Final

GROUNDWATER PROTECTION PLAN

for the

TOWN OF GERMANTOWN
COLUMBIA COUNTY, NEW YORK

Prepared for:

Town of Germantown Comprehensive Plan Committee

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1.0 INTRODUCTION

1.1 Goals and Objectives

Ground water is a valuable resource for the Town of Germantown (see Figure 1). In Germantown, several privately-owned public water systems and many individual residences rely upon wells for their source of supply (see Section 3.0). In addition, ground water contributes a significant portion of water to local streams, wetlands, and ponds. Unfortunately, groundwater contamination can and does occur as a consequence of a variety of land use activities. In addition, ground water can become depleted if withdrawal rates exceed natural replenishment rates.

The Town of Germantown is in the process of planning for the future. In order to preserve the groundwater resources of Germantown for today and the future, the following Groundwater Protection Plan has been prepared by the New York Rural Water Association (NYRWA) in cooperation with the Town of Germantown Comprehensive Plan Committee. This plan maps the groundwater resources and aquifers in the Town of Germantown area, identifies potential sources of contamination, and outlines potential protection strategies.

1.2 Scope and Methods

New York Rural Water Association has utilized a variety of published and unpublished data sources for this plan. All data were inputted into a Geographical Information System (GIS). This is a computer system that allows one to visualize, manipulate, analyze, and display geographic (spatial) data.

Well data was collected from the United States Geological Survey and the New York State Department of Environmental Conservation. Geologic maps from the New York Geological Survey and unpublished sources were used. Similarly, digital maps from the Columbia County Soil Survey were utilized. Elevation data were taken from digital elevation models (DEMs). This information was then used to derive hillshading and slopes. Land use information was taken from parcel mapping made available from the Hudson Valley Greenway. Other digital data including surface waters, roads, aerial photography, etc. were downloaded from the New York State GIS Clearinghouse and the Cornell University Geospatial Information Repository.

New York Rural Water Association also conducted on-site activities in Germantown to document the location of public water supply wells, potential contaminant sources, etc. A global positioning system (GPS) device was used to capture the geospatial coordinates of such features. New York Rural Water Association also conducted geologic reconnaissance in selected areas to confirm surficial and bedrock mapping.

2.0 PHYSICAL SETTING

The Town of Germantown is located in southwestern Columbia County (Figure 1) in the Hudson Valley physiographic province. Elevations in Germantown range from near sea-level along the Hudson River to as high as 340 feet above sea-level along Hilltop Road in the central part of the Town (Figure 2). The topography of Germantown has three characteristic landforms: north-south ridges, plains, and dissected valleys (Figure 3).

A distinctive feature of the topography of Germantown is the number of north-south trending ridges (Figure 3). These ridges are largely the topographic expression of underlying thrust faults and folds in the bedrock. These structural features were formed by the collision of ancient crustal plates some 450 million years ago. In many instances, older rocks belonging to the Stuyvesant Falls, Germantown, and Nassau Formations were thrust westward over younger rocks such as the Austin Glen Formation (Figure 4). The Stuyvesant Falls Formation consists of greenish argillite, a hard shaly rock. Underlying the Stuyvesant Falls Formation is the Germantown Formation. This consists of interlayered limestone, siltstone, and shale. Underlying the Germantown Formation is the Nassau Formation, consisting of greenish-reddish shale and quartzite. Along the western edge of Town, a body of rock known as mélange is mapped (Figure 4). This is a body of highly deformed rock that had been disrupted and sheared into fragments and blocks of various lithologies. Bedrock is found at or near the surface on many of the ridges (Figure 5). However, some of the ridges in the eastern half of Town also have an accumulation of up to 80 feet of glacial till above the bedrock (Figure 5). Till is an unsorted, unstratified, dense mixture of boulders, angular gravel, sand, silt, and clay. It was deposited directly beneath the glacier during active ice advance.

Plains consist of flat or gently undulating land between the north-south trending ridges (Figure 3). These more or less level and lower-lying areas are commonly underlain by more erosive rocks such as the Austin Glen Formation (Figure 4). This bedrock formation consists of graywacke interbedded with gray and black shales. Graywacke is a type of rock composed principally of angular quartz and shale fragments in a clayey matrix. Most of the plains in Germantown were covered by a large lake that existed during deglaciation known as Glacial Lake Albany. As a consequence, fine-grained glaciolacustrine silt and clay deposits were laid down in deeper water areas on top of earlier glacial till and bedrock (Figure 5). In shallower water areas of the lake, coarser-grained glaciolacustrine silt and sand deposits were deposited (Figure 5).

Following deglaciation, modern streams and rivers such as the Roelff Jansen Kill eroded through glacial lake sediments and glacial till, creating narrow dissected valleys. These valleys are characterized by steep sided slopes. In places erosion has caused bedrock to outcrop. In other places, alluvium has been deposited (Figure 5). Alluvium consists of fine sand to gravel to silt that has been deposited in areas historically prone to flooding.

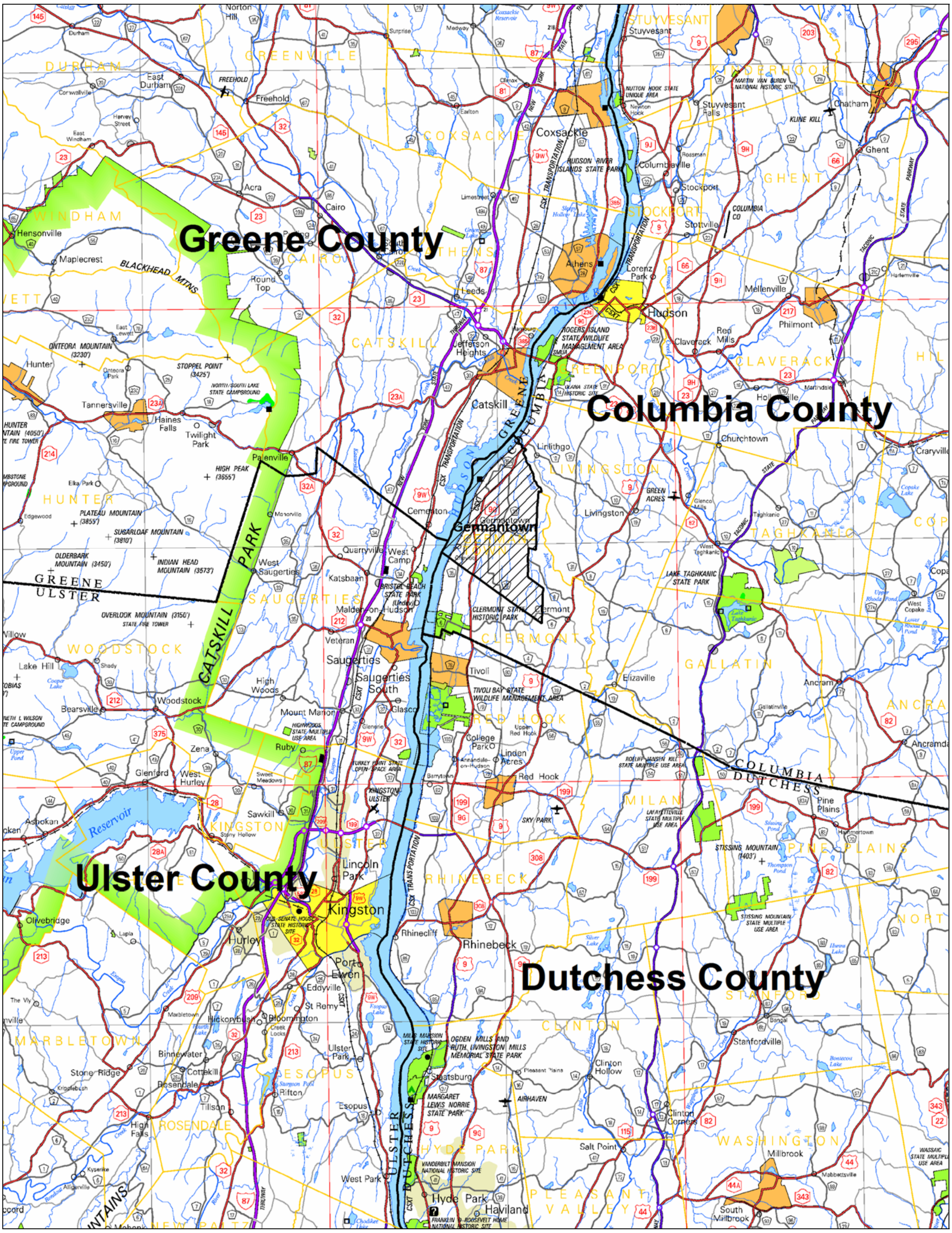


Figure 1. Town Location.

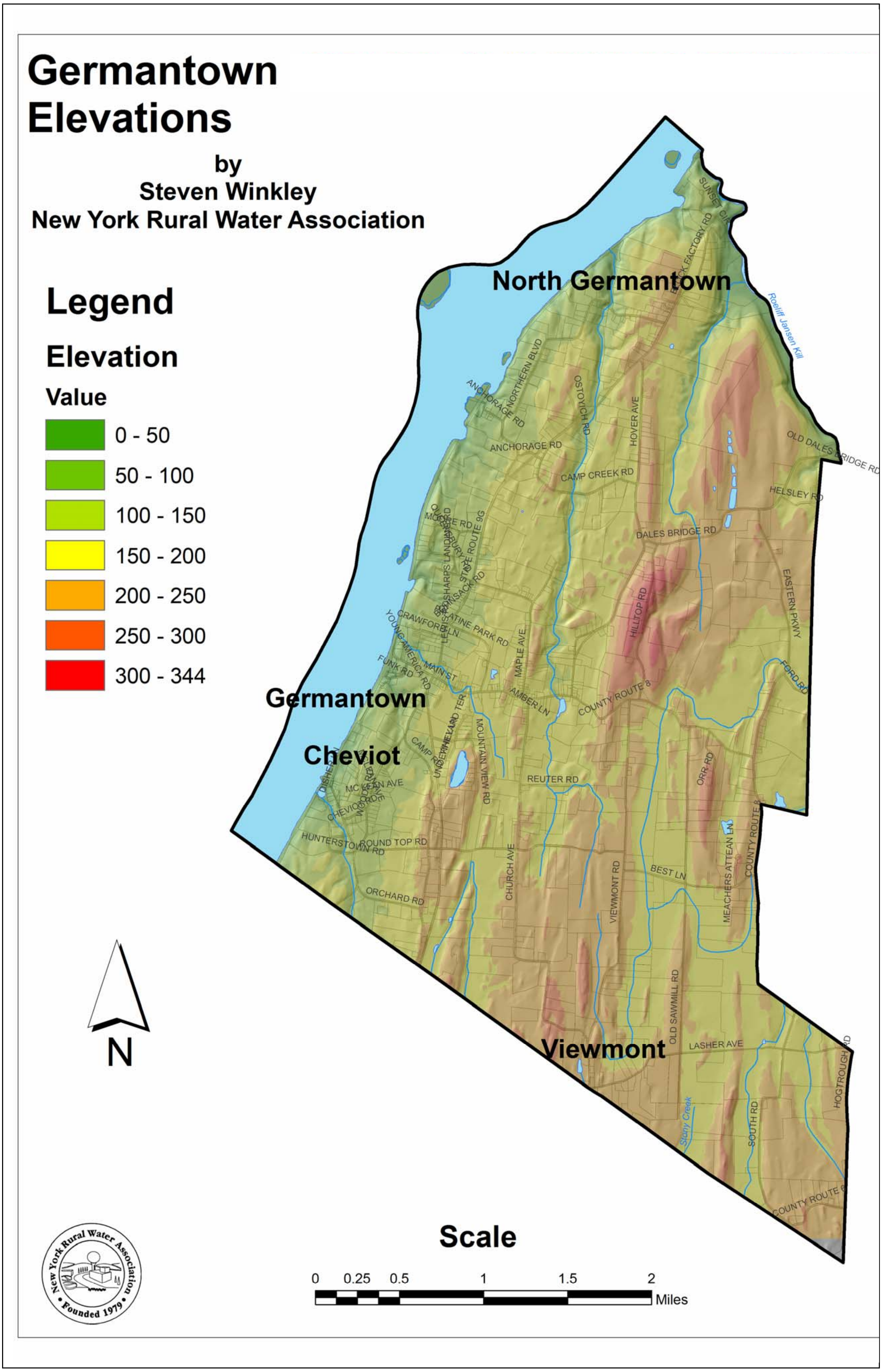


Figure 2. Elevations.

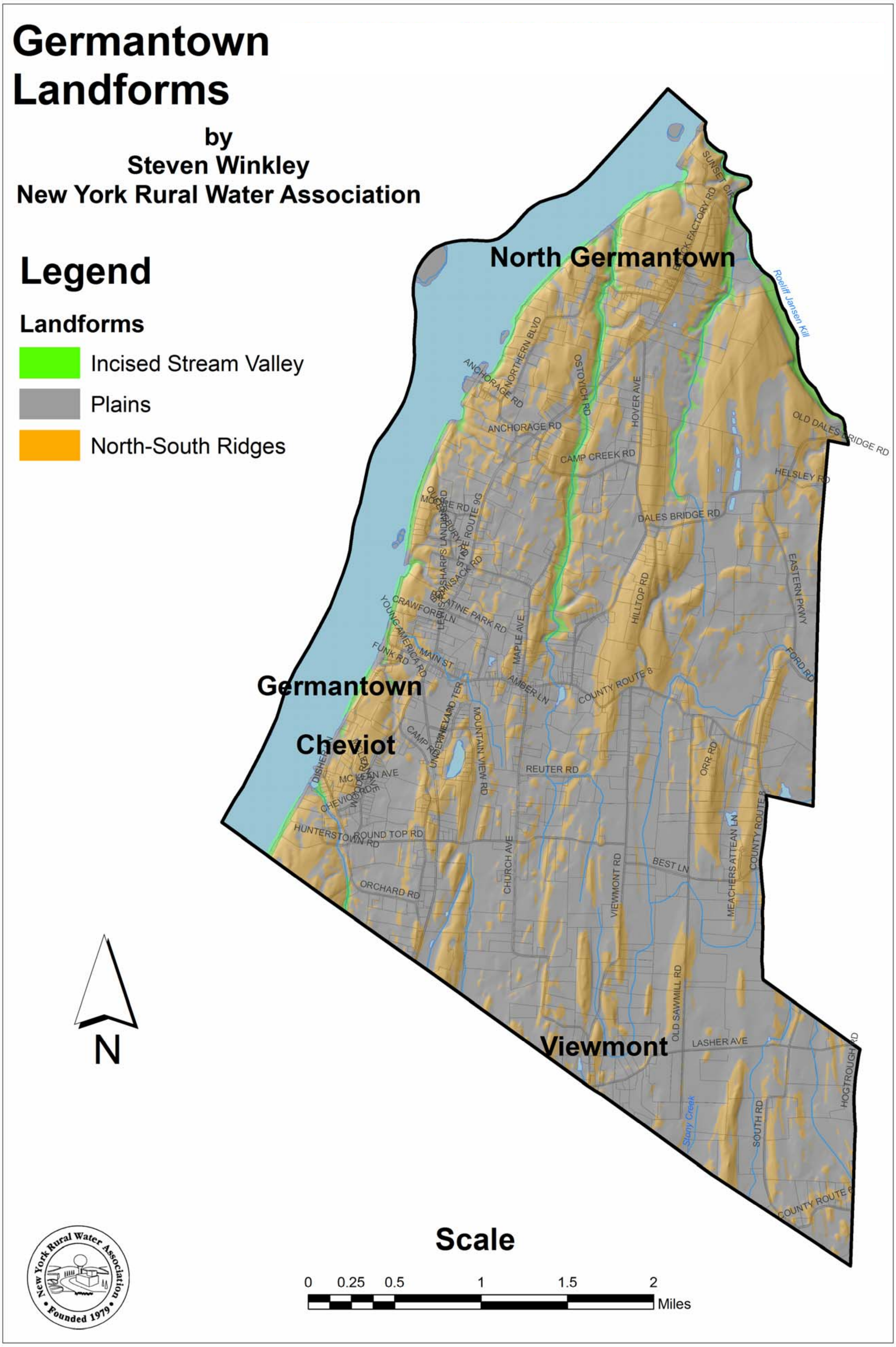


Figure 3. Landforms.

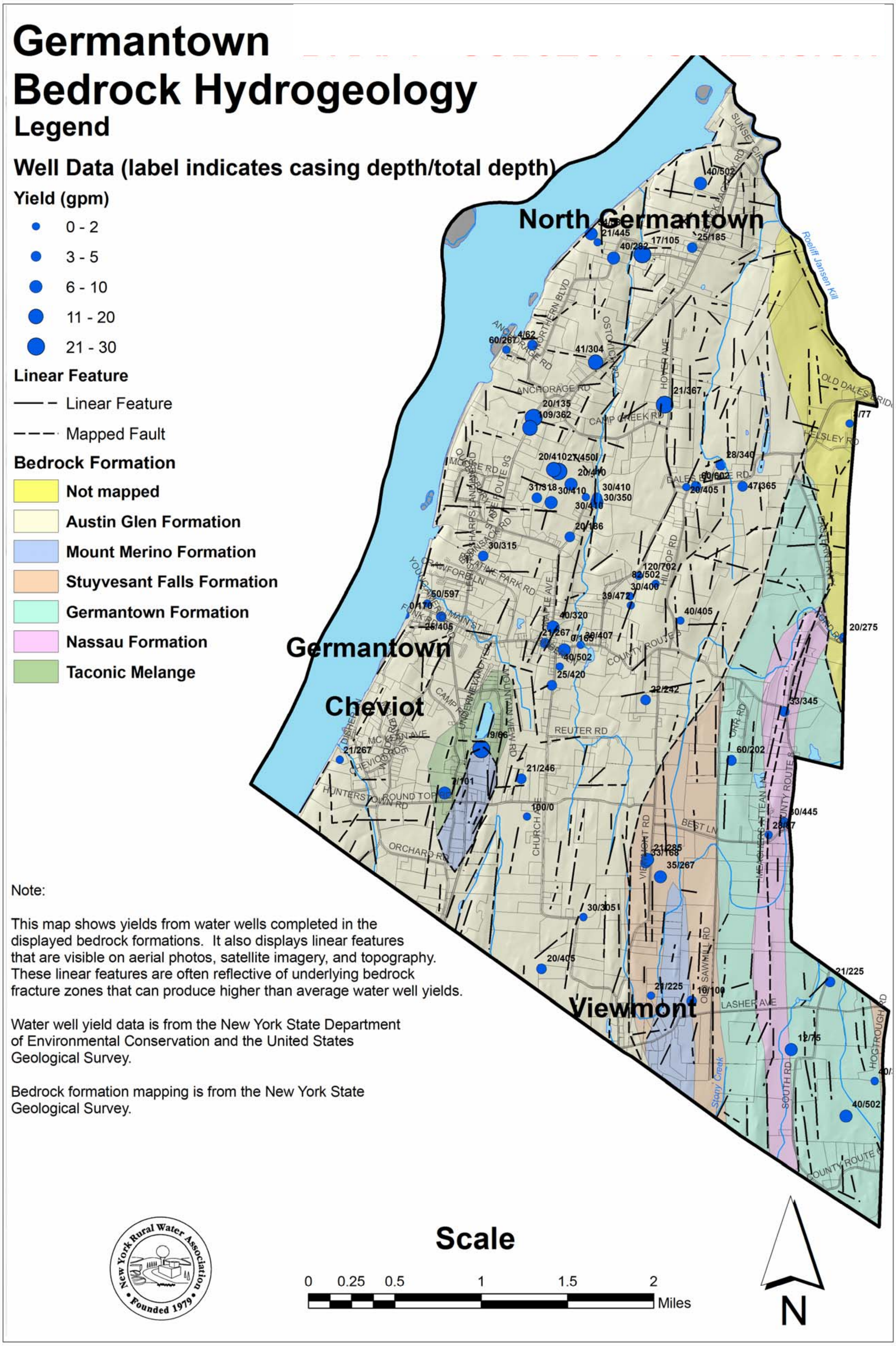


Figure 4. Bedrock Hydrogeology.

