GROUNDWATER RESOURCES STUDY
AND
PROTECTION PLAN

for the

TOWN OF HILLSDALE
COLUMBIA COUNTY, NEW YORK

September 2009

Prepared by:

Steven Winkley
New York Rural Water Association

Prepared for:
Town of Hillsdale Comprehensive Plan Review Committee

Funded by:
the Hudson River Valley Greenway, the Berkshire Taconic Community Foundation, and the Town of Hillsdale

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1.0 INTRODUCTION

1.1 Goals and Objectives

Groundwater is a valuable resource in the Town of Hillsdale. Virtually all residents and businesses in Town rely upon groundwater for drinking water. In addition, groundwater 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, excessive groundwater withdrawals can lead to objectionable consequences, such as depletion of surface water resources.

In order to preserve the groundwater resources of Hillsdale for today and the future, the following Groundwater Resources Study and Protection Plan has been prepared by the New York Rural Water Association (NYRWA). This report and plan inventories and maps the groundwater resources and aquifers of Hillsdale, identifies potential sources of contamination and the vulnerability of groundwater to pollutants, discusses sources of drinking water, evaluates the susceptibility of groundwater resources to growth and development, and outlines potential protection planning strategies.

1.2 Scope and Methods

New York Rural Water Association has utilized a variety of published and unpublished data sources for this report and plan.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 a variety sources, including the United States Geological Survey's Water Data Site Inventory System, the New York State Department of Environmental Conservation's Water Well Program, and the New York State Department of Health's Source Water Assessment Program (SWAP). In addition, test boring data was collected from the New York State Department of Transportation. In all, data on 176 wells and borings were documented. Details from these locations (depth of well, yield, etc.) are summarized on Plate 1 contained within this report and plan.

A number of published and unpublished geologic maps were reviewed. A digital version of the Columbia County Soil Survey and the New York State Geologic Map were utilized for analyses and mapping. In addition, elevation data for Hillsdale were taken from digital elevation models (DEMs). This information was then used to derive slope data and hillshading images. Parcel boundaries and land use information were provided by Columbia County Real Property Tax Service and the New York State Office of Real Property Services respectively. Other digital data on wetlands, floodplains, surface waters, roads, regulated facilities, aerial photography, etc. were downloaded from the New York State GIS Clearinghouse and the Cornell University Geospatial Information Repository.

Finally, New York Rural Water Association conducted on-site activities in Hillsdale to map surficial geology and unconsolidated aquifers, and to also 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.

2.0 SETTING

2.1 Physiography and Bedrock Geology

As illustrated on Figure 1, Hillsdale spans three different physiographic regions. Each of these physiographic regions has distinctive topographic relief, landforms, and geology. The physiography of the region is largely a function of the fact that Hillsdale is underlain by a series of overlapping rock slices, many pushed miles to the west during ancient mountain-building events. This geology is illustrated in Figure 2A, a cross-section from Fisher (2006).

The Southern Taconic Mountains occupy the eastern portion of the Town of Hillsdale (Figure 1). Here, elevations rise dramatically eastward to heights of up to 1,775 feet above sea-level atop White Hill. Slopes in the Southern Taconics are less than three percent along valley floors (such as that of the Green River) to up to 30 to 40 percent along the glacially-eroded valley walls. The Southern Taconic Mountains are the result of a collision of crustal plates that began to occur some 450 million years ago. As the two plates collided, the Southern Taconic Mountains were thrust upwards and older rocks were pushed large distances westward over the younger Walloomsac Formation and the Wappinger-Stockbridge carbonates. The rocks that were pushed up and thrusted include the Everest Schist (see Figure 2B) that today underlies much of the Southern Taconic Mountains. It is a highly metamorphosed rock that is greenish in color due to the distinctive minerals in it. Underlying the Everett Schist is the Walloomsac Formation, a dark gray to black slate and a higher grade metamorphic rock known as phyllite. Separating the two rock types are low-angle faults known as thrust faults. Bedrock is at or near the surface across the Southern Taconics.

