NORTH AND SOUTH BRANCH RARITAN WATERSHED CONSERVATION PLAN

to create a strategic vision and to set priorities for protection of water resources within the Raritan Headwaters region

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Raritan Headwaters
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Kristi MacDonald is Director of Science at Raritan Headwaters. She has a PhD in ecology from Rutgers University. Her research has mainly focused on understanding how species respond to human-caused stressors such as urban and agricultural land use, pollution, invasive species and climate change. Prior to joining RHA she worked with the Wildlife Conservation Society, Hudsonia, and NY/NJ Baykeeper on programs to guide decision-makers on how they might incorporate protection of habitat and other ecosystem functions into local and regional land use planning. Recently, she completed a long-term trend analysis of ground water data from over 30 years of Raritan Headwaters Well Test Program records and she is currently doing a similar trend analysis of stream monitoring data. Kristi is co-author of a book on conservation of urban biodiversity in the NJ Meadowlands.

Melissa Mitchell Thomas is GIS and IT Specialist at Raritan Headwaters. She has a B.S. in Computer Science from Minot State University, ND. Prior to joining RHA, she worked with the Washington State Department of Ecology, Water Resources and the Upper Raritan Watershed Association.

Executive Summary

1. In the Watershed Conservation Plan (WCP), Raritan Headwaters (RHA) presents a model and methodology that clearly identifies restoration/BMP and land preservation priorities for water resource protection in the North and South Branch Raritan Watershed (WMA8) of New Jersey.
2. The 470 square mile Watershed is a mosaic of land use and land cover with some regions dominated by urban, agriculture, forest, and wetland or a mixture of these. Forests and wetlands are integral to maintaining the water cycle and contribute greatly to water quality and quantity. Alternately, urban and agricultural land uses in their common form tend to result in degraded water quality and disruption of natural water cycles.
3. In order to proactively address threats to water resources, RHA developed this model to aid in decisions about where in the Watershed to focus efforts and which approach (restoration/BMP or preservation) is most appropriate.
4. Mapping the resources and collating land use land cover data provides a useful tool for RHA and its partners to make decisions about projects and identify common focal areas as well as provide a valuable outreach tool.
5. WMA8 has 52 subwatersheds (HUC-14s), which are smaller areas that drain into tributaries within the larger watershed. These subwatersheds make sense as a unit for planning because they are affected by common ecological conditions and human impacts at a smaller scale than the larger watershed.
6. Six major resource categories of data for each subwatershed that indicate either high water quality or support high water quality or quantity were incorporated into a table/matrix. These categories included Forest Cover, Soils, Surface Water Quality, Aquifers & Recharge, Riparian Areas & Wetlands, and Wetland Dependent Wildlife. The 52 subwatersheds were ranked based on their scores for each category. The sum of the six category ranks were then summed to get a total score for each subwatershed, which could then be ranked for a final overall ranking.
7. The ranks from 1 to 52 represent a spectrum from subwatersheds in need of extreme restoration/BMP projects on the low end and preservation on the high end.
8. The overall ranks were presented on a map as a spectrum of color; subwatersheds with high urban and/or agricultural land use were dark blue and subwatersheds with a lot of remaining forests and wetlands for preservation are dark green with a gradient between the extremes.
9. The 6 major resource categories and ranks are presented as raw data and ranks both in the table/matrix as well as on maps in Appendix A.
10. Additional data excluded from the ranking model but potentially useful in decisions for some cases is included in Appendix B.
11. The WCP is a dynamic tool that is adaptable and updatable as new information becomes available and goals evolve. It is intended as a tool for guiding and informing priorities for water resource protection. It is meant to be used along with context-dependent considerations such as opportunities for partnerships and available funding sources.

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1. INTRODUCTION

1.1 Mission and History of the Raritan Headwaters

Raritan Headwaters (RHA) is a 501(c)(3) non-profit, member-supported conservation organization. Our mission is to *protect, preserve, and improve water quality and other natural resources of the headwaters region of the Raritan River through science, education, advocacy, land preservation, and stewardship*.

RHA was formed through the merger of the Upper Raritan Watershed Association (URWA) and the South Branch Watershed Association (SBWA) in 2011. RHA's focal area is the North and South Branch Raritan Watershed, which covers the 470-square mile Raritan River headwaters region. The region is identified by the New Jersey Department of Environmental Protection (NJDEP) as Watershed Management Area 8 (WMA8). The region includes parts of three counties (Hunterdon, Morris, and Somerset) and 38 municipalities. The watershed plays a critical role in meeting the demands of residential, commercial, agricultural, municipal and manufacturing water users within and beyond the region. The Raritan Basin is the largest river basin entirely within New Jersey, and part of the Highlands water supply system, serving more than half the state's population.

1.2 Purpose and Need

RHA seeks to create a strategic vision and to set priorities for protection of water resources within the Raritan Headwaters region. The Watershed Conservation Plan is intended:

(1) to identify and map the critical water resources and the ecosystems, geological features, and soils supporting these resources across our watershed;

(2) to provide a decision-making tool for prioritizing subwatersheds for land preservation and/or restoration to protect water resources;

(3) to develop interactive maps for RHA's new web site;

(4) to compile the data and RHA's analysis of priorities in a report and share it with partners and municipal stakeholders.

The Watershed is a true mixed land use/land cover mosaic of urban, agricultural, forest and wetland area (Figure 1). In our headwaters, maintaining natural, ecologically functional open space with low impervious surface is important because there is ample evidence of the function of forests and wetlands in maintaining surface and groundwater resources (Lowrance et al., 1997; Brabec et al., 2002; The National Academy of Sciences 2008; Neary et al., 2009). These functions include buffering streams, stabilizing banks, slowing water and absorbing impacts of flooding, filtering pollutants from water, capture of precipitation in canopy, provide leaf fall base of stream food chain, maintaining low stream temperatures via shading, aiding infiltration of precipitation into the ground, which in turn recharges aquifers and provides baseflow to streams. Wetlands provide a variety of functions in protecting water resources (Mitsch and Gosselink, 2000; Verhoeven et al., 2006). They capture stormwater and remove, process or retain pollutants such as organic nutrients and inorganic nutrients, nitrogen and phosphorous, and heavy metals. They also play a major role in the storage and slow release of water to streams and groundwater, which are critical functions in maintaining stream flow during droughts as well as mitigating the impacts of flooding. Therefore, in places of high forest and wetland cover, land preservation through various planning and acquisition tools is of high priority. However, where agricultural and urban development predominate, natural ecosystem function and the services they provide are diminished due to lack of buffers, erosion, impervious surfaces and increased stormwater runoff and use of road salt, fertilizers and pesticides associated with human land use. In these places, the target is reducing the impacts of non-point source pollution, mitigating the impacts of flooding, and improving hydrologic function through restoration, implementation of Best Management Practices (BMPs), construction of green infrastructure, and improved land use planning (hereafter referred to as "restoration"). Both of the preservation and restoration approaches are needed to protect water resources throughout the Watershed. In some areas a mixed approach may be appropriate because there is still some forest to preserve but human impacts also need to be addressed through restoration/BMPs/green infrastructure.

Furthermore, land use in the Watershed is drastically changing at a rapid pace. Over the past two decades, urban/suburban development has been replacing farmland and forestland. Between 1995 and 2012, urban land cover increased from 80,349 acres to 97,789 acres (a net change of 17,440 acres: 22% increase) and agriculture decreased from 75,179 acres to 62,960 acres (a net change of -12,219 acres; 16% decrease). Forest cover decreased from 108,571 acres to 104,619 acres (a net change of -3,952 acres; 4% decrease). Wetlands decreased from 27,290.8 acres to 25,556.13 acres (a net change of -1,734.67 acres; 6% decrease). Protection of remaining forest and wetlands in this headwaters region is critical to maintaining surface and groundwater quality. Farmland preservation may also be a key component of land acquisition to maintain low impervious surface cover. However, common agricultural practices have their own suite of negative impacts on water resources. Thus, farmland preservation must coincide with restoration and agricultural BMPs that decrease erosion, maintain stream buffers, protect wetlands, conserve water and require lower inputs of pesticides and fertilizers. Existing farms and suburbs need to be retrofitted with improved stormwater infrastructure, native landscaping, and other river friendly practices. Where new urban development occurs, it should incorporate state of the art planning and green infrastructure from the start.

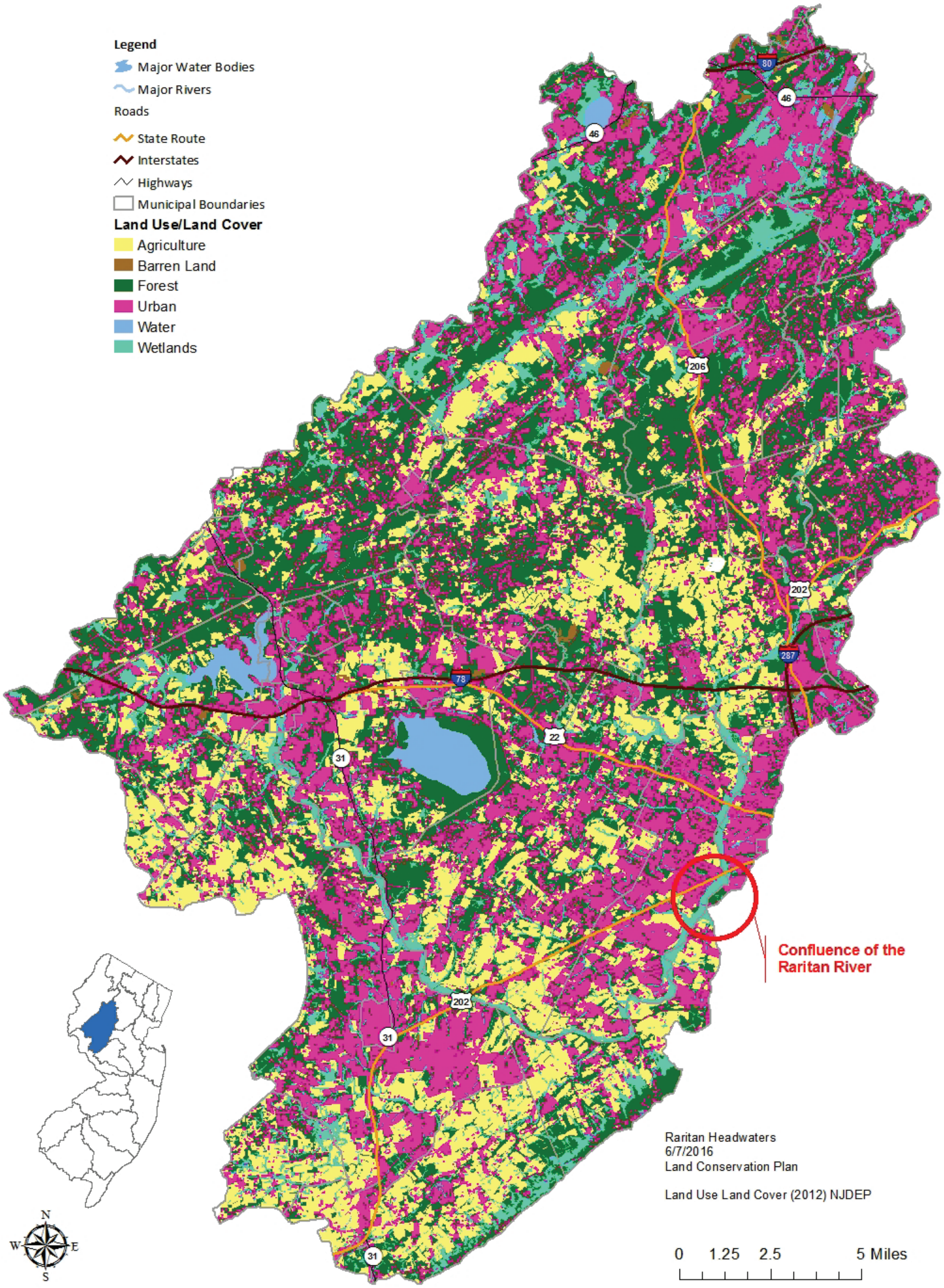


FIGURE 1. MAP OF MAJOR LAND USE/LAND COVER TYPES (2012) IN WMA 8.

The need for a water protection strategy was clearly identified as the Upper Raritan Watershed Association (URWA) and the South Branch Watershed Association (SBWA) worked through a comprehensive planning process to merge their organizations in October 2011. A critical outcome of this exercise was the realization of the need for a tool that will guide decisions about land preservation and restoration activities; incorporating criteria that prioritize regional targets for protection of sensitive water resources based on a variety of data sources on presence of critical or sensitive water resources and existing land use/land cover. In addition, RHA recognizes the need to ensure that future land preservation and restoration projects will be guided by sound planning, which will:

- ensure that land acquisition or preservation projects are consistent with RHA's mission and further the land preservation program goals by contributing to the protection of water quality, the preservation of ecosystem integrity, and the prevention of inappropriate or irresponsible development;

- ensure that acquiring a parcel, protecting it through a conservation easement, or restoring its ecological integrity is a sound investment of fiscal and human resources;

- strategically identify and pursue projects that offer exceptional resource values in need of preservation, are vulnerable due to a lack of alternative protection measures, or require restoration or improvement of water quality through green infrastructure and BMPs.

WMA8 contains some of New Jersey's premier surface water supplies. It is the headwaters of the Raritan River Basin which constitutes the largest watershed located entirely within New Jersey. The Basin is a part of the Highlands Water System that supplies drinking water to 5.2 million residents and supports much of the state's economy. Land use patterns are a continuous threat; increasing amounts of impervious surface diminish ground water recharge and stormwater carries pollutants into the region's streams. Planning and implementing a strategy for land preservation and restoration in the headwaters of this critical basin will have a positive, cumulative impact on all the communities within and far beyond the region, into New Jersey's urban areas.

1.3 Key Characteristics of the Plan

The WCP incorporates a wide range of variables affecting water resources in the Watershed. It would be expected that the WCP will change over time to adapt to changing environmental conditions, changing priorities, additional data, and varying circumstances. It is important to note that this plan is designed to be an objective tool in prioritizing subwatersheds based on their land preservation and restoration values.

The plan consists of two major land evaluation components:

1. A method to facilitate the comparison of one RHA subwatershed to another across a set of resources for land acquisition and restoration prioritization. The plan includes a current ranking of these subwatersheds based on the criteria resources identified as the best indicators of ecological functions that support water resource integrity (e.g., forest cover) and indicators that demonstrate high quality water and habitat structure is present (e.g., stream macroinvertebrate communities; see Table 1, Figure 2 and Appendix A).

2. The establishment of site-specific acquisition evaluation guidelines (Section 6.1).

While the plan may facilitate the process to determine where to focus preservation or restoration funding and efforts, it is not intended to provide the final decision on any land acquisition prioritization. The plan contains a series of maps that serve as a visual aid to facilitate the review of subwatershed resources (Figure 2 and Appendix A). These maps contain both resources that are linked to water quality protection and included in Table 1 as well as additional data and mapping (Appendix B) that may impact prioritization decisions, such as open space mapping. These maps will be interactive and available to the public at www.raritanheadwaters.org.

