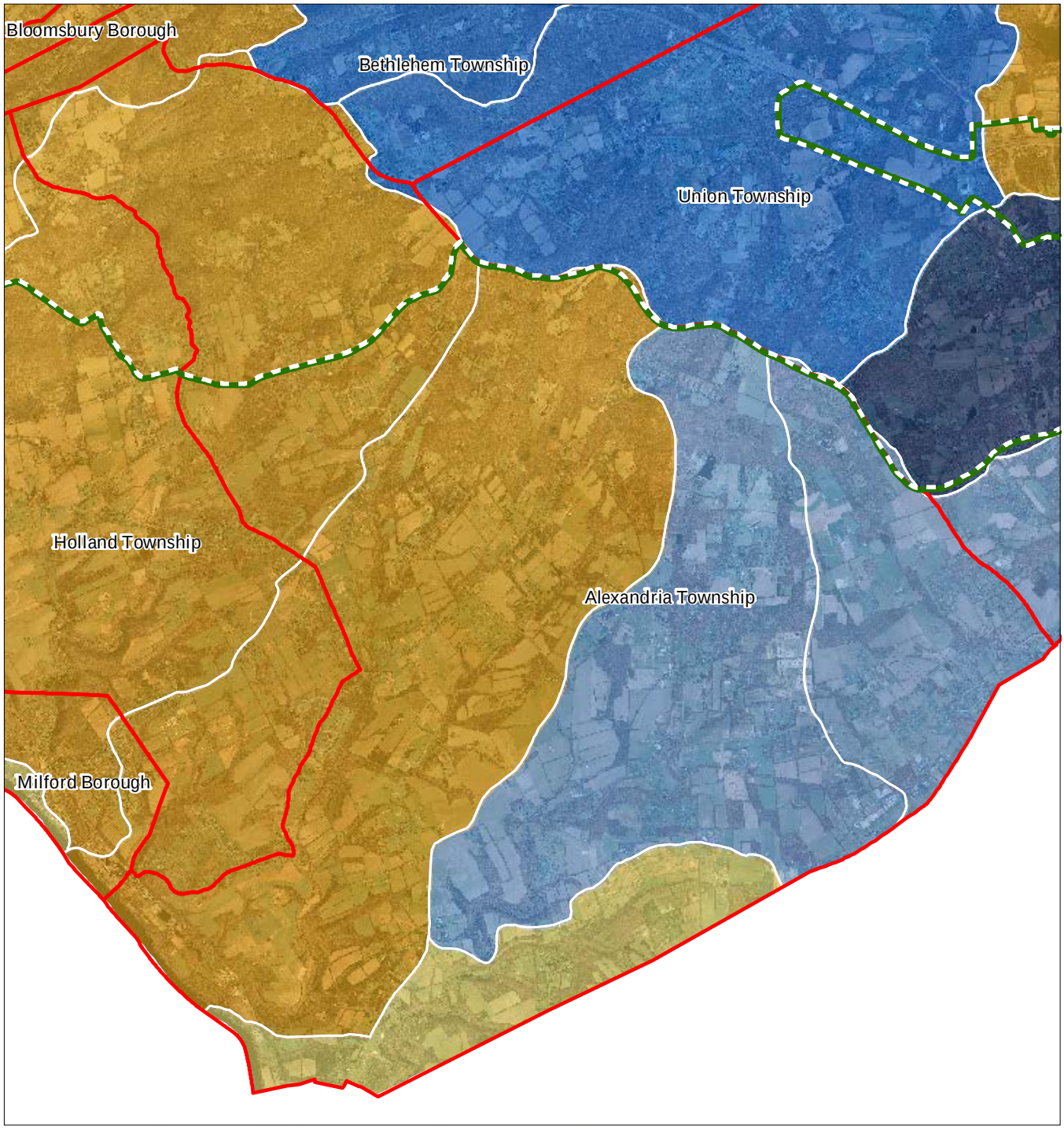
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 20: Net Water Availability



Net Water Availability By HUC14

Million Gallons Per Day (MGD)

- 0.10 - 0.39
- 0.05 - 0.09
- 0.00 - 0.04
- -0.09 - 0.00
- -0.99 - -0.10
- -7.10 - -1.00

Preservation Area

Municipal Boundaries

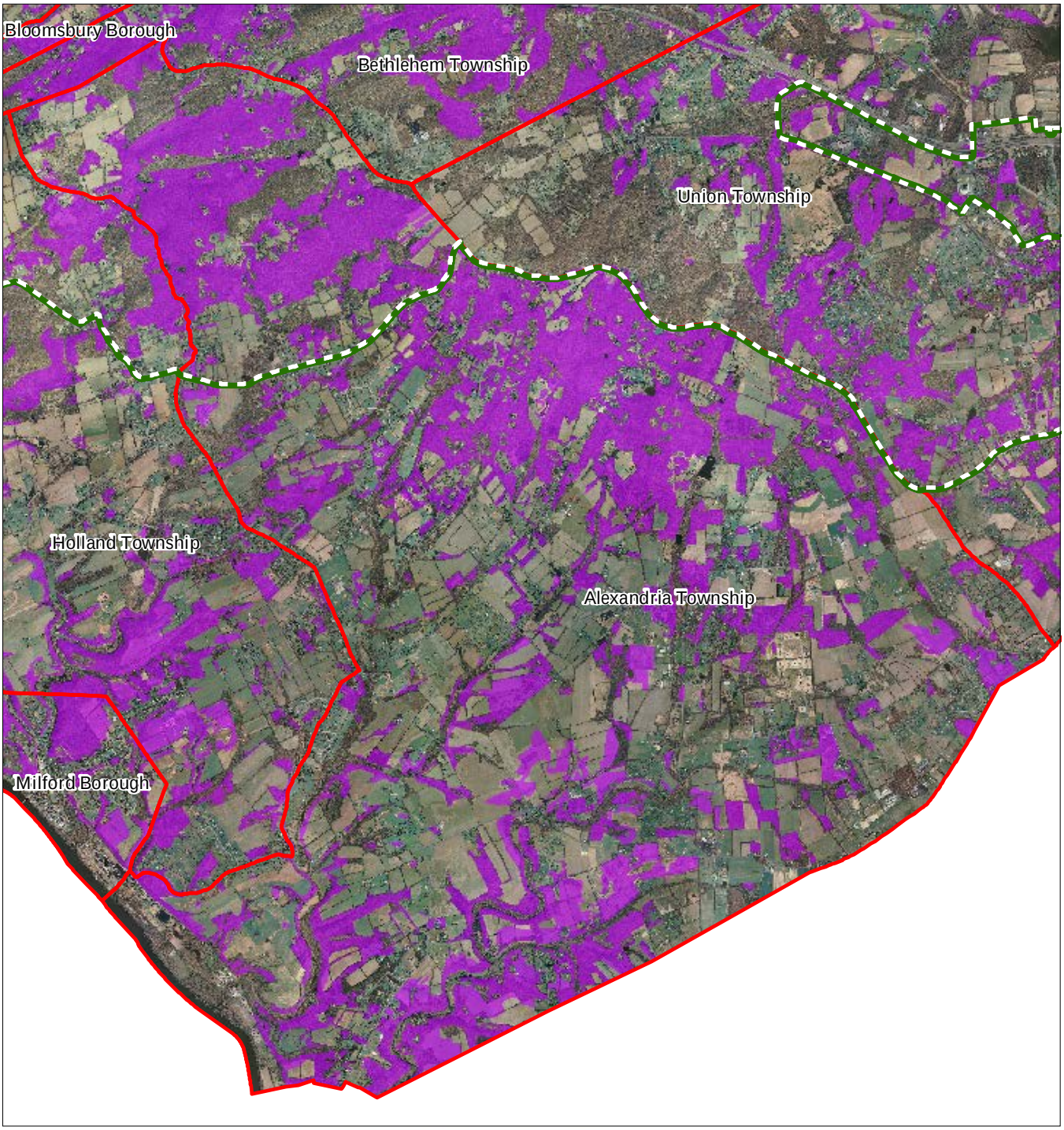
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 21: Prime Ground Water Recharge Areas