To the west of the Southern Taconic Mountains lies the Carbonate Belt (Weaver, 1957) (see Figure 1). Here, the rocks of the Walloomsac Formation have largely been eroded away, leaving the Stockbridge-Wappinger Group carbonates underlying most of the area. These rocks are whitish to gray limestone and dolostone, that often weathering to an orange-gray color. Elevations across the Carbonate Belt range from 650 to 1,050 feet above sea-level. Slopes typically are less 3 percent across the valley floor, with steeper slopes present on elongated bedrock hills that have been streamlined by glacial erosion.

To the west of the Carbonate Belt is an area that has been termed the Slate Hills (Weaver, 1957) (see Figure 1). It is an area underlain by several argillites (derived either from mudstone or shale): the Walloomsac Formation, the Elizaville Formation (gray to greenish shale), and the Austerlitz Phyllite (purple and green phyllite. The Slate Hills Region is highly dissected, with elevations ranging from 650 to 1,540 feet above sea-level, variable slopes from less than 1 percent along the Taghkanic Creek valley to 20 to 45 percent along hill sides. Bedrock is fairly shallow in the Slate Hills, with numerous exposures present.

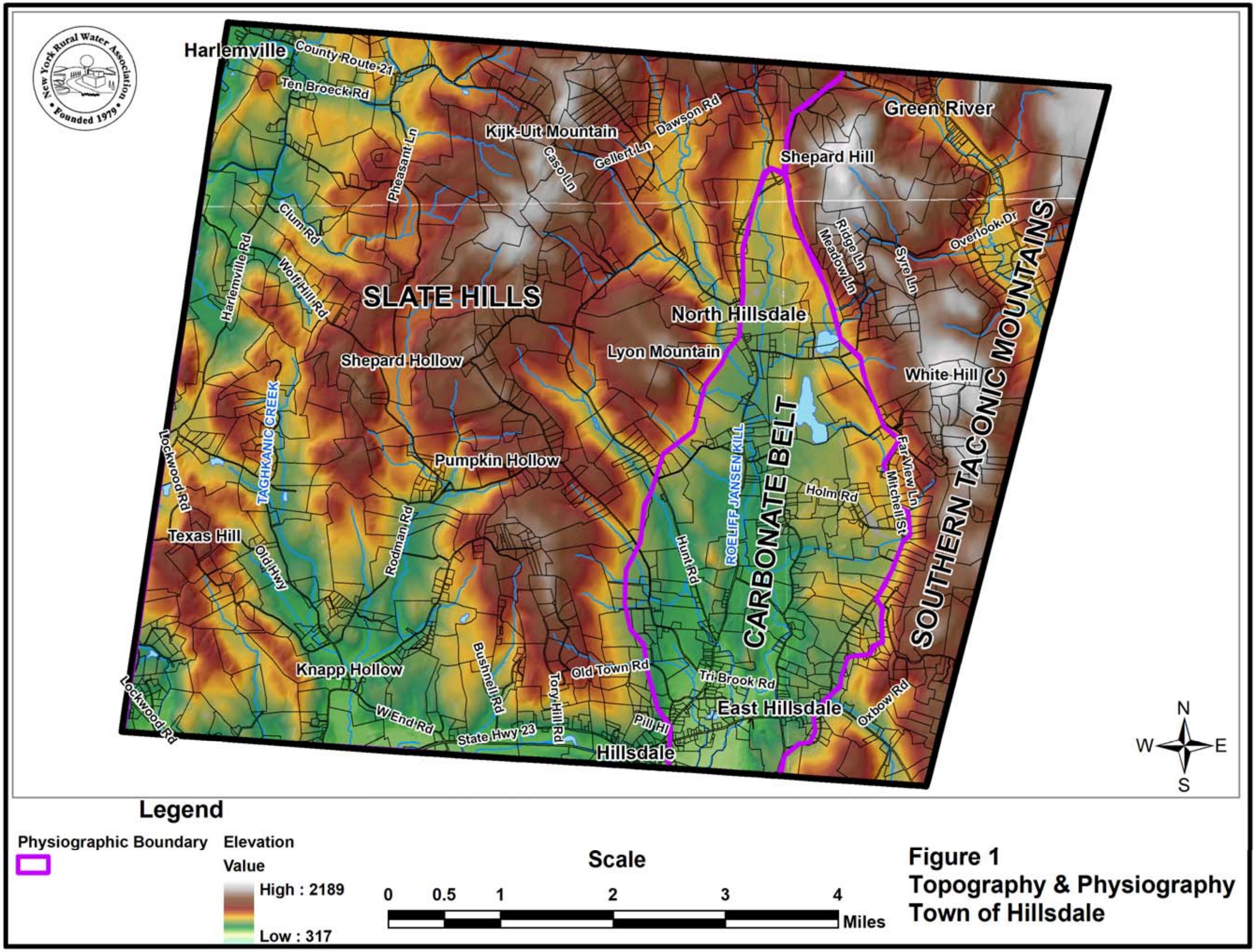


Figure 1
Topography & Physiography
Town of Hillsdale

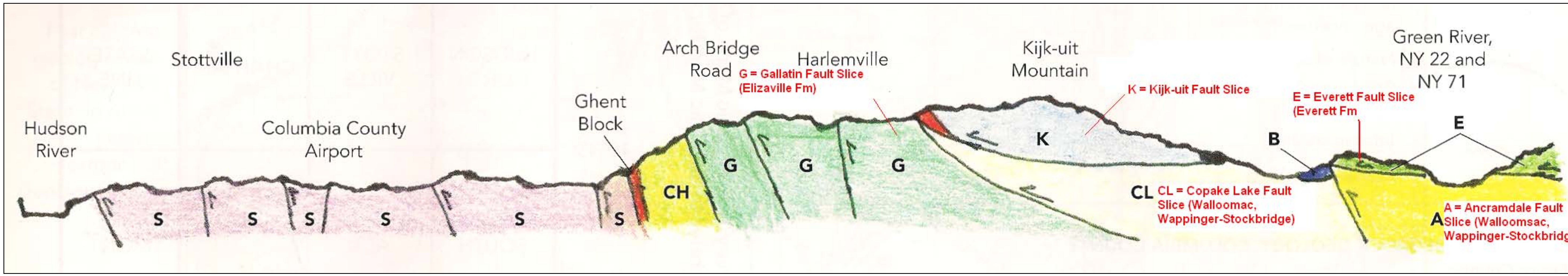


Figure 2A Geologic Cross-Section (modified from Fisher, 2006).