Additional considerations such as amount of preserved land and existing funding sources, partnerships and other factors will contribute to the subwatershed prioritization process (see Section 5) and are included in site-specific general guidelines section (see Section 6). The plan is modeled to incorporate new or more accurate information, such as refined versions of GIS data, as it becomes available. Other environmental considerations, such as Global Climate Change (see Section 5), may also impact the prioritization process in the future and are discussed. Climate change may factor into acquisition decisions as its impacts on the Raritan Headwaters and on specific subwatersheds become better defined.

1.4 Watershed Approach to Management

A watershed is an area of land that drains to a specific surface waterbody or wetland. This includes surface water features and the surrounding land itself (NJDEP 2012a). A watershed level approach to land management is a widely-accepted, geographically focused way of managing and protecting land, ecosystems and water quality (USEPA 2013). A watershed approach provides a scientifically–based, organizational framework for planning. This approach can include setting specific watershed level goals and objectives, and aid in securing targeted resources and incorporating voluntary and regulatory programs. Within the State of New Jersey, WMAs, their watersheds and subwatershed management approaches are often referenced or incorporated into regulation and environmental protection. For these reasons, the WCP is primarily designed around the watershed and subwatershed level approach.

The US Geological Survey (USGS) has mapped and identified watersheds throughout New Jersey and elsewhere using a hierarchical numbering system. The State of New Jersey manages its watersheds through 20 distinct Watershed Management Areas (WMAs), each defined by topographic features such as hills and slopes. Each WMA contains multiple watersheds and smaller subwatersheds. Each watershed is identified by a unique hydrologic unit code (HUC) consisting of 11 digits (HUC-11). Watersheds are further divided into subwatersheds, which are distinguished by a HUC consisting of 14 digits (HUC-14). There are 150 HUC-11 watersheds in New Jersey, ranging in size from 0.1 to 143 square miles, with an average size of 51.9 square miles. There are 921 HUC-14 subwatersheds in New Jersey, ranging in size from 0.1 to 42 square miles, with an average size of 8.5 square miles. Watershed and subwatersheds are also given names based on associated surface water features. The HUC-14 subwatershed level is the most specific planning level unit evaluated in the RHA Watershed Conservation Plan.

The focus of this conservation plan, Raritan Headwaters region, corresponds with WMA 8 and is defined by the area of land that drains into the North and South Branches of the Raritan River. WMA8 is referred to as the North and South Branch Raritan Watershed Management Area. This watershed covers approximately 470 square miles in three counties: Morris, Hunterdon, and Somerset. It includes all or portions of 39 municipalities. The Raritan Headwaters region consists of seven HUC 11 watersheds containing a total of 52 HUC 14 subwatersheds (see Appendix B). Major tributaries associated with the North and South Branch Raritan River include the Neshanic River, Spruce Run Creek, Mulhockaway Creek and Cakepoulin Creek.

2.0 GOALS, OBJECTIVES AND, INTENDED IMPACTS

Goal: Improve ground and surface water quality within WMA 8

Objective 1: GIS Mapping and Data Access Map the water resources and supporting ecological features of WMA8.

Short-term impacts: RHA will have created a snapshot of the natural resources and land uses within the entire WMA8 region. **Long-term impacts**: The maps will serve as a baseline from which to measure the project's progress.

Objective 2: Create a Strategic Plan of Land Conservation/Acquisition and Restoration/BMPs to protect water resources

Short-term impacts: RHA will have a tool to strategically guide land preservation or restoration activities and a proposed framework for implementation. **Long-term impacts**: Lands within WMA8 with high resource value will be prioritized for protection and subwatersheds requiring restoration will be identified.

Objective 3: Public Outreach Design web content to educate public about the resources in their subwatersheds and municipalities and the linkages between land and water protection.

Short-term impacts: The public will have access to interactive maps of water resources and the features that support them, an overview of Watershed Conservation Planning, a menu of opportunities for land preservation and restoration/BMPs, recreational activities and links to conservation services and partners. **Long-term impacts**: Support for open space protection will be expanded to a broader and more educated audience.

Objective 4: Develop and Strengthen Partnerships Convene workshops/roundtables of partner organizations to disseminate findings. The purpose of roundtable sessions will be to introduce conservation priorities, disseminate maps, and determine where there are shared priorities and strategies for preservation and restoration in WMA8.

Short-term impacts: Protection of sensitive water resources will be advocated for, partners will gain science-based data, leverage for financing will improve, and projects will be strengthened with a broader base of partners that bring a range of expertise and resources. **Long-term impacts**: Land preservation or restoration activities will intensify, more work will be accomplished and more resources protected.

3.0 METHODOLOGY

3.1 Background

The primary focus of the RHA Watershed Conservation Plan is to create an objective guide to facilitate the prioritization of subwatersheds for the purpose of allocating resources for preservation and restoration where they are most needed; as well as to determine the type of action (preservation or restoration) most appropriate for a specific subwatershed. As previously mentioned, the WCP and any methodologies utilized for prioritizing subwatersheds in the Plan are not intended as the final determination in allocating resources for land acquisition or restoration. There are many additional considerations, such as partnerships, existing preservation and projects, that would be evaluated on a case-by-case or site-by-site basis. Some of these major considerations are addressed in Section 5.0 of the WCP.

RHA developed the matrix of data used in the final ranking of subwatersheds (Table 1) by first categorizing all potential resources and conditions linked to water quality and quantity that have available GIS layers and could be evaluated on a landscape level. For the purposes of the WCP, a "resource" is defined as a source or supply from which some benefit or use is derived, environmental or otherwise.

The data presented for each subwatershed in the table may be quantifiably expressed as acres (e.g., wetland or open water), linear feet (e.g., C1 streams), an index (e.g., HGMI) or count depending on how to best to quantify the resource. Primary data sources that were utilized for this first portion of the analysis include NJDEP, NJGS, USEPA, and NJWSA.

Once these data were compiled, it was then determined which resource data sets would be most crucial in a subwatershed prioritization ranking system that meets the conservation goals of the WCP. In several cases during the process of selecting data to include in the ranking analysis, data were redundant or cancelled each other out. A goal was to create a ranking system that would produce priorities in areas of acquisition and restoration that make sense based on land use patterns in the Watershed and could be justified based on an understanding of the underlying data. In addition, the criteria included selecting data that indicate high water quality, a greater amount of sensitive water resources, and/or a contribution to maintenance of ecological functions that support these water resources. Variables that indicate degraded water quality or factors that degrade water quality were not used for ranking because they are redundant data. Other forms of redundancy were avoided where possible. While much of the data from the data tables may be useful in various contexts, some data sets that were developed and meet the aforementioned criteria were not directly incorporated into prioritization process. Most often this was to avoid repetition in the final prioritization matrix. This includes data sets are tied to, and typically very similar in distribution to other key data layers or sets. For example, hydric and alluvial soils were not directly included in the final matrix because the distribution of these resources is represented through wetlands distribution data and riparian data in the WCP matrix.

All of the key resources chosen in the subwatershed prioritization process are described in Section 3.3.

The data sets that were chosen for ranking subwatershed priorities (Table 1) share the following characteristics:

A. Are most clearly scientifically linked to water quality or quantity. The water quality function of resources such as wetlands and forest are well documented by NJDEP, US Forest Service, EPA and others. Other resources, such as water/wetland-dependent, sensitive wildlife, have been well documented by NJDEP and other agencies as indicators of water quality. The identified resource layers have been utilized for similar purposes in other plans with similar purposes.

B. May effectively be protected or improved through land acquisition or improvement. For example, air quality is not utilized in the plan because air quality improvement cannot easily and demonstrably be linked to land acquisition in most cases.

C. May be easily evaluated on a spatial scale. The resource must be mapped with enough detail, that it could be evaluated on a subwatershed level. If the data presented are too generalized (such as rare plant grids or county rare plant lists) or the resource too ubiquitous (such as the consideration of Sole Source Aquifer Areas), it cannot effectively aid in making distinctions between subwatersheds.

D. If needed, data can be combined from multiple data sets within the broad summary tables. For instance, coniferous, deciduous, and mixed wooded wetlands are combined for the “forested wetlands” layer in the subwatershed ranking system.

Once the key prioritization data sets were determined, they were incorporated into the ranking matrix discussed in Section 3.2.

3.2 Resource Ranking System and Matrix

The cornerstone of the subwatershed prioritization method in the WCP is the development of a ranking matrix (Table 1). The matrix quantifies the GIS data derived from the summary data tables and ranks these subwatersheds based on the presence of the resource. Ranking is based on the relative amount of that resource - that is all rankings are calculated by determining amount (which may be linear miles, acres, etc.) relative to the size of that subwatershed where standardization was deemed necessary.

Matrices are an effective tool for objectively ranking data. The matrix process cross references each subwatershed with the presence and amount of each key resource. A matrix approach is utilized by environmental agencies seeking to prioritize resources, lands or actions. For example, US Fish and Wildlife Service, in the development of Refuge Comprehensive Conservation Plans, uses this methodology to more objectively identify priority refuge resources and provide a more systematic approach to land management planning (USFWS 2013).

The WCP matrix ranks each subwatershed based on 6 major criteria (see Table 1, Green Columns) that are critically linked to protection of water quality and quantity. Each of these resources, including its characteristics and application within the WCP, is discussed in Section 3.3.

Major Resources include the following:

1. Forest Cover
2. Soils
3. Surface Water Quality
4. Aquifers and Recharge
5. Riparian Areas and Wetlands
6. Wetland Dependent Wildlife

Each major resource (six categories; Section 3, Table 1 and Appendix A) represents a subset of data sets collected during the initial data collection process that began in 2011 (Appendix B). These six major categories were created by utilizing various elements of the data that were most relevant and adaptable to the ranking process.

Each of the 52 subwatersheds received a rank for each category from 1 to 52 based on the relative quantity of that resource. For example, the greater the amount of forest relative to watershed size, the greater the score and the higher the prioritization rank. The watershed ranked "52" has the highest relative amount of forest, while the one ranked "1" has the least relative amount. Subwatersheds that do not have a particular resource mapped within their boundaries were given a "1" in the ranking for that resource. Therefore in some cases, such as surface waters mapping, there are multiple subwatersheds ranked as 1 in the final matrix and the highest rank does not go up to 52.

Two of the major categories, Total Water Quality and Aquifers/Recharge, each consist of three subcategories in the matrix table (see blue columns in Table 1) that were first evaluated and ranked independently. Those subcategory scores were then summed and then ranked accordingly as the major category.

For each subwatershed, the ranks (1 to a maximum of 52) for each of the six major categories are summed for a total raw number (see Table 1). That raw number is then used to get the final ranking with the greatest total sum of the 6 category ranks corresponding to a rank of 52. Watersheds with the highest scores would be prioritized for preservation and subwatersheds with lower scores would be prioritized for restoration. The higher score/higher rank is associated with high quality and quantity of water resources and the ecological features that support them such as forests and wetlands. These areas rank high on the preservation end of the water resource protection target approaches most appropriate for that subwatershed. The lower score/lower rank is associated with areas of poorer water quality, a lower presence of sensitive water resources and are dominated by urban/suburban or agricultural land use. These areas have little undeveloped land cover left to protect through acquisition/easements and require an emphasis on implementation of plans for restoration and BMPs. Many watersheds have opportunities for both the preservation and restoration approaches.

Although all RHA subwatersheds have been ranked for this plan (see Table 1), the ranking criteria and therefore the prioritization order of subwatersheds may need to be changed over time. As with other components of the WCP, the matrix is designed to be a flexible and should be adjusted to meet changing needs of RHA or changing conditions within the Raritan Headwaters region. The table and the plan itself should also be periodically reviewed and updated as new relevant data are developed, or existing data are refined by NJDEP or others. In certain cases, one or several major resource categories (as opposed to all eight) may need to be evaluated for ranking or certain datasets may be evaluated in different ways. For example, RHA may want to identify, acquire and remediate land within subwatersheds most threatened or impacted by urbanization. In this situation, RHA may choose to include or independently analyze "urban cover" data set to prioritize the most developed subwatersheds. In another example, a highly complicated land use such as agriculture may have benefits or impacts to water quality depending on the type and level of intensity. Such uses may be evaluated independently for ranking. To facilitate this process, the final matrix table is designed and provided as a digital "pivot table" spreadsheet that allows for the adjustment and rearrangement of ranking criteria as needed.

Appendix A contains maps of coverage for each of the six major resources as well as a map that ranks the subwatersheds just on that resource category. Appendix B contains maps and data on important coverages not included in the ranking matrix.

3.3 Major Resources for Subwatershed Prioritization Ranking

This section provides brief descriptions of the resources, impairments and existing protections utilized in the acquisition analysis process for the Raritan Headwaters. Each of the resources described has been incorporated into the RHA subwatershed prioritization process. Each section includes a ranking application discussion that explains how the resource is evaluated and functions in subwatershed prioritization and in some cases site acquisition guidelines. These resources have been previously incorporated into land evaluations prepared by NJ Water Supply Authority (Zhang, 2009), NJDEP, and others.

In accordance with the land preservation and restoration goals and objectives set forth in Section 2, each of these resources is considered on how it relates to land acquisition in the context of protecting water quality and quantity. Much of the data utilized and discussed in this section is derived from the most recent available NJDEP GIS data.

After the initial data were acquired through GIS research, the list of appropriate resources to focus on was refined to avoid redundancy and where feasible, to streamline the subwatershed evaluation process.

3.3a Land Use/Land Cover - Forest Cover

Land use/land cover and the quality of water resources are critically linked (Lowrance et al., 1997; Brabec et al., 2002; The National Academy of Sciences, 2008; Neary et al., 2009). Careful land use that includes well planned development and the preservation or restoration of naturally vegetated habitats is key in maintaining the water quality of the Raritan Headwaters' streams, lakes and reservoirs, wetlands, and aquifers. Development that creates impervious surfaces such as rooftops, driveways and roads can increase runoff volume and rates and decrease aquifer recharge. Stream base flows and drinking water supplies may ultimately be impacted by development resulting in impervious surface increases. Increased pollutant loads from household chemicals, pathogens, metals, fertilizers and oils typically correspond with increases in urban development. Construction activities that disturb soils often release sediment and other pollutants into streams. Land use changes, when compounded by slopes and the natural erodibility of soils can contribute to surface water sedimentation, the leading cause of stream impairment in the US.

Forest habitats, in particular, are vital in preserving water quality by preventing sediment erosion into surface waters, filtering groundwater and providing areas of high aquifer recharge. Forests act as buffers to runoff, and stabilize soils that may otherwise erode into adjacent streams. Subsequently, the quality of water that drains from forested watersheds is higher than other land uses (USDA 1994). It is important to consider that within forests, the management of that forest can impact water quality (USDA 2008). Although forested areas typically have excellent associated water quality, well managed forests with fewer roads are less likely to have any water quality impacts (USDA 1994). GIS coverage of core forests is therefore incorporated into land evaluations in this plan and in other plans or planning tools such as the NJWSA critical areas mapping.

Ranking Application

Forest Cover

The forest coverage in this category contains any lands covered by woody vegetation that do not occur in wetlands. The forest coverage consists of deciduous, coniferous, mixed deciduous-coniferous, and brushland identified in the NJDEP GIS Land Use/Land Cover data. This designation is derived from the Anderson Classification System (Anderson et al., 1976) and edited by the NJDEP. The NJDEP 2007 Land Use/Land Cover Data indicates that there are approximately 104,540 acres of forest (approximately 35% of the total area) within the Raritan Headwaters Watershed. The majority of this forest is upland deciduous forest coverage with greater than 50% crown closure.