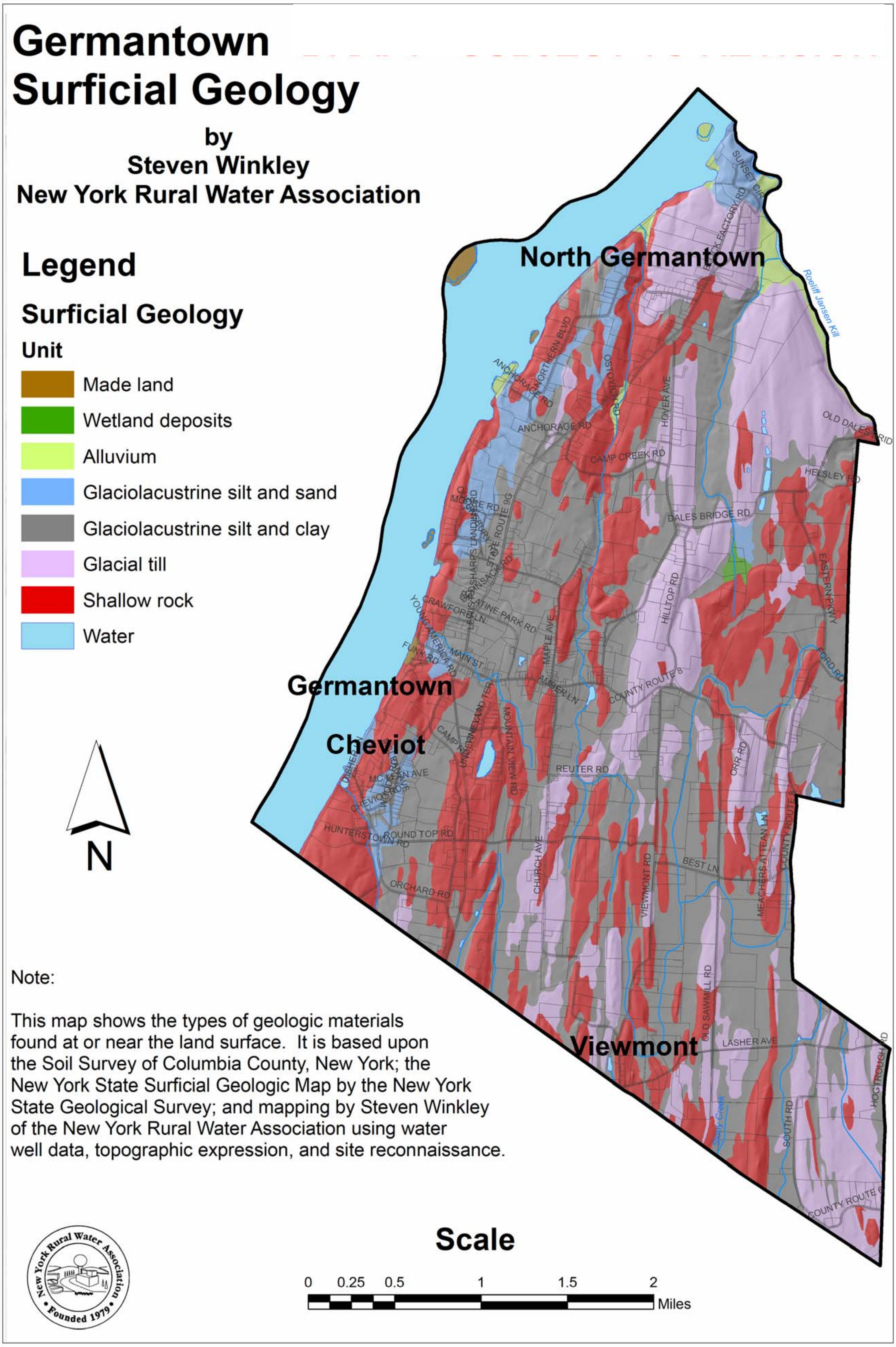


Figure 5. Surficial Geology.

3.0 GROUND WATER UTILIZATION

All of Germantown relies upon ground water for its source of supply. This includes private residences and businesses. Some establishments are classified as public water systems and are regulated by the New York State Department of Health and the Columbia County Department of Health. Individual, domestic wells are not regulated. According to data from the New York State Department of Environmental Conservation, 54 new water wells were drilled in Germantown between June 2000 and May 2005. Nine different drilling firms completed these wells.

3.1 Public Water Supply Wells

Although there are presently no municipal water supply wells in the Town of Germantown, there are several public water supply wells. These are privately-owned wells that supply public water systems regulated by the New York State Department of Health (NYSDOH) in cooperation with the Columbia County Department of Health. A public water system is an entity that provides water to the public for human consumption through pipes or other constructed conveyances. Any system having at least 5 service connections or that regularly serves an average of at least 25 people daily for at least 60 days out of the year is considered a public water system. Public water systems are classified as one of three types: community, non-transient non-community, or transient non-community.

A community water system is a public water system that serves the same people year-round. It has the most regulatory requirements of the three system types, including the need for a certified operator and more extensive monitoring. Based upon NYSDOH data, community water systems relying upon wells in the Town of Germantown include: Palatine Manor (apartment complex with approximately 50 residents) and Hillside Manor (a mobile home park with approximately 20 residents). Figure 6 includes the approximate location of these community wells.

A non-transient non-community water system water system does not serve year-round residents, but does regularly serve at least 25 of the same people more than six months per year. It now requires a certified operator, but has less monitoring and reporting requirements than a community system. Based upon NYSDOH data, non-transient non-community water systems in the Town of Germantown include Taconic Farms (with approximately 600 employees) and Germantown Central School District (with about 700 students and staff). These systems are included on Figure 6.

A transient non-community water system does not regularly serve at least 25 of the same people over six months per year. It does not require a certified operator and monitoring is largely limited to bacteria, nitrate, and nitrite. There are 9 establishments in Germantown that have wells and are regulated as transient non-community water systems. These are included on Figure 6.

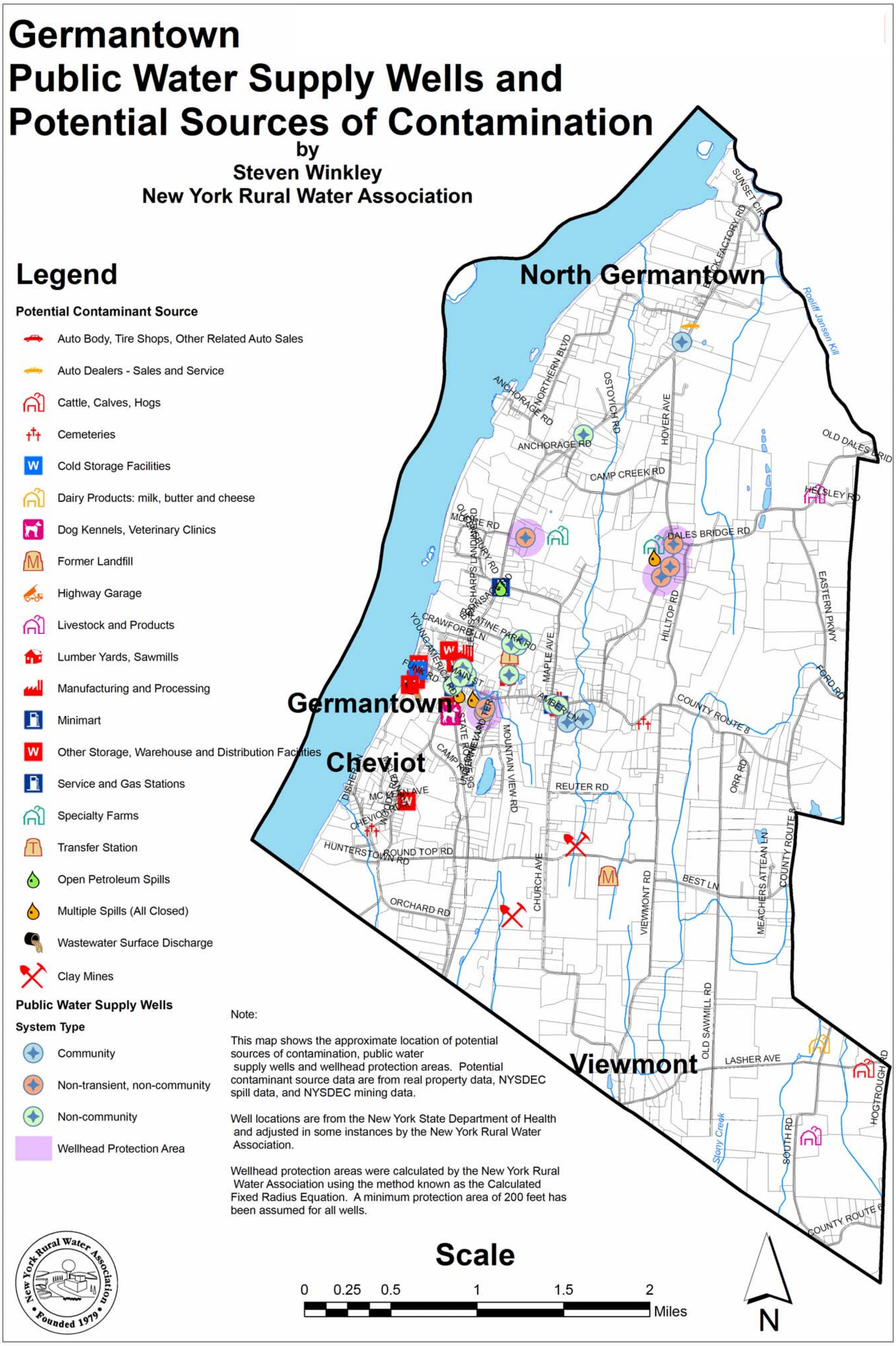


Figure 6. Public Water Supply Wells and Wellhead Protection Areas.

3.2 Delineation of Wellhead Protection Areas

The USEPA defines a wellhead protection area as the surface and subsurface area surrounding a well through which contaminants are reasonably likely to move toward and reach the water well. Wellhead protection areas generally approximate the area that supplies recharge for supply wells.

New York Rural Water Association has mapped the wellhead protection areas for the public water supply wells in the Town of Germantown area (see Figure 6). A minimum 200-foot radius wellhead protection area was around each public well. NYSDOH regulations stipulate that the owner of a public water supply system control by ownership, lease, easement or other legally enforceable arrangement the land use activities within 200' of the supply well. For the community and non-transient, non-community supply wells, the wellhead protection areas were extended to a radius calculated using an equation known as the Calculated Fixed Radius method. This equation uses the inferred amount of water pumped per day, the average saturated depth (239 feet), and a porosity (0.02) of the bedrock aquifer to calculate an area that represents the area contributing groundwater flow during a 5 year period. This area is mapped on Figure 6 and ranges from 200 feet to as much as 570 feet from the supply well.

4.0 GROUND WATER AVAILABILITY

Ground water is subsurface water that fills (saturates) all the voids in the rock or soil. Ground water is found between in the pore spaces between individual grains that range in size from clay to gravel. This is referred to as primary porosity. Ground water also occurs in cracks (fractures) found in rock. This is known as secondary porosity. Some of the local bedrock includes layers that have primary porosity. However, most of the water in bedrock is found in fractures.

An aquifer is a loosely-defined term that has several different meanings. Some refer to an aquifer as a body of rock or sediment that produces usable quantities of water. Using this definition, virtually all of the Town of Germantown overlies an aquifer because typically enough ground water can be found at most locations for residential purposes. However, an aquifer is also sometimes defined as a body of rock or sediment that yields *significant* quantities of water. This is the definition of aquifer that is referred to in this plan. A significant quantity of water is defined in this report as an amount of water that is sufficient for use as a *potential* municipal water supply source. For a community such as the hamlet of Germantown, this would be an amount of approximately equivalent to 86,000 gallons per day or 60 gallons per minute (gpm). This is based upon the 2000 Census delineation of the hamlet of Germantown (see shaded area on Figure 16), an area containing a population of 862.

4.1 Bedrock

Bedrock in the Town of Germantown is the source of ground water for residents and businesses. In bedrock, steel casing is set through the overburden and into the first few feet of sound rock. The remainder of the well is left as an open borehole in the rock. There are three types of well drilling methods used in Town. These are rotary, air hammer, and cable tool. The most popular method by far is the rotary method. Rotary drilling involves rotating a bit and removing the cuttings by circulation of air and/or a drilling fluid. Next most popular is the air hammer method. This method is a specific type of rotary drilling where a pneumatic drill or "hammer" strikes the rock as the drill pipe is rotated.

Studies have shown that there are several factors that control bedrock well yield. Higher yielding wells are generally found in more permeable bedrock formations that have more intense rock fracturing, are more often in topographic lows, and frequently are situated near linear features found on topographic maps or aerial photographs (see Figures 4 and 7). Conversely, low yielding wells are often found in poorly permeable formations (shale), and are usually situated on steep slopes at higher elevations or hilltops.

The yield of bedrock wells in Town range from 1 to 30 gpm. The median yield of bedrock wells is 4 gpm. This is the yield at which half the wells produce more (> 4 gpm) and half of the wells produce less (< 4 gpm). The U.S. Department of Housing and Urban Development (HUD) has a minimum well yield for Federal Housing Administration (FHA) insured loans. For new construction, the pump test must indicate that the system is capable of delivering a flow of five gpm over at least a four-hour period. For existing homes, the system must be capable of delivering three gpm over at least a four-hour period. As Figure 7 shows, wells drilled in many areas of the Town are not likely to meet the requirement for new or existing construction.

High yielding wells, those that yield 20 gpm or more, represent less than 10 percent of all bedrock wells in Town. In Germantown, the highest yielding wells are clearly found in two zones (Figure 7). Each of these zones is closely associated with large fault sheets that are marked by mapped thrust faults. One of these zones is located in the vicinity of North Germantown. The other is located east of Cheviot. These zones in Germantown have produced 20 to 30 gpm to wells. Although these individual yields are not sufficient for a municipal source, it may be possible to obtain higher yields here using prospecting techniques such as fracture trace analyses and/or geophysics. Two to three wells in these zones could be sufficient the needs of a possible future municipal water system (depending upon the water demands).

The depth of bedrock wells in Germantown varies with the bedrock formation, topographic position, and the drilling method. Figure 8 is a map of bedrock well depths in Germantown based upon recent data from the NYSDEC. The method of drilling is a key determining factor in the final well depth. Well data from U.S. Geological Survey is on wells drilled prior to 1947. These wells were drilled prior to the widespread use of rotary drilling methods and likely were completed with the cable-tool method. The depth of these older wells range from a minimum of 62 feet to a maximum of 186 feet with a mean depth of 111 feet. In contrast, the depths of wells drilled since 2000 in Germantown range from 58 to 702 feet, averaging 360 feet. Approximately 98% of these wells were completed using rotary drilling methods.

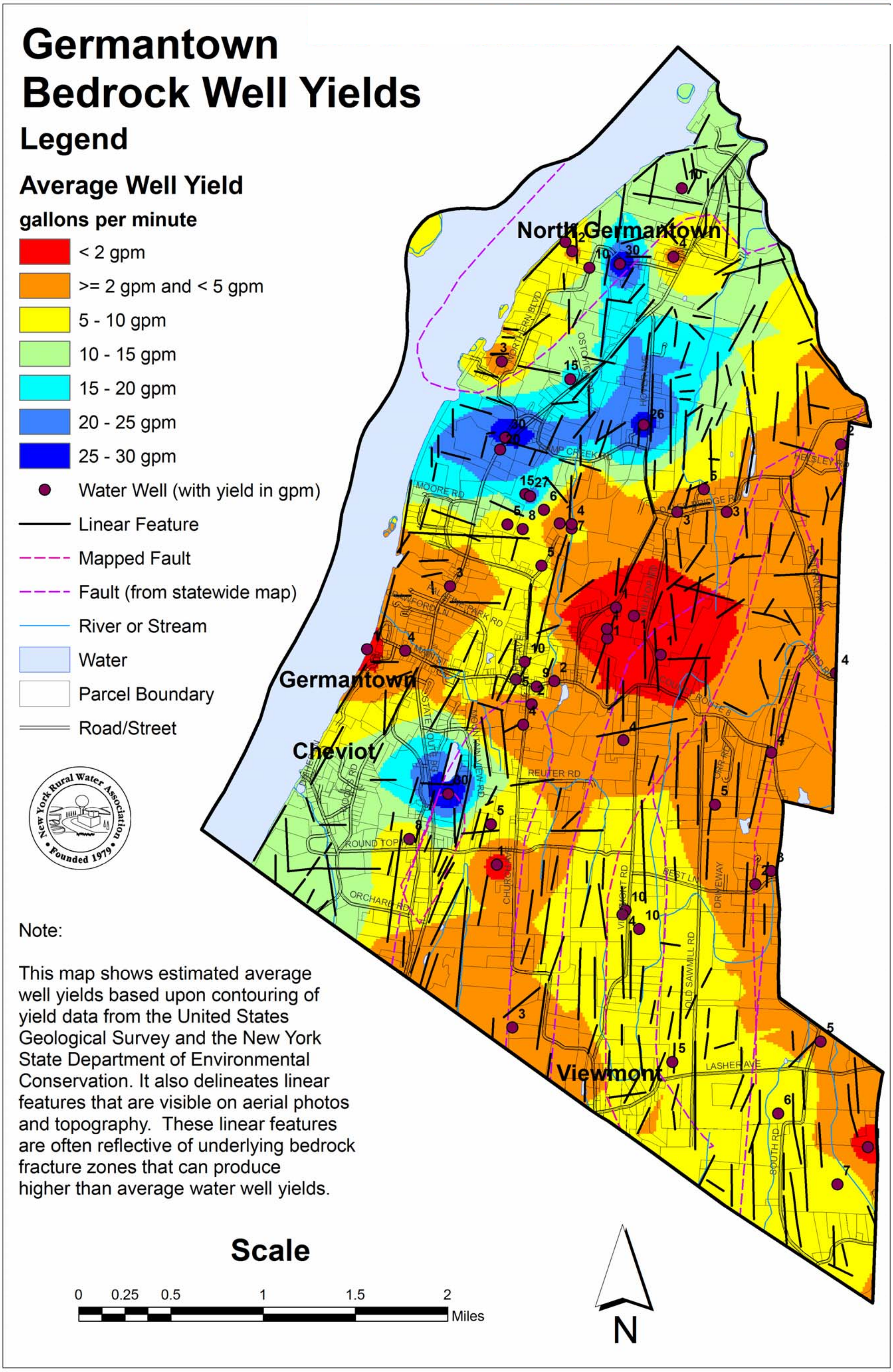


Figure 7. Estimated Bedrock Yields.