Prime Ground Water Recharge Areas
Preservation Area
Municipal Boundaries

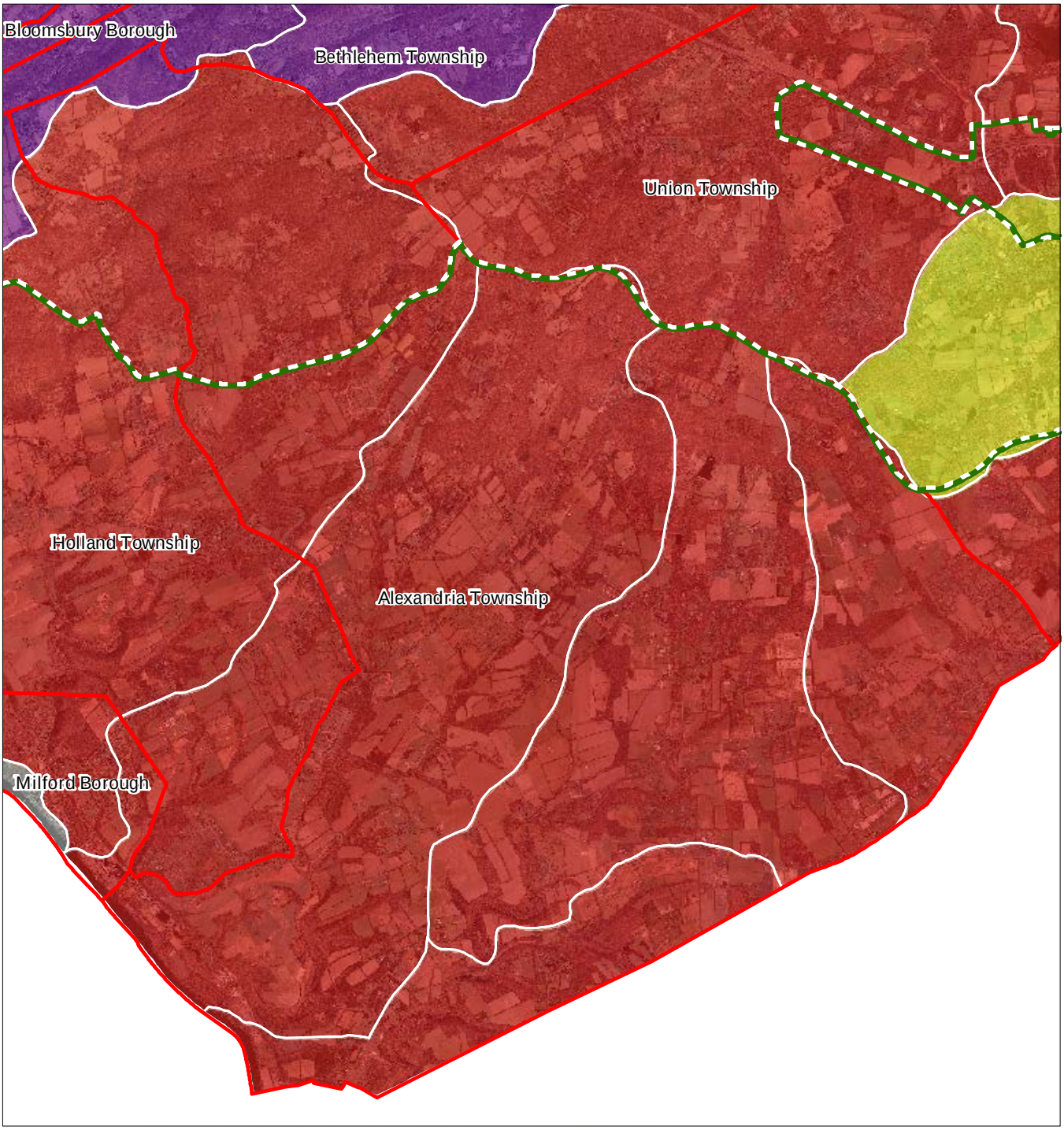
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 22: HUC 14s on NJDEP Impaired Waters List



Impaired Waters Overall Assessment by HUC14 Subwatershed

- *Non Impacted*
- *Insufficient Data Available*
- *Moderate*
- *Water Quality Impaired*
- Preservation Area
- Municipal Boundaries

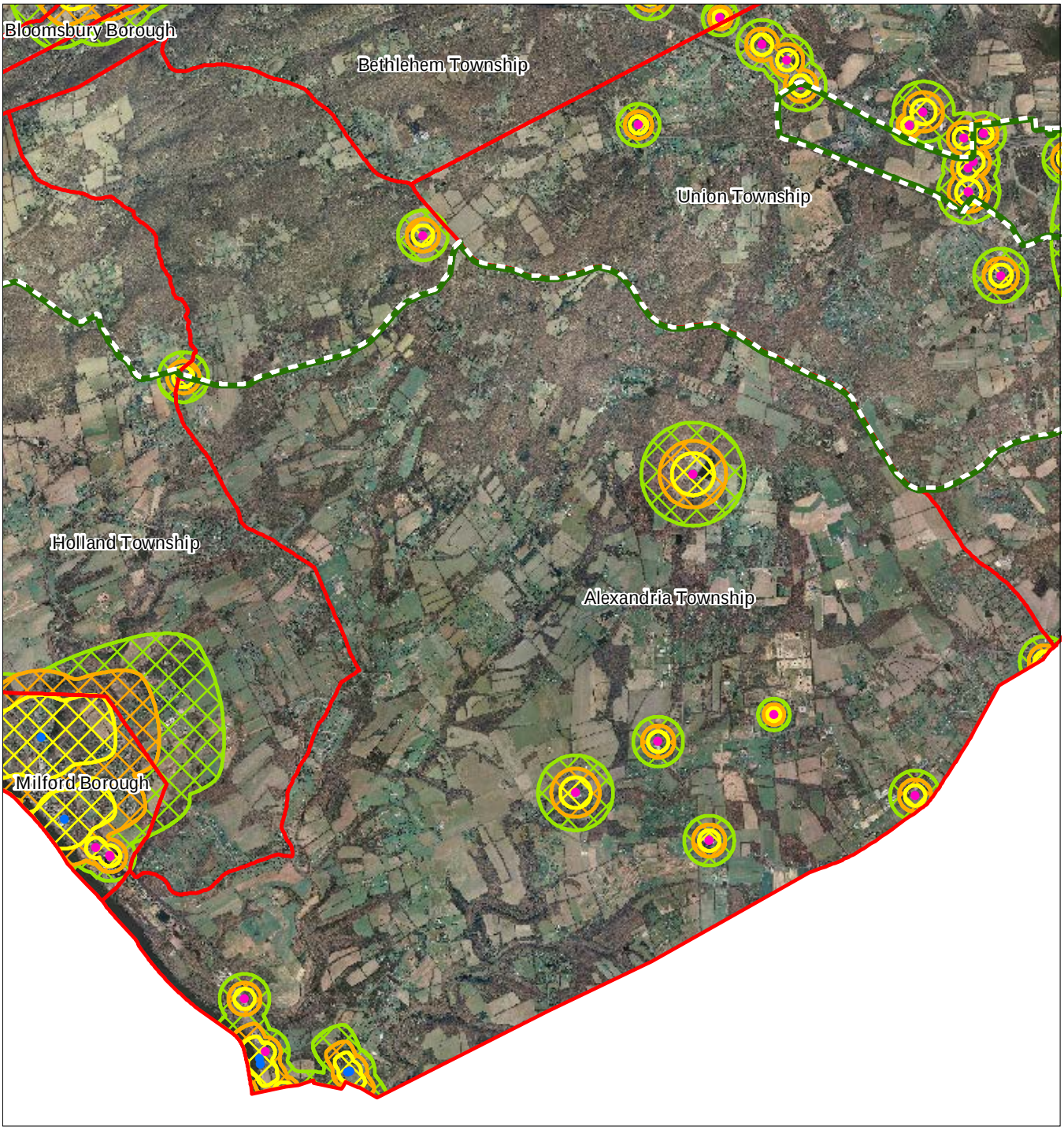
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 23: Wellhead Protection Areas