The primary upland forest of Raritan Headwaters area consists of Mixed-Oak forest; and to a lesser extent Hemlock-Mixed Hardwood forest, and the Sugar Maple-Mixed Hardwood forest. Mixed-Oak forests consist of varying mixtures of large trees including red oak (*Quercus rubra*), white oak (*Quercus alba*), and black oak (*Quercus velutina*). Rocky and dry areas may be dominated by Chestnut oak (*Quercus prinus*) forest (Collins and Anderson, 1994). Other tree species in oak forests may include tulip poplar (*Liriodendron tulipifera*), various hickories (*Carya* spp.), sugar maple (*Acer saccharinum*), American beech (*Fagus americana*), white ash (*Fraxinus americana*), flowering dogwood (*Cornus florida*), sassafras (*Sassafras albidum*), ironwood (*Carpinus caroliniana*), black birch (*Betula lenta*), red maple (*Acer rubrum*) and black cherry (*Prunus serotina*). A minor forest component within the Raritan Headwaters would include coniferous or mixed coniferous/deciduous forests. Eastern red cedar (*Juniperus virginiana*) occurs within and on the edges of younger forests. Within the Highlands Region, these areas are often hemlock (*Tsuga canadensis*) ravines. Scattered trees of hemlock, white pine, American elm and black walnut are found in some of the wooded areas of the limestone valleys.

SEE APPENDIX A1 FOR MAPS OF COVERAGE AND RANKING OF FOREST COVER FOR EACH SUBWATERSHED.

3.3b Soils

Soils provide the basis for the potential land uses and land cover. They determine the types of vegetation or crops that can be grown and influence the development activities and design of structures that can be constructed. Soils are formed by forces of the environment acting on soil material deposited or accumulated by geologic processes (Ritter, 2006). Characteristics of soil including how erodible the soil is and the slope relief may have a huge impact of that soil's development and ultimately water quality.

Ranking Application

For the purposes of the WCP, soil mapping/data developed for WMA 8 by NJWSA for the creation of a Highly Erodible Soils Map is utilized. In addition to Land Use/Land Cover (see Section 3.3a), the composite soil characteristics utilized in the NJWSA model include erodibility

(K-factor) and steep slopes mapping. The significance of these resources is briefly explained in this section. Because protection of sensitive soil areas is vitally connected to water quality, the subwatershed with a greater relative amount of Highly Erodible Soils is ranked higher for preservation and the subwatershed with the less erodible soils is ranked lower for preservation. Additional hydric and alluvial soil data were utilized in the development of NJDEP wetlands data and the NJWSA riparian area layer utilized in the document.

Erodible Soils

Erodible soils are determined by a value known as the K-erodibility factor (K-factor). K-Factor is a standardized quantitative measurement of the inherent erodibility of a particular soil when all other factors (such as water capacity, rain splash and abrasion) are the same. The K-factor describes the susceptibility of soil particles to detachment and transport by rainfall and runoff. Identification of K-factor soil locations is useful in determining areas that are particularly susceptible to runoff, erosion and other water quality issues (source on K factor). Percentage of K-factor soils out of total area of the watershed was the metric used in calculating soil rank.

SEE APPENDIX A FOR MAPS OF COVERAGE AND RANKING OF ERODIBLE SOILS COVER FOR EACH SUBWATERSHED.

3.3c Aquifers and Recharge

Aquifers are confined, partially confined or unconfined saturated permeable geologic units (similar to those described above) that can transmit significant quantities of water under ordinary hydraulic gradients. Geologic formations that have high hydraulic conductivity values tend to be the most productive in terms of well yields. Examples of aquifers with high conductivity include unconsolidated sands and gravels, permeable sandstones and limestones, and heavily fractured sedimentary, volcanic and crystalline rocks. An actively pumped well in an unconfined aquifer can draw down the surface water table in the vicinity of the well when pumped, affecting nearby surface water bodies. In order for pumped aquifers to be sustained, they require sufficient recharge. Recharge is the groundwater derived from a portion of precipitation that does not run off into streams or return to the atmosphere through evaporation and evapotranspiration (through plant uptake). Factors which determine the amount of water that infiltrates to the groundwater aquifer include the porosity and permeability of the surface material, the slope of the land, the amount and kind of natural and artificial cover; as well as the intensity and amount of precipitation.

Ranking Application

Within this section, there are three subcategories that comprise the aquifers and recharge score. These are surface aquifers, limestone/dolomite bedrock aquifers, and NJGS Primary Aquifer Recharge Areas. The NJGS Recharge Data are derived from NJWSA mapping data. Subwatersheds are ranked from one to 52 based on the relative amount of each of these features located within the subwatershed. The subwatershed with the most relative amount of calcareous geology is ranked "52**.**"

Surface Aquifers

While bedrock aquifers tend to be large, deeper aquifers existing within fractured bedrock, surface aquifers are shallow (typically less than 200 feet deep) glacial deposits comprised of sands, silts, clays and gravels containing various quantities of water. Most of these sand and gravel aquifers were laid down in valleys by the Wisconsin Glacier during the Pleistocene Epoch and then "confined" when covered by lake clay, silt, or glacial till (NJDEP). Surface aquifers are often comprised of loose unconsolidated materials and have high conductivity. As a result, water and materials such as pollutants may freely move through these aquifers and make them vulnerable to contamination from the ground surface. The surface aquifer area was obtained from the NJGS and is represented as a percentage of total subwatershed area.

Calcareous Aquifers (Limestone/ Dolomite geology layers)

NJDEP mapping indicates that much of the primary bedrock aquifers associated with the Northern Portion of the Raritan Headwaters are Precambrian Igneous and Metamorphic rock aquifers. These aquifers occur in fractures of gneiss, granite, schist and marble. Igneous and metamorphic rocks tend to be highly erosion and fracture resistant and therefore tend to have very poor well yield in terms of gallons per minute (GPM). Interspersed in lesser amounts within the igneous and metamorphic rock are limestone based formations. The rocks of these formations are occasionally referred to as "carbonate rock" and are generally good and productive sources of well water. Within the dolomite and limestone, water is stored in fractures that tend to be erodible through chemical weathering.

Groundwater flow can be through open conduits in the rock of these aquifers. Because of the ease of water transfer, limestone areas tend to be important as recharge areas and can be sensitive to chemical pollution. The primary aquifer in the Piedmont Portion of the Raritan Headwaters is the Brunswick Aquifer, which is primarily associated with the shales, sandstones and mudstones of the Passaic Formation. The calcareous aquifer area was obtained from the NJGS and is represented as a percentage of total subwatershed area.

Recharge

In order for pumped aquifers to be sustained, they require sufficient recharge. Recharge is the groundwater derived from a portion of precipitation that does not run off into streams or return to the atmosphere through evaporation and evapotranspiration (through plant uptake). Factors which determine the amount of water that infiltrates to the groundwater aquifer include the porosity and permeability of the surface material, the slope of the land, the amount and kind of natural and artificial cover; as well as the intensity and amount of precipitation.

Therefore identifying areas of high replenishment is crucial to protect groundwater from pollution and land-use practices that impact the quality and availability of clean water. Aquifer recharge areas are mapped by NJDEP and others by utilizing rainfall data from climate-monitoring stations, combined with, land use/land cover, wetlands mapping, and soils data. Included in the plan is the NJWSA 2009 Primary Aquifer Recharge Areas data**.** These priority areas were derived by overlaying groundwater recharge data with priority (high yield) aquifer areas, which are related to limestone formations in the northern portions of the Raritan Headwaters. The primary aquifer recharge area was obtained from NJWSA and is represented as a percentage of total subwatershed area.

SEE APPENDIX A FOR MAPS OF COVERAGE AND RANKING OF AQUIFER AND RECHARGE COVER FOR EACH SUBWATERSHED.

3.3d Surface Water Quality

As part of New Jersey's responsibility to protect restore and enhance surface waters, surface water quality is evaluated with respect to Surface Water Quality Standards (SWQS) and water quality concerns occur when SWQS are not met or are threatened. New Jersey's Surface Water Quality standards (N.J.A.C. 7:9B, *et seq.*) establish the water quality goals and policies underlying the management of the State's water quality. As a headwaters region, water quality in WMA8 should be very high or near pristine. This section utilizes and evaluates four key indicators of surface water quality that facilitate determining the location of the most pristine surface waters are located within the Raritan Headwaters Watershed.

Ranking Application

Because of the scale and diversity of resources under this category, each of the three subcategories is scored independently and the scores are then averaged for a single ranking under "Total Water Quality." The subwatershed with the least amount of water resources relative to its size is ranked "1" while the subwatershed with the most is ranked "52".

Category 1 Waters

Waters within New Jersey are also classified as either Category 1 or Category 2 waters. Category 1 (C1) waters are those waters designated for additional protection due to their "color, clarity, scenic setting, other aesthetic value, exceptional ecological significance, recreational significance, water supply significance or fisheries resources." All other waters are considered Category 2 (C2) waters. Under the New Jersey Stormwater Management Rules (N.J.A.C. 7:8), C1 waters are protected from "measurable or calculable changes in water quality" and are afforded a designated special waters resource protection area (SWRPA). The SWRPAs are those areas within 300 feet of the top of each bank of C1 waters. Under the New Jersey Flood Hazard Area Control Act rules (N.J.A.C. 7:13), a stream buffer (riparian zone) of 300 feet is protected adjacent to C1 waters. This was included as percentage of total stream length.

Trout Waters

The relatively high oxygen, colder, low-nutrient headwater conditions of many Raritan Headwaters subwatersheds are conducive to both reproductive (TP) and maintained (TM) populations of trout. Within the Raritan Headwaters, there are approximately approximately 515 linear miles of TP streams within 30 subwatersheds and 201 miles of TM streams within 24 subwatersheds. The three most common New Jersey salmonid (trout) species include stocked or native brook trout (*Salvelinus fontinalis*), stocked rainbow trout (*Oncorhynchus mykiss*), and stocked brown trout (*Salmo trutta* or various hybrids). The presence of trout has some regulatory implications under various rules including the riparian zone restrictions of the NJDEP Flood Hazard Control Act Rules (N.J.A.C. 7:1 3-4.1). The rules mandate a 150 foot riparian zone (see N.J.A.C. 7:1 3-4.1 Section 6.5) for TM (up to one linear mile upstream) and TP (and all upstream waters). In addition, wetlands associated with TP waters are subject to an exceptional resource value designation and a corresponding 150 ft. transition area under the Wetlands Protection Act rules at N.J.A.C. 7:7A-2.5. The Non-trout (NT) designation indicates that these waters do not contain populations of stocked and maintained or reproductive populations of trout and are therefore not subject to certain restrictions. This was included as percentage of total stream length for the subwatershed.

RHA HGMI Rank

RHA conducts a stream monitoring program to collect surface water quality data in order to determine overall health of the streams. About sixty-five sites are monitored annually. Monitoring consists of three components; Visual Assessments, Biological Assessments, and Chemical Testing. Biological Assessment data are used to calculate the High Gradient Macroinvertebrate Index (HGMI) Score. The steam monitoring methodology Quality Assurance Project Plan (QAPP) has been approved by NJDEP, which allows RHA's data to be used for regulatory decisions including the 303d List of streams that are not meeting their designated use under The Clean Water Act.

Biological Assessments involves collecting benthic macroinvetebrates and sending them to a certified taxonomy lab where they are identified down to the lowest taxonomic level possible. These data are used to calculate species richness and relative abundances. Once the diversity of species and ratios of pollution tolerant to intolerant species are evaluated, a standard impairment (High Gradient Macroinvertebrate) score allows for the assignment of a water quality rating (poor, fair, good, excellent).

RHA's HGMI scores from 2010 to 2015 were averaged within a watershed and across monitoring sites if a watershed contained more than one. Ten subwatersheds did not contain an RHA monitoring site. In those cases, NJDEP's 2014 HGMI scores were used.

SEE APPENDIX A FOR MAPS OF COVERAGE AND RANKING OF WATER QUALITY FOR EACH SUBWATERSHED.

3.3e Riparian Areas and Wetlands

Riparian areas or corridors are (typically) vegetated areas such as forests or wetlands along river and stream systems, lakes or other water bodies. The riparian area contains uplands and wetlands hydrologically linked to a surface water network by surface water and/or groundwater.

The riparian corridors in which streams and rivers are located serve many functions in protecting surface waters; and their protection is vital to prevent degradation of water resources from sources such as runoff, erosion, sedimentation, chemical pollution and temperature spikes. They are complex ecosystems that provide food and shade and are effective in removing excess nutrients and sediment from surface runoff and shallow groundwater. Riparian vegetation also buffers the impacts of some pesticides and provides dissolved and particulate organic food needed to maintain high biological productivity and diversity. Streamside forests improve water quality and biological diversity by filtering out sediments and suspended solids; transforming excess nitrogen and phosphorus; storing nutrients for extended periods; and providing energy to the stream in the form of dissolved carbon compounds and particulate organic detritus (dead plant matter). This detritus forms the basis for the aquatic food chain. The nutrient filtering and shading properties of riparian corridors can be particularly important to the cool water systems that support native trout populations. The effectiveness of a preserved buffer along stream corridors can vary, depending on soil permeability and slopes. For instance, areas with flatter slopes and soils having a greater proportion of sand would not require a buffer as wide as areas with steeper slopes and soils containing less sand. The most effective riparian corridors are typically 100 feet or wider. Wider riparian corridors allow for the river to stay connected to the floodplain during high flows and also allows for the natural changes in river sinuosity that occur over time. For regulatory purposes, regulated Riparian Zone widths are established on a case-by-case basis by NJDEP through Flood Hazard Area Control Act (FHACA) Rules (N.J.A.C. 7:13), (see 3.3d Surface Water Quality).

Ranking Application

For the purposes of the WCP, the riparian areas coverage is utilized from Riparian Corridor GIS layers created by the NJWSA and are discussed in greater detail in *NJWSA Preservation of Sensitive Water Resources* (Zhang 2009). The riparian data were created by combining several different data sources listed here directly from Zhang (2009). Riparian area is represented in the WCP as percentage of total watershed area. Most of the NJDEP 2002 LULC wetland coverage was included in the NJWSA calculation of riparian area with the exception of wetlands isolated from waterways. For the purposes of the Raritan Headwaters WCP, those wetlands were re-inserted so that all wetlands are considered. In addition, urban land use was removed from the NJWSA riparian area coverage.

Description of Riparian Corridors (Area) Data Layer (Zhang, 2009):

The riparian area is one of the most important components of the sensitive water resources GIS database. The definition of the riparian area coverage comes from the NJWSA's report "A Methodology for Defining and Assessing Riparian Areas in the Raritan River Basin", finished in 2000 for the Raritan Basin Watershed Management Project. Please refer to that report for detailed definition and mapping methodology for the riparian zone at www.raritanbasin.org, or contact the Watershed Protection Programs unit of the NJ Water Supply Authority.

A riparian zone is defined as the areas adjacent to or hydrologically connected to the surface water network (e.g., streams, rivers, lakes or reservoirs). Riparian zones constitute the immediate upland buffers to surface water as well as areas that may be more physically distant but are hydrologically connected through groundwater flow (e.g., hydric soils or wetlands that are in close proximity to a stream). Below are the definitions and data sources for each of the coverages contained in the riparian corridor database.