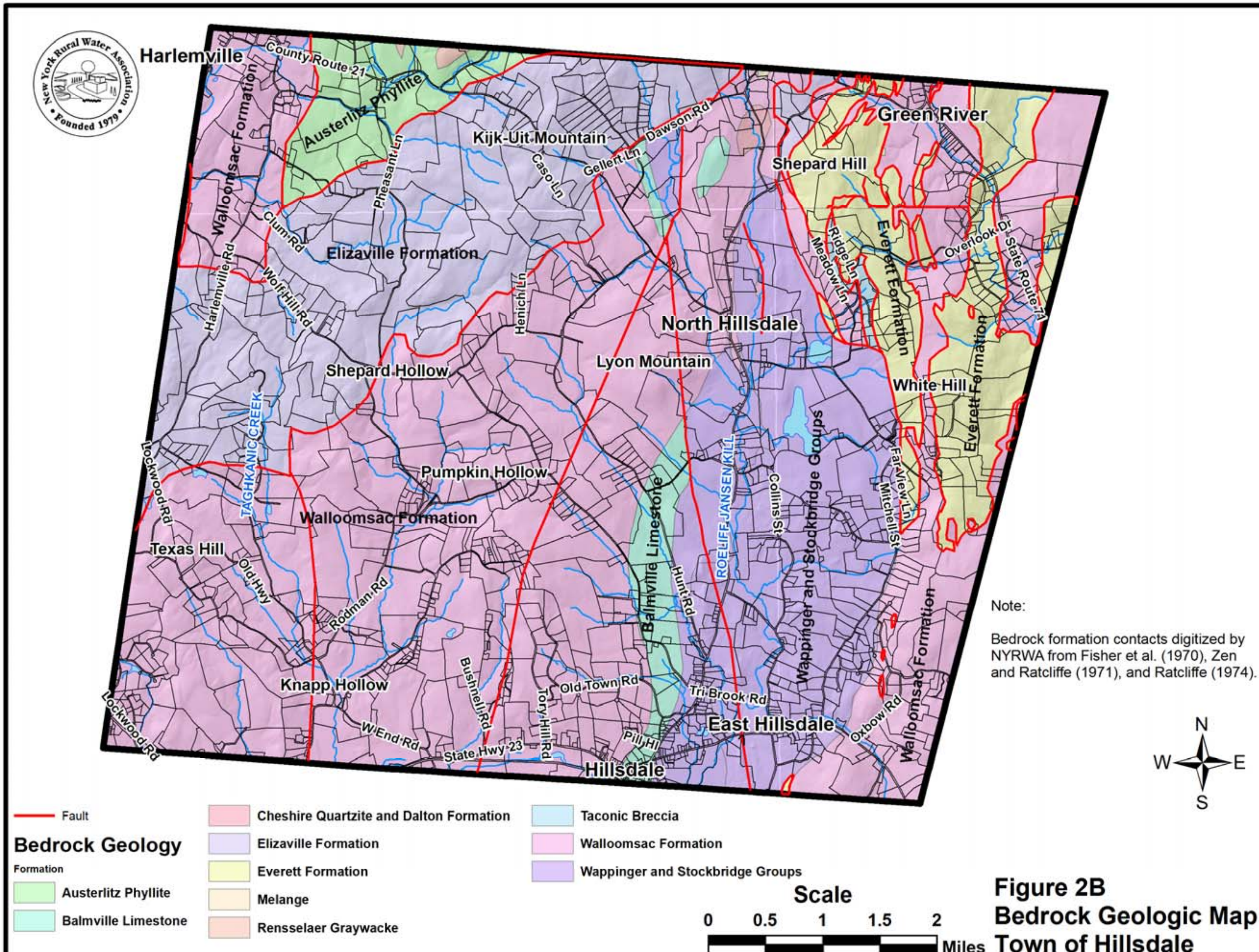


Figure 2B
Bedrock Geologic Map
Town of Hillsdale

2.2 Drainage

The western two-thirds of Hillsdale is located within the Hudson River Basin and is divided into three smaller watersheds: the Agawamuck Creek, the Roeliff Jansen Kill, and Taghkanic Creek (Figure 3). The eastern one-third of Hillsdale is within the Green River Watershed, a portion of the Housatonic River Basin (Figure 3). Most of the Green River Watershed in Hillsdale coincides with the Southern Taconic Mountains physiographic region.

2.3 Surficial Geology

Surficial deposits are geologic materials that are found at the land surface. The unconsolidated deposits above the bedrock originated within the past 15,000 years and actually continue to be formed today. A detailed map of surficial deposits has been completed by NYRWA (see Figure 4 and Plate 2). This map was derived from examination of digital soils mapping, topographic expression of the various deposits, water well data, and site reconnaissance. Surficial geologic maps have many different potential uses for planning purposes. One of the most frequent uses is to help identify sand and gravel aquifer boundaries. Surficial geologic maps are also important for identifying economically important deposits such as sand and gravel for aggregate. Surficial geologic maps are also important to study environmental issues such as the potential for migration of groundwater contaminants. Finally, surficial geology maps are useful for planning site development activities such as designing and locating septic systems, building new roads, excavating foundations, etc.