- Public Community Wells
- Public Non-Community Wells

Wellhead Protection Areas

- *2-Year Tier*
- *5-Year Tier*
- *12-Year Tier*

- Preservation Area
- Municipal Boundaries

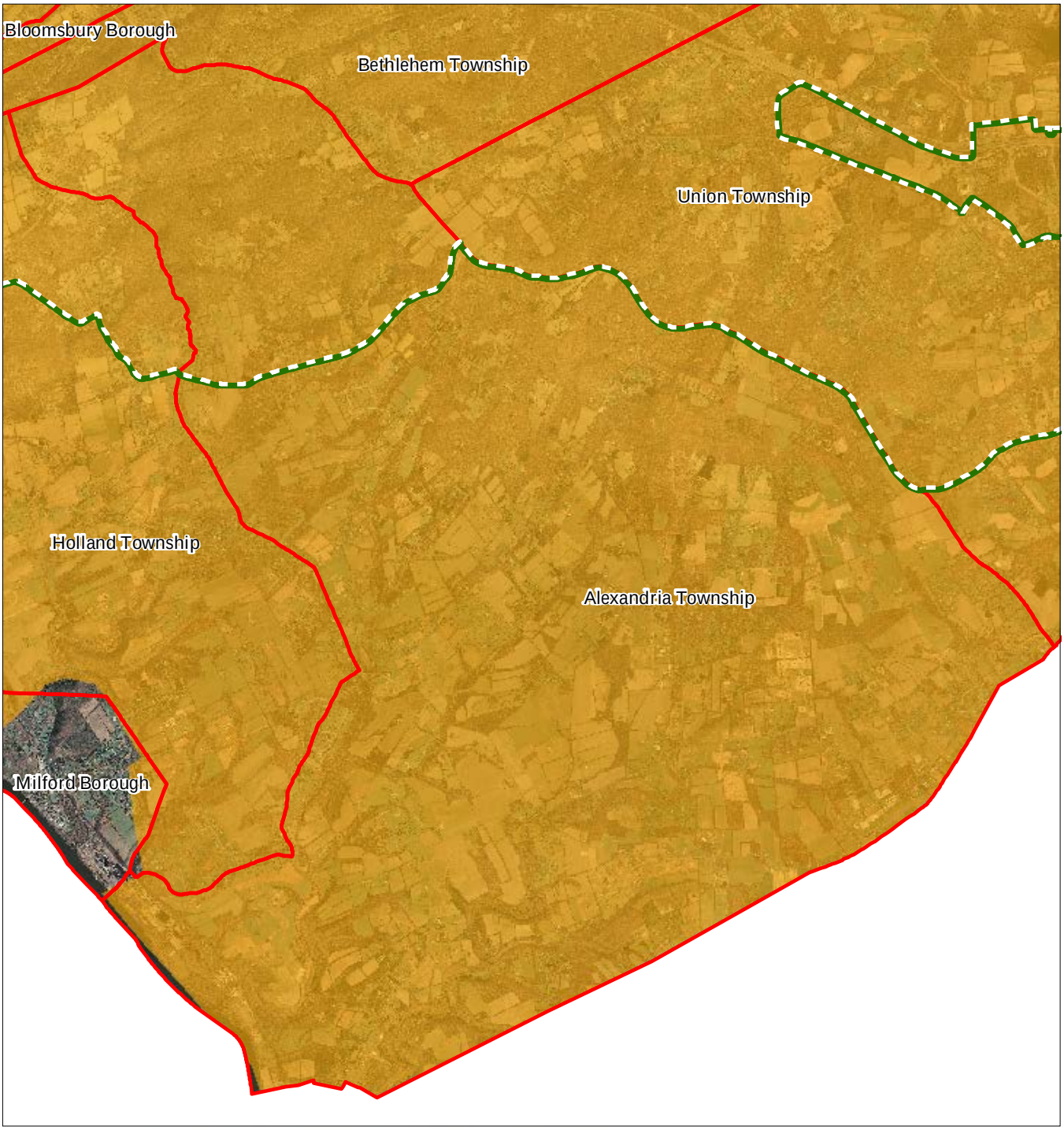
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 24: Agricultural Resource Area