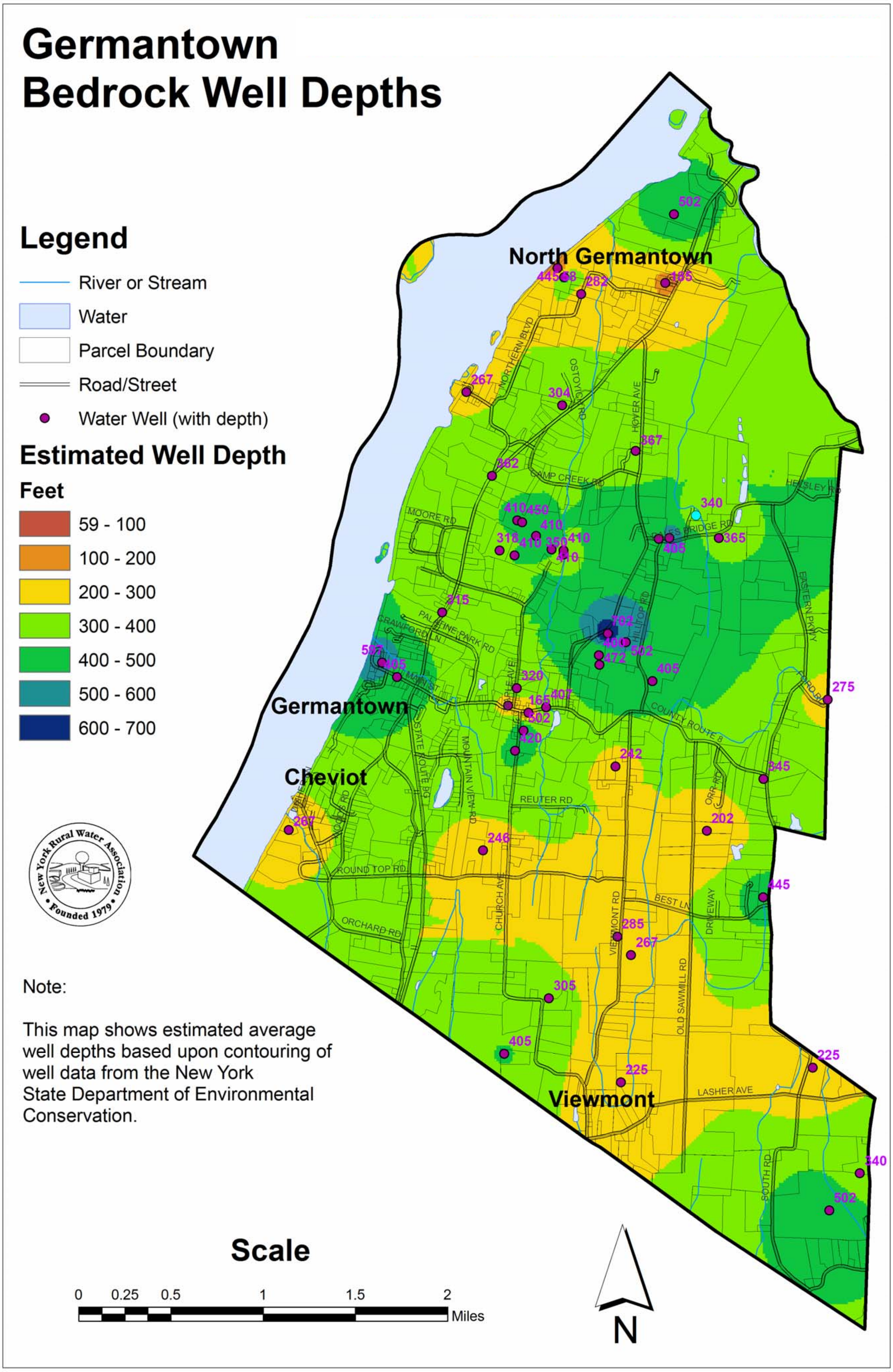


Figure 8. Estimated Bedrock Well Depths.

4.2 Unconsolidated Aquifer

The Town of Germantown is not blessed with an abundance of water-bearing unconsolidated aquifers. The only unconsolidated aquifer located within Town is located along the Roeliff Jansen Kill and the Hudson River beside Germantown's northern border (Figure 9). Unconsolidated deposits are capable of producing very high yields if wells are finished with a properly sized and developed screen. The unconsolidated aquifer depicted on Figure 8 is best described as a potential aquifer since no water well data exists here. Site specific testing would be necessary to determine if the glaciolacustrine sand and alluvium deposits have a suitable saturated thickness and texture. Any supply well located here would likely be under the direct influence of surface water. This is an undesirable water quality condition where there may be microscopic pathogens of a surface water origin present. Ground water that is under the direct influence of surface water should be filtered to eliminate these organisms.

5.0 GROUND WATER RECHARGE AND DISCHARGE

Ground water flows from recharge areas to discharge areas. Recharge areas are where ground water is being replenished and it is flowing downwards and away from the water table. Typically recharge areas represent 70 to 95 percent of a region (Freeze & Cherry, 1979). Conversely, in discharge areas, ground water flows upwards toward the water table and eventually is removed from the subsurface into surface water bodies. In an area of high topographic relief, much of the ground water moves in local flow systems. In local flow systems, ground water is recharged at a topographic high and discharged at the next local topographic low. Some deeper ground water in Town *may* be involved in regional flow systems.

5.1 Recharge

Most of the ground water in Germantown is ultimately recharged (replenished) through infiltration of rainfall or snow melt. Rates of ground water recharge vary widely based upon many factors, but the important variable is believed to be the surficial geologic material. Rates of shallow groundwater recharge in Germantown have been calculated by NYRWA based on base flow estimates and mean annual runoff in the region. These calculations are based upon the widely held assumption that long-term average natural groundwater recharge is equal to long-term average baseflow to streams. Recharge rate calculations are contained in Appendix A. Rates of annual groundwater recharge range from as much as approximately 13 inches per year in some surficial sand and gravel deposits to as little as 4 inches per year in areas of poorly permeable glaciolacustrine silt & clay sediments. Figure 10 is a map of estimated annual groundwater recharge rates.

5.2 Discharge

Ground water discharge areas are relatively low-lying areas where ground water is removed from the subsurface through evapotranspiration at the land surface or movement into surface water bodies. The water table is at or relatively near the land surface in discharge areas. One indicator of these wet conditions is what is commonly referred to as the Topographic Wetness Index (TWI). This parameter is a function of the topography and the slope of the landscape. A high

TWI indicates probable wet conditions and a likely discharge area. Figure 11 is a map of suspected ground water discharge areas based upon high wetness index values**.**

6.0 GROUNDWATER CONTAMINATION POTENTIAL

Ground water resources are susceptible to contamination from a variety of manmade sources. These include various industrial, commercial, residential, and agricultural uses and activities. Several of these potential sources of contamination are regulated by state agencies such as the New York State Department of Environmental Conservation (NYSDEC). Some others are not. Once contaminated, ground water is very difficult and costly to cleanup

6.1 Existing and Potential Sources of Contamination

Groundwater resources are susceptible to contamination from a variety of manmade sources. These include various so-called high-risk industrial, commercial, residential, and agricultural uses and activities (see Table 1). Most of these potential sources of groundwater contamination are regulated by county, state, and federal agencies.

Once contaminated, ground water is very difficult and costly to cleanup. There have been a number of petroleum and other chemical spills that have been investigated by the NYSDEC Spill Response Unit. The majority of these spills were found to not be of serious concern and their cases were closed. Some of these spills were investigated further and some cleanup activities were undertaken. Four spills have not been closed in the Town of Germantown (see Figure 6). These spills are either still being investigated or have not met cleanup standards. Petroleum contamination of ground water has occurred at the intersection of NYS Route 9G and Main Street. Here, several gasoline stations have historically existed.

As indicated previously, there are a number of different uses and activities that have the potential to contaminate ground water. These practices typically involve the handling, use, storage, and/or disposal of petroleum and other hazardous substances that are capable of contaminating ground water. The threat of groundwater contamination can be reduced to some extent through the use of environmentally-sound best management practices and/or structural methods.

Figure 6 is a map displaying potential groundwater contamination sources in Town of Germantown. Some of these potential sources (petroleum storage tanks, spills) are regulated by the NYSDEC. Others are not. A fairly high density of potential contaminant sources exist in and around the hamlet of Germantown. NYRWA used property classification codes from Columbia County real property data to identify land uses. Many homes within the hamlet of Germantown are connected to the Town’s sewer system. The rest of the Town’s residents outside of the hamlet rely upon on-site septic system. Some agricultural use remains in Town as well

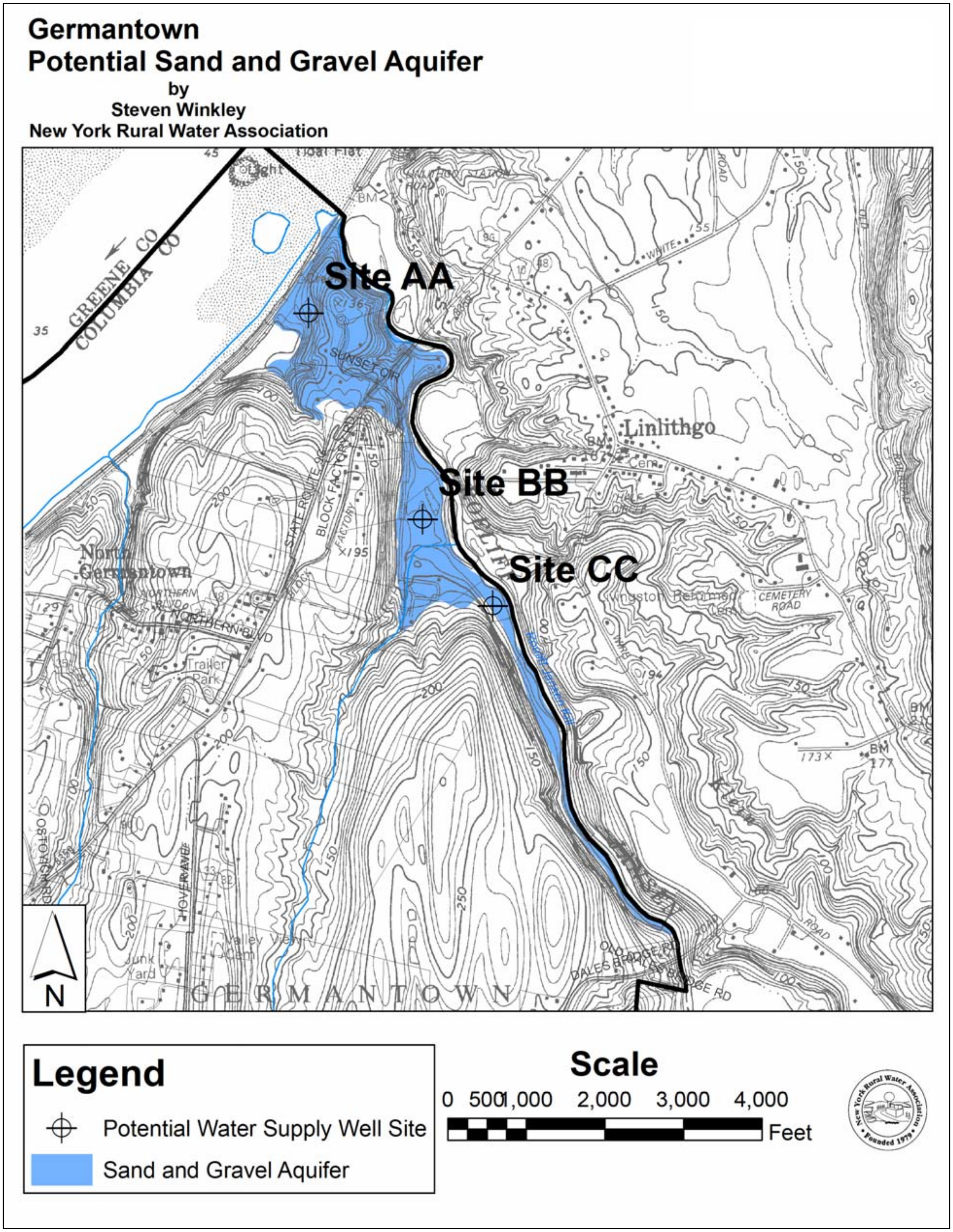


Figure 9. Potential Unconsolidated (Sand and Gravel) Aquifer.

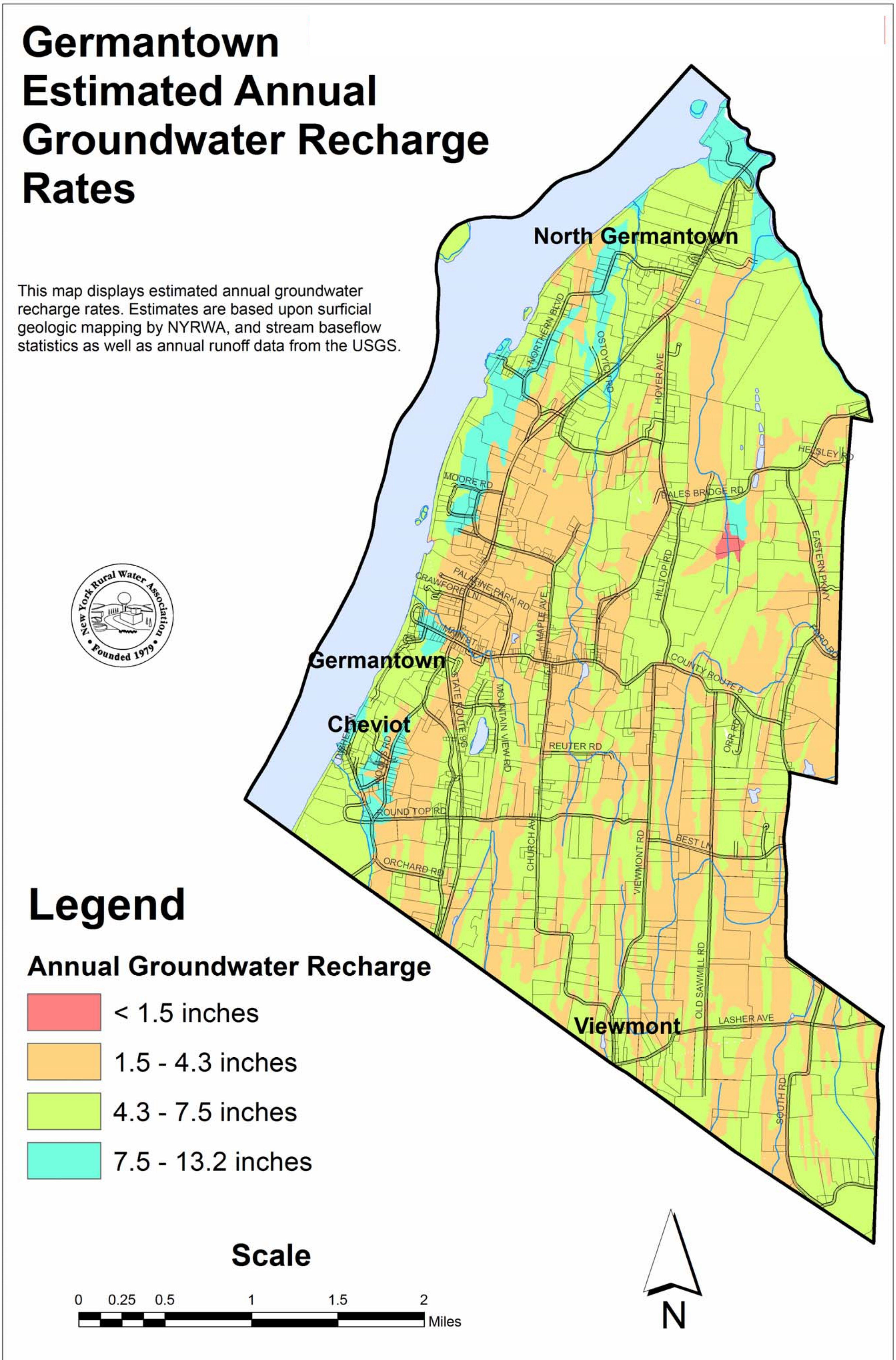


Figure 10. Estimated Annual Groundwater Recharge Rates.