The principal material left by the advancing glacial ice sheet was glacial till, a relatively dense poorly-sorted mixture of boulders, gravel, sand, silt and clay. Till is commonly found in upland areas and underlies other deposits in valleys. Relatively thin accumulations of till are found across sixty percent of Hillsdale (see Figure 4 and Plate 2). Here there is generally less than ten feet of till present, and bedrock outcrops are common. Till thicknesses are often greater than ten feet in Hillsdale (27 percent of Town), though bedrock outcrops can still occur in these areas (Figure 4 and Plate 2). Till thickness is highly variable, with well data indicates that till can exceed 100 feet in some places.

Surficial materials deposited by glacial meltwater are called glaciofluvial deposits. These comprise the highest yielding unconsolidated aquifers (see Section 4). Glaciofluvial deposits can occur as ice-contact deposits or outwash. Ice-contact deposits consist of sand and gravel laid down by glacial meltwater adjacent to stagnating and decaying glacial ice. Ice-contact deposits can be found along the Roeliff Jansen Kill valley and other valleys. Such deposits have characteristic hummocky topography, a variable topography with numerous knobs (small hills) and kettles (small depressions).

Outwash is generally well-sorted sand and gravel deposited on flat plains or deltas by glacial meltwater beyond the ice margin. The largest accumulation of outwash is found in the valleys of the Roeliff Jansen Kill, Taghkanic Creek, Agawamuck Creek, and the Green River (see Figure 4 and Plate 2).