Agricultural Resource Area
Preservation Area
Municipal Boundaries

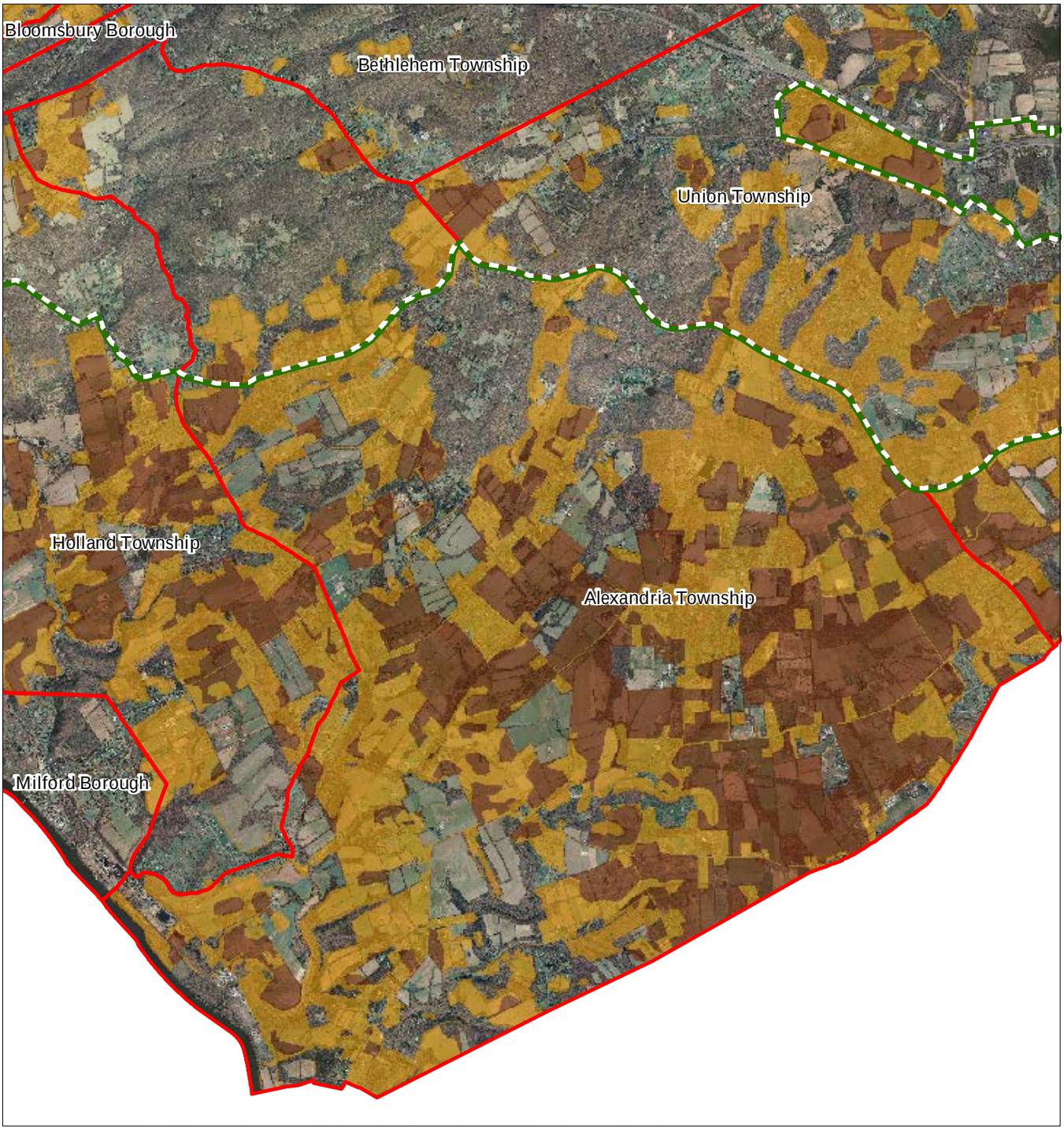
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 25: Highlands Agricultural Priority Area



Agricultural Priority Area
- *Moderate*
- *High*
- Preservation Area
- Municipal Boundaries

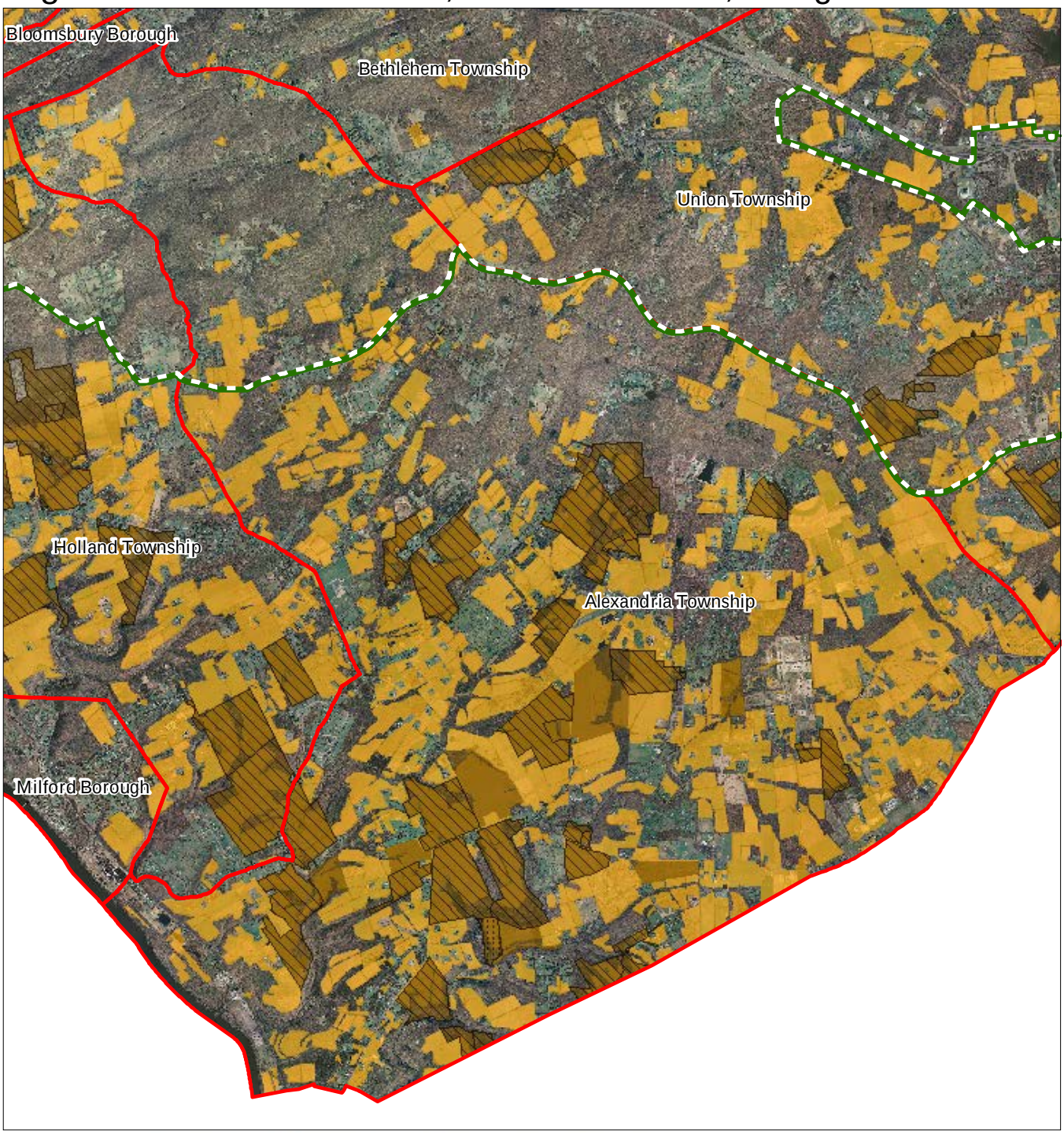
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

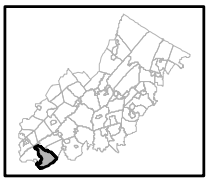
Figure 26: Preserved Farms, SADC Easements, All Agricultural Uses

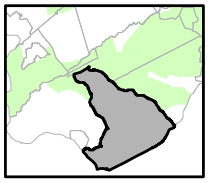


SADC Easements

- *SADC Final*
- *SADC Preserved*
- Preserved Farmland
- Agriculture Uses
- Preservation Area
- Municipal Boundaries