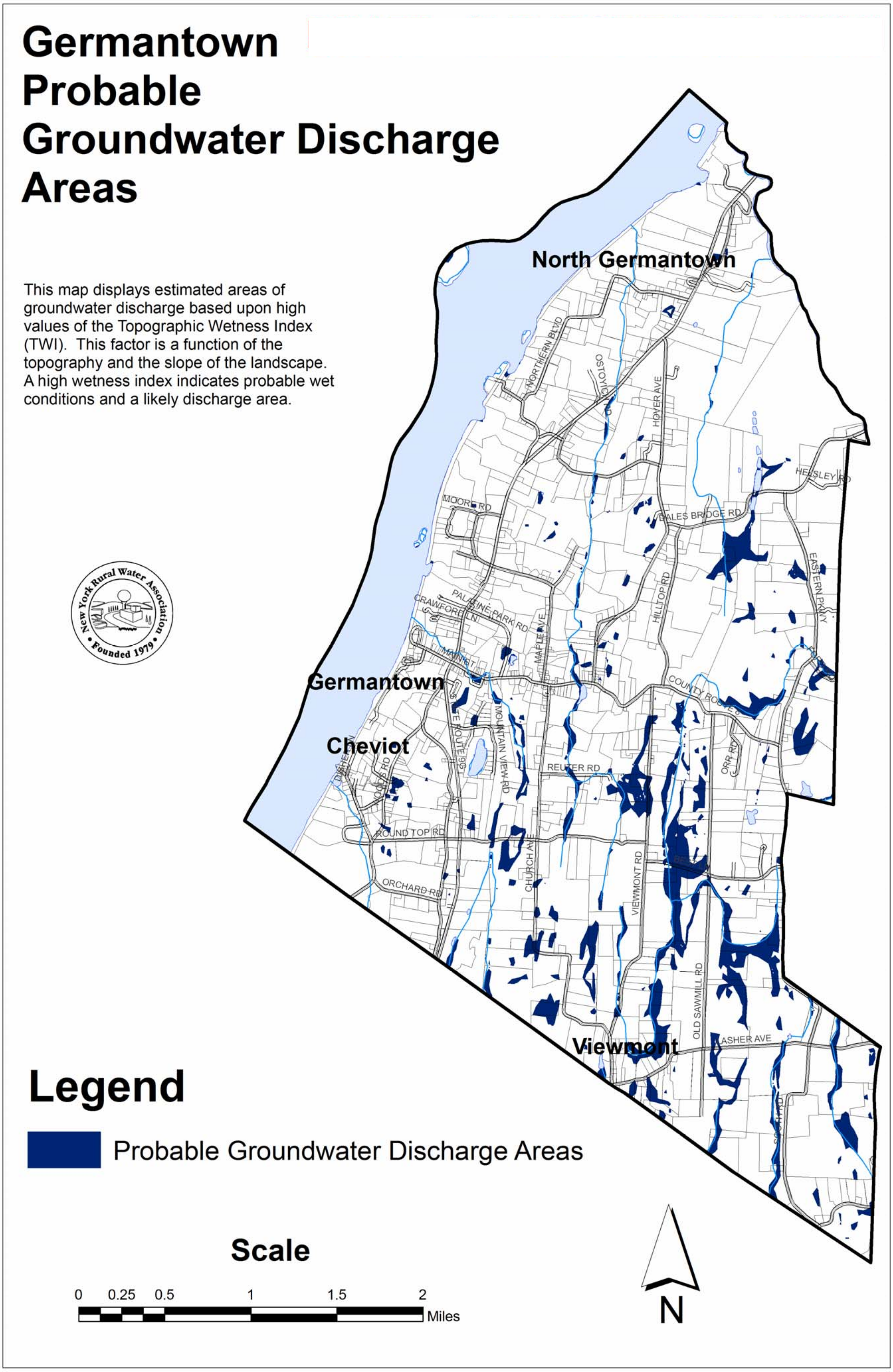


Figure 11. Suspected Groundwater Discharge Areas.

Risk Categories of Land Uses and Activities Affecting Ground Water Quality

High Risk (Frequently Prohibited in High Priority Water Supply Protection Areas)

___ Airport maintenance areas
___ Animal feedlots
___ Appliance/small engine repair shops
___ Asphalt/concrete/coal tar plants
___ Auto repair and body shops*
___ Boat service, repair and washing establishments
___ Beauty parlors/hairdressers
___ Business and industrial uses (excluding agriculture) which involve the onsite disposal of process wastes from operations
___ Car washes
___ Chemical/biological laboratory
___ Chemical manufacturing/industrial areas
___ Cleaning service (dry cleaning, laundromat, commercial laundry)*
___ Disposal of liquid or leachable waste except for properly designed commercial and residential onsite wastewater disposal systems and normal agricultural operations
___ Electroplaters (metal plating and finishing) and metal fabricators*
___ Fuel oil distributors
___ Furniture and wood stripping and refinishing*
___ Gasoline stations
___ Golf courses/parks/nurseries
___ Graveyards
___ Improperly constructed or abandoned wells (perched, confined aquifers)
___ Junkyards and salvage yards*
___ Landfills and dumps
___ Making the surface of more than 10% of any lot impervious
___ Mining operations
___ Medical services (including dental/vet)
___ Military installations
___ Motels/hotels
___ Municipal sewage treatment facilities with onsite disposal of primary or secondary effluent
___ Oil and gas drilling and production
___ Outdoor storage of road salt, or other de-icing materials, the application of road salt and the dumping of salt-laden snow*
___ Outdoor storage of pesticides or herbicides
___ Parking areas of over 50 spaces
___ Pesticide/herbicide stores
___ Petroleum product refining and manufacturing
___ Photo processors/printing establishments
___ RCRA hazardous materials TSDs
___ Sand and gravel extraction
___ Trucking or bus terminals
___ Underground storage and/or transmission of oil, gasoline or other petroleum products
___ Use of septic system cleaners which contain toxic chemicals (such as methylene chloride, and 1,1,1 trichloroethane)
___ Wood preserving and treating*

Table 1. High Risk Potential Sources of Contamination (from EPA, 1994)

6.2 Potential Future Development

Residential development does have the potential to affect the quantity and quality of available ground water resources. If improperly planned, development in sensitive hydrogeologic areas could conceivably lead to a diminishment of ground water supplies or an increased risk of contamination.

6.2.1 Predicting Growth Areas

In order to protect ground water resources from aspects of growth, it is necessary to try to predict where development may occur. First, an assumption is made that development will occur on land that is not now developed. A second assumption is made that development is not likely in some areas due to physical constraints. Open space are lands that are not intensively developed for residential, commercial, industrial or institutional use. NYRWA used a GIS and land classification data to identify open space areas in Germantown. The assumption was made that open space includes parcels that are vacant or agricultural. A resulting map showing various types of open space lands is presented as Figure 12.

Some areas are either not developable or are less likely to be developed due to certain site characteristics that are referred to as physical site development constraints. These constraints include: (1) proximity to wetlands, streams, ponds, lakes, and other surface waters; flood plain areas; (2) hydric soils; and (3) steep slopes.

Residential or commercial development would not likely occur within close proximity to wetlands and surface water bodies due to state or local regulations. For example, a setback of 50 feet is required from surface water bodies for certain components of onsite wastewater treatment systems. A wetlands permit is required for most development activities within 100 feet of a mapped NYSDEC-regulated wetland.

Areas located within flood hazard areas are not recommended for development and new construction is often prohibited. Hydric soils are soils that are sufficiently wet in their upper part to develop anaerobic conditions during the growing season. They are often used as an indicator of possible wetlands and are not very suitable for septic systems.

Steep slopes are problematic for new construction for a variety of reasons including surface erosion, creep and sudden slope failure, as well as septic system failure. Septic systems are generally not permitted on slopes greater than 15 percent.

Figure 13 is a map of physical site development constraints in the Town of Germantown area that was produced by NYRWA using a GIS.

Subtracting Figure 13 from Figure 12 yields a map of *potentially* developable open space areas. These areas are depicted on Figure 14. Note that on-site investigations are necessary to determine the actual feasible of site development in these areas.

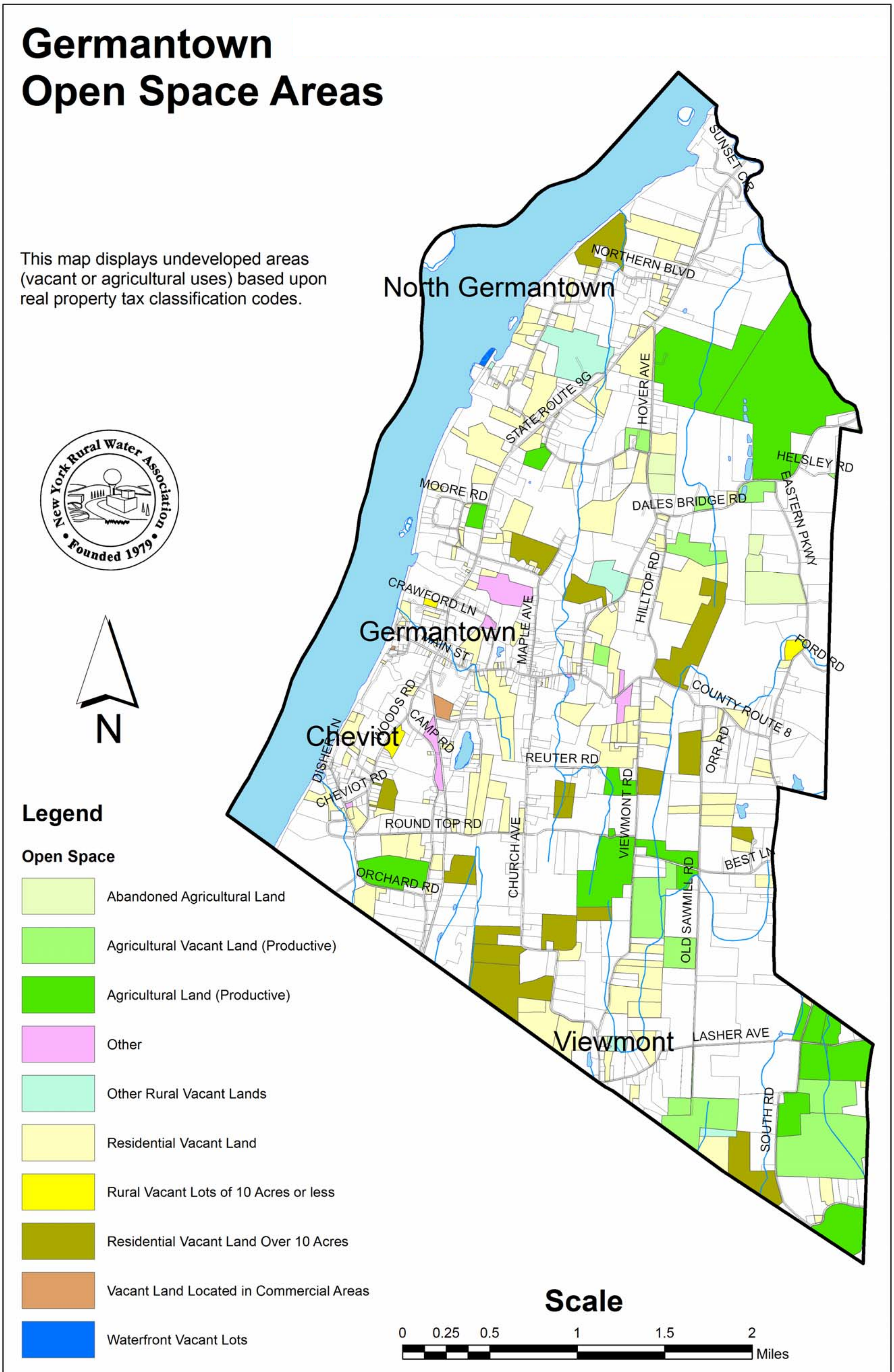


Figure 12. Open Space Areas.

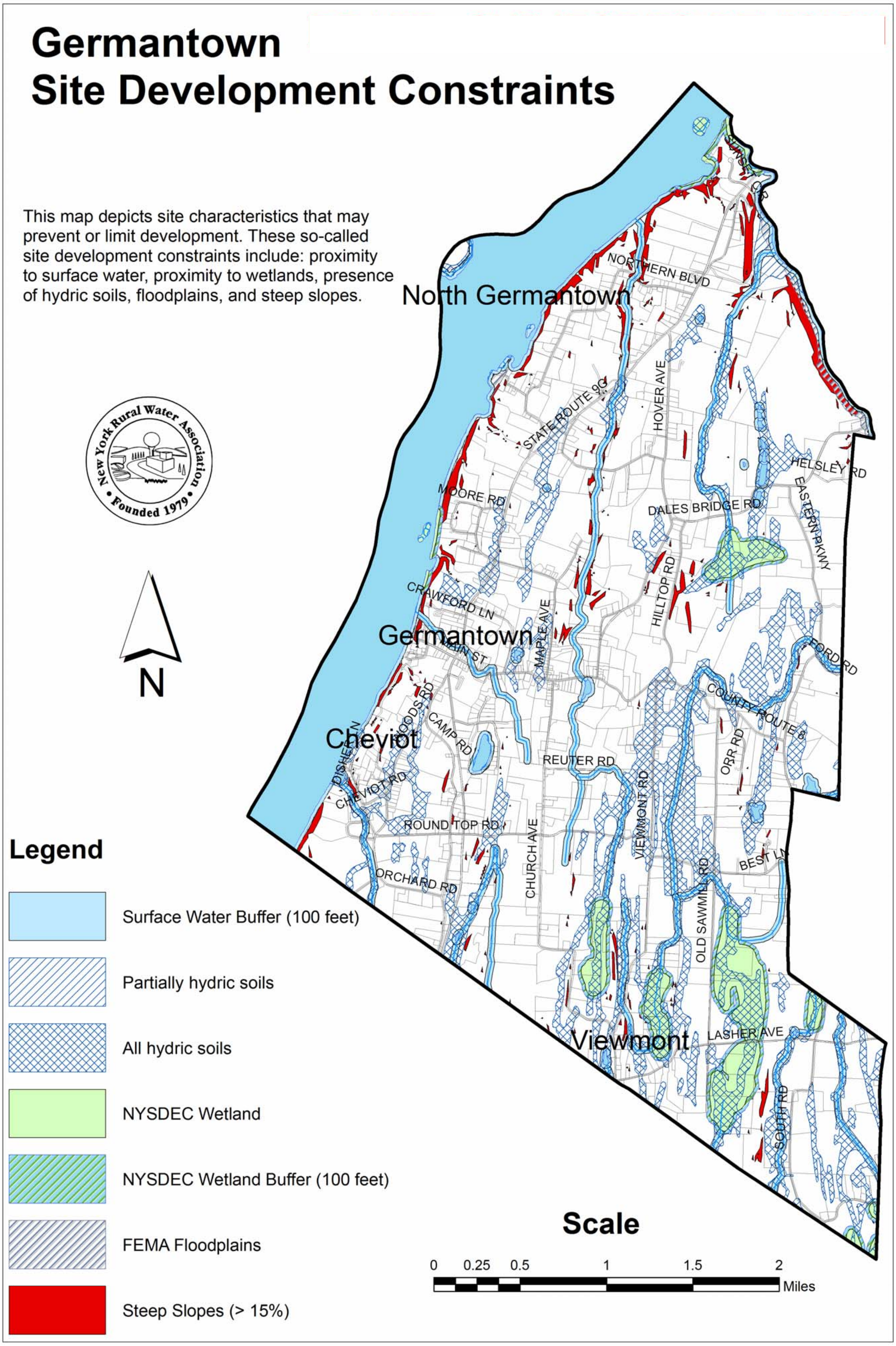


Figure 13. Site Development Constraints.

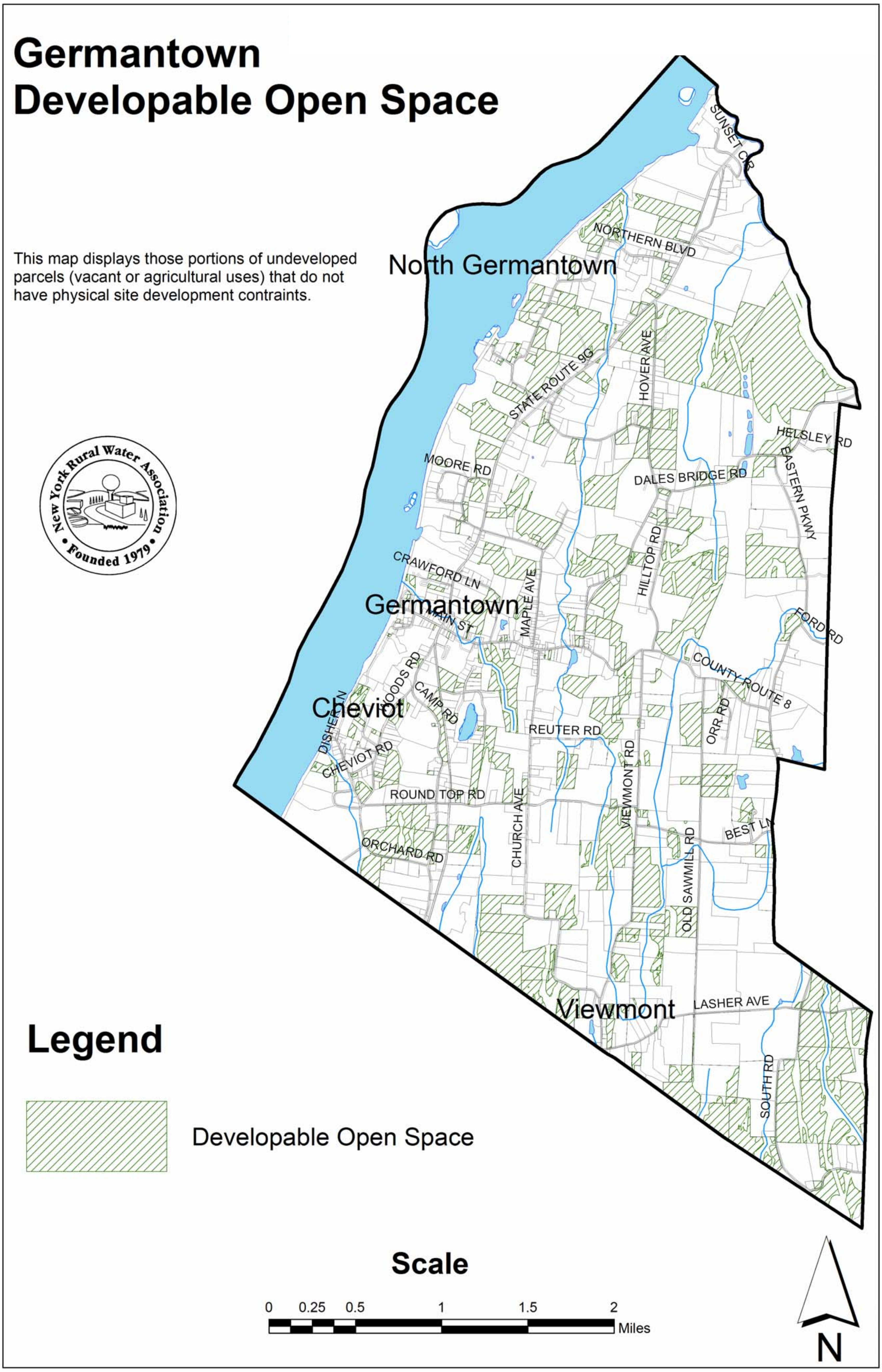


Figure 14. Potentially Developable Open Space Areas.