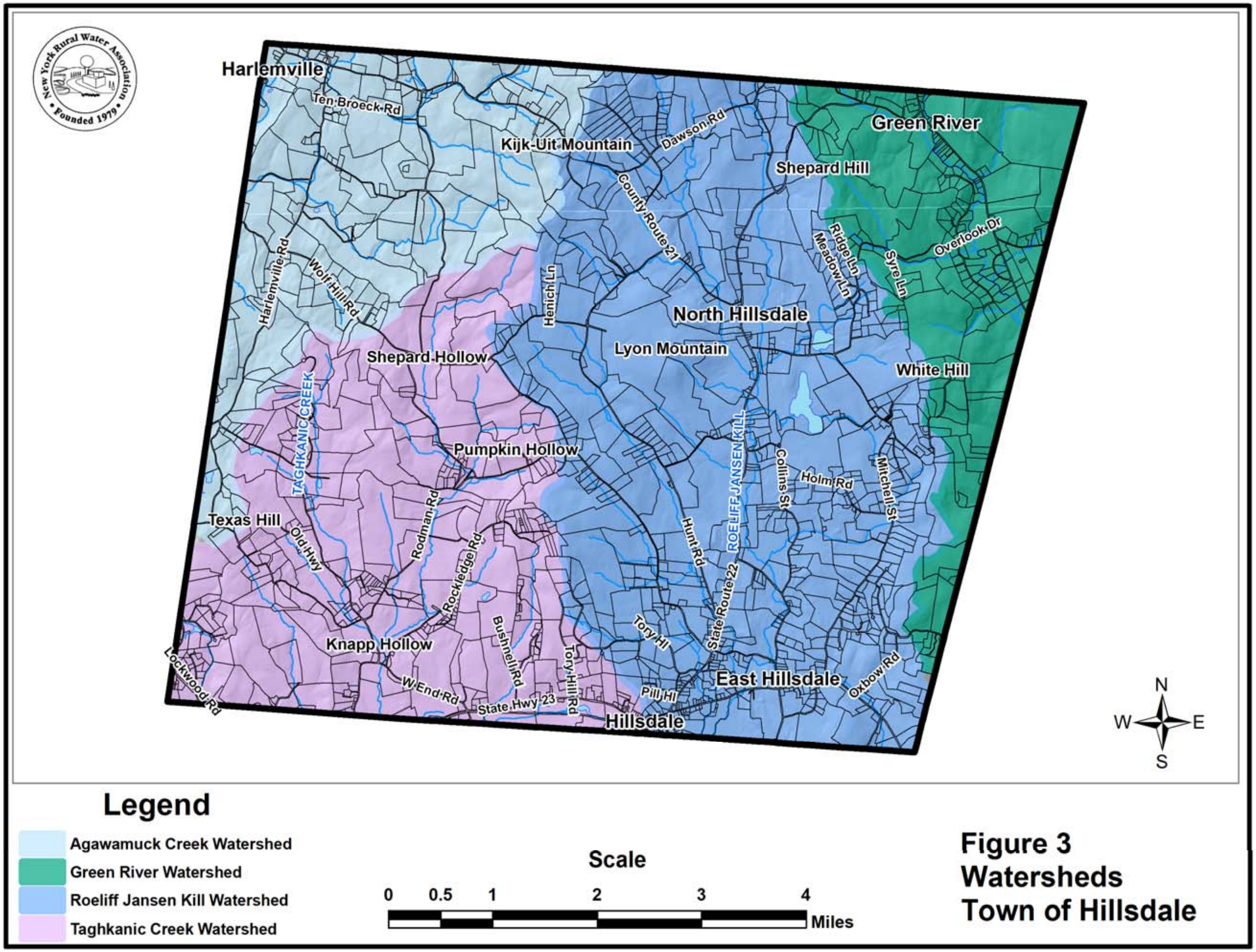