Alexandria Township



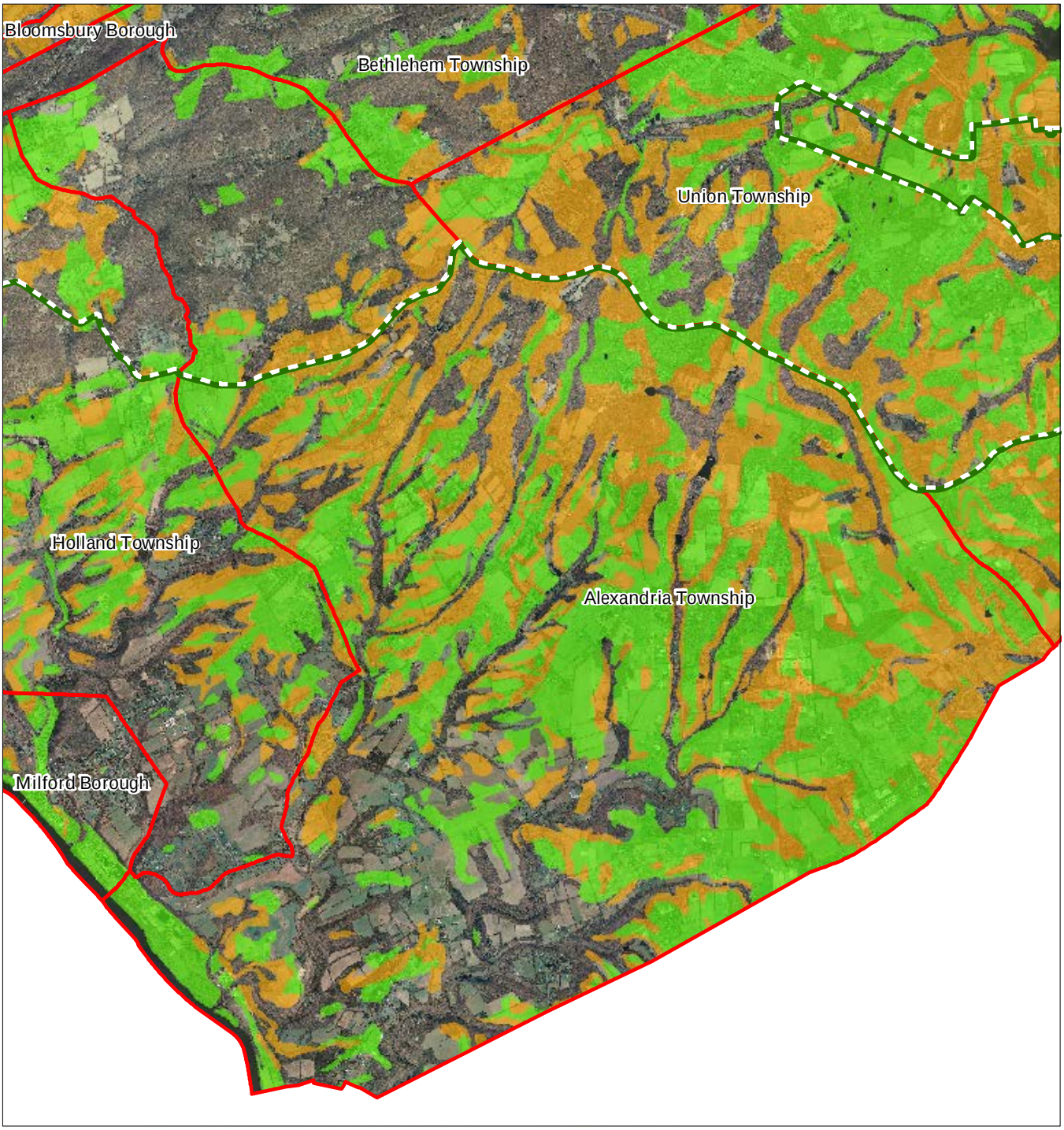


1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 27: Important Farmland Soils



Important Farmland Soils

- *Prime Farmland*
- *Farmland of Local Importance*
- *Farmland of Statewide Importance*
- *Farmland of Unique Importance*
- Preservation Area
- Municipal Boundaries

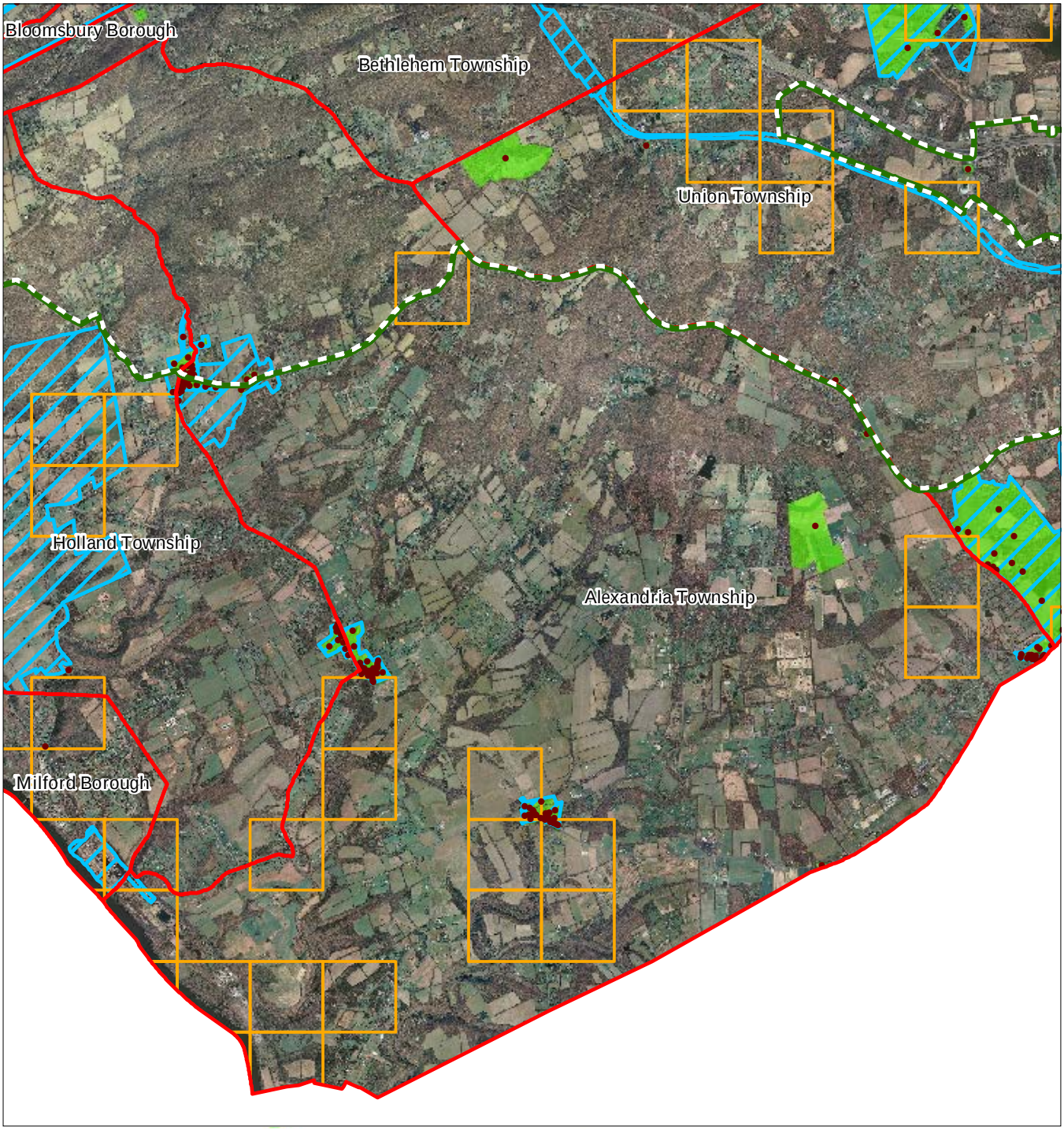
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 28: Historic, Cultural, and Archaeological Resources Inventory