6.2.2 Ground Water Related Development Issues

Development involves a number of potential ground water resource issues. These issues involve: (1) water supply; 2) wastewater treatment; 3) impervious surfaces and storm water systems; and (4) improper waste disposal and spills.

Water Supply

Development in non-urbanized areas typically involves the use of onsite ground water for water supply. Sometimes a community water system is formed to serve a residential development. These systems may be privately or publicly owned. In this instance, one or two wells typically serve the needs of many homes. Community water systems are closely regulated by local county health departments and are managed by licensed water system operators. New community water systems are carefully planned and designed to minimize contamination potential. However, community water systems are expensive to install and operate.

Recent development in the Town of Germantown has chiefly involved the use of individual private wells. Compared to central water systems, individual wells are less expensive to install and their operation is not regulated. However, the location, construction, and testing of private water wells has recently been regulated by the New York State Department of Health in Appendix 5-B of 10 NYCRR Part 5. Table 2 lists the required minimum separation distances from potential contamination sources contained in the NYSDOH regulations for private wells.

The density and placement of individual water wells with respect to the ground water flow direction is also important. Adequate well spacing is necessary to sustain well yields. Due to the limited water-bearing characteristics of the overburden and bedrock in some areas of Germantown (see below), the density and spacing of water wells can be very important. Too many wells in some areas could lead to ground water depletion or deterioration of ground water quality. NYRWA has calculated estimated recharge areas that are necessary to safely supply a typical household in Germantown (see Appendix B) for various recharge rates. Calculated well recharge areas range from 0.3 to 0.9 acres. Wells should be placed such that their recharge area does not overlap with that portion of the lot where effluent from the wastewater disposal system is diluted. Ideally, wells should not be placed directly downgradient of disposal systems on adjacent lots as well.

For new residential construction, mortgage lending agencies often like the well system to sustain a flow rate of 5 gpm. In some areas of the Town of Germantown, it is difficult, if not impossible, to obtain an instantaneous well yield of 5 gpm (see Figure 7). Where yields of less than 5 gpm exist, larger diameter wells are sometimes drilled in order to increase available storage. Alternatively, a larger storage tank along with re-pumping at 5 gpm may need to be provided. Wells with yields of less than 2 gpm are generally not recommended for supply purposes.

Table 2: Required Minimum Separation Distances to Protect Water Wells From Contamination From Appendix 5-B of 10 NYCRR Part 5

Contaminant Source	Distance (Feet)[1]
Chemical storage sites not protected from the elements (e.g., salt and sand/salt storage)[2]	300
Landfill waste disposal area, or hazardous or radiological waste disposal area[2]	300
Land surface application or subsurface injection of effluent or digested sludge from a Municipal or public wastewater treatment facility	200
Land surface application or subsurface injection of septage waste	200
Land surface spreading or subsurface injection of liquid or solid manure [3]	200
Storage Areas for Manure piles [4]	200
Barnyard, silo, barn gutters and animal pens [5, 6]	100
Cesspools (i.e. pits with no septic tank pretreatment)	200
Wastewater treatment absorption systems located in coarse gravel or in the Direct path of drainage to a well	200
Fertilizer and/or pesticide mixing and/or clean up areas	150
Seepage pit (following septic tank) [5]	150
Underground single walled chemical or petroleum storage vessels	150
Absorption field or bed [5]	100
Contained chemical storage sites protected from the elements (e.g. salt and sand/salt storage within covered structures) [7]	100
Septic system components (non-watertight) [5]	100
Intermittent sand filter without a watertight liner [5]	100
Sanitary Privy pit [5]	100
Surface wastewater recharge absorption system constructed to discharge storm water from parking lots, roadways or driveways [5]	100
Cemeteries	100
Sanitary privy with a watertight vault	50
Septic tank, aerobic unit, watertight effluent line to distribution box	50
Sanitary sewer or combined sewer	50
Surface water recharge absorption system with no automotive-related Wastes (e.g., clear-water basin, clear-water dry well)	50
Stream, lake, watercourse, drainage ditch, or wetland	25
All known sources of contamination otherwise not shown above	100

Notes for Table:

1. The listed water well separation distances from contaminant sources shall be increased by 50% whenever aquifer water enters the water well at less than 50 feet below grade. If a 50% increase in separation distances can not be achieved, then the greatest possible increase in separation distance shall be provided with such additional measures as needed to prevent contamination.
2. Water wells shall not be located in a direct line of flow from these items, nor in any contaminant plume created by these items, except with such additional measures (e.g., sentinel groundwater monitoring, hydraulic containment, source water treatment) as needed to prevent contamination.
3. Based upon on-site evaluations of agricultural properties done per agricultural environmental management (AEM) or comprehensive nutrient management plan (CNMP) programs by a certified nutrient management planner or soil and water conservation district (SWCD) official, water wells may be located a minimum of 100 feet from areas subject to land spreading of manure.
4. Water wells may be located 100 feet from temporary (30 days or less) manure piles/staging areas that are controlled to preclude contamination of surface or groundwater or 100 feet from otherwise managed manure piles that are controlled pursuant to regulation in a manner that prevents contamination of surface or groundwater.
5. When these contamination sources are located in coarse gravel or are located upgrade and in the direct path of drainage to a water well, the water well shall be located at least 200 feet away from the closest part of these sources.
6. Animal pen does not include small pet shelters or kennels housing 3 or fewer adult pets.
7. Chemical storage sites as used in this entry do not include properly maintained storage areas of chemicals used for water treatment or areas of household quantities of commonly used domestic chemicals.

Wastewater Treatment

Excessive nitrate loading of ground water can occur if there is too high a density of septic systems in a given area. Thus, it is vital to locate septic systems on large enough lots to minimize excess loading. A critical area, referred to as the effluent dilution area, is the minimum area of recharge to dilute resultant nitrate-nitrogen concentration to 5 mg/l (ppm), one-half of the maximum contaminant level (MCL) for drinking water. NYRWA has calculated required effluent dilution areas based upon recharge rates in Germantown (see Appendix B). Effluent dilution areas should be 2.3 acres to 7 acres in size depending upon the groundwater recharge rate in the area. Note that the sum of the necessary effluent dilution area and the lot well's recharge area is the recommended minimum lot size. In Germantown, the recommended minimum lot size ranges from 3 to 8 acres (see Figure 15).

Impervious Surfaces and Storm Sewer Systems

Development inevitably increases the amount of impervious surfaces in an area. These are roofs, roads, driveways, parking lots, pools, and other surfaces that do not allow precipitation to infiltrate into the soil and reach the water table. Impervious surfaces result in water running off the land surface, directly into wetlands, lakes, and streams. As overland flow and stormwater runoff increases, so does the magnitude and frequency of flooding. Imperviousness can significantly decrease ground water recharge. This in turn reduces the amount of ground water available to local wells, and reduces stream baseflow.

Also, as the volume of stormwater increases, pollutants picked up by the water have less time to settle out. These include nutrients such as phosphorus and nitrogen, hazardous substances and chemicals from automobiles and other sources, sediment from construction activities, and pesticides, herbicides and fertilizers. The result is that these pollutants are more likely to contaminant surface waters and ground water.

Recent research indicates that ground water resources and streams can be considered stressed once the impervious coverage in an area exceeds a threshold of 10 to 15 percent. Table 3 below includes typical values of impervious coverage for residential development on various lot sizes as estimated by the U.S. Dept. of Agriculture (1986).

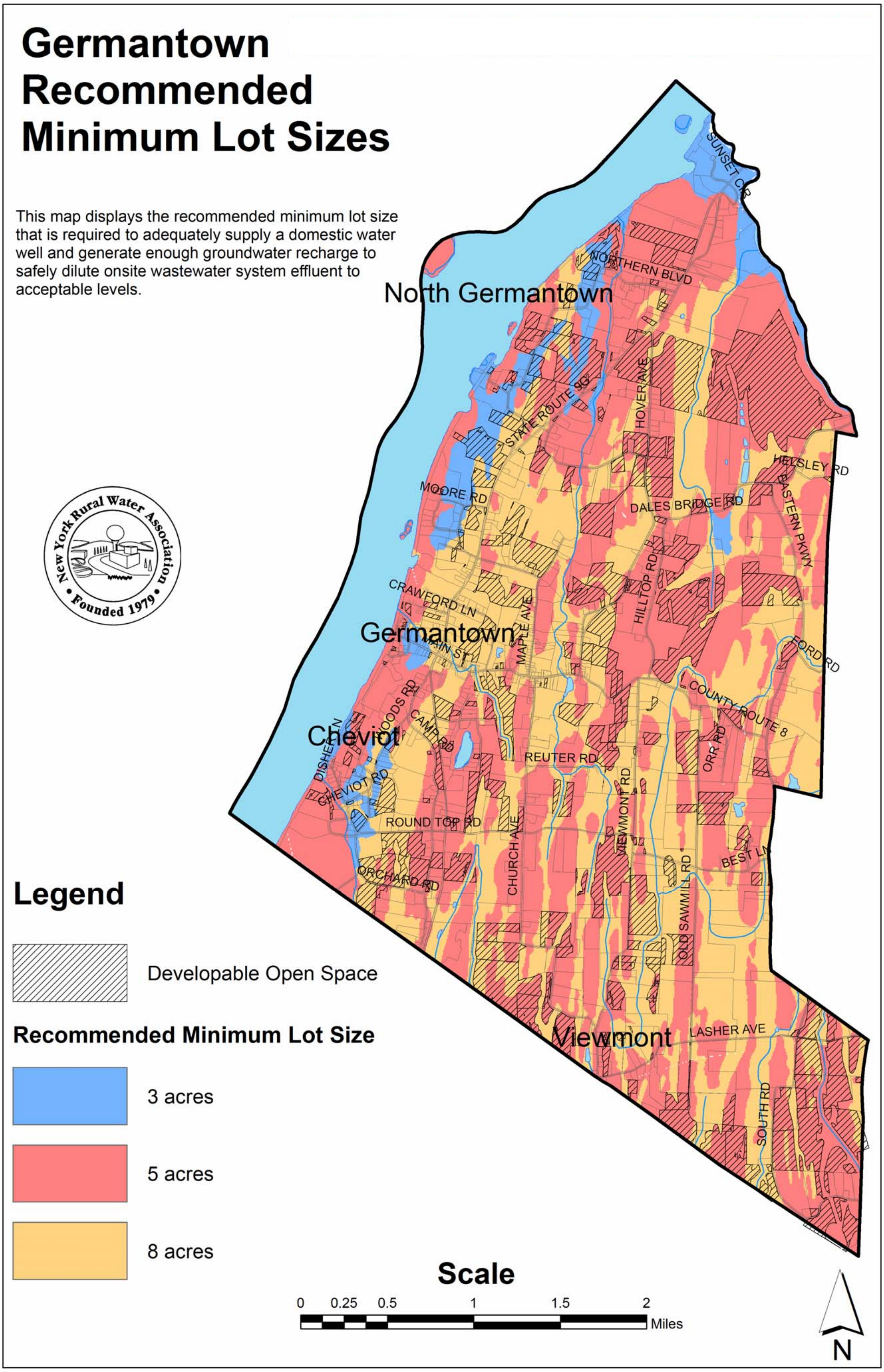


Figure 15. Recommended Minimum Lot Sizes.

Parcel Size (acres)	Estimated Impervious Cover (percent)
1/8	65%
1/4	38%
1/2	25%
1	20%
2	12%
3	10%
4	8%

Table 3. Lot size and Impervious Cover Relationship (From U.S. Dept. of Agriculture, 1986)

Historically, most storm water sewer systems discharged water to surface waters. This diversion of water reduces ground water recharge rates. Today, infiltration of storm water to ground water is often encouraged through a number of storm water management practices.

Improper Waste Disposal and Spills

As an area becomes developed, there is an increased likelihood that contamination could result from either improper waste disposals or accidental spills. Dumping of waste oil, paint wastes, antifreeze, and other substances on the ground or down the drain can harm ground water quality. It does not take very much of a substance to contaminate a large volume of ground water. It is not surprising therefore that the source of contaminants found in ground water often cannot be identified. Spills of fuel oil and other substances can sometimes be the result of equipment failure such as a tank failure. Other times the cause is human error such as overfilling a tank, etc.

7.0 GROUNDWATER PROTECTION STRATEGIES

It is important to develop and implement effective groundwater protection measures in order to protect water resources and encourage future development where and how it is best suited. There are number of groundwater protection measures that can be chosen. Some of these are regulatory in nature. Others are non-regulatory. The Town of Germantown must determine which measures are acceptable given local socioeconomic and political conditions.

7.1 Open Space Planning

As growth continues in the Hudson River Valley, the Town of Germantown should consider developing an Open Space Preservation Plan. This plan could inventory open space resources and recommend short-term and long-term actions to initiate open space preservation. In order to accomplish this, Germantown could create a local conservation advisory council/conservation board. Protection of vulnerable open space areas is critical to groundwater resource protection in the Town of Germantown. This is especially true given the limited nature of productive groundwater resources. Areas that should be planned for open space protection include developable areas within the higher-yielding bedrock zones (Figure 7) and the potential sand and gravel aquifer (Figure 9).

In some instances, a community may wish to purchase the full interest in a particular parcel(s) in order to conserve its natural or scenic resources. A more common method of land preservation is the purchase of an interest in the land, called a conservation easement. The easement places deed restrictions on property uses to assure that the property is not developed in an inappropriate manner. Typical easements permit agriculture, forestry, recreation, etc. but restrict or prohibit industrial, commercial, and residential development. Communities may purchase conservation easements or individuals can donate the easements and thus qualify for possible tax advantages. Alternatively, non-profit land trusts may purchase conservation easements or work with local governments to facilitate conservation easements.

7.2 Land Use Regulations

There are three types of land use regulations that can be used to protect ground water and other water resources. These include subdivision regulations, site plan review, and zoning.

7.2.1 Subdivision Regulations

Subdivision regulations relate to how land is to be divided into lots and what improvements such as streets, lighting, fire protection, utilities, drainage, and parks are made to service the lots. In Germantown, the Town has subdivision regulations. The Planning Board of the Town of Germantown has the power and authority to approve, modify and disapprove the plan of subdivision. This involves review of the proposed layout of lots, roads, water supply, drainage, sewerage and other needed improvements and utilities, open space for parks and playgrounds, etc.

NYRWA recommends that subdivision regulations in Germantown should be amended to optimize protection of ground water resources. The following elements could be included in plats and documents for approval:

- Location of any existing wells onsite and other proposed lot wells in relation to: local topography, lot lines, roads, on-site sewage system components or sewer lines, petroleum storage tanks, surface water and other drainage features, stormwater conveyance systems, and other applicable features.
- Copies of New York State Department of Environmental Conservation Well Completion Reports for completed well(s) (including the well log and pump test data).
- Any and all water quality testing results.
- Proposed individual water supply system details such as pumps, storage, treatment, controls, etc.

- A completed hydrogeological study, if required.

Such details should be in the plats and documents for final approval as well.

A hydrogeological study could be required for any new subdivision involving ten (10) or more lots that relies upon either on-site ground water withdrawals and/or on-site sewage disposal. A hydrogeological study is also recommended for any new subdivision involving five (5) or more lots that relies upon on-site ground water withdrawals and overlies an area averaging less than 5 gpm (see Figure 7). Proposed requirements for a hydrogeological study are indicated in Appendix C.

Finally, a new section on subdivision design standards should be included. This section could include the following:

A. Well locations. Existing and proposed wells are located at minimum separation distances from on-site and off-site potential sources of contamination as specified in Appendix 5-B of 10 NYCRR Part 5.

B. Supply suitability. A representative number of well(s) indicate that the available quantity and quality of on-site groundwater resources are suitable for household purposes.

C. Adverse impacts. For proposed subdivisions requiring a hydrogeological study, the determination has made that the subdivision avoids adverse impacts to existing or future groundwater users and/or surface waters within 1,500 feet of the subdivision. If adverse impacts cannot be avoided, the applicant must provide adequate mitigation of such impacts.

Within the definitions section of the subdivision regulations, adverse impacts should be defined. An adverse impact to ground water can be defined as any reductions in ground water levels or changes in ground water quality that limit the ability of a ground water user to withdraw ground water. An adverse impact to surface water would be any reductions in the level of flow or water quality needed for beneficial uses such as protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, cultural and aesthetic values, drinking water supply, agriculture, electric power generation, commercial, and industrial uses.

Germantown’s subdivision regulations can also be rewritten to encourage the use of so-called conservation subdivisions. The Town of Marbletown in Ulster County has produced local laws dealing with conservation subdivisions. A conservation subdivision is essentially a cluster-type development that is planned around the open space protection of conservation areas. These conservation areas can include areas that are regulated such as wetlands and floodplains as well as other elements such as steep slopes, mature woodlands, prime farmland, meadows, wildlife habitats, stream corridors, historic and archeological sites, scenic views, and of course groundwater recharge areas.

Conservation subdivisions also use the similar principles of low-impact development and better site design. In the case of the ground water, the guiding design standard is to maintain or replicate the predevelopment hydrologic functions of storage, infiltration, and ground water recharge. This can be done by using stormwater retention and detention areas, reducing impervious surfaces, lengthening flow paths and runoff time, and preserving environmentally sensitive site features.

Low-impact development and better site design are primarily stormwater management concepts. Wastewater management is also a very important consideration. On-site septic systems recharge ground water. Properly located, installed, and operated on-site septic systems should be encouraged in order to return water to the subsurface. Sewers not only export wastewater away that can be recharged, they also export ground water and storm water as well since most sewers are prone to inflow from these sources.