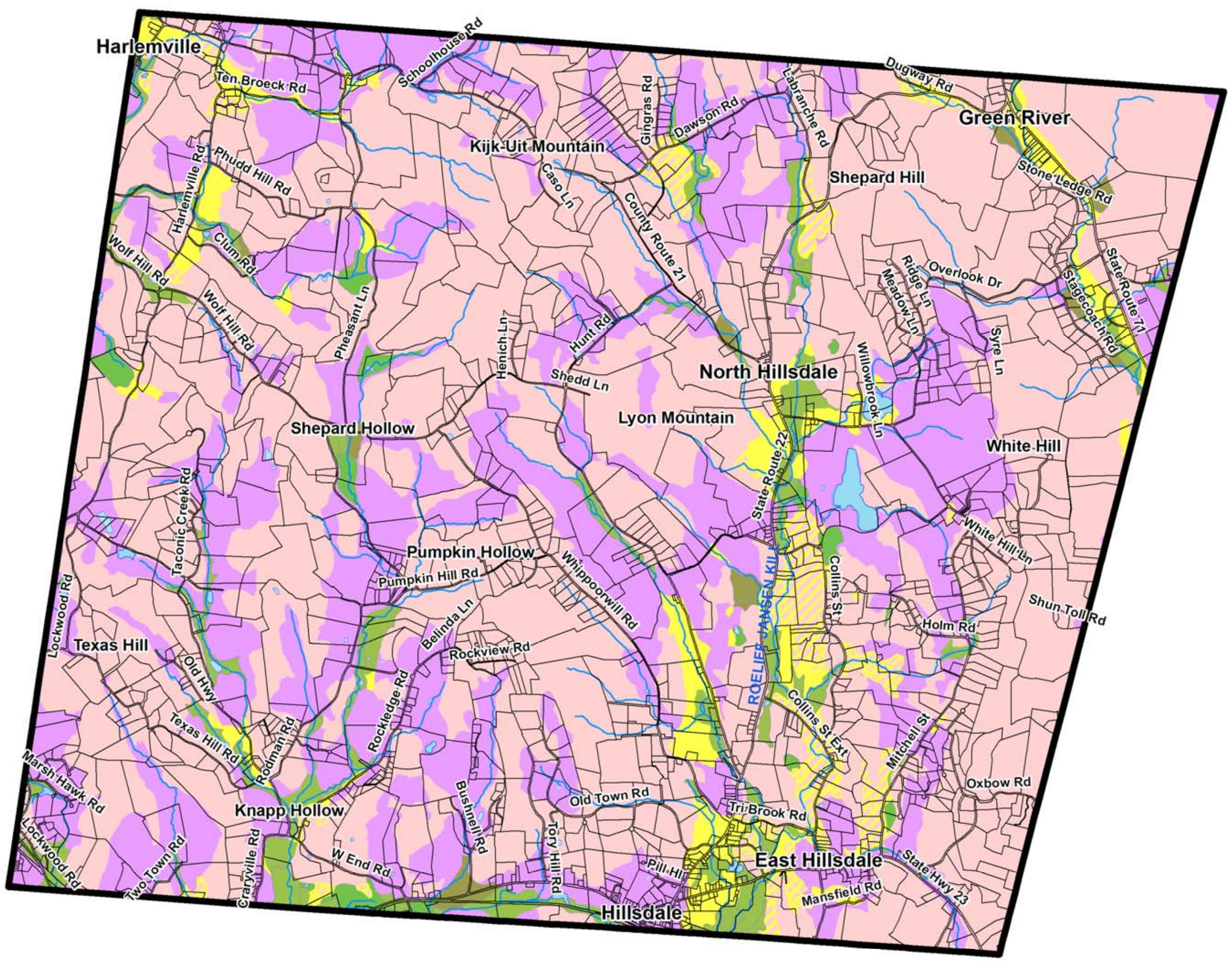