Wetlands serve many important ecological functions directly related to water quality and quantity and critical to populations of humans and wildlife. Wetlands are a vulnerable interface between land and water, as well as surface water and groundwater. They minimize flooding by absorbing water during storm events and releasing it slowly over time. They also improve water quality by filtering sediments, absorbing nutrients and pollutants and reducing those pollutants to their elemental forms. For these reasons, wetlands are an essential consideration in any land acquisition program with the goal of improving water quality and quantity.

The NJDEP, under the New Jersey Freshwater Wetlands Protection Act (N.J.S.A. 13:9A-1 et seq.), defines a wetland as "An area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation." The location and extent of wetlands is established using a three-parameter approach: 1) dominance of hydrophytic vegetation, 2) presence of hydric soils, and 3) evidence of long-term wetland hydrology.

The wetlands of the Raritan Headwaters are primarily categorized as "palustrine freshwater" wetlands (Anderson 1976). Palustrine wetlands typically include all wetlands termed marsh, bogs, swamps, and fens. They are usually bordered by uplands and often shoreward of lakes and river channels. Palustrine wetlands may include small, shallow intermittent or permanent ponds, such as vernal pools. Palustrine wetlands may be further defined by vegetation type, hydrology source, and human influences.

Since July 1, 1988, the NJDEP Bureau of Freshwater Wetlands has regulated all disturbances in freshwater wetlands under the NJ Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A-1.1 et seq.). In March 1994, the NJDEP assumed the State's administration of the Federal wetlands program, Section 404, of the Federal Clean Water Act (33 U.S.C. §1251 et seq. (1972)) for the majority of freshwater wetlands in the State. This is true for all wetlands within the Raritan Headwaters area. Activities that are regulated in wetlands and adjacent buffers include ditching, draining, flooding, cutting of vegetation, filling, and placement of structures.

Since July 1, 1989, buffer or transition areas adjacent to wetlands have also been regulated. The Freshwater Wetlands Protection Act (N.J.S.A. 13:9A) classifies wetlands, and determines transition area size, according to resource value. The corresponding transition area, or upland buffer, must be maintained between the wetland and adjacent development to protect the integrity and viability of the wetland ecosystem (N.J.A.C.7:7A-2.5). Depending on the size and various resources present, wetlands may be listed as exceptional (requiring a 150 foot transition area), intermediate (requiring a 50 foot transition area) or ordinary (requiring no transition area).

100 Year Flood Hazard Area

In support of the National Flood Insurance Program, FEMA has undertaken a massive effort of flood hazard identification and mapping to produce Flood Hazard Boundary Maps, Flood Insurance Rate Maps, and Flood Boundary and Floodway Maps. Several areas of flood hazards are commonly identified on these maps. One of these most important areas is the Special Flood Hazard Area (SFHA) - 100-year flood. The 1 percent annual chance standard was chosen after considering various alternatives. The standard constitutes a reasonable compromise between the need for building restrictions to minimize potential loss of life and property and the economic benefits to be derived from floodplain development. Development may take place within the SFHA, provided that development complies with local floodplain management ordinances, as well as meeting the minimum federal requirements. The data used for this WCP were extracted from the FEMA 100-year flood hazard area database.

NJDEP Flood Prone Areas

Flooding has been a chronic problem for many of our state's residents. Flooding of New Jersey's waterways has caused loss of life as well as substantial property damage, much of it repetitive loss. The flood-prone areas have been delineated through the use of readily available information on past floods rather than from detailed surveys and inspections. In general, the delineated areas are for natural conditions and do not take into consideration the possible effects of existing or proposed flood control structures except where those effects could be evaluated. Even though the flood-prone area map developed by NJDEP is very similar to the FEMA 100-year flood hazard area map, there are still areas in one map not totally covered by the other. The flood-prone area data were developed by NJDEP from USGS Flood-prone Maps. Approximate boundaries of flood-prone areas are shown on this map.

Streams and Stream Buffer

Stream coverage is based on the NJDEP 2002 Hydrography mapping, All mapped streams are buffered by 200 feet on either side of the stream bank or from the centerline of the stream if no stream bank is mapped. The 200 feet buffer is a compromise decision because of the lack of "Stream Order" information in the NJDEP 2002 stream network attribute table. The original methodology was to put 150 foot buffers on both sides of 1st and 2nd order streams to create a 300 foot wildlife corridor, and 300 foot buffers on each side of the 3rd and above order streams to create a 600 foot wildlife corridor.

Open Water Bodies

Water supply is one of New Jersey's most critical resources for future prosperity and environmental quality, as emphasized by the 1998-2002 drought period. Protecting both the quality and quantity of water supplies is a fundamental purpose of watershed management. Protection of supplies is far preferable to the expensive and time-consuming process of treating polluted supplies. NJWSA operates two state-owned reservoirs in the WMA8 area, the Spruce Run and Round Valley reservoirs. Without additional protection of its watersheds, reservoir degradation will occur, from both water yield and water quality perspectives. The stream systems themselves will also suffer, losing flow during dry periods and experiencing increased contamination and storm water runoff. Federal and state laws have addressed the problems through several actions; for example, the Stream Encroachment regulations, the Flood Hazard Area Control Act rules, the Highlands Water Protection and Planning Act.

Open Water Bodies Buffer

All open water bodies (lakes, etc.) get a 300 foot buffer area.

2002 NJDEP LU/LC Wetlands

Wetlands contribute to the social, economic, and environmental health of our nation in many ways. They can protect drinking water by filtering out chemicals, pollutants, and sediments that would otherwise clog and contaminate our waters. Wetlands provide critical habitats for a major portion of the state's fish and wildlife, including endangered, commercial and recreational species, and they soak up runoff from heavy rains and snow melts, providing natural flood control. Many of these values were not widely appreciated until the 1970s and 1980s. By then, more than half of the nation's wetlands were destroyed. New Jersey lost about 2,500 acres of wetlands from 1995 to 2002. The wetlands information used in the GIS model was extracted from the NJDEP 2002 Land Use/Land Cover dataset.

Wetland Buffer

"Wetland buffer" usually means a transition area, which is a strip of land bordering the wetlands. The width of the transition area may vary from 150 feet to nothing, depending on the value of the particular wetland. For example, a wetland containing endangered species habitat would require a 150-foot wide transition area, whereas a small wetland in a ditch might not require any transition area at all. Most freshwater wetlands require a 50-foot transition area. There are many small activities that can be pursued in a transition area under a General Permit from the NJDEP. In some cases the transition area's shape may be altered to allow an activity, without diminishing its total size. This is called transition area averaging. The wetland buffer GIS data was developed by NJWSA based on the definition in the Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A) which defines the width of the transition area according to the value of the particular wetland, with the exception of putting a 25 foot buffer on "ordinary wetlands" instead of zero, as the Rules suggest.

Hydric soils

Hydric soils are those partial and full hydric classified soils; as defined in the SSURGO HYDCOMP (hydric component information) soil attribute table. For all counties represented in the SSURGO data, hydric soils were extracted using the Hydric Class Presence Field, [hydclsprs], in the muaggatt table, which is defined as "An indication of the proportion of the map unit, expressed as a class, that is "hydric", based on the hydric classification of individual map unit components." All features with a [hydclsprs] value of 'All hydric' or 'Partially hydric' were extracted.

Alluvial soils

Alluvial soils include those taxonomically classified as fluvents, udifluvents, or fluvaquents. For all counties represented in the SSURGO data, alluvial soils were extracted using the Taxonomic Class Field, [taxclname], in the component table, which is defined as "A concatenation of the Soil Taxonomy subgroup and family for a soil (long name)." All features that included the characters "fluv" in the [taxclname] field were extracted to capture fluvents, udifluvents, and fluvaquents.

Highland Preservation Area Open Water Buffer

Since part of the acquisition project area is located within the Highland Preservation Area, the WCP adopted the Highlands Protection Act rule to put a

300 foot buffer on all open waters, including all lakes and streams in the Highlands region.

The final Riparian Coverage is a combination of the entire above mentioned components through data integration. A more detailed report on Riparian methodology is available through the Raritan Basin Alliance's website or by contacting NJWSA staff.

http://www.raritanbasin.org/Publications/Methodologies/Riparian_Methodology.pdf

SEE APPENDIX A FOR MAPS OF COVERAGE AND RANKING OF RIPARIAN AREA AND WETLANDS FOR EACH SUBWATERSHED.

3.3f Wetland Dependent Wildlife

The wildlife utilized for this evaluation are either State or Federally-listed as threatened and endangered species and have been determined to be either wetlands and open water dependent for all or some part of their life cycle. These species may be highly sensitive to water quality and or quantity changes and are indicators of expansive high quality wetlands systems. Examples include birds that nest or forage in forested or emergent wetlands and reptiles that use streams and/or wetlands for all portions of their life-cycle including brumation (hibernation). Two federally-listed species found in the Raritan Headwaters, the bog turtle (*Glyptemys muhlenbergii* – Federal Listed Threatened) and the Indiana bat (*Myotis sodalis* – Federal Listed Endangered) are included in this section.

The WCP focus is ultimately to improve water quality and aquatic systems through land acquisition, preservation and restoration. As a result, the incorporated threatened and endangered habitat data are limited to those species whose population stability/and lifecycles are <u>most directly</u> linked to water quality and quantity and their protection strongly correlates with the protection of water and water related resources. The WCP does not evaluate the vulnerability or specific life cycle requirements of particular species. As a result, the wildlife rank may not be reflective of the overall wildlife value of a particular subwatershed. Additional detailed wildlife information that may factor into land acquisition would need to be considered on a site-by-site basis and is included in the general guidelines.

The wildlife utilized for this evaluation have been determined to be either wetlands and open water dependent for all or some of their life cycle. Fisheries (Trout) are similarly considered, but are included under the existing water quality evaluation because of their direct association with surface water. Rare or sensitive water-dependent plants (although often excellent indicators of water quality) were not utilized in the subwatershed evaluation. There is no public GIS model that can be used to efficiently and accurately incorporate the rare plant data layer into the subwatershed model. Plants should be evaluated on a site-by site basis through the acquisition of a Natural Heritage Letter.

NJDEP Landscape Project – Rank 3 to 5 Wetland Species (Wetlands habitat for threatened and endangered species)

In 1994, the NJ Division of Fish, Game and Wildlife's Endangered and Nongame Species Program (ENSP) adopted a landscape level approach to rare species protection called the Landscape Project. The Landscape Project (v 3.1) has been designed to provide peer reviewed, scientifically sound information that is easily accessible and can be integrated with planning, protection and land management programs at every level of government – state, county and municipal, as well as nongovernmental organizations and private landowners. The ENSP has developed landscape maps that identify critical rare species habitats based on land use classifications, documented rare species locations and habitat models linked to each of the rare, threatened or endangered species. The habitat patches are assigned a Rank of 1 through 5, based on the status of the species present as follows:

Rank 1: Habitat patches with minimum habitat specific suitability size and potential condition requirement for threatened or endangered or priority species that do not intersect with any confirmed occurrence.

Rank 2: Presence of one or more occurrence of State Special Concern species.

Rank 3: Presence of one or more State - listed threatened species.

Rank 4: Presence of one or more State - listed endangered species.

Rank 5: Presence of one or more Federally - listed threatened or endangered species.

The habitat patches are identified by the highest rank species occurring within that patch. For example, all patches within the Raritan Headwaters Rank of 5 have the presence of federally-endangered bog turtle even if lower ranked species such as the (Rank 3) wood turtle is identified in the same patch.

Ranking Application

For the purposes of the WCP subwatershed evaluation, endangered and threatened species wildlife habitat is evaluated by its relationship to wetland habitat. This completed by overlaying NJDEP Landscape Version 3.1 Rank 3 (State threatened) or greater habitat coverage with NJDEP wetland coverage to approximate the amount of wetland and water-dependent endangered and threatened species habitat areas within each subwatershed.

Water dependent species were defined as species that require regulated water for their survival as determined by NJDEP (2013). These species may rely on groundwater-fed wetlands, vernal habitats, riparian areas, open waters for all are part of their life cycles. Species that may contribute to a Rank 3 or greater in wetland habitats can be identified through the *Protocols for the Establishment of Exceptional Resource Value Wetlands Pursuant to the Freshwater Protection Act Based on Documentation of State or Federal Threatened or Endangered Species* (NJDEP 2013). Based on general location information, species that could potentially (currently or in the future) affect wetland habitat Landscape Rank 3 or greater within the Raritan Headwaters include the following:

Wood Turtle -ST

Bog Turtle – SE, LT

Long Tailed Salamander- ST

American Bittern - SE

Red-shouldered Hawk – SE b

Indiana bat – SE LE

Bald Eagle – SE b, ST

Red-headed woodpecker - ST

Barred owl - ST

Gray Petaltail Dragonfly -SE

Short eared Owl - SE b

Bobolink – ST b

Pied Billed Grebe - SE b

SE – State endangered, ST – State threatened, LT – Federally listed threatened, LE – federally listed endangered, b - listed for breeding

Wetland dependent wildlife area is expressed as the combined Rank 3, Rank 4, and Rank 5 acreage as a percentage of total subwatershed area. See Appendix A for maps of coverage and ranking of wetland-dependent wildlife habitat cover for each subwatershed.

4.0 MATRIX RESULTS

The summary data and the scores and ranking of the 52 subwatersheds both for the six main criteria (green columns) and the final rank (orange column) is presented in a matrix (Table 1). The highest ranking subwatersheds (orange column; 52 is the maximum rank) are those with the most sensitive water resources and intact ecosystems such as forests; most in need of preservation focus. The lowest ranking subwatersheds (orange column; 1 is lowest rank) have impaired water quality and lack some of the ecological features needed to support water resources; most in need of restoration and BMPs with little left to preserve.