Conservation subdivisions do pose a concern with respect to onsite wastewater disposal. By clustering homes on smaller lots, there is the possibility that the density of individual disposal systems will lead to excess nitrate loading. If individual disposal systems are planned, lot sizes must be appropriately sized to prevent loading. Alternatively, a small on-site centralized wastewater disposal facility could be constructed for the subdivision as long as it is carefully located with respect to ground water and surface water.

7.2.2 Site Plan Review

Site plan review is a local regulatory process that involves municipal review and approval of how development is to occur on a single parcel of land. In this way, site plan review differs substantially from subdivision regulations. Site plan review does not prohibit certain land uses. However, it does regulate how development will take place by specifying the arrangement, layout and design of the proposed use.

NYRWA recommends that the following site plan elements are included:

- The proposed means of storage, distribution, use, treatment, and/or disposal of wastewater, other wastes, chemicals, etc.
- The proposed means of water supply, including if applicable an estimate of the total daily groundwater withdrawal rate;
- The location(s) of all public water systems and other groundwater users within 1,500 feet of the proposed development boundaries;
- A list of all petroleum, chemicals, pesticides, fuels and other hazardous substances/wastes to be used, generated, stored, or disposed of on the premises;
- A description of the pollution control measures proposed to prevent ground water or surface water contamination; and
- A statement as to the degree of threat to water quality and quantity that could result if the control measures failed.

NYRWA believes that submittal of a site plan *and* a hydrogeological study should be required for *any* proposed project in Germantown that has projected on-site groundwater withdrawals and/or on-site sewage disposal flows potentially equal to or exceeding an average of two thousand (2,000) gallons per day (gpd). This amount of flow would be during any single thirty (30)-day period. These types of projects could include, but are not limited to, recreational developments (golf courses, water theme parks, etc.), multi-family housing (apartments, condominiums, townhouses, etc.), industrial, or commercial developments. Proposed requirements for a hydrogeological study are indicated in Appendix C.

The basis and standards for approval of a site plan could include the following additional criteria:

- The proposed use has an adequate water supply in terms of quantity and quality to meet specified needs.

- The proposed use does not adversely impact existing or future groundwater users as well as surface waters within 1,500 feet of the site development boundary. If adverse impacts cannot be avoided, the applicant must provide adequate mitigation of such impacts.

An adverse impact to ground water could be defined similar that proposed for the subdivision regulations (see above).

7.2.3 Zoning

Zoning regulates land uses, the density of land uses, and the siting of development. For those communities with zoning, like Germantown, it can prove to be an effective means of water resource protection. There are a number of zoning techniques that are applicable to groundwater protection. One of these techniques is minimum lot size. As discussed before, an individual lot must be sufficiently large to supply on-site groundwater needs and adequately dilute effluent introduced from the site's septic system. NYRWA has calculated minimum lot sizes based upon groundwater recharge rates in Germantown. These calculations are found in Appendix B. NYRWA recommends that minimum lot size for on-site sewer *and* wells range from 3 to 5 acres and possibly as much as 8 acres in some areas of limited recharge (see Figure 15).

Perhaps the most widely accepted zoning technique for water resource protection involves overlay zoning. Overlay zoning creates a set of regulations for a given area that are in addition to the regulations in the standard "underlying" zoning districts. The area that is covered by overlay zoning depends upon the particular resource to be protected. Examples of overlay zoning are for waterfront areas, flood plains, historic areas, steep slopes, and sensitive environmental areas such as wellhead protection areas, watersheds, and groundwater recharge areas. Overlay zoning regulations frequently define what additional uses are prohibited, what the bulk and area regulations exist in the overlay zone, and what design standards apply.

It is proposed by NYRWA that the Town of Germantown develop and implement a Groundwater Protection Overlay District. This overlay district could include the higher-yielding bedrock zones and the unconsolidated aquifer.

7.3 Environmental Review

In New York, all state and local government agencies are required by the State Environmental Quality Review Act (SEQR) to consider environmental impacts prior to making decisions to approve, fund, or directly undertake an action. Types of decisions or actions that are subject to SEQR include approval or direct development of physical projects, planning activities that require a decision, and adoption of rules, regulations, procedures and policies. Note that so-called Type II actions do not require environmental review because they either do not significantly impact the environment or are specifically precluded from environmental review under SEQR. However, all other so-called Type I or Unlisted Actions do require a determination of significance. If an action is determined to have potentially significant adverse environmental impacts, an Environmental Impact Statement (EIS) is required.

One way to insure that agencies take an area of critical environmental importance into account when making discretionary decisions is for a local municipality to designate a specific geographic area within its boundaries as a critical environmental area (CEA) under SEQR. Aquifer, watersheds, wetlands, etc. would meet the SEQR criteria for a CEA. The consequence of designating a CEA is that all government agencies (local or state) must consider the potential impact of any Type I or Unlisted Action on the environmental characteristics of the CEA when determining the significance of a project.

It is recommended that the Town of Germantown name the Groundwater Protection Overlay District as a critical environmental area. In this way, potential impacts on water supplies and the environment can be adequately addressed.

7.4 Education

Public education can be an excellent non-regulatory tool to minimize potential contamination. There are several instances where education may be effective. These include:

- Educating homeowners on proper operation and maintenance of onsite wastewater treatment systems and wells;
- Encouraging the use of water saving devices within homes;
- Promoting natural landscaping and other lower demand vegetation;
- Educating homeowners on proper fertilizer/pesticide application rates and practices; and
- Supporting proper waste disposal (i.e. recycling).

7.5 Future Planning

The number of potential sources of contamination and the poor yield of most of the local bedrock formations does raise the possibility of future development of a municipal water supply system to service that area known as the hamlet of Germantown (Figure 10). The most promising areas to service this area is the unconsolidated aquifer and the two higher-yielding bedrock zones. A public water supply site must meet requirements set forth by the NYSDOH. These include ownership/control of 200 feet and distance from potential sources of contamination. To reduce the possibility of flooding and direct surface water influence, a setback distance of 200 feet from surface water is often taken. Using these and other criteria, NYRWA has identified a number of potential test drilling sites. These sites would have to specifically tested in order to determine their suitability for water supply purposes. Three unconsolidated aquifer sites are located on Figure 9. A total of 11 bedrock sites are shown on Figure 16.

Unfortunately, emergency situations affecting ground water do sometimes occur. One conceivable scenario involves petroleum/hazardous material spills and/or the discovery of contamination. As indicated before in this plan, spills have occurred in the Town of Germantown. With the NYS Route 9G corridor in the Town of Germantown area, the potential exists for accidents to occur.

Under state law, all petroleum and most hazardous material spills must be reported to the DEC Hotline (1-800-457-7362). NYSDEC then informs other response agencies such as the local fire department if the spill poses a potential explosion and/or fire hazard and the health department if a drinking water supply is threatened as result of a spill. However, in most instances, the local municipality is not required to be notified. Nevertheless, it is important that the Town be notified if a spill is discovered.

Another emergency situation involving ground water is drought. Here in New York State we on average have ample precipitation. However, there are variations in weather patterns that result in periods of drier weather. Based upon data from the National Climatic Data Center, New York State regularly experiences moderate drought conditions every 2 to 5 years. These moderate droughts typically last for a few months. Of much more concern is the fact that we also experience severe to extreme droughts every 10 to 20 years. These can last nearly a year to over two years.

During these periods of severe to extreme drought, many wells with marginal yields may fail. The Town of Germantown may wish to work with local water suppliers to have a plan in place in order to assist households or water systems in such difficulty.

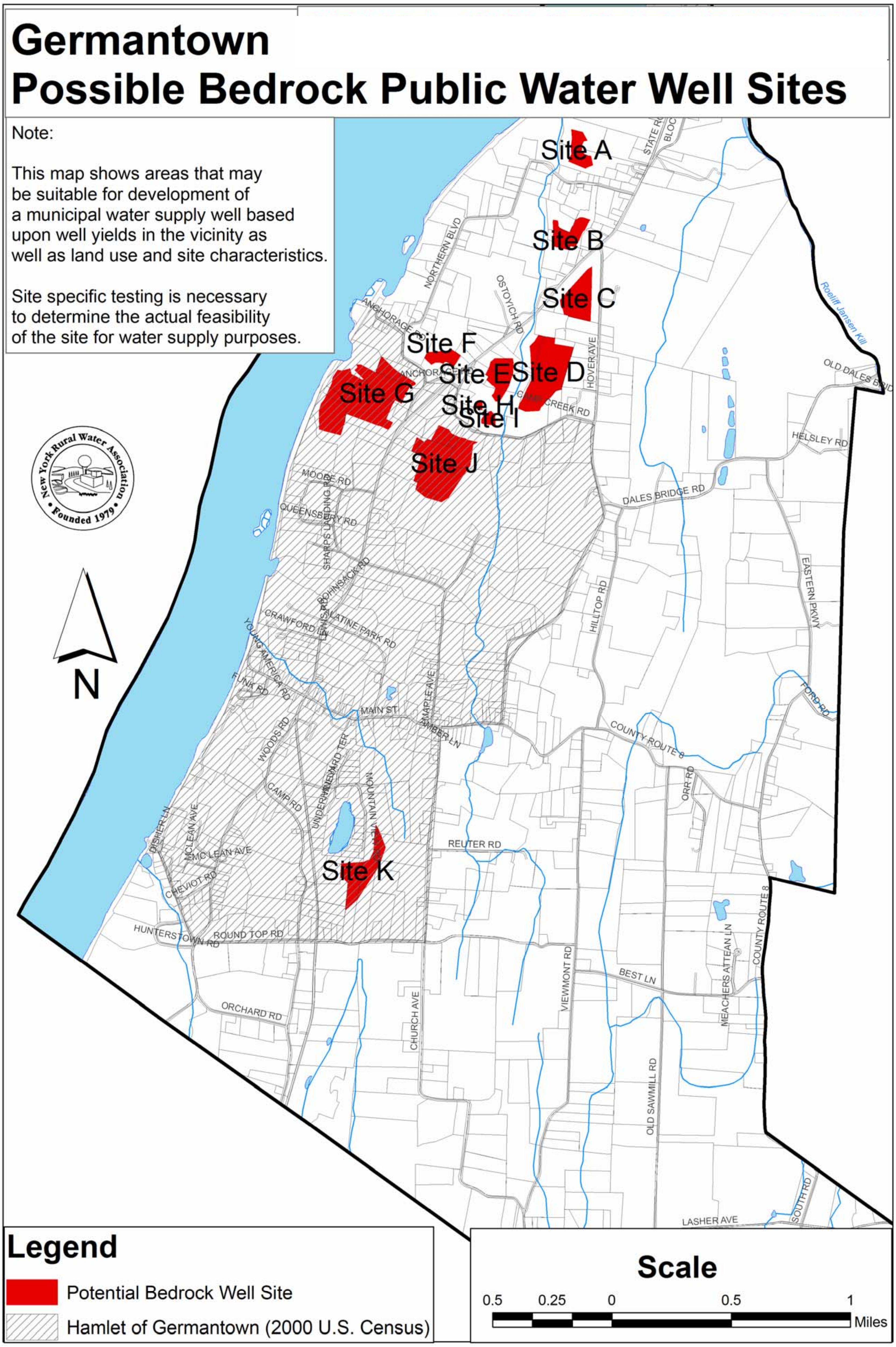


Figure 16. Potential Bedrock Public Water Supply Well Sites.

APPENDIX A

RECHARGE RATE CALCULATIONS

Groundwater Recharge Estimates
Town of Germantown, NY

Rates of shallow groundwater recharge in Germantown have been estimated by NYRWA based on base flow estimates and mean annual runoff in the region. Base flow is the component of stream flow that can be attributed to groundwater discharge into streams. The commonly-held assumption is that water that discharges to a stream as base flow originated as local shallow groundwater recharge. The United States Geological Survey (USGS) has calculated a variable known as the base flow index (BFI) for the watersheds of each of its stream gages. BFI is the ratio of base flow to total flow, and values were computed using an automated hydrograph separation computer program called the BFI program. BFI values for current and historical USGS stream gages in the conterminous U.S. are available from Wolock (2003a).

Working in the Great Lakes Basin, Neff et al. (2005) developed an empirical relation between measured base flow characteristics at gaging stations and the surficial geologic materials in the surrounding drainage area. In this study, a value of BFI was assigned to each surficial geologic material. The BFI for the gage watershed was calculated by the following equation taken from Neff et al. (2005):

$$y_{g,i} = \sum_j A_{g,i,j}\, x_{g,j} ,$$

where:

$y_{g,i}$ is the value of BFI for watershed i that results because of geological factors,
$A_{g,i,j}$ is proportion of geology class j within watershed i, expressed as a decimal between 0 and 1, and
$x_{g,j}$ represents ground-water discharge to the stream and is the value of BFI assigned to geology class j.

The value of BFI for each different surficial geologic material, x_{gj}, is indicated below from Neff et al. (2005):

Table 1. Values of $x_{g,j}$, the value of BFI assigned to geologic class j, used in equations 1 and 2 to calculate base-flow index used in this study.

Surficial-Geologic Material	$x_{g,j}$
Bedrock	0.78
Coarse-textured sediments	.89
Fine-textured sediments	.25
Till	.52
Organic sediments	.09

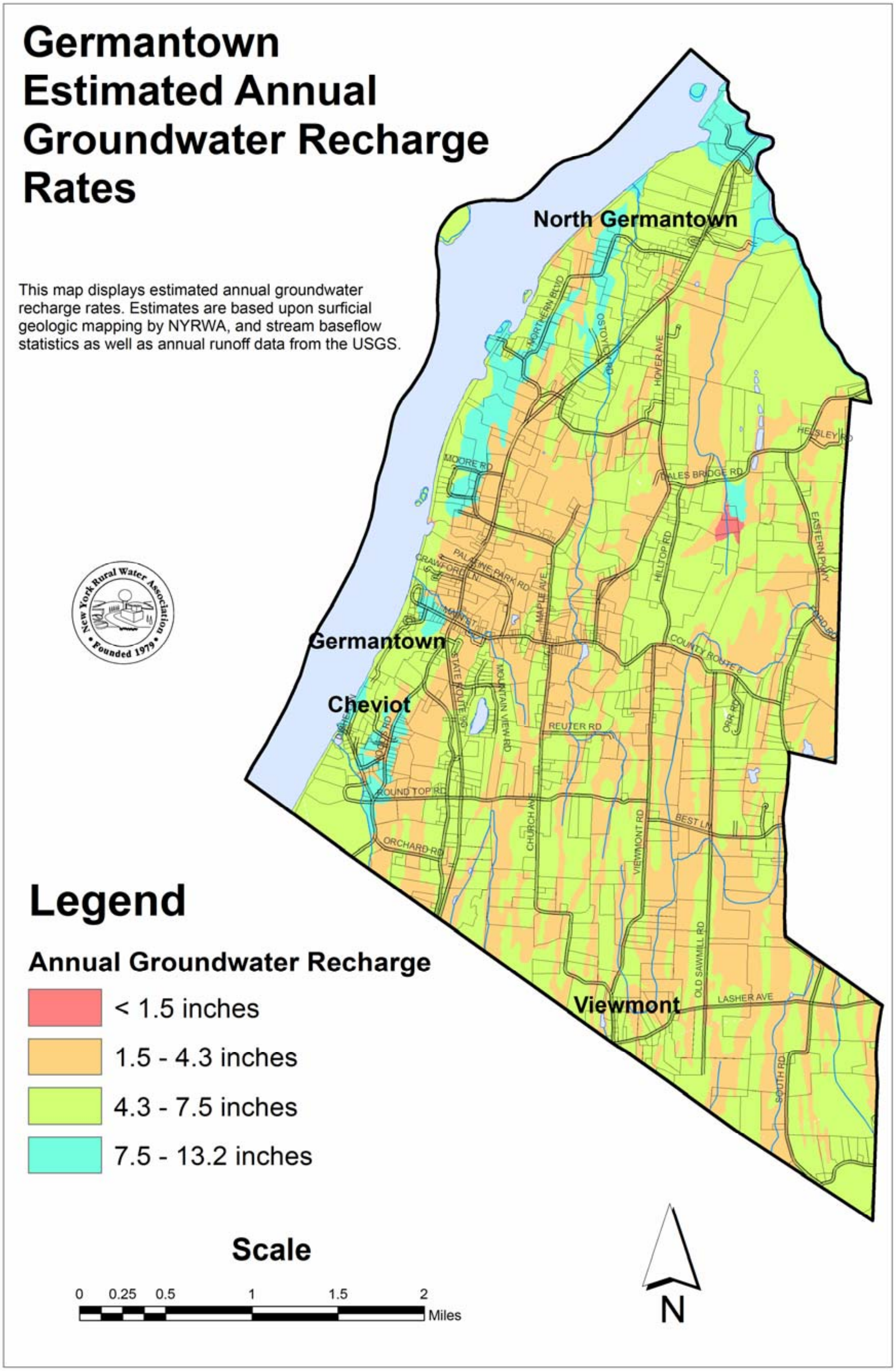
The surficial geologic materials for the Neff et al. (2005) study were taken from a 1:1,000,000-scale map of Quaternary deposits developed by Soller (1993) and digitized as Soller and Packard (1998). To test the BFI method, NYRWA initially used the values of x_{gj} from Neff et al. (2005) for the Soller and Packard (1998) mapping for six adjacent watersheds containing similar geologic and topographic settings. Through iterative methods, the following mean values of x_{gj} for found:

Surficial Material	**Geometric Mean x_{gj}**
Bedrock & Till	0.43
Coarse-textured sediments	.78
Fine-textured sediments	.25

Note that due to the observed variability of the surficial mapping unit for shallow bedrock, areas underlain by till and shallow bedrock were combined. The values of x_{gj} closely corresponded to those of Neff et al. (2005). The smaller value of x_{gj} for bedrock & till compared with the findings of Neff et al. (2005) is likely due to the lower permeability of local shale bedrock, as compared with the largely fractured crystalline bedrock, limestone, and sandstone found in the Great Lakes Basin.

Mean annual groundwater recharge can be calculated by multiplying a grid of local base flow index (BFI) values by a grid of mean annual runoff values. This approach is consistent with that of Wolock (2003b) to estimate mean annual natural groundwater recharge. The approach assumes that: (1) long-term average natural groundwater recharge is equal to long-term average natural ground-water discharge to streams, and (2) the BFI reasonably represents, over the long term, the percentage of natural groundwater discharge in streamflow. NYRWA constructed a grid of BFI values in Germantown using the detailed surficial geology dataset that was derived by NYRWA for the Town. A grid spacing of 10 meters was utilized. Note that in Germantown, coarse-grained stratified sediments were assumed to include alluvium and glaciolacustrine sand surficial units. Fine-grained stratified sediments were taken to include the glaciolacustrine silt & clay surficial unit. Mean annual runoff is long-term average stream flow expressed on a per-unit-area basis. A USGS GIS dataset by Cohen and Randall (1998) was used to define a grid of mean annual runoff across the Town. Note that annual runoff ranges from 16 inch/year to 17.3 inch/year. These are relatively low values for New York State.