Preservation Area
Municipal Boundaries
Archaeological Grids (1 sqmi)
NJ Historic Districts
Historic Property Points
Historic Property Polygons

Alexandria Township

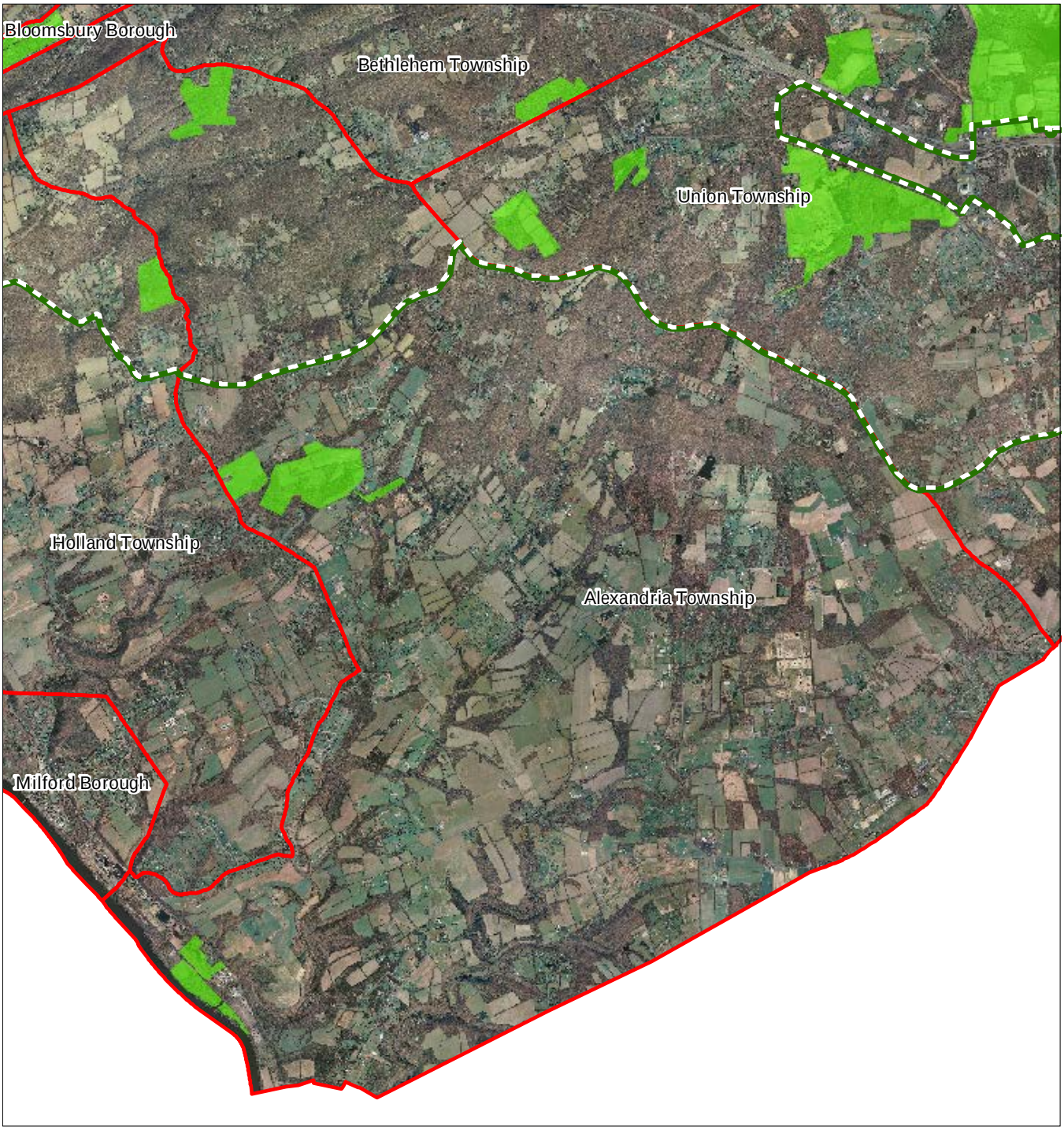
1 inch = 0.94 miles

Highlands Council
New Jersey

N

July 2014

Figure 29: Baseline Scenic Resources Inventory



Scenic Resources
Municipal Boundaries
Preservation Area

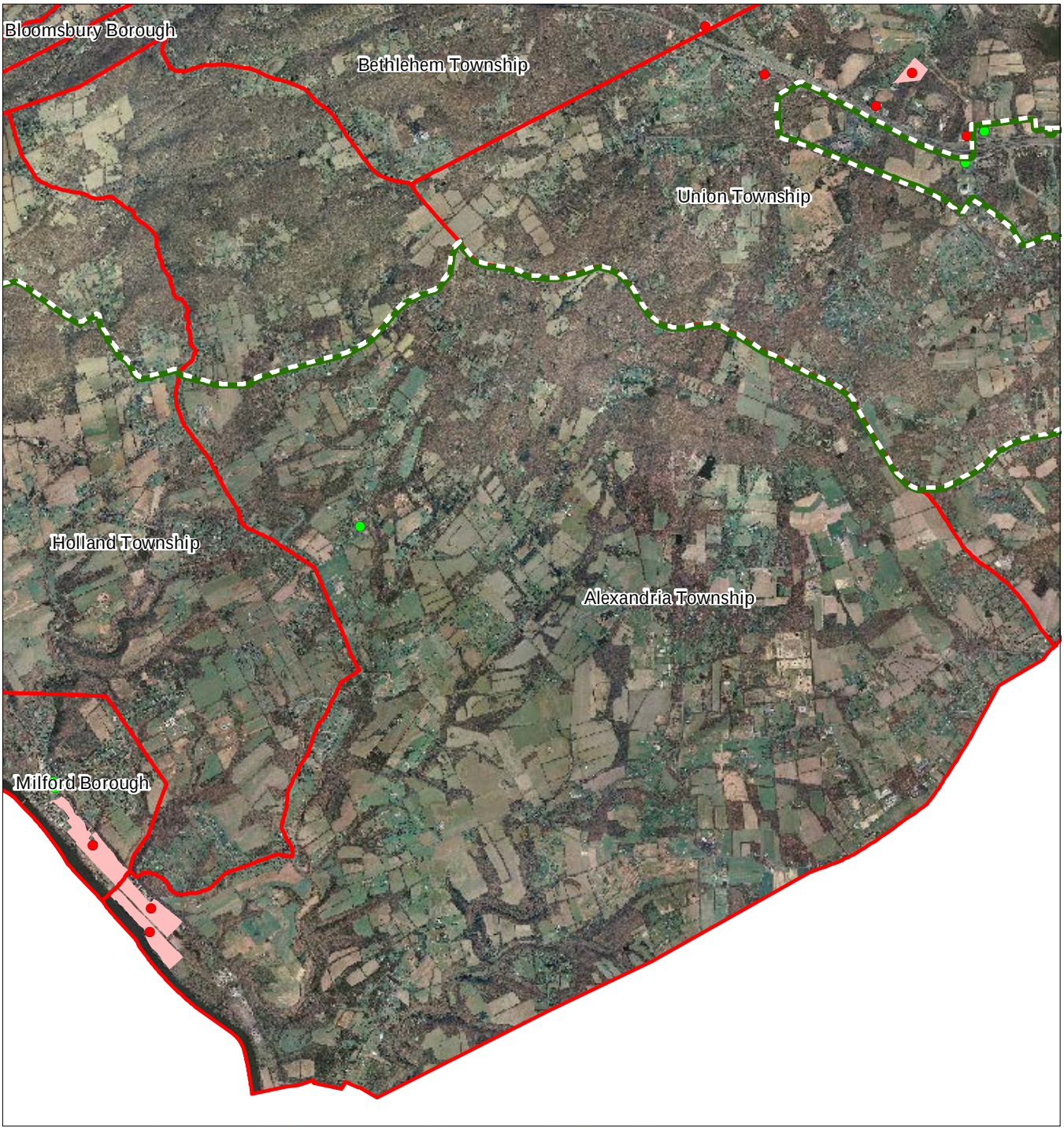
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 30: Highlands Contaminated Site Inventory