TABLE 1. WATERSHED MATRIX SHOWING CATEGORIES, SUBCATEGORIES AND FINAL RANKINGS

#	HUC11	HUC14	Subwatershed Name	Huc14 Acres	Size (sq mi)	Stream (Miles)	Forest Cover	Forest Cover %	Forest Cover Score	Erodible Soils	Erodible Soils %	Erodible Soils Score	SWQS_NT (miles)	SWQS_C1NT (miles)	SWQS_TM (miles)	SWQS_C1TM (miles)	SWQS_TP (miles)	SWQS_C1TP (miles)	Total Category 1 waters	% of Category 1 waters	% waters category 1 Water Rank	% of Trout Waters	Trout Waters Rank	HGMI_Score	RHA_HDMI_Rank	Water Quality Totals	Total Water Quality Score	Surficial Aquifer	Surficial Aquifer %	Surficial Aquifer Rank
37	02030105070	02030105070030	Raritan R NB (below Rt 28)	3,801.66	5.94	19.36	648.90	0.17	4.00	3.27	0.00	3.00	18.73						-	-	1.00	-	1.00	49.52	26.00	28.00	13.00	-	-	1.00
36	02030105070	02030105070020	Chambers Brook	6,582.84	10.29	23.45	1,721.68	0.26	12.00	9.87	0.00	5.00	23.28						-	-	1.00	-	1.00	45.96	20.00	22.00	10.00	-	-	1.00
39	02030105040	02030105040030	Holland Brook	7,965.60	12.45	37.28	2,186.53	0.27	13.00	60.88	0.01	23.00	37.27						-	-	1.00	-	1.00	48.70	24.00	26.00	11.00	-	-	1.00
44	02030105030	02030105030010	First Neshanic River	3,303.52	5.16	16.61	985.99	0.30	18.00	6.45	0.00	6.00	7.89		8.68				-	-	1.00	0.52	24.00	29.88	3.00	28.00	13.00	-	-	1.00
48	02030105030	02030105030030	Headquarters trib (Third Neshanic River)	3,610.20	5.64	17.24	501.51	0.14	2.00	30.75	0.01	29.00	16.60						-	-	1.00	-	1.00	36.03	9.00	11.00	5.00	-	-	1.00
46	02030105030	02030105030040	Third Neshanic River	3,319.85	5.19	16.18	660.90	0.20	6.00	23.13	0.01	20.00	16.10						-	-	1.00	-	1.00	34.74	6.00	8.00	2.00	-	-	1.00
47	02030105030	02030105030050	Back Brook	7,460.78	11.66	31.47	1,655.28	0.22	7.00	71.83	0.01	34.00	31.47						-	-	1.00	-	1.00	33.93	4.00	6.00	1.00	-	-	1.00
49	02030105030	02030105030060	Neshanic River(Black Brk to FN/SN confl)	5,646.36	8.82	34.54	657.24	0.12	1.00	91.27	0.02	41.00	33.71						-	-	1.00	-	1.00	35.44	8.00	10.00	4.00	-	-	1.00
40	02030105040	02030105040020	Pleasant Run	6,919.04	10.81	36.82	1,792.33	0.26	11.00	70.61	0.01	35.00	36.80						-	-	1.00	-	1.00	43.99	16.00	18.00	8.00	-	-	1.00
41	02030105020	02030105020100	Raritan R SB(Three Bridges-Prescott Bk)	13,137.07	20.53	68.85	2,932.54	0.22	8.00	101.45	0.01	24.00	54.67		13.06				-	-	1.00	0.19	19.00	55.85	38.00	58.00	20.00	-	-	1.00
45	02030105030	02030105030020	Second Neshanic River	3,958.81	6.19	19.13	1,100.06	0.28	15.00	11.87	0.00	13.00	18.73						-	-	1.00	-	1.00	39.96	10.00	12.00	6.00	-	-	1.00
32	02030105070	02030105070010	Raritan R NB (Rt 28 to Lamington R)	5,951.09	9.30	33.46	1,647.50	0.28	14.00	35.44	0.01	18.00	33.07	0.05					0.05	0.00	19.00	-	1.00	50.71	30.00	50.00	19.00	-	-	1.00
6	02030105010	02030105010020	Drakes Brook (below Eyland Ave)	4,685.17	7.32	21.63	1,313.72	0.28	16.00	10.49	0.00	9.00	11.01	5.57		0.01		4.85	10.43	0.48	27.00	0.22	20.00	48.00	23.00	70.00	24.00	-	-	1.00
43	02030105040	02030105040010	Raritan R SB(Pleasant Run-Three Bridges)	7,607.65	11.89	41.11	1,435.57	0.19	5.00	88.31	0.01	38.00	40.89						-	-	1.00	-	1.00	54.59	37.00	39.00	16.00	-	-	1.00
21	02030105060	02030105060070	Raritan R NB(incl Mine Bk to Peapack Bk)	5,380.10	8.41	25.69	2,226.12	0.41	36.00	43.98	0.01	27.00	20.96		0.46			4.18	4.18	0.16	21.00	0.18	18.00	49.78	27.00	66.00	23.00	-	-	1.00
42	02030105040	02030105040040	Raritan R SB(NB to Pleasant Run)	4,267.84	6.67	19.72	674.13	0.16	3.00	45.97	0.01	37.00	19.51						-	-	1.00	-	1.00	54.02	35.00	37.00	15.00	-	-	1.00
29	02030105060	02030105060090	Raritan R NB (Lamington R to Mine Bk)	5,562.82	8.69	32.07	1,804.57	0.32	22.00	20.88	0.00	14.00	31.39						-	-	1.00	-	1.00	45.42	19.00	21.00	9.00	-	-	1.00
38	02030105020	02030105020060	Cakepoulin Creek	9,105.34	14.23	36.64	2,156.02	0.24	9.00	86.11	0.01	33.00	0.40					36.22	36.22	0.99	49.00	0.99	48.00	78.04	51.00	148.00	51.00	-	-	1.00
50	02030105030	02030105030070	Neshanic River (below Black Brook)	8,353.32	13.05	38.35	2,425.34	0.29	17.00	155.68	0.02	45.00	37.64						-	-	1.00	-	1.00	42.75	13.00	15.00	7.00	-	-	1.00
10	02030105050	02030105050030	Lamington R (Furnace Rd to Hillside Rd)	3,843.04	6.00	18.35	1,379.16	0.36	28.00	17.71	0.00	16.00	3.66	8.43	4.28	1.34			9.76	0.53	28.00	0.31	22.00	43.50	14.00	64.00	22.00	-	-	1.00
22	02030105060	02030105060080	Middle Brook (NB Raritan River)	4,279.33	6.69	24.43	1,412.30	0.33	23.00	99.40	0.02	47.00	24.22						-	-	1.00	-	1.00	34.89	7.00	9.00	3.00	-	-	1.00
7	02030105060	02030105060010	Raritan R NB (above/incl India Bk)	4,282.20	6.69	19.08	1,649.17	0.39	30.00	8.58	0.00	7.00	0.80		0.13			17.88	17.88	0.94	40.00	0.94	36.00	86.43	52.00	128.00	43.00	-	-	1.00
1	02030105050	02030105050010	Lamington R (above Rt 10)	4,204.64	6.57	13.74	1,393.62	0.33	24.00	2.10	0.00	2.00	11.50	2.23					2.23	0.16	20.00	-	1.00	34.50	5.00	26.00	11.00	2,932.98	0.70	52.00
8	02030105010	02030105010050	Raritan R SB(LongValley br to 74d44m15s)	9,766.20	15.26	44.53	3,652.42	0.37	29.00	9.55	0.00	4.00	2.39	0.00				41.49	41.49	0.93	39.00	0.93	34.00	46.40	21.00	94.00	33.00	-	-	1.00
52	02030105050	02030105050070	Lamington R(HallsBrRd-Herzog Brk)	8,735.10	13.65	45.18	3,494.55	0.40	34.00	63.52	0.01	22.00	1.77	21.39	9.56	0.77	8.88	2.00	24.17	0.53	29.00	0.47	23.00	46.71	22.00	74.00	26.00	-	-	1.00
9	02030105060	02030105060020	Burnett Brook (above Old Mill Rd)	4,253.69	6.65	19.42	1,988.11	0.47	44.00	20.63	0.00	17.00	0.06		0.23			19.10	19.10	0.98	47.00	0.99	52.00	53.90	34.00	133.00	46.00	-	-	1.00
28	02030105010	02030105010080	Raritan R SB(Spruce Run-StoneMill gage)	2,961.23	4.63	13.29	1,180.15	0.40	33.00	7.64	0.00	11.00	2.23		10.66				-	-	1.00	0.80	28.00	53.72	32.00	61.00	21.00	-	-	1.00
2	02030105010	02030105010010	Drakes Brook (above Eyland Ave)	5,649.90	8.83	24.43	2,401.69	0.43	38.00	13.76	0.00	10.00	3.48		0.14	12.09	1.74	6.96	19.04	0.78	34.00	0.86	29.00	42.15	12.00	75.00	27.00	814.20	0.14	49.00

Dark Blue- Subcategories; Green – Major Categories; Orange – Final rank

TABLE 1. WATERSHED MATRIX SHOWING CATEGORIES, SUBCATEGORIES AND FINAL RANKINGS

#	HUC11	HUC14	Subwatershed Name	Huc14 Acres	Size (sq mi)	Stream (Miles)	Forest Cover	Forest Cover %	Forest Cover Score	Erodible Soils	Erodible Soils %	Erodible Soils Score	SWQS_NT (miles)	SWQS_C1NT (miles)	SWQS_TM (miles)	SWQS_C1TM (miles)	SWQS_TP (miles)	SWQS_C1TP (miles)	Total Category 1 waters	% of Category 1 waters	% waters category 1 Water Rank	% of Trout Waters	Trout Waters Rank	HGMI_Score	RHA_HDMI_Rank	Water Quality Totals	Total Water Quality Score	Surficial Aquifer	Surficial Aquifer %	Surficial Aquifer Rank
3	02030105010	02030105010030	Raritan River SB(above Rt 46)	3,218.56	5.03	11.61	1,023.44	0.32	19.00	1.51	0.00	1.00	4.53	3.59	3.48				3.59	0.31	24.00	0.30	21.00	19.60	2.00	47.00	18.00	584.45	0.18	50.00
12	02030105010	02030105010060	Raritan R SB(Califon br to Long Valley)	9,530.62	14.89	36.57	3,739.35	0.39	32.00	89.20	0.01	31.00	3.79					32.51	32.51	0.89	36.00	0.89	31.00	50.40	29.00	96.00	35.00	-	-	1.00
4	02030105010	02030105010040	Raritan River SB(74d 44m 15s to Rt 46)	4,264.53	6.66	17.75	1,654.53	0.39	31.00	11.36	0.00	12.00	1.04	6.93		1.11		8.33	16.36	0.92	37.00	0.53	25.00	53.77	33.00	95.00	34.00	-	-	1.00
30	02030105050	02030105050100	Rockaway Ck SB	7,910.05	12.36	39.61	3,165.67	0.40	35.00	62.30	0.01	25.00	1.76		6.21	5.52		25.72	31.24	0.79	35.00	0.95	37.00	40.91	11.00	83.00	29.00	-	-	1.00
33	02030105020	02030105020070	Raritan R SB(River Rd to Spruce Run)	5,753.60	8.99	28.94	1,414.81	0.25	10.00	86.10	0.01	40.00	0.81	1.72	13.43	11.40		0.02	13.15	0.45	26.00	0.86	30.00	51.36	31.00	87.00	30.00	-	-	1.00
26	02030105020	02030105020050	Beaver Brook (Clinton)	4,437.35	6.93	20.66	1,416.69	0.32	20.00	60.14	0.01	39.00	0.46		6.91			13.27	13.27	0.64	32.00	0.98	43.00	45.27	18.00	93.00	32.00	-	-	1.00
35	02030105020	02030105020080	Raritan R SB(Prescott Bk to River Rd)	4,720.69	7.38	24.66	1,516.12	0.32	21.00	82.00	0.02	42.00	10.52		13.87				-	-	1.00	0.56	26.00	62.86	43.00	70.00	24.00	-	-	1.00
34	02030105020	02030105020090	Prescott Brook / Round Valley Reservior	7,218.25	11.28	24.97	2,581.67	0.36	27.00	76.10	0.01	36.00	0.57		17.92			6.27	6.27	0.25	23.00	0.97	40.00	69.14	47.00	110.00	37.00	-	-	1.00
15	02030105020	02030105020010	Spruce Run (above Glen Gardner)	7,868.26	12.29	29.67	3,678.12	0.47	45.00	49.44	0.01	19.00	1.11					28.12	28.12	0.95	42.00	0.95	38.00	74.78	48.00	128.00	43.00	-	-	1.00
20	02030105010	02030105010070	Raritan R SB(StoneMill gage to Califon)	5,050.39	7.89	18.74	2,966.40	0.59	50.00	91.27	0.02	44.00	0.25		4.53	2.12		11.57	13.68	0.73	33.00	0.97	42.00	61.82	42.00	117.00	42.00	-	-	1.00
5	02030105050	02030105050020	Lamington R (Hillside Rd to Rt 10)	7,065.88	11.04	40.69	2,518.59	0.36	26.00	15.41	0.00	8.00	25.95	13.26				1.17	14.43	0.35	25.00	0.03	17.00	16.24	1.00	43.00	17.00	1,875.98	0.27	51.00
31	02030105050	02030105050090	Rockaway Ck (below McCrea Mills)	5,302.28	8.28	25.91	2,242.69	0.42	37.00	22.94	0.00	15.00	9.36		11.45			4.93	4.93	0.19	22.00	0.63	27.00	57.76	40.00	89.00	31.00	-	-	1.00
25	02030105050	02030105050060	Cold Brook	3,989.39	6.23	16.54	1,345.23	0.34	25.00	95.22	0.02	48.00	0.33					16.21	16.21	0.98	46.00	0.98	45.00	44.83	17.00	108.00	36.00	-	-	1.00
11	02030105060	02030105060030	Raritan R NB(incl McVickers to India Bk)	4,897.15	7.65	26.21	2,316.08	0.47	47.00	40.92	0.01	28.00	0.99			10.32		13.87	24.19	0.92	38.00	0.92	33.00	57.72	39.00	110.00	37.00	-	-	1.00
14	02030105050	02030105050040	Lamington R(Pottersville gage-FurnaceRd)	5,702.56	8.91	30.77	2,792.59	0.49	48.00	40.64	0.01	21.00	1.81		4.80	5.03	5.07	13.82	18.86	0.61	31.00	0.93	35.00	66.81	46.00	112.00	40.00	-	-	1.00
17	02030105060	02030105060060	Peapack Brook (below Gladstone Brook)	3,247.97	5.07	16.09	1,416.85	0.44	40.00	64.95	0.02	46.00					0.07	15.45	15.45	0.96	44.00	0.97	39.00	50.12	28.00	111.00	39.00	-	-	1.00
13	02030105060	02030105060050	Peapack Brook (above/incl Gladstone Bk)	4,228.28	6.61	19.07	1,842.67	0.44	39.00	39.75	0.01	32.00			0.13			18.55	18.55	0.97	45.00	0.98	46.00	48.74	25.00	116.00	41.00	-	-	1.00
19	02030105060	02030105060040	Raritan R NB(Peapack Bk to McVickers Bk)	4,804.73	7.51	27.56	2,644.83	0.55	49.00	198.86	0.04	51.00	1.22		7.99	0.07	0.53	16.02	16.09	0.58	30.00	0.89	32.00	43.51	15.00	77.00	28.00	-	-	1.00
23	02030105020	02030105020020	Spruce Run (Reservior to Glen Gardner)	2,057.28	3.21	8.29	1,228.40	0.60	51.00	98.18	0.05	52.00						8.21	8.21	0.99	52.00	0.99	50.00	75.12	49.00	151.00	52.00	-	-	1.00
18	02030105050	02030105050080	Rockaway Ck (above McCrea Mills)	10,840.33	16.94	52.33	4,877.07	0.45	41.00	259.75	0.02	49.00	0.12					51.63	51.63	0.99	48.00	0.99	47.00	63.78	45.00	140.00	49.00	-	-	1.00
51	02030105050	02030105050130	Lamington R(Herzog Brk-Ptrsvle gage)	3,004.63	4.69	16.85	1,407.69	0.47	46.00	94.64	0.03	50.00	0.15				0.19	16.16	16.16	0.96	43.00	0.97	41.00	63.77	44.00	128.00	43.00	-	-	1.00
27	02030105020	02030105020030	Mulhockaway Creek	9,414.13	14.71	40.14	4,385.47	0.47	43.00	86.41	0.01	30.00	0.17					39.68	39.68	0.99	50.00	0.99	49.00	54.04	36.00	135.00	47.00	-	-	1.00
24	02030105020	02030105020040	Spruce Run Reservoir / Willoughby Brook	7,316.95	11.43	21.53	3,293.14	0.45	42.00	59.68	0.01	26.00			0.74	12.97		7.35	20.32	0.94	41.00	0.98	44.00	76.88	50.00	135.00	47.00	-	-	1.00
16	02030105050	02030105050050	Pottersville trib (Lamington River)	3,147.93	4.92	17.14	1,994.57	0.63	52.00	56.03	0.02	43.00					0.05	16.96	16.96	0.99	51.00	0.99	51.00	59.75	41.00	143.00	50.00	-	-	1.00