The resulting grid of estimated mean annual groundwater recharge is depicted on the following page. The highest rates of groundwater recharge in Germantown (approximately 13 inches per year) can be found in the glaciolacustrine sand deposits east of the Hudson River. The lowest rates of groundwater recharge (approximately 4 inches per year) are found across the low-lying glaciolacustrine clay sediments in Town.


Germantown
Estimated Annual
Groundwater Recharge
Rates
This map displays estimated annual groundwater recharge rates. Estimates are based upon surficial geologic mapping by NYRWA, and stream baseflow statistics as well as annual runoff data from the USGS.
North Germantown
Germantown
Cheviot
Viewmont
NORTHERN BLVD
OSTOYC RD
HOVER AVE
MOORE RD
HALES BRIDGE RD
HILLTOP RD
EASTERN PKWY
PALATINE PARK RD
CRAWFORD LN
MAPLE AVE
COUNTY ROUTE 8
STATE ROUTE 9G
MOUNTAIN VIEW RD
REUTER RD
ORR RD
ROUND TOP RD
CHURCH AVE
VIEWMONT RD
BEST LN
ORCHARD RD
OLD SAWMILL RD
LASHER AVE
SOUTH RD
New York Rural Water Association
Founded 1979
Legend
Annual Groundwater Recharge
< 1.5 inches
1.5 - 4.3 inches
4.3 - 7.5 inches
7.5 - 13.2 inches
Scale
0
0.25
0.5
1
1.5
2
Miles
N

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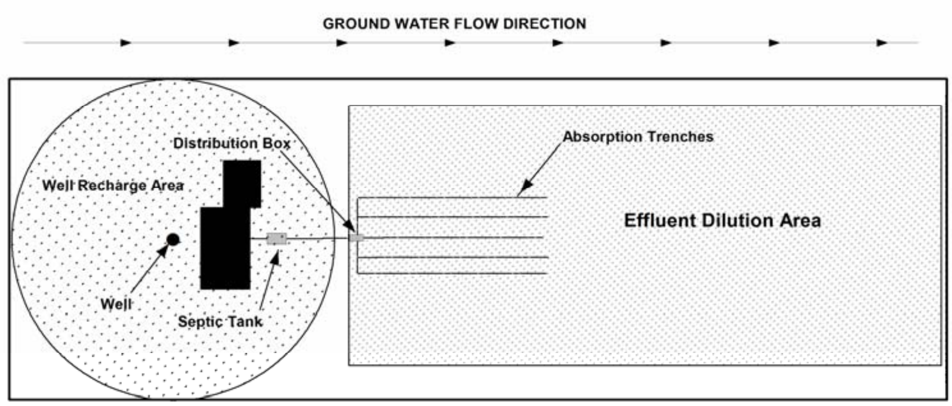
APPENDIX B

RECOMMENDED MINIMUM LOT SIZE CALCULATIONS

Calculations for Minimum Lot Size

The basis of the recommended minimum lot size is that the area of the lot must be sufficiently large to supply enough groundwater recharge to: (1) dilute the effluent from the lot's septic system effluent to acceptable levels; and (2) replenish the lot's water well without interference with other adjacent wells or the lot's septic system. This is illustrated in the figure below. Ideally, the lot enough so that the well's recharge area does not reach out and intersect the area needed to dilute the septic system's effluent.



The effluent dilution area can be calculated from an equation known as the modified Trela-Douglas nitrate dilution equation (Hoffman and Canace, 2001). This equation is:

$$R = 4.4186HM /(C_q A(1\text{-}0.179A^{-0.5708}))$$

where: H equals persons per home;
M equals pounds per person per year
Cq is the target concentration in mg/L of nitrate-nitrogen;
A is the effluent dilution area in acres per home; and
R equals the groundwater recharge rate in inches per year.

Since A is difficult to directly solve for, various values of A are chosen in order to match the recharge rate, R, in the area. Note that the following constants are used:

H = 3 persons per home
M = 10 pounds per person per year
C_q = 5 mg/L (½ of the nitrate MCL).

The modified Trela-Douglas equation was solved using a Microsoft Excel spreadsheet program.

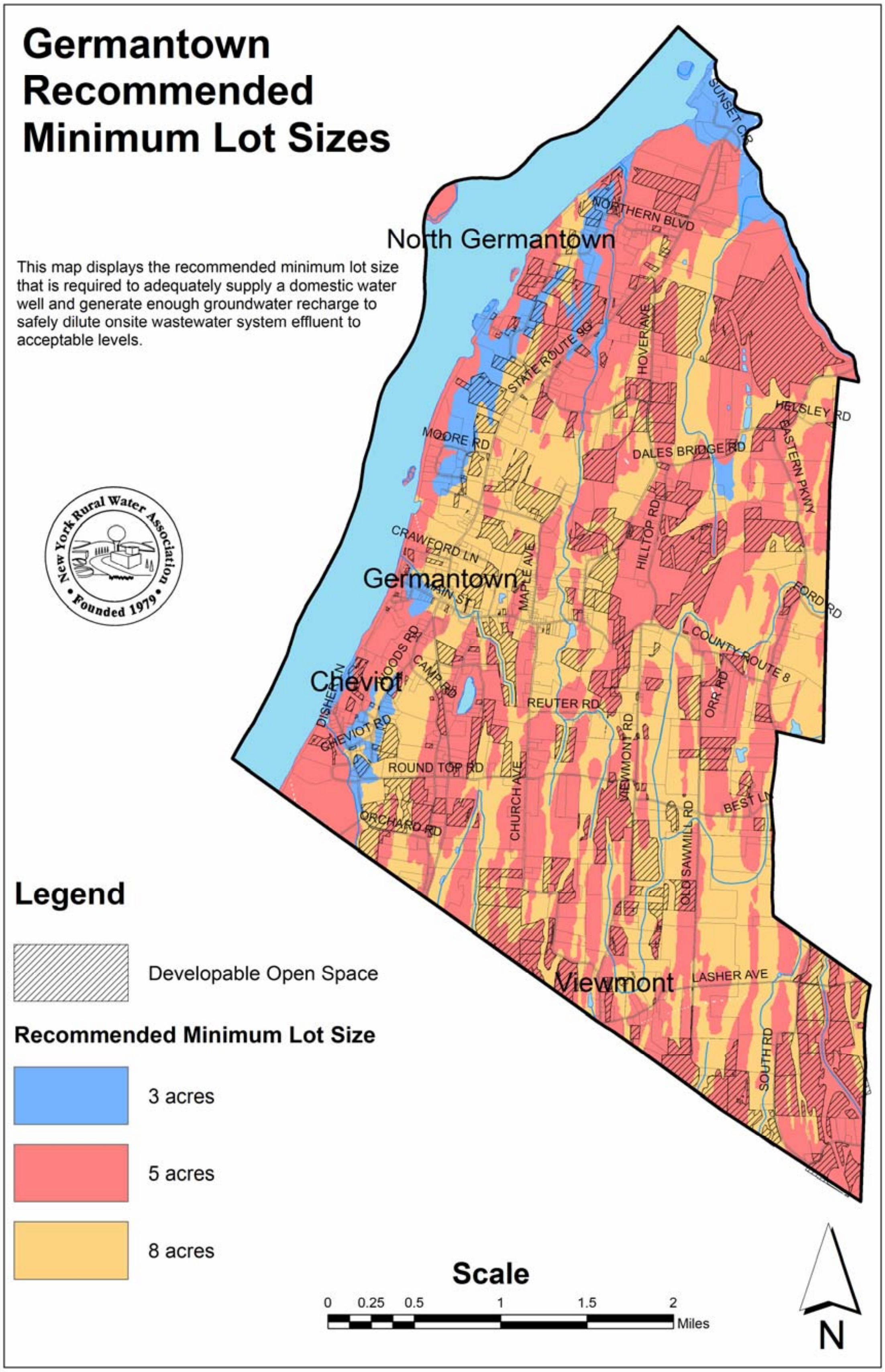
The approximate recharge area for an onsite well was determined by dividing the estimated annual pumpage (in ft^3/yr) by the groundwater recharge rate (ft/yr) in the area. A water consumption rate of 75 gallons per person per day was assumed, together with an average household of three individuals. As with the Trela-Douglas equation, the effects of impervious cover were taken into account using a relationship between estimated impervious cover and lot size that was developed by the Soil Conservation Service. The resulting necessary recharge area was calculated using a Microsoft Excel spreadsheet program.

The total minimum lot area is the sum of the necessary dilution area and the well recharge area. This is a conservative approach designed to minimize water quality and quantity effects arising from a housing development.

A summary of the calculated results for minimum necessary lot size for Germantown follow:

Recharge Rate (in/yr)	Effluent Dilution Area (acres)	Well Recharge Area (acres)	Total Lot Area (acres)
4.00	7.05	0.93	7.98
4.05	6.96	0.92	7.88
4.09	6.89	0.91	7.80
4.14	6.81	0.90	7.71
4.19	6.73	0.89	7.62
4.24	6.65	0.88	7.53
4.29	6.57	0.87	7.44
4.34	6.52	0.86	7.38
6.88	4.19	0.58	4.77
6.96	4.14	0.58	4.72
7.04	4.09	0.57	4.66
7.13	4.05	0.57	4.62
7.21	4.00	0.56	4.56
7.30	3.96	0.55	4.51
7.38	3.92	0.55	4.47
7.46	3.88	0.54	4.42
12.47	2.39	0.36	2.75
12.62	2.36	0.35	2.71
12.78	2.33	0.35	2.68
12.92	2.31	0.35	2.66
13.08	2.28	0.34	2.62
13.24	2.26	0.34	2.60

The calculated minimum lot sizes fall into three main groups: Group 1 (2.60 to 2.75 acres); Group 2 (4.42 to 4.77 acres); and Group 3 (7.38 to 7.98 acres). For mapping and possible zoning purposes, the average Group 1 lot size was rounded to 3 acres, the average Group 2 lot size was rounded to 5 acres, and the average Group 3 lot size was rounded to 8 acres (see the figure below).


Germantown
Recommended
Minimum Lot Sizes
This map displays the recommended minimum lot size that is required to adequately supply a domestic water well and generate enough groundwater recharge to safely dilute onsite wastewater system effluent to acceptable levels.
New York Rural Water Association
Founded 1979
North Germantown
Germantown
Cheviot
Viewmont
SUNSET CR
NORTHERN BLVD
STATE ROUTE 9G
HOVER AVE
HELSLEY RD
EASTERN PKWY
MOORE RD
DALES BRIDGE RD
HILLTOP RD
CRAWFORD LN
MAPLE AVE
MAIN ST
FORD RD
COUNTY ROUTE 8
WOODS RD
CAMP RD
DISHER LN
CHEVIOT RD
REUTER RD
ORR RD
VIEWMONT RD
ROUND TOP RD
CHURCH AVE
OLD SAWMILL RD
BEST LN
ORCHARD RD
LASHER AVE
SOUTH RD
Legend
Developable Open Space
Recommended Minimum Lot Size
3 acres
5 acres
8 acres
Scale
0 0.25 0.5 1 1.5 2
Miles
N

APPENDIX C

PROPOSED REQUIREMENTS FOR A HYDROGEOLOGICAL STUDY

TOWN OF GERMANTOWN
HYDROGEOLOGICAL STUDY REQUIREMENTS

SECTION 1.0 INTRODUCTION

Hydrogeological studies are required for certain development activities as specified below. The purposes of such hydrogeological studies are to: (1) assess the adequacy of the available groundwater supply to support the proposed development; and (2) evaluate the potential impacts for adverse impacts upon any nearby groundwater users and surface waters. Hydrogeological studies as set forth in this document are based on both on-site testing, and existing and readily available information.

Hydrogeological testing and evaluation shall be performed by a qualified consultant approved by the Town of Germantown Planning Board. Work shall be performed or directly supervised by a licensed or certified professional geologist who has related project experience in Columbia County. Alternatively, work may be performed or directly supervised by a licensed professional engineer who is experienced in performing groundwater studies and has related project experience in Columbia County. Where not specifically defined in this document, the methodology used for testing and evaluation shall follow generally accepted professional hydrologic and hydrogeologic practices and standards.

SECTION 2.0 APPLICABILITY

Hydrogeological studies are required for two general types of land development projects: (1) certain residential subdivisions utilizing on-site ground water and/or on-site sewage disposal; and (2) other types of development that utilize relatively large amounts of on-site ground water and/or dispose of a high volume of sewage on-site (see specific thresholds below).

A hydrogeological study must be performed for any new subdivision involving ten (10) or more lots that relies upon either on-site ground water withdrawals and/or on-site sewage disposal. A hydrogeological study must also be performed for any new subdivision involving five (5) or more lots that relies upon on-site ground water withdrawals and overlies an area with average well yields of less than 5 gallons per minute as indicated on Figure 7 of the Town of Germantown Groundwater Protection Plan prepared by the New York Rural Water Association. Eight (8) copies of a hydrogeological study for such a subdivision must be submitted to the Town of Germantown Planning Board in conjunction with submission of the preliminary plat. The hydrogeologic study must be formally approved prior to approval of the preliminary plat.

A hydrogeological study is also required for any type of proposed development project with on-site groundwater withdrawals and/or on-site sewage disposal flows potentially equal to or exceeding an average of two thousand (2,000) gallons per day (gpd) during any single thirty (30)-day period. These types of projects could include, but are not limited to, recreational developments (golf courses, water theme parks, etc.), multi-family housing (apartments, condominiums, townhouses, etc.), industrial, or commercial developments. Ten (10) copies of a hydrogeological study for such a development project is required to be submitted to the Town of Germantown Planning Board as part of the site plan review process indicated in the Town's zoning regulations.

SECTION 3.0 BACKGROUND EVALUATION

A background evaluation and analysis of the regional and site specific hydrogeologic conditions should be conducted using readily available existing resources such as publications and/or data from the U.S. Geological Survey (USGS), U.S. Environmental Protection Agency, U.S. Department of Agriculture's Natural Resources Conservation Service (formerly the Soil Conservation Service), New York State Geological Survey, New York State Department of Environmental Conservation, New York State Department of Transportation, New York State Department of Health, Columbia County Health Department, etc. At a minimum, the evaluation shall include the area within approximately one (1) mile beyond the project boundary.

The evaluation and analysis shall include the following:

- Topographic information from USGS mapping and other sources.
- Property maps, aerial photographs, and land use data (for example from real property classifications).
- Geologic maps and data reports (well logs, water quality analyses, geologic information, soils data, etc).
- Existing well data and descriptive statistical summary of the same (e.g. minimum, maximum and mean of well data, etc.)
- Existing research reports, hydrogeologic reports, etc.
- Locations and identifications of all wells within a minimum of 1,500 feet of the proposed development boundaries, including public water supplies.
- Existing and potential contaminant sources of record or those observed on site and within a minimum of 1,500 feet of the project site boundary. An attempt shall be made to verify sources of record by field reconnaissance.
- Preliminary field verification of existing geologic information including rock outcrops, bedrock fractures, karst features, linear features, photo linears, etc.
- At sites with bedrock outcrops, fracture orientations (strike and dip measurements) shall be measured and documented in the report. The number and orientations of linear features or photo lineaments shall be analyzed and correlated with documented bedrock fractures.

- Evaluation of the site hydrogeology and the occurrence, quality, and quantity of ground water.

SECTION 4.0 TESTING REQUIREMENTS

Section 4.1 Water Supply Testing for Applicable Subdivisions

A. Wells

1. The applicant must submit a plan to the Town of Germantown Planning Board showing the locations and construction details of proposed test wells. The Town of Germantown may approve, approve with conditions, reject, or request more information within 45 days of receipt of such a well plan.

2. Well construction and testing shall be performed by a certified water well contractor (NYS Environmental Conservation Law 15-1525) in accordance with Appendix 5-B of 10 NYCRR Part 5 (Standards for Water Wells).

3. Pumping tests should be conducted during a period of time of average or below average seasonal stream flow conditions (typically not during the months of March, April, and May).

4. Where individual wells are proposed for each lot, test wells shall be installed and tested on at least twenty percent (20%) of the proposed lots and on at least forty percent (40%) of the lots having a portion of the lot situated in an area with average well yields of less than 5 gallons per minute as indicated on Figure 7 of the Town of Germantown Groundwater Protection Plan prepared by New York Rural Water Association. The purpose of these wells is to provide evidence that the hydrogeologic system is capable of furnishing and sustaining the potable water needs of the proposed development.

5. Test wells may be used as designated lot wells if they meet all requirements of Appendix 5-B of 10 NYCRR Part 5 (Standards for Water Wells).

6. For wells that will be used for public water systems, all test wells shall also be located, constructed, and protected in accordance with Appendix 5-D of 10 NYCRR Part 5 (Special Requirements for Wells Serving Public Water Systems) as well as other applicable portions of Subpart 5-1 of 10 NYCRR.

7. Where individual wells are proposed for each lot, test well locations should provide a representative geographic distribution across the proposed subdivision.

8. Where individual wells are proposed for each lot, test well sites shall include wells in each bedrock and/or unconsolidated geologic unit in which wells are proposed.

9. Where individual wells are proposed for each lot, test wells shall be situated in each topographic setting that wells are proposed on the subdivision (i.e. high areas, low areas, sloping areas, etc.).

10. Where individual wells are proposed for each lot, an adequate number of test wells should be installed on adjacent lots in the proposed subdivision in order to evaluate potential adverse impacts to adjacent wells.

11. If there are existing, off-site wells within 1,000 feet of the subdivision, test well(s) should be located in order to evaluate the potential for adverse impacts to these existing wells.

12. If any portion of the subdivision is located within 100 feet of a surface water body or wetland, and individual wells are proposed for each lot, at least one well should be located between 25 and 100 feet of such surface waters in order to determine potential adverse impacts and groundwater quality issues.

13. A well log must be submitted to the Town for each well drilled, along with a copy of the New York State Department of Environmental Conservation Well Completion Report.

14. Where individual wells are proposed for each lot, physical or chemical alteration of geologic materials or structures (e.g., hydraulic fracturing, use of explosives, or addition of chemicals) to increase yield of test wells will not be permitted prior to the pumping test.