Highlands Contaminated Site Inventory

- *Tier 1 Sites*
- *Tier 1 Sites (Polygons)*
- *Tier 2 Sites*
- Preservation Area
- Municipal Boundaries

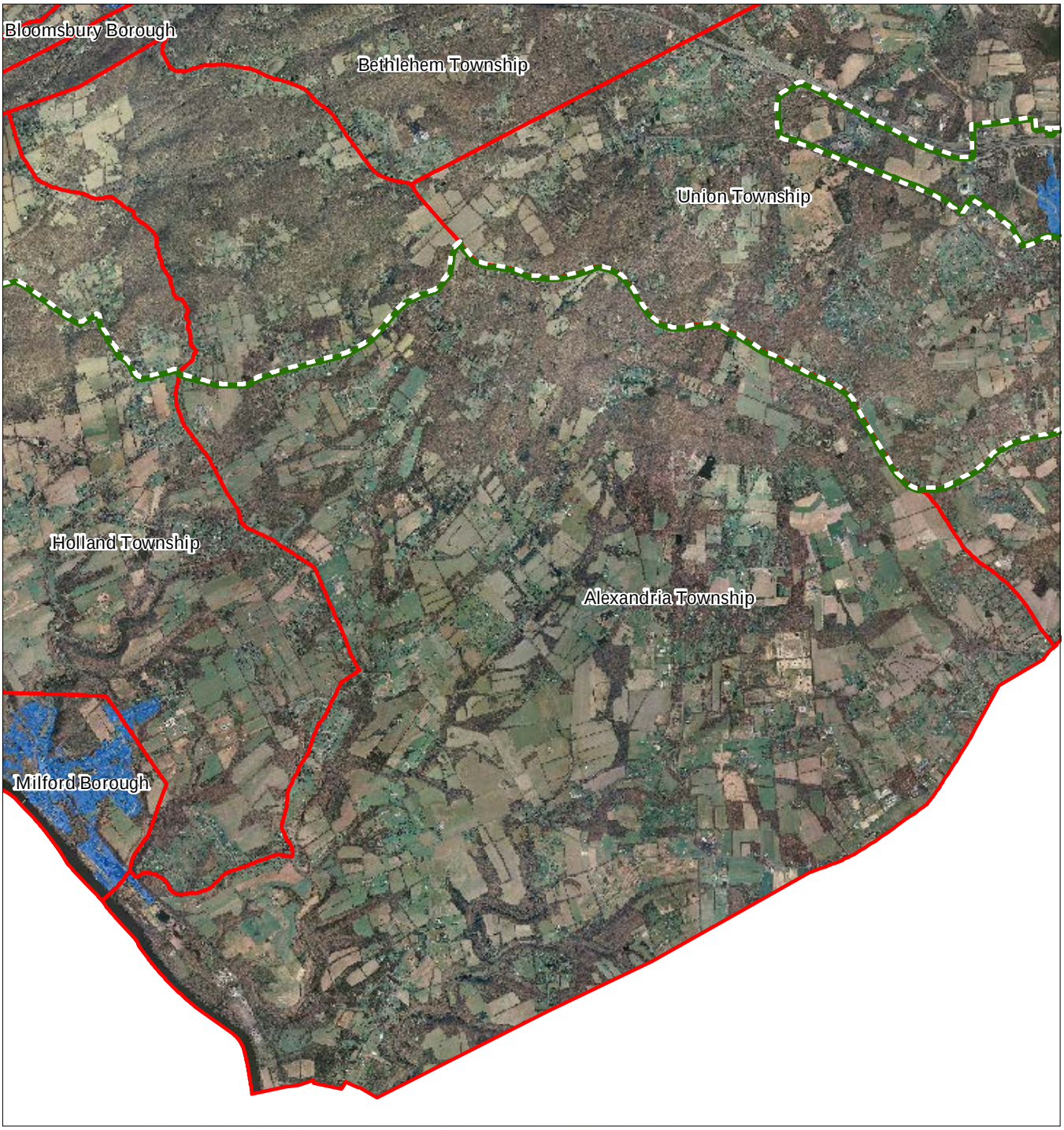
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 31: Public Community Water Systems