Dark Blue- Subcategories; Green – Major Categories; Orange – Final rank

TABLE 1. WATERSHED MATRIX SHOWING CATEGORIES, SUBCATEGORIES AND FINAL RANKINGS

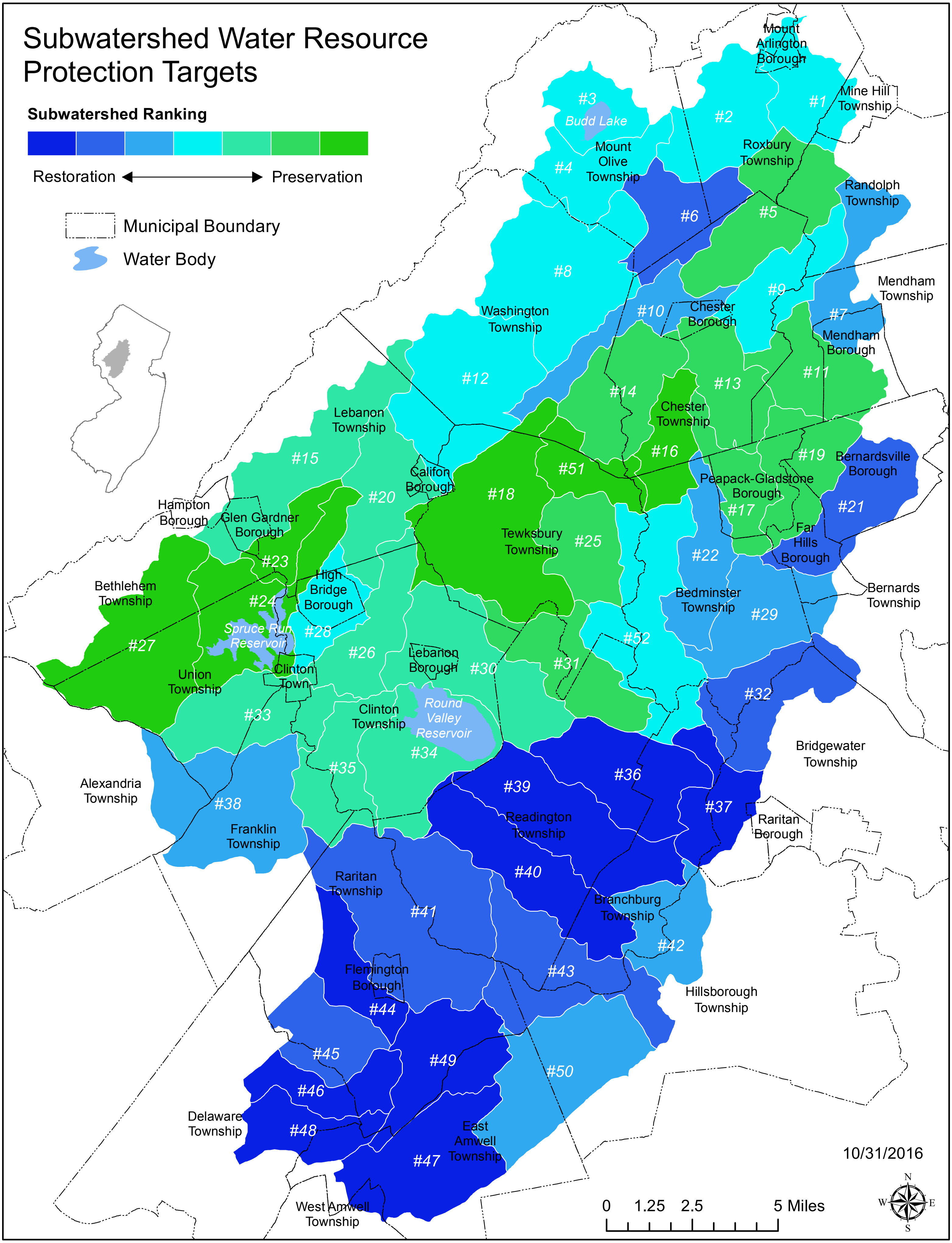
#	HUC11	HUC14	Subwatershed Name	Calcareous Aquifer Acres (Karst-Limestone & Dolomite	Calcareous Aquifer %	Calcareous Aquifer Rank	NJWSA Primary Aquifer Recharge Areas	NJWSA Primary Aquifer Recharge % (NJWSA/Surficial Aquifer) ???	NJWSA Primary Aquifer Rcharge Rank	Aquifer Recharge Totals	Aquifer Recharge Score	Riparian Area & Wetlands	Riparian & Wetlands Area % (Riparian Area/Huc Acres)	Riparian Area Score	Rank 3 (acres)	Rank 4 (acres)	Rank 5 (acres)	Rank 6 (acres)	Landscape %	Landscape 3+ Habitat Score	Green Category Totals	WCP Rank
37	02030105070	02030105070030	Raritan R NB (below Rt 28)	-	-	1.00	-	-	1.00	3.00	1.00	740.85	0.19	6.00	19.32	5.17	0.00		0.01	9.00	36.00	1
36	02030105070	02030105070020	Chambers Brook	-	-	1.00	-	-	1.00	3.00	1.00	975.46	0.15	1.00	113.80	4.24			0.02	15.00	44.00	2
39	02030105040	02030105040030	Holland Brook	-	-	1.00	-	-	1.00	3.00	1.00	1,392.76	0.17	2.00	35.71	0.17			0.00	5.00	55.00	3
44	02030105030	02030105030010	First Neshanic River	-	-	1.00	-	-	1.00	3.00	1.00	739.30	0.22	17.00	18.13	0.31			0.01	7.00	62.00	4
48	02030105030	02030105030030	Headquarters trib (Third Neshanic River)	-	-	1.00	-	-	1.00	3.00	1.00	871.94	0.24	21.00	4.39	0.08			0.00	4.00	62.00	4
46	02030105030	02030105030040	Third Neshanic River	-	-	1.00	-	-	1.00	3.00	1.00	900.51	0.27	32.00	0.62				0.00	1.00	62.00	4
47	02030105030	02030105030050	Back Brook	-	-	1.00	-	-	1.00	3.00	1.00	1,849.95	0.25	22.00	3.59	0.09			0.00	2.00	67.00	5
49	02030105030	02030105030060	Neshanic River(Black Brk to FN/SN confl)	-	-	1.00	-	-	1.00	3.00	1.00	1,275.33	0.23	18.00	4.92	0.00			0.00	3.00	68.00	6
40	02030105040	02030105040020	Pleasant Run	-	-	1.00	-	-	1.00	3.00	1.00	1,423.19	0.21	8.00	41.73	1.77	0.55		0.01	8.00	71.00	7
41	02030105020	02030105020100	Raritan R SB(Three Bridges-Prescott Bk)	-	-	1.00	-	-	1.00	3.00	1.00	2,736.26	0.21	10.00	116.60	0.44			0.01	12.00	75.00	8
45	02030105030	02030105030020	Second Neshanic River	-	-	1.00	-	-	1.00	3.00	1.00	1,093.52	0.28	37.00	44.12	1.25			0.01	14.00	86.00	9
32	02030105070	02030105070010	Raritan R NB (Rt 28 to Lamington R)	-	-	1.00	-	-	1.00	3.00	1.00	1,539.08	0.26	27.00	46.68	1.21			0.01	11.00	90.00	10
6	02030105010	02030105010020	Drakes Brook (below Eyland Ave)	-	-	1.00	-	-	1.00	3.00	1.00	1,231.16	0.26	29.00	237.53	24.27			0.06	25.00	104.00	11
43	02030105040	02030105040010	Raritan R SB(Pleasant Run-Three Bridges)	-	-	1.00	-	-	1.00	3.00	1.00	2,081.25	0.27	35.00	53.27	0.59			0.01	10.00	105.00	12
21	02030105060	02030105060070	Raritan R NB(incl Mine Bk to Peapack Bk)	-	-	1.00	-	-	1.00	3.00	1.00	972.16	0.18	3.00	109.01				0.02	16.00	106.00	13
42	02030105040	02030105040040	Raritan R SB(NB to Pleasant Run)	-	-	1.00	-	-	1.00	3.00	1.00	1,219.35	0.29	38.00	40.96	0.17			0.01	13.00	107.00	14
29	02030105060	02030105060090	Raritan R NB (Lamington R to Mine Bk)	-	-	1.00	-	-	1.00	3.00	1.00	1,726.79	0.31	44.00	257.08	34.85	0.08		0.05	24.00	114.00	15
38	02030105020	02030105020060	Cakepoulin Creek	-	-	1.00	-	-	1.00	3.00	1.00	1,933.43	0.21	11.00	199.20	10.51			0.02	17.00	122.00	16
50	02030105030	02030105030070	Neshanic River (below Black Brook)	-	-	1.00	-	-	1.00	3.00	1.00	2,885.18	0.35	48.00	44.45	0.16			0.01	6.00	124.00	17
10	02030105050	02030105050030	Lamington R (Furnace Rd to Hillside Rd)	-	-	1.00	-	-	1.00	3.00	1.00	1,261.94	0.33	47.00	108.39	0.41			0.03	18.00	132.00	18
22	02030105060	02030105060080	Middle Brook (NB Raritan River)	-	-	1.00	-	-	1.00	3.00	1.00	1,099.96	0.26	26.00	334.28	34.74	0.10		0.09	34.00	134.00	19
7	02030105060	02030105060010	Raritan R NB (above/incl India Bk)	-	-	1.00	-	-	1.00	3.00	1.00	1,084.47	0.25	24.00	339.29	26.33			0.09	33.00	138.00	20
1	02030105050	02030105050010	Lamington R (above Rt 10)	-	-	1.00	583.50	0.20	52.00	105.00	50.00	970.93	0.23	20.00	320.32	79.03	0.75		0.10	36.00	143.00	21
8	02030105010	02030105010050	Raritan R SB(LongValley br to 74d44m15s)	-	-	1.00	-	-	1.00	3.00	1.00	2,974.48	0.30	41.00	890.88	123.64	0.02		0.10	41.00	149.00	22
52	02030105050	02030105050070	Lamington R(HallsBrRd-Herzog Brk)	-	-	1.00	-	-	1.00	3.00	1.00	2,519.07	0.29	39.00	646.33	82.30	0.18		0.08	32.00	154.00	23
9	02030105060	02030105060020	Burnett Brook (above Old Mill Rd)	-	-	1.00	-	-	1.00	3.00	1.00	877.43	0.21	9.00	388.10	23.46			0.10	39.00	156.00	24
28	02030105010	02030105010080	Raritan R SB(Spruce Run-StoneMill gage)	272.26	0.09	50.00	-	-	1.00	52.00	47.00	587.58	0.20	7.00	264.53	26.65			0.10	40.00	159.00	25
2	02030105010	02030105010010	Drakes Brook (above Eyland Ave)	34.57	0.01	38.00	38.85	0.05	50.00	137.00	51.00	1,210.62	0.21	12.00	205.79	8.35	0.12		0.04	21.00	159.00	25

Dark Blue- Subcategories; Green – Major Categories; Orange – Final rank

TABLE 1. WATERSHED MATRIX SHOWING CATEGORIES, SUBCATEGORIES AND FINAL RANKINGS

#	HUC11	HUC14	Subwatershed Name	Calcareous Aquifer Acres (Karst-Limestone & Dolomite	Calcareous Aquifer %	Calcareous Aquifer Rank	NJWSA Primary Aquifer Recharge Areas	NJWSA Primary Aquifer Recharge % (NJWSA/Surficial Aquifer) ???	NJWSA Primary Aquifer Rcharge Rank	Aquifer Recharge Totals	Aquifer Recharge Score	Riparian Area & Wetlands	Riparian & Wetlands Area % (Riparian Area/Huc Acres)	Riparian Area Score	Rank 3 (acres)	Rank 4 (acres)	Rank 5 (acres)	Rank 6 (acres)	Landscape %	Landscape 3+ Habitat Score	Green Category Totals	WCP Rank
3	02030105010	02030105010030	Raritan River SB(above Rt 46)	534.46	0.17	51.00	16.76	0.03	49.00	150.00	52.00	1,150.52	0.36	50.00	87.99	8.37	4.15		0.03	19.00	159.00	25
12	02030105010	02030105010060	Raritan R SB(Califon br to Long Valley)	-	-	1.00	-	-	1.00	3.00	1.00	2,605.43	0.27	34.00	491.64	65.76	1.21		0.06	27.00	160.00	26
4	02030105010	02030105010040	Raritan River SB(74d 44m 15s to Rt 46)	-	-	1.00	-	-	1.00	3.00	1.00	1,321.03	0.31	43.00	408.09	121.01	0.03		0.12	42.00	163.00	27
30	02030105050	02030105050100	Rockaway Ck SB	604.72	0.08	47.00	-	-	1.00	49.00	44.00	1,490.87	0.19	4.00	539.75	71.04	0.38		0.08	31.00	168.00	29
33	02030105020	02030105020070	Raritan R SB(River Rd to Spruce Run)	14.73	0.00	36.00	-	-	1.00	38.00	34.00	1,540.06	0.27	31.00	222.39	58.15	0.09		0.05	23.00	168.00	28
26	02030105020	02030105020050	Beaver Brook (Clinton)	360.25	0.08	48.00	-	-	1.00	50.00	45.00	972.53	0.22	14.00	233.90	24.01			0.06	26.00	176.00	30
35	02030105020	02030105020080	Raritan R SB(Prescott Bk to River Rd)	92.94	0.02	39.00	-	-	1.00	41.00	36.00	1,204.93	0.26	25.00	331.75	29.56	0.08		0.08	30.00	178.00	31
34	02030105020	02030105020090	Prescott Brook / Round Valley Reservior	-	-	1.00	-	-	1.00	3.00	1.00	3,551.87	0.49	52.00	281.37	154.33	0.17		0.06	28.00	181.00	32
15	02030105020	02030105020010	Spruce Run (above Glen Gardner)	-	-	1.00	-	-	1.00	3.00	1.00	2,097.86	0.27	30.00	892.12	117.38	0.08		0.13	44.00	182.00	33
20	02030105010	02030105010070	Raritan R SB(StoneMill gage to Califon)	-	-	1.00	-	-	1.00	3.00	1.00	1,091.34	0.22	13.00	577.61	69.78			0.13	43.00	193.00	34
5	02030105050	02030105050020	Lamington R (Hillside Rd to Rt 10)	-	-	1.00	230.17	0.12	51.00	103.00	49.00	2,450.52	0.35	49.00	822.33	123.47	2.00	0.04	0.13	45.00	194.00	35
31	02030105050	02030105050090	Rockaway Ck (below McCrea Mills)	115.85	0.02	40.00	-	-	1.00	42.00	37.00	1,443.70	0.27	33.00	629.79	82.20	0.13		0.13	46.00	199.00	36
25	02030105050	02030105050060	Cold Brook	856.37	0.21	52.00	-	-	1.00	54.00	48.00	992.94	0.25	23.00	140.91	0.11			0.04	20.00	200.00	37
11	02030105060	02030105060030	Raritan R NB(incl McVickers to India Bk)	119.13	0.02	41.00	-	-	1.00	43.00	38.00	1,077.39	0.22	15.00	431.31	41.62			0.10	37.00	202.00	38
14	02030105050	02030105050040	Lamington R(Pottersville gage-FurnaceRd)	-	-	1.00	-	-	1.00	3.00	1.00	1,791.60	0.31	45.00	840.65	108.06	0.00		0.17	48.00	203.00	39
17	02030105060	02030105060060	Peapack Brook (below Gladstone Brook)	99.26	0.03	42.00	-	-	1.00	44.00	39.00	625.55	0.19	5.00	229.81	84.17	0.08		0.10	38.00	207.00	40
13	02030105060	02030105060050	Peapack Brook (above/incl Gladstone Bk)	180.34	0.04	44.00	-	-	1.00	46.00	41.00	966.03	0.23	19.00	358.92	32.32	0.00		0.09	35.00	207.00	40
19	02030105060	02030105060040	Raritan R NB(Peapack Bk to McVickers Bk)	-	-	1.00	-	-	1.00	3.00	1.00	1,260.67	0.26	28.00	736.53	159.40	0.44		0.19	51.00	208.00	41
23	02030105020	02030105020020	Spruce Run (Reservior to Glen Gardner)	-	-	1.00	-	-	1.00	3.00	1.00	456.61	0.22	16.00	338.75	28.91	1.39	0.00	0.18	50.00	222.00	42
18	02030105050	02030105050080	Rockaway Ck (above McCrea Mills)	399.06	0.04	43.00	-	-	1.00	45.00	40.00	2,981.54	0.28	36.00	472.36	3.11			0.04	22.00	237.00	43
51	02030105050	02030105050130	Lamington R(Herzog Brk-Ptrsvle gage)	16.50	0.01	37.00	-	-	1.00	39.00	35.00	898.69	0.30	40.00	184.83	0.01			0.06	29.00	243.00	44
27	02030105020	02030105020030	Mulhockaway Creek	607.90	0.06	46.00	-	-	1.00	48.00	43.00	2,904.95	0.31	42.00	1,302.58	369.82	0.94		0.18	49.00	254.00	45
24	02030105020	02030105020040	Spruce Run Reservoir / Willoughby Brook	598.01	0.08	49.00	-	-	1.00	51.00	46.00	2,797.90	0.38	51.00	1,029.13	181.11	0.21		0.17	47.00	259.00	46
16	02030105050	02030105050050	Pottersville trib (Lamington River)	150.11	0.05	45.00	-	-	1.00	47.00	42.00	1,014.28	0.32	46.00	856.54	256.80	0.00		0.35	52.00	285.00	47

Dark Blue- Subcategories; Green – Major Categories; Orange – Final rank



Subwatershed Water Resource Protection Targets
Subwatershed Ranking
Restoration
Preservation
Municipal Boundary
Water Body
Mount Arlington Borough
Mine Hill Township
Roxbury Township
Mount Olive Township
Budd Lake
Randolph Township
Mendham Township
Mendham Borough
Chester Borough
Chester Township
Washington Township
Lebanon Township
Califon Borough
Hampton Borough
Glen Gardner Borough
Bethlehem Township
High Bridge Borough
Spruce Run Reservoir
Union Township
Clinton Town
Tewksbury Township
Peapack-Gladstone Borough
Bernardsville Borough
Far Hills Borough
Bernards Township
Bedminster Township
Lebanon Borough
Clinton Township
Round Valley Reservoir
Bridgewater Township
Alexandria Township
Franklin Township
Readington Township
Raritan Borough
Raritan Township
Branchburg Township
Flemington Borough
Hillsborough Township
Delaware Township
East Amwell Township
West Amwell Township
#1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11 #12 #13 #14 #15 #16 #17 #18 #19 #20 #21 #22 #23 #24 #25 #26 #27 #28 #29 #30 #31 #32 #33 #34 #35 #36 #37 #38 #39 #40 #41 #42 #43 #44 #45 #46 #47 #48 #49 #50 #51 #52
10/31/2016
0 1.25 2.5 5 Miles
N E S W

#	HUC14	Subwatershed Name
1	02030105050010	Lamington R (above Rt 10)
2	02030105010010	Drakes Brook (above Eyland Ave)
3	02030105010030	Raritan River SB(above Rt 46)
4	02030105010040	Raritan River SB(74d 44m 15s to Rt 46)
5	02030105050020	Lamington R (Hillside Rd to Rt 10)
6	02030105010020	Drakes Brook (below Eyland Ave)
7	02030105060010	Raritan R NB (above/incl India Bk)
8	02030105010050	Raritan R SB(LongValley br to 74d44m15s)
9	02030105060020	Burnett Brook (above Old Mill Rd)
10	02030105050030	Lamington R (Furnace Rd to Hillside Rd)
11	02030105060030	Raritan R NB(incl McVickers to India Bk)
12	02030105010060	Raritan R SB(Califon br to Long Valley)
13	02030105060050	Peapack Brook (above/incl Gladstone Bk)
14	02030105050040	Lamington R(Pottersville gage-FurnaceRd)
15	02030105020010	Spruce Run (above Glen Gardner)
16	02030105050050	Pottersville trib (Lamington River)
17	02030105060060	Peapack Brook (below Gladstone Brook)
18	02030105050080	Rockaway Ck (above McCrea Mills)
19	02030105060040	Raritan R NB(Peapack Bk to McVickers Bk)
20	02030105010070	Raritan R SB(StoneMill gage to Califon)
21	02030105060070	Raritan R NB(incl Mine Bk to Peapack Bk)
22	02030105060080	Middle Brook (NB Raritan River)
23	02030105020020	Spruce Run (Reservior to Glen Gardner)
24	02030105020040	Spruce Run Reservior / Willoughby Brook
25	02030105050060	Cold Brook
26	02030105020050	Beaver Brook (Clinton)
27	02030105020030	Mulhockaway Creek
28	02030105010080	Raritan R SB(Spruce Run-StoneMill gage)
29	02030105060090	Raritan R NB (Lamington R to Mine Bk)
30	02030105050100	Rockaway Ck SB
31	02030105050090	Rockaway Ck (below McCrea Mills)
32	02030105070010	Raritan R NB (Rt 28 to Lamington R)
33	02030105020070	Raritan R SB(River Rd to Spruce Run)
34	02030105020090	Prescott Brook / Round Valley Reservior
35	02030105020080	Raritan R SB(Prescott Bk to River Rd)
36	02030105070020	Chambers Brook
37	02030105070030	Raritan R NB (below Rt 28)
38	02030105020060	Cakepoulin Creek
39	02030105040030	Holland Brook
40	02030105040020	Pleasant Run
41	02030105020100	Raritan R SB(Three Bridges-Prescott Bk)
42	02030105040040	Raritan R SB(NB to Pleasant Run)
43	02030105040010	Raritan R SB(Pleasant Run-Three Bridges)
44	02030105030010	First Neshanic River
45	02030105030020	Second Neshanic River
46	02030105030040	Third Neshanic River
47	02030105030050	Back Brook
48	02030105030030	Headquarters trib (Third Neshanic River)
49	02030105030060	Neshanic River(Black Brk to FN/SN confl)
50	02030105030070	Neshanic River (below Black Brook)
51	02030105050130	Lamington R(Herzog Brk-Ptrsvle gage)
52	02030105050070	Lamington R(HallsBrRd-Herzog Brk)

Explanation of Figure 2, Subwatershed Rankings Map

Dark Green: Subwatersheds with the highest priority for preservation mainly due to the presence of high quality, sensitive water resources and a large amount of forest cover to protect those resources and potentially in need of preservation. (Ten subwatersheds)

Light Green: Subwatersheds of second highest priority for preservation due to the presence of similar resources and forest cover. (Ten subwatersheds)

Aqua Blue: Subwatersheds that fall in the middle of preservation and restoration priority. There are critical water resources, some forest in need of preservation, as well water resources already impacted by human land use such as urbanization and/or agriculture. (Ten subwatersheds)

Lighter Blue: Subwatersheds that are tending toward requiring a focus on restoration and BMPs to protect water resources that are becoming impaired by urban and/or agricultural land use. (Nine subwatersheds)

Dark Blue: Subwatersheds in great need of restoration and BMPs to improve water quality. Typically, urban and agricultural land uses dominate the landscape and water resources are impaired. (Eleven subwatersheds)

5.0 OTHER IMPORTANT FACTORS TO CONSIDER OUTSIDE THE RANKING CRITERIA

The matrix in Table 1 provides an objective baseline for evaluating subwatersheds. However, as previously discussed, there are many compounding variables, data limitations, or complex land uses that may factor into subwatershed prioritization independently of the WCP matrix.

Many of these variables may be addressed on a more specific level during case-by-case analysis or consideration for land acquisition. This section discusses some of these variables and addresses ways that these variables can be factored into the land acquisition process through site analysis.

5.1 Urban Land Cover

The following are primary land uses and covers listed under the NJDEP Landscape Mapping as "Urban." Urban lands are often characterized as lands that have substantially altered by development and contain higher levels (typically 25% or more) of impervious surfaces. As discussed above, high impervious surface volumes often relate directly to impacted water quality. Analysis of Urban Cover and the specific type of urban cover (see below) independently may provide insight into how to best develop conservation objectives or actions for that subwatershed.

Residential Coverage – Residential includes single-family residences, multiple-unit dwellings, and mobile homes. This land coverage also includes mixed residential, which is comprised of two or more of the aforementioned groups. Residential coverage is further divided into smaller categories based on density in terms of dwelling units per acre (NJDEP 2010). Higher density dwellings typically have higher levels of impervious surfaces.

Commercial and Services – The Commercial and Services coverage identifies areas that contain structures predominantly used for the sale of products and services. Coverage may include a main building, secondary structures, and supporting areas, such as parking lots, driveways, and landscaped areas up to an acre (NJDEP 2010).

Transportation / Communications / Utilities – The Transportation, Communication, and Utilities land uses are often associated with the other Urban or Build-up categories, but are often found in other categories. The presence of major transportation routes, utilities (i.e., sewage treatment plants), and power lines, power substations, and communication facilities greatly influence both the present and potential uses of an area (NJDEP 2010).

Other Urban Categories, Altered Land – Remaining urban land under NJDEP coverage may include undeveloped, open lands within, adjacent to, or associated with urban areas. Unvegetated lands in transition to development, quarries, large maintained lawns, regrown urban lots, and cemeteries are all additional examples of urban coverage (NJDEP 2010).

5.2 Agricultural Cover

Agricultural land includes all lands used primarily for the production of food and fiber, as well as some of the structures associated with this production (NJDEP 2010). Under the NJDEP system typical agriculture coverage includes cropland and pastureland; orchards, vineyards, nurseries, and horticultural areas and confined feeding operations; and other agricultural lands such as horse farms and crop or equipment storage areas.

The relationship of agriculture to water quality is complicated depending on use and practice. Certain agriculture practices may have less impact on water quality while others may have more. Pollutants including nitrogen, phosphorous, sediment and pathogens may be related to agricultural runoff. This may be true on heavily plowed farmland or in high density confined feed lots. The purchase and restoration of agricultural areas may ultimately benefit water quality; however, there are cultural, environmental and other considerations.

Farmland preservation may also be a key component of land acquisition to maintain low impervious surface cover. However, common agricultural practices have their own suite of negative impacts on water resources. Thus, farmland preservation must coincide with restoration and agricultural BMPs that decrease erosion, maintain stream buffers, protect wetlands, conserve water and require lower inputs of pesticides and fertilizers.

The relationship of agriculture to water quality and land acquisition contains many variables that must be ascertained on a site-by-site basis. As a result of the complexity of this land use, a set of agricultural questions are included in site acquisition guidelines. The questions are designed to facilitate the water quality and conservation value of a specific agricultural land acquisition.

5.3 Contamination

Knowing the presence and location of NJDEP Known Contaminated Sites and the extent of contaminated soils of groundwater is crucial in land acquisition efforts and obviously will shape the type of restoration required for a site. Although information relating to contamination is readily available through NJDEP GIS data, the full verification of contamination presence or absence must be conducted by additional means. As Known Contaminated Sites are constantly in some stage of remediation and the State's listing of sites change, these data are most appropriately ascertained as part of a more intensive site-by-site analysis. Some relevant site information may require contacting the NJDEP directly and preparing an Open Public Records Act (OPRA) request.

5.4 Funding and Partnerships and projects

The availability or potential availability of funds or partnering for specific types or project or on specific sites or subwatersheds is a crucial factor included in the evaluation of land acquisitions and projects. Often projects are initiated because there is an opportunity to partner on a project or funding sources are available. Potential partnerships may involve local, state or federal agencies or organizations. This type of consideration is most adequately addressed in a case-by case situation as it may be independent of subwatershed location. The WCP will allow RHA to be more proactive in seeking projects that meet its mission of protecting water resources.

5.5 Existing Preservation and Protection, Plans and Open Space

5.5a. Existing Preservation and Protection

It is important to consider that many of the resources and associated lands discussed in the WCP are provided some existing protection or resource use limitations through State and Federal or other regulation such as the Clean Water Act, Wetlands Protection Act, the Highlands Act, the State and Federal Endangered Species Act, and the Flood Hazard Control Act. In addition, there may be varying additional levels of municipal protection for steep slopes, stream buffers, and other vulnerable areas.

The existing protection under some of these regulations may factor into prioritization of land acquisition for preservation or restoration under various ways. Under certain circumstances, land which currently has restrictions or protection under legislation such as the Highlands Act has less development risk subsequently may be less of a priority for acquisition and preservation. However, protected lands often have the most sensitive or highest priority water related resources such as high value recharge areas or wetlands. These resources may be currently degraded or threatened by existing or adjacent land uses such as agriculture or by established development. Acquisition and the subsequent restoration of these lands may in many cases result in great opportunities for improvement to water quality in the Raritan Headwaters. Furthermore, purchase of lands with some level of existing protection may facilitate landowner and municipal cooperation on future projects and land acquisitions.

For the purposes of RHA, land protected from development through the Highlands Act, or as direct land preservation through Federal, County, State, Municipal or NGO levels is considered "preserved land." This information is; however, not factored into the summary matrix. How these data are utilized in preservation prioritization may vary on a case-by-case basis and change in time with evolving preservation philosophies and strategies. As a result preservation and plan data are not incorporated into a matrix rank, but available for use within the Existing Plans Summary table in Appendix B.

5.5b. Highlands Planning and Protection Areas

The New Jersey Highlands region is an area of approximately 859,358 acres incorporating 88 municipalities in seven counties. The Highlands Region is characterized by its geology, which includes a series of basalt ridges and valleys that contain softer fractured and erodible rock (see Section 3.3b); significant forested areas and a vital water supply characterized by the presence of major reservoirs. To provide increased protection to this Region, both houses of the New Jersey Legislature passed the Highlands Water Protection and Planning Act in 2004.

The Act requires all municipalities (or portions) within the Highlands Protection Area to conform to requirements in the Regional Master Plan. Municipalities (or portions) within the Highlands Planning Area may voluntarily conform to the Plan and its Goals. Goals of the Preservation Area (Highlands Plan 2008) are summarized here:

- Preserve to the maximum extent possible contiguous areas of unique Highlands land in its natural state.
- Protect the natural, scenic and other resources of the Highlands Region such as contiguous forests wetlands, vegetated stream corridors, steep slopes and other critical habitat.
- Promote compatible agricultural horticultural, recreational and cultural uses and opportunities within the framework of protecting the Highlands environment.
- Prohibit or limit to the maximum extent possible, construction or development which is incompatible with preservation of this unique area.