Figure 3
Watersheds
Town of Hillsdale



Note:

Surficial geology mapped by NYRWA based upon topographic expression, digital soil mapping by the Natural Resource Conservation Service (NRCS), subsurface data, and field reconnaissance.

Legend

Surficial Geology

- Alluvial fan deposits
- Alluvium
- Glaciofluvial deposits
- Thinner glaciofluvial deposits
- Organic material
- Till
- Thinner till
- Water

Scale

0 0.5 1 2 3 4 Miles

Figure 4
Surficial Geology
Town of Hillsdale

Alluvial fans consist of post-glacial stratified silt, sand, and boulders that accumulate in fan shaped landforms at the bottoms of steep slopes and at mouths of valleys. A related deposit is alluvium. It is sand, gravel, and silt recently deposited on flood plains and stream beds. Both alluvial fan deposits and alluvium can grade vertically and laterally into glaciofluvial deposits. Finally, peat, silt, clay and/or sand accumulate in depressions and other poorly drained areas.

3.0 GROUNDWATER UTILIZATION

3.1 Public Water Supply Wells

There are currently nineteen public water systems in Hillsdale (see Table 1 below). Most of these systems are mapped on Figures 5A and 5B. All rely upon groundwater wells for their source of supply. 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 (C), non-transient non-community (NTNC), or transient non-community (NC). 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.

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. 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.

NAME	PWS TYPE	POPULATION SERVED
B & G WINE STORE	NC	25
COBBLE POND FARM STORE #2	NC	25
FOUR BROTHERS PIZZA, INC.	NC	154
HAWTHORNE VALLEY FARM STORE	NC	25
HAWTHORNE VALLEY SCHOOL	NTNC	350
HILLSDALE COUNTRY DINER	NC	60
HILLSDALE FIRE COMPANY NO 1	NC	200
HILLSDALE GARDEN APTS.	C	40
HILLSDALE HOUSE	NC	65
HILLSDALE SUPERMARKET	NC	25
HOLIDAY HOUSE MOTEL	NC	25
INN AT GREEN RIVER	NC	25
LINDEN VALLEY BED & BREAKFAST	NC	25
MT. WASHINGTON HOUSE	NC	45
SILVANUS LODGE	NC	25
STEWARTS SHOP #281 HILLSDALE	NC	25
SUMMER @ HAWTHORNE VALLEY FARM	NC	50
SWISS HUTTE	NC	75
UNDERHILL INN	NC	26

Table 1. Public Water Systems in Hillsdale.