Public Community Water Systems
Preservation Area
Municipal Boundaries

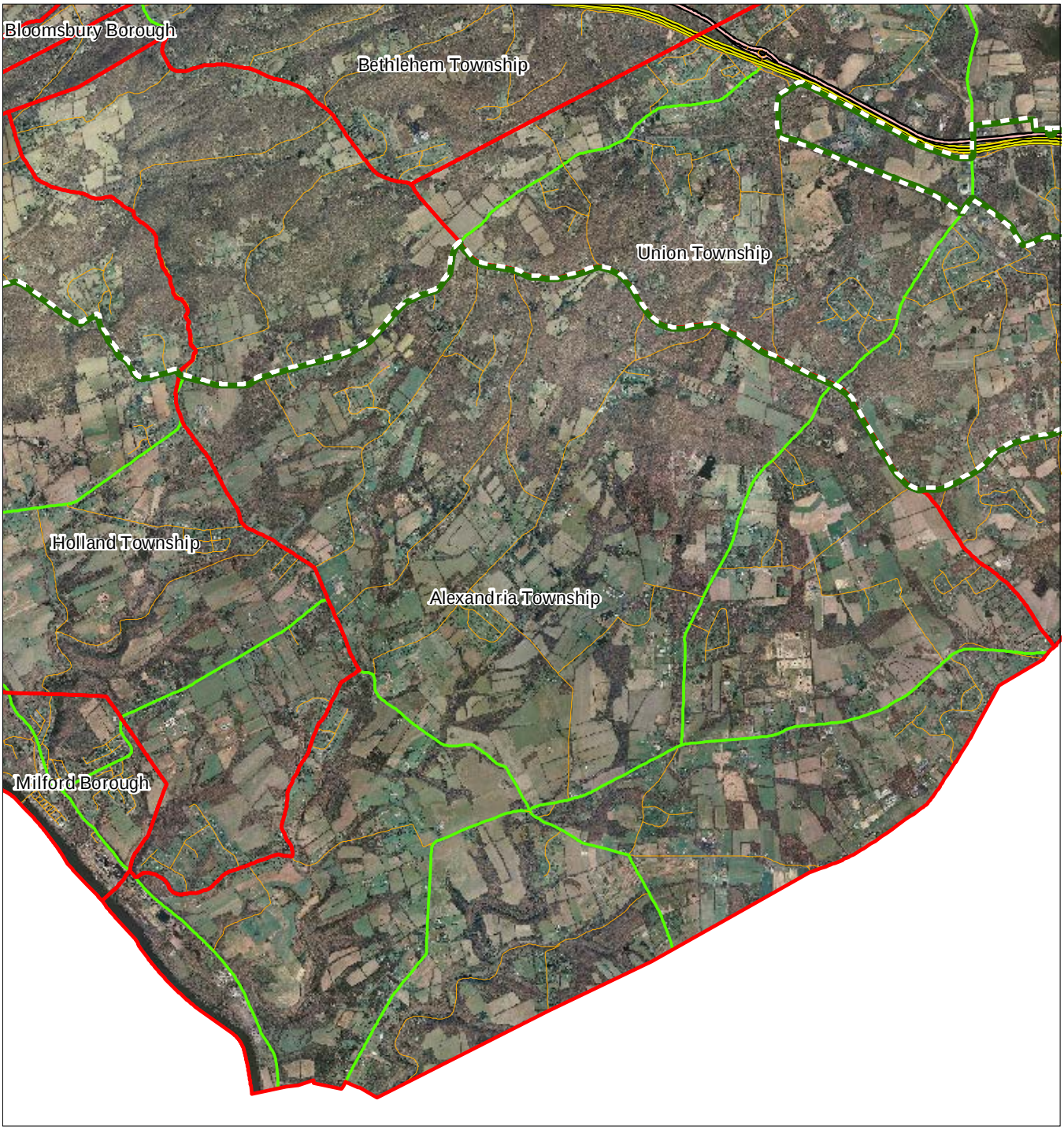
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 33: Highlands Roadway Network



Roadway Network

- *Interstate Highways*
- *U.S. Routes*
- *State Routes*
- *County Routes*
- *Local Routes*
- Preservation Area
- Municipal Boundaries

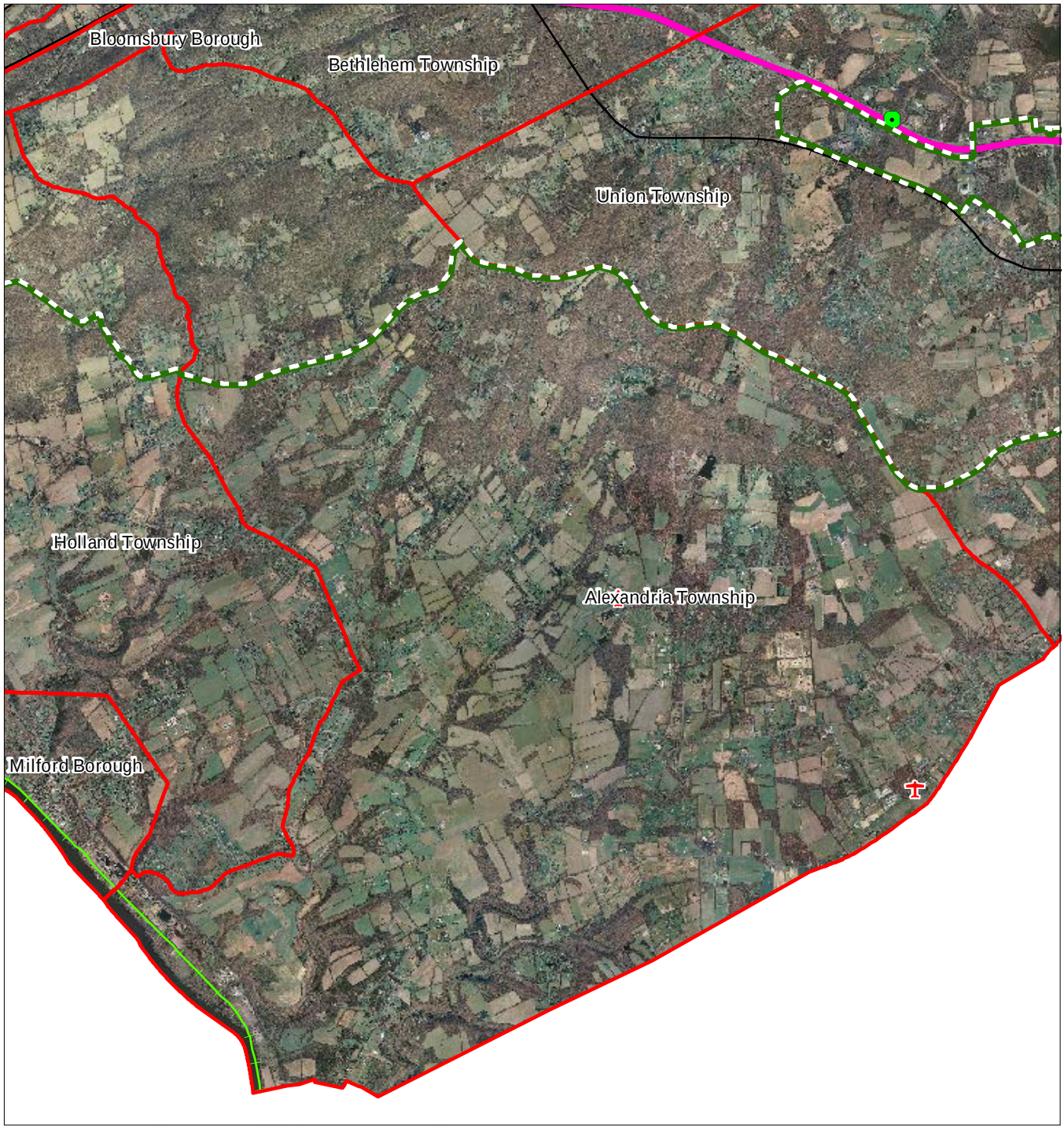
Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N

Figure 34: Highlands Transit Network



Rail Network
- *Boonton Line*
- *Main Line & Bergen County Line*
- *Morris and Essex Line*
- *Raritan Valley Line*

Freight Rail Lines
- *Freight Rail Lines*
- *Abandoned Freight Rail*

- Rail Stations
- Park and Ride Sites
- Private Bus Lines
- NJ Transit Bus Lines
- Airports

Alexandria Township

1 inch = 0.94 miles

Highlands Council
New Jersey

N