The Highlands Act contains regulatory components that protect lands within Highlands Preservation areas or those areas that have opted into Highlands Preservation.

There are approximately 171,336 acres of Highlands Preservation Land in the RHA subwatersheds. Thirty- seven of the 52 subwatersheds within the RHA lands contain at least one percent of land within the Highlands Preservation Area. Nineteen of these subwatersheds are 99-100% within the Highlands Preservation Area. There are an additional approximate 123,457 acres of land within 37 RHA subwatersheds that fall within the Highlands Planning Areas and have opted into preservation. An additional 51,021 acres of Highlands Planning Area land within 22 RHA subwatersheds have not opted into Highlands Preservation.

5.5c Other Preserved Lands and Open Space

These preserved lands may be federal, state, county, municipal or NGO obtained lands derived through various data sources. What constitutes "open space" in data sets is highly variable. Open space may include parks, preserves, historic sites, recreational fields, military installations, wildlife management areas and state forests. Because "open space" land use and its importance to or impact on water quality varies greatly, further detailed evaluation of what constitutes the open space within a given subwatershed may be warranted. In terms of subwatershed prioritization, considerations may include a philosophy of creating open space connectivity by purchasing lands adjacent to open space within the subwatershed or it may be to seek out subwatersheds with very little open space and seek to maximize the amount of preserved land within them. Therefore while these data are not incorporated into the WCP subwatershed prioritization matrix, it may be useful to RHA in developing land acquisition strategies and site consideration on a case-by-case basis.

Federal Lands

This layer is a composite of Federal lands that includes USFWS Wildlife Refuges, Federal Water Supply Management Areas, National Parks Service Lands, and Military Installation Lands.

State Open Space

These data were derived by utilizing existing NJDEP GIS layers for State Land and includes State parks, forests, historic sites, natural areas and wildlife management areas. The data were derived from a variety of source maps including tax maps, surveys and hand-drafted boundary lines on USGS topographic maps (NJDEP metadata).

County Open Space

These data were derived utilizing a county NJDEP GIS layer that includes County Lands encumbered by Green Acres and an Additional County Layer.

Municipal and other Green Acres Open Space

These data include open space within the NJDEP Green Acres Recreation and Open Space Inventory (ROSI) database. These ROSI identifies municipal, county and nonprofit parkland encompassed by the Green Acres Program. These data also include lands protected through Blue Acres Funding under the NJDEP Green Acres program. This funding was developed through the Green Acres, Farmland, Blue Acres, and Historic Preservation Bond Act of 2007 for acquisition of lands in the floodways of the Delaware River, Passaic River or Raritan River, and their respective tributaries, for recreation and conservation purposes. Additional funding was approved through Green Acres, Water Supply and Floodplain Protection, and the Farmland and Historic Preservation Bond Act of 2009. RHA is aware that the ROSI database does not account for NGO, municipal or county preserved land in all subwatersheds. Additional preserved land data (not identified from ROSI) could be incorporated into this model at a later time.

5.6 NJWSA Sensitive Resource Areas Mapping

The New Jersey Water Supply Authority (NJWSA) was created in 1981 as a public body to operate the water supply facilities owned by the State of New Jersey. The Authority states its purpose as "to maintain a dependable supply of water to central New Jersey residents, and preserve and enhance source water quality and quantity through planning, preservation, assessment and rehabilitation of critical watershed parcels." The WCP utilizes data from the NJWSA Watershed Management Plan for various elements of the matrix.

Among the NJWSA plan goals, was the goal to develop a GIS based methodology to objectively identify sensitive water resource areas for land preservation. In 2009, the NJWSA created prioritization mapping for the Raritan Headwaters using 2007 NJDEP Land Use/Land Cover.

The data incorporated into their GIS model include many of the resources discussed in this Section. The final prioritization mapping was created by overlaying these GIS layers and ranking areas (one-highest to six-lowest) based on the number of resources layers within a particular area.

Key layers that were utilized in the WCP include:

- Riparian Areas (NJWSA definition – this layer incorporates alluvial and hydric soils, streams and buffers, flood areas, open waters and highlands areas
- NJGS Primary Aquifer Recharge areas
- Erodible Soils (derived from Land Use/Land Cover, Slopes and K-factor Soil Erodibility).

Additional subwatershed information may be ascertained from their coverage and ranking system and may be useful as a complimentary tool to the WCP in subwatershed or site analysis.

5.7 Environmental Considerations

WCP objectives, priorities, and rankings will need to adapt as new data are acquired that provide new or additional insight into watershed and water quality preservation, and as technologies improve accuracy of existing GIS data. This adaptation may be in the form of reprioritization of existing criteria, updated information under existing criteria, or the addition of new criteria in the prioritization process. This section briefly identifies potential factors that may play a role in future revisions of the WCP.

5.7a Regional Issues

RHA may consider the activities of adjacent watersheds in land acquisitions particularly adjacent watersheds where there might be common land acquisition or restoration interests. Examples may include State or Federal level planning objectives to protect water supplies or preservation forested areas that cross boundaries with neighboring Watershed Management Areas.

5.7b Global Climate Change.

The scientific community at large and major world governments have reached the consensus that the climate is changing rapidly due to human activities since the Industrial Revolution and, without substantial intervention, will continue to change throughout the world in the coming decades with various consequences to ecosystems (IPCC 2014).

Changes in global temperature may influence rainfall patterns and subsequent flow and cycling of water within ecological systems. Weather instability (including an increase in short-term droughts and floods) resulting from global climate change may impact water recharge or input timing, reduce storage capacity, and increase drought or flooding (NABCI 2010). Increase in precipitation during winter and spring months may exacerbate flooding conditions during snow melt. Within the Northeast, winter flooding, precipitation and high flow periods are expected to increase by as much as 20 to 30% with increased rainfall impacts under varying levels of emissions (Frumhoff, et al., 2007). Some studies have projected two to five fold increases of extremely hot summer days and increases in short-term (one to three month) warm season droughts in the Northeast. Subsequent low flow (least amount of water volume within a stream) periods during summer seasons may be prolonged for northeastern streams. Water demands within ecosystems may also increase seasonally within the region due to increases in plant productivity and subsequent evapotranspiration (Frumhoff, et al., 2007).

While there is ample climatic and ecological evidence for anthropogenic climate change, the precise and localized predictions of impacts are difficult to determine due to the numerous variables involved. Long-term variations in carbon emissions, climate and ecosystem response, and other compensation mechanisms or compounding factors all complicate the process of determining impacts. In the future, land stewards, municipal planners, and agency representatives responsible for managing land will need to carefully monitor conditions and take an adaptive approach to mitigating impacts of global climate change on their lands or within their communities. With this in mind, how RHA prioritizes land conservation and acquisition will depend on the future ecological responses and conditions of the Raritan Headwaters. Particular issues that may be of concern include the expansion of flood hazard areas and increased impacts to flood-prone riparian zones; changing hydrologic conditions to palustrine wetlands and other hydrologically sensitive areas; and forest impacts due to species shifts and other climate induced changes in ecosystems such as the prevalence of new or expanding invasive species.

5.7c Other Environmental Factors (Upland Wildlife, Aesthetics, and Historic Resources)

There are many additional environmental, aesthetic or cultural factors that, while often not directly relating to water quality, may be an important asset or limitation to acquiring and managing lands. These issues are again best evaluated in a case-by-case basis and therefore are included as an item the Site Analysis Worksheet (Section 6). Examples may include historical structures such as houses or barns; archaeological sites, many of which are often associated with riparian areas; Threatened and Endangered Species habitat for upland species such as various grassland birds; or sites or areas that have particular aesthetic value.

Presence of invasive species and degradation of habitat may also influence land preservation and restoration decisions and project planning.

6.0 SITE ANALYSIS WORKSHEET FOR LAND PRESERVATION DECISIONS

This sheet is designed to help determine whether support for preservation activities is supported by subwatershed prioritization as well as additional factors that may contribute to a site's value or pose limitations for use on a case-by-case basis.

The worksheet is derived from various site analysis worksheets already utilized including those utilized by NJDEP Green Acres (NJDEP 2016).

To complete the site specific analysis and data sheet, multiple sources can be accessed to collect site specific information in addition to the information available through the RHA WCP. NJDEP GeoWeb (http://www.nj.gov/dep/gis/geowebsplash.htm) is a publicly accessible tool that provides site specific GIS data for a host of environmental and cultural resources, and limitations that were not included in the WCP subwatershed evaluation data. NJDEP DataMiner (http://www.nj.gov/dep/opra/online.html) may also be utilized for site specific information such as NJDEP violations or permit history.

6.1 Land Preservation: Site By Site Preliminary Analysis Sheet

Mapping provided parcel proposed for acquisition (Airphoto, USGS Topographic, other).

Watershed (HUC 11) Name/#____

Subwatershed (HUC 14) Name/#____

Subwatershed Rank (From WCP)____

County____

Municipality ____

Parcel Block(s) and Lot (s)____

Size (acres)____

Surrounding Population and Landscape (urban, rural, medium density residential, etc.)

____

____

Municipal Zoning of Parcel(s)_______________________________________

Previous Zoning ____

Current Owner____

Previous Ownership____

Leases or Rentals on Property______________________________________

Partnerships and Any Additional Funding Sources

____

____

____

____

A. Land Use/Land Cover

1. Provide a brief description on general site man-made land use – include number of structures, roadways, utilities (gas lines, powerlines/electric, public water/ sewer), residences (active or

inactive), houses, barns, paths, etc.

____
____
____

a. Percent forest/forest type

Core forest (Y or N)   approx. %________

Core forest connected to offsite forest patch (Y or N)

Briefly describe vegetation communities including general vegetation types (mature oak forest, secondary successional forest, coniferous, etc.), native, non-native communities

____
____
____

b. Urban and impervious surfaces (Y or N) approx. %_______

c. Agriculture present (Y or N) approx. %_________

If Yes:

Active   approx. %____   Inactive   approx. %________

Circle Type: Harvested Cropland – Row crop/hay etc.

Pastureland, Horse farm, Orchard, Vineyard, Nursery, Horticultural, Floral, Sod or Seed Farm, Confined feeding operation, Other

____
____

1. Is the site or portion under farmland preservation? (Y or N)

2. Are farming practices occurring onsite a potential threat to water resources? (Y or N) Describe____

____
____

3. Would acquisition result in a benefit to those agricultural resources? (Y or N)

____
____
____

B. Soils and Slopes

1. Briefly describe Topographic Features AMS elevations, outcrops, faults or other geologic features.

____
____

2. Describe any erosion or soil issues known onsite (For contamination, see E below.)

____
____
____

a. Erodible soils (from NJWSA Mapping) (Y or N) approx.%_________

b. Steep slopes (from NJWSA Mapping) (Y or N) approx.%_________

c. Quality Soils (Prime Farmland/Statewide (Y or N) approx.%_________

d. Parent Material Bedrock Types____

e. Soil Series/Unit Types and % (include urban soils)_________________________________

f. Hydric or alluvial soils____

C. Surface Water/ Water Quality

1. Describe existing threats to water quality and/or benefits to water quality by acquisition of the parcel.

____

____

____

2. Evidence of flooding or floodplains including flood damage, wrack or scour marks, buttressed trees, etc.____

____

____

a. Surface water present onsite (Y or N) acres_________

b. Isolated pond or stream (Y or N)

c. Category 1 Waters (Y or N)

d. Trout Maintenance/Production (Y or N)

e. 303d water present (Y or N) Describe____

____

f. NJDEP Determined or estimated riparian zone width and %___________________________

D. Aquifers and Bedrock

1. Describe observed onsite groundwater hydrology. Include evidence of groundwater springs, spring houses, sink holes, faults, etc.

____

____

____

a. Surface Aquifers mapped onsite (Y or N) type______________

b. Bedrock Aquifer Type/Limestone Present (Y or N)

c. NJGS Priority Aquifer Recharge Area (Y or N)

d. USGS Priority Groundwater Recharge Area (Y or N)

e. 100 year Floodplains Present (Y or N) approx. %_________________

f. Riparian Zone (Y or N) estimated approx. %____________________

g. Sole Source Aquifer (Y or N) _____________

E. Wetlands

1. Wetlands identified onsite (Y or N)

2. General description of wetland types and features onsite

____
____
____
____
____

a. Letter of Interpretation (LOI) or NJDEP Wetlands Permits Known or Completed for the Property (Y or N)____

____
____

b. Palustrine Forested (Y or N) approx. %_____________________________________

c. Palustrine Scrub/Shrub (Y or N) approx. %__________________________________

d. Palustrine Emergent (Y or N) approx. %____________________________________

e. Modified Wetlands (Y or N) approx. %_____________________________________

f. Riverine or Other Wetlands (Y or N) approx. %______________________________

g. Known or Likely Resource Value (ordinary, intermediate, exceptional) - Transition Area %

____

h. EPA Priority Wetlands ____

D. Wildlife

1. Known Rare, Threatened or Endangered Plants, Communities, or State or Federal-Listed Wildlife Species potentially onsite or documented onsite (Note State or Federal Listing).

____
____
____
____

a. Water Dependent Wildlife Habitat Mapped Landscape v 3.1 (Y or N) %___________________

b. Mussel Habitat Present (Y or N)____

c. Landscape Cover (Rank 3 or greater) %____

d. Other Landscape Cover (Rank 1 or 2) or Vernal Pools___________________________________

e. NJDEP Natural Heritage Project Letter (Y or N) Date___________________________________

f. Water- dependent plant species within one mile based on NHP__________________________

E. Contamination

1. Known Contamination (Y or N) Other information on contamination history or suspected contamination. Describe.____
____
____

a. Type NJDEP KCS CEA CKE Brownfield

b. Contamination Type: Surface, Groundwater, Soil _______________

c. Contaminants known (Y or N) Type____
____
____
____

F. Existing Preservation/Limitations/Planning

1. Highlands Preservation Area or Adopted (Y or N)

   Highlands Planning Area (Y or N)

   NJ Smart Growth Planning Area Designation____

____

____

2. Any existing deeds, violations, or other restrictions on land use (Y or N) approx. %. Describe.

____

____

____

____

3. Has the property been designated for use in meeting municipal fair housing obligations? (Y or N) If yes, describe the coordination with COAH as to alternatives.

____

____

____

4. Public Participation or Interest (Y or N) Describe – Include existing dates and feedback.

____

____

____

5. Existing rights-of-way on property or other easements (Y or N) acres.

____

____

____

6. Proposed passive or active uses of and designated management of property.

7. Adjacent open space or greenways and potential for connectivity (Y or N) Describe.

8. Subdivision or development approvals for the property. Describe.

G. Cultural Considerations

1. Historic resources (Y or N). Archaeological site. Is any portion of the site on a municipal, County, State or National Historic Register (Including Districts, Structures, Features)? Describe.

2. Previous State Historic Preservation Office (SHPO) review of Site (Y or N) or study such as Phase I archaeological survey. Describe.

Total Score_____________________________ (Where does this score come from?)

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APPENDIX B Watershed Summary Data Tables