B. Formation Sampling

1. During all drilling, representative samples shall be collected for each unconsolidated and consolidated geologic formation encountered. The applicant shall retain these samples and provide them to the Town if requested.

2. A well driller certified in accordance with NYS Environmental Conservation Law (ECL) 15-1525 or a certified/professional geologist shall complete and submit to the Town a well log for each test well constructed for the investigation. The log shall describe materials

encountered during drilling (unconsolidated and consolidated materials), and indicate the depth below ground surface of each material change. The log should be indicated on the New York State Department of Environmental Conservation Well Completion Report.

C. Pumping Tests

1. The applicant must submit a plan to the Town of Germantown Planning Board showing the wells that are to be pump tested, along with water level monitoring locations, surface water bodies and wetlands, possible pumping rates, discharge locations, schedules, and laboratory water quality testing details. The Town of Germantown may approve, approve with conditions, reject, or request more information within 45 days of receipt of such a testing plan.

2. No pumping should be conducted at or near the test well site for at least 24 hours prior to the test.

3. A pumping rate shall be used that reasonably stresses the aquifer but does not result in excessive drawdown in the well. The minimum acceptable pumping rate for the test shall be two (2) gallons per minute. However, a water well that yields a pumping rate of at least 5 gallons per minute is usually necessary to safely meet peak and daily needs of most residences.

4. A test pump capable of providing a minimum of 2 to 5 gallons per minute at the required head must be used to perform the test. Any pump failure must have no significant effect on the data or a similar termination and restart is necessary.

5. The pumping rate shall be measured using a flow meter installed in the discharge line along with a control valve. The flow meter shall be calibrated at the beginning of the pumping period (all calibration measurements shall be recorded). The discharge flow rate shall be monitored and recorded at least once every 15 minutes during the first hour of the test and every 60 minutes thereafter.

   For relatively low flow rates, (< 5 gallons per minute), the flow rate may be obtained by determining the time required to fill a container of known volume (e.g., a 5-gallon bucket). The number of seconds/minutes to fill the container and the exact time of day shall be recorded.

6. The pumping test should include a minimum four-hour period of stabilized drawdown while pumping occurs at a constant flow rate. During the period of stabilized drawdown the stabilized water level shall not fluctuate more than plus or minus 0.5 foot (i.e., within a vertical tolerance of one

foot) for each 100 feet of water in the well (i.e., initial water level to bottom of well) over the duration of constant flow rate of pumping. During the duration of constant flow rate pumping, the pumping rate shall not vary by more than 10 percent.

7. Water level measurements must be made to the nearest 0.01 foot. Preferred measurement methods include electronic sensors and pressure transducers.

8. Water level measurements in the pumping well and in at least two (2) of the closest available test wells are required immediately before the start of the test and during the pumping test at the following intervals:

Time After Pumping Started	**Time Intervals**
0 to 15 minutes	5 minutes
15 to 120 minutes	15 minutes
120 to 360 minutes	30 minutes

Note that <u>all</u> wells within a minimum distance of 500 feet of the pumping well shall be monitored, including any off-site wells (if practicable).

9. The water height of any bodies of water within 500 feet of the pumping well shall be monitored prior to the test, hourly during the pumping test, and at the end of the recovery period (see item 11).

10. Water discharged from the pumping well must be discharged a sufficient distance from the pumping well and other measured wells to avoid possible impacts from re-circulating the water. The water should be discharged to a drainage ditch or swale that will direct the water away from the well(s) if possible. If necessary, a temporary water storage tank can be used.

11. Upon completion of the pumping portion of the test, water level measurements should be recorded at the pumped well until the water level recovers back to at least 90 percent of the initial water level or for a period of 24 hours, whichever occurs first. If the water level does not recover to 90 percent of the initial water level after 24 hours, the tested flow rate may not be sustainable for an extended period of time.

12. A check valve must be installed at the base of the pump column pipe in the pumping well to eliminate backflow of water into the well during the recovery period.

13. For public water systems, all test wells shall be tested in accordance with Appendix 5-D of 10 NYCRR Part 5 (Special Requirements for Wells Serving Public Water Systems) as well other applicable portions of Subpart 5-1 of 10 NYCRR. In addition for community water systems, pump tests will follow NYSDEC Appendix 10, TOGS 3.2.1 (Recommended Pump Test Procedures for Water Supply Applications).

D. Laboratory Testing for Water Quality.

1. Water quality samples should be collected at the conclusion of the pumping test.

2. Water quality samples should be analyzed for the following: coliform bacteria, lead, nitrate, nitrite, iron, manganese, sodium, chloride, pH, hardness, sulfate, alkalinity and turbidity.

3. Additional tests for petroleum products or solvents may be necessary if the pumping well is located in the vicinity of a spill, petroleum storage facility, or other similar land use.

4. Tests for hazardous substance list metals, PCBs, and pesticides may be necessary if the pumping well is located adjacent to a landfill, junkyard, etc.

5. Analyses for specific chemicals may be necessary if the pumping well is located near an industry that stores and/or uses particular chemicals.

6. For public water systems, all test wells shall be tested for water quality in accordance with Subpart 5-1 of 10 NYCRR including Appendix 5-D of 10 NYCRR Part 5.

Section 4.2 Water Supply Testing For Other Developments with Groundwater Withdrawals and/or On-Site Sewage Disposal Flows ≥ 2,000 GPD

A. Geology

1. During all drilling, representative samples shall be collected for each unconsolidated and consolidated geologic formation encountered. The applicant shall retain these samples and provide them to the Town if requested.

2. A well driller certified in accordance with NYS Environmental Conservation Law (ECL) 15-1525 or a certified/professional geologist shall complete a well log for each test well constructed for the investigation. The log shall describe materials encountered during drilling (including unconsolidated materials), and indicate the depth below ground surface of each material change. The log should be indicated on the New York State Department of Environmental Conservation Well Completion Report.

B. Wells

1. The applicant must submit a plan to the Town of Germantown Planning Board showing the locations and construction details of proposed test wells. The Town of Germantown may approve, approve with conditions, reject, or request more information within 45 days of receipt of such a well plan.

2. Well construction and testing shall be performed by a certified water well contractor (NYS Environmental Conservation Law 15-1525) in accordance with Appendix 5-B of 10 NYCRR Part 5 (Standards for Water Wells).

3. For water wells that will serve a public water system, the location, protection, construction, yield, etc. of such wells shall be in accordance with Appendices 5-D and other applicable portions of Subpart 5-1 of NYCRR Title 10.

4. A well log must be submitted to the Town for each well drilled, along with a copy of the New York State Department of Environmental Conservation Well Completion Report.

C. Pumping Tests

1. The applicant must submit a plan to the Town of Germantown Planning Board showing the wells that are to be pump tested, along with water level monitoring locations, surface water bodies and wetlands, possible pumping rates, discharge locations, schedules, and laboratory water quality testing details. The Town of Germantown may approve, approve with conditions, reject, or request more information within 45 days of receipt of such a testing plan.

2. A pumping test shall be performed on each well that is to be utilized by the proposed development in order to determine that the water supply adequately meet the needs of the applicant without adversely affecting others who may rely on the same aquifer.

3. For public water systems, all pumping tests shall be conducted in accordance with Appendix 5-D of 10 NYCRR Part 5 (Special Requirements for Wells Serving Public Water Systems) as well other applicable portions of Subpart 5-1 of 10 NYCRR. In addition for community water systems, pump tests will follow NYSDEC Appendix 10, TOGS 3.2.1 (Recommended Pump Test Procedures for Water Supply Applications).

3. Pumping tests should be conducted during a period of time of average or below average seasonal stream flow conditions (typically not during the months of March, April, and May).

4. No pumping should be conducted at or near the test well site for at least 24 hours prior to the test.

5. Pumping tests should be done when nearby wells normally in operation are running. Pumping of such other wells in the test area should be monitored.

6. A test pump capable of providing the design flow rate at the required head must be used to perform the test. Any pump failure must have no significant effect on the data or a similar termination and restart is necessary.

7. The pumping rate shall be measured using a flow meter or circular orifice weir installed in the discharge line along with a control valve. The flow meter or weir shall be calibrated at the beginning of the pumping period (all calibration measurements shall be recorded). The discharge flow rate shall be monitored and recorded manually at least once ever 15 minutes during the first hour of the test and every 1 to 4 hours thereafter.

   For relatively low flow rates, (< 5 gallons per minute), the flow rate may be obtained by determining the time required to fill a container of known volume (e.g., a 5-gallon bucket). The number of seconds/minutes to fill the container and the exact time of day shall be recorded.

8. The pumping test(s) shall be conducted at a pumping rate at least equal to the design pumping rate. If multiple wells are to be pumped simultaneously to achieve the necessary yield, the test should incorporate such a pumping plan.

9. Water discharged from the pumping well must be discharged a sufficient distance from the pumping well and other measured wells (minimum 200 feet) to avoid possible impacts from re-circulating the water. The water should be discharged to a drainage ditch or swale that will direct the water away from the well(s) if possible.

10. Water from the pumping well cannot be discharged into any water body or wetland if such discharge results in turbidity or erosion leading to turbidity or down stream flooding. If it is anticipated that discharged water will create flooding, erosion and/or turbidity, water must be directed to a holding area and released in a controlled manner to prevent such problems.

11. The selected pumping rate shall not vary by more than ten (10) percent during the test. Pumping rates should be frequently measured and recorded, following the schedule of the water level measurements (see below).

12. Pumping tests shall be conducted for a minimum of 72 hours at a constant pumping rate. A minimum of six hours of stabilized drawdown must be displayed at the end of the test. Stabilized drawdown is defined as a water level that has not fluctuated by more than plus or minus 0.5 foot for each 100 feet of water in the well. If stabilized drawdown is not achievable, the test period may be extended or semi-log extrapolation of drawdown versus time (or other similar methods) may be employed to demonstrate the ability of the aquifer to supply a pumping rate equal to the desired yield.

13. Water level measurements must be made to the nearest 0.01 foot. Preferred measurement methods include electronic sensors and pressure transducers.

14. Periodic water level measurements in the pumping well and in the observation wells are required immediately before the start of the test and during the pumping test at the following intervals:

Time After Pumping Started	Time Intervals
0 to 15 minutes	1 minute
15 to 50 minutes	5 minutes
50 to 100 minutes	10 minutes
100 to 500 minutes	30 minutes
500 to 1000 minutes	1 hour
1000 to 5000 minutes	4 hours

15. At least three (3) observation wells should be monitored on-site during the pumping test. Note that all site wells shall be monitored, as well as any off-site wells within 1,000 feet (if practicable). Observation wells should be located at varying distances from the pumping well in order to characterize the well's zone of pumping influence. Observation wells should be large enough to allow accurate and rapid measurement of the water levels. Observation wells should be screened in, or open to, the same formation as the pumping well.

16. The water height of any bodies of water within 1,000 feet of the pumping well shall be monitored before the pumping test, every four hours during the test, and at the end of the recovery period (see item 17).

17. Water level measurements should be collected during the recovery period for all wells using the same procedure and time pattern followed at the beginning of the pump test (see item 14). Measurements at the pumping well should continue for at least 24 hours or until the well recovers to 90 percent of the original water level.

18. A check valve must be installed at the base of the pump column pipe in the pumping well to eliminate backflow of water into the well during the recovery period.

19. Rainfall should be measured to the nearest 0.01 inch and recorded for one day preceding the pump test, during the test, and during the recovery period.

D. Laboratory Testing for Water Quality.

1. Water quality samples should be collected at the conclusion of the pumping test.

2. Water quality samples should be analyzed for the following: coliform bacteria, lead, nitrate, nitrite, iron, manganese, sodium, chloride, pH, hardness, sulfate, alkalinity and turbidity.

3. Additional tests for petroleum products or solvents may be necessary if the pumping well is located in the vicinity of a spill, petroleum storage facility, or other similar land use.

4. Tests for hazardous substance list metals, PCBs, and pesticides may be necessary if the pumping well is located adjacent to a landfill, junkyard, etc.

5. Analyses for specific chemicals may be necessary if the pumping well is located near an industry that stores and/or uses particular chemicals.

6. For public water systems, all test wells shall be tested for water quality in accordance with Subpart 5-1 of 10 NYCRR including Appendix 5-D of 10 NYCRR Part 5.

SECTION 5.0 REPORTING REQUIREMENTS

The detailed hydrogeologic report shall include, at a minimum, the items described below. Note that the all data shall be organized by either "type" (well completion reports, pumping test data and analyses, water quality reports, etc.) or by well, in tabbed appendices clearly marked showing the content of the tabbed section.

A. Description of the Proposed Development

The proposed development project must be summarized including information on property acreage; projected water demand; means of wastewater disposal; stormwater runoff control; parking areas and other impervious surfaces; fuel storage; and the number, size and distribution of proposed residential lots (if applicable).

B. Discussion of Site and Regional Hydrogeology

A written discussion of the site and regional hydrogeology shall be included. Items to be included in this discussion include:

1. Geologic setting;
2. Local drainage and watershed(s);
3. Lateral and vertical distribution of local unconsolidated and consolidated hydrogeologic units as well as their hydraulic properties;
4. Land surface elevation and relief;
5. Occurrence and flow characteristics of surface water and ground water;
6. The relationship between local ground water and surface water;
7. Well yield and depth data;
8. Local groundwater use and quality; and
9. Known or potential contamination sources.

Appropriately-scaled maps and cross-sections should be used to depict the hydrogeologic setting (see below).

C. Maps

A set of maps at appropriate scales covering the proposed development should be enclosed. The maps shall contain all existing planimetric features, topography, all proposed roads, proposed lot lines, proposed lot sites, proposed house sites, proposed septic systems, surface water features, proposed and existing wells, bedrock outcrops, karst features, linear features, springs, hydrogeologic units, etc. In addition, map(s) of static groundwater elevations shall be illustrated, along with maps showing drawdown contours and pumping groundwater elevations.

D. Cross-Sections

The report shall contain one or more cross-sections, at true horizontal scale and vertical scale (exaggerated as appropriate). The location of each cross-section shall be shown on the plan view map(s) and the cross-section shall contain the following information:

1. Geologic data including bedrock contacts and structural features if present.
2. Well site locations showing well casings, total depths, and specific capacities.
3. Elevations of ground surface, bedrock depths, and static water surfaces.
4. Final water level in each pumped well and observation well(s) at the end of the pumping tests with the corresponding pumping rate of the well.

E. Well Completion Reports

For each well drilled for the investigation, a New York State Department of Environmental Conservation Well Completion Report will be completed and enclosed. This will include a log of materials encountered that is completed by a certified well driller or a licensed/certified professional geologist. Well construction details will also be noted on each Well Completion Report, including the well number, date of construction, well location coordinates (lat/long, UTM, or State Plane), land surface elevation, total depth, well casing depth, grout depth, bentonite seal thickness, top and bottom of well screen, height of casing above land surface, static water level and date, etc.

F. Well Construction Summary

For all wells constructed for the investigation, a summary table will be provided that includes, at a minimum, the well number, completion date, land surface elevation, well diameter, total well depth, well casing depth, screened interval (if applicable), depth to bedrock, static water level (all on the same date), well yield, and aquifer.

G. Well Testing Summary

In a separate table(s), well testing results shall be summarized, including at a minimum: the well number (and pumping well number if different); date tested; duration of pumping; pumping rate; pre-pumping (static) water level; maximum observed water level drawdown; distance to pumped well; percent of available drawdown used (assume maximum available drawdown is 40 feet above well bottom or use more stringent criteria if appropriate); specific capacity; transmissivity; storativity (if available); and time to achieve 90 percent recovery (or the percent recovery after 24 hours) in the pumped well. Note that the analytical method used to calculate the aquifer transmissivity and storativity should be noted. All pumping test data will be included in the appendices.

H. Groundwater Quality

For all wells tested for the investigation, provide a table summarizing the groundwater quality and include the maximum contaminant levels (MCLs) for each tested parameter. Copies of the laboratory reports shall be included in the appendices.

I. Water Balance

The report shall contain groundwater mass balance and recharge estimates for the area. Applicable calculations and references shall be included as well as assumptions and limitations of the methods used. The report shall include a discussion of the following information, including appropriate supporting calculations and diagrams, which shall include, at a minimum:

1. Identification of the source or sources of recharge, using recharge from rainfall for normal conditions and for drought conditions (assume 60% of average annual precipitation), and the average outflow from the development area.

2. Comparison of calculated recharge to projected withdrawals associated with the development.

J. Potential Impacts to Water Quality

The report shall contain an analysis of potential impacts to groundwater and/or surface water quality that may result from the development. For example, this could include a discussion of impacts from fuel storage, stormwater runoff, nitrate loading associated with septic system effluent, etc.

Calculations should be developed and discussed in the report to estimate the overall loading of inorganic nitrogen to ground water from the development's subsurface wastewater disposal systems (if applicable). In general, the nitrate entering the ground water can be computed for a given area by dividing the annual nitrate load from the area by the annual amount of groundwater recharge (see above). Both normal and drought conditions should be assumed. In order to prevent cumulative degradation of groundwater quality in the region, the resultant projected nitrate level in ground water at the project boundary should not exceed ½ of the MCL (5 mg/L).

K. Potential Impacts of Pumping

The report will present an analysis of the magnitude and extent of water level drawdown that will result from groundwater withdrawals at the project as well as an evaluation of potential impacts of drawdown on groundwater and surface waters within a minimum of 1,500 feet from the development boundary. This analysis will be developed using standard methods and will include an analysis of potential conditions during normal and drought periods. The possibility of other adverse affects of pumping such as altering the flow direction of groundwater from potential pollution sources, introducing zones of poor water quality, etc. must be discussed as well. For community water system wells, the zone contributing ground water (zone of contribution) for such wells must be delineated.

L. Suitability of Groundwater Resources

The consultant must prepare a preliminary written conclusion regarding the suitability of groundwater resources to support the proposed development. A comparison of projected water demands to available source capacity should be included. If applicable, mean and median yields of lot wells must be presented and compared to the 5 gallons per minute usually necessary to safely meet peak and daily needs of a typical residence. In addition, the possibility of wells on the remaining (non-tested) individual lots having inadequate yield must be discussed. Plans on how to overcome potential inadequacies must be addressed.

The adequacy of the development's drinking water quality should be evaluated. The possibility of contamination from on-site and off-site sources must be assessed. Any necessary treatment options should be identified.

M. Investigation and Mitigation Plan

The report must include a plan for investigating and mitigating existing water supply wells or surface waters in the event that either experience reductions in water level or water quality during and/or after construction of the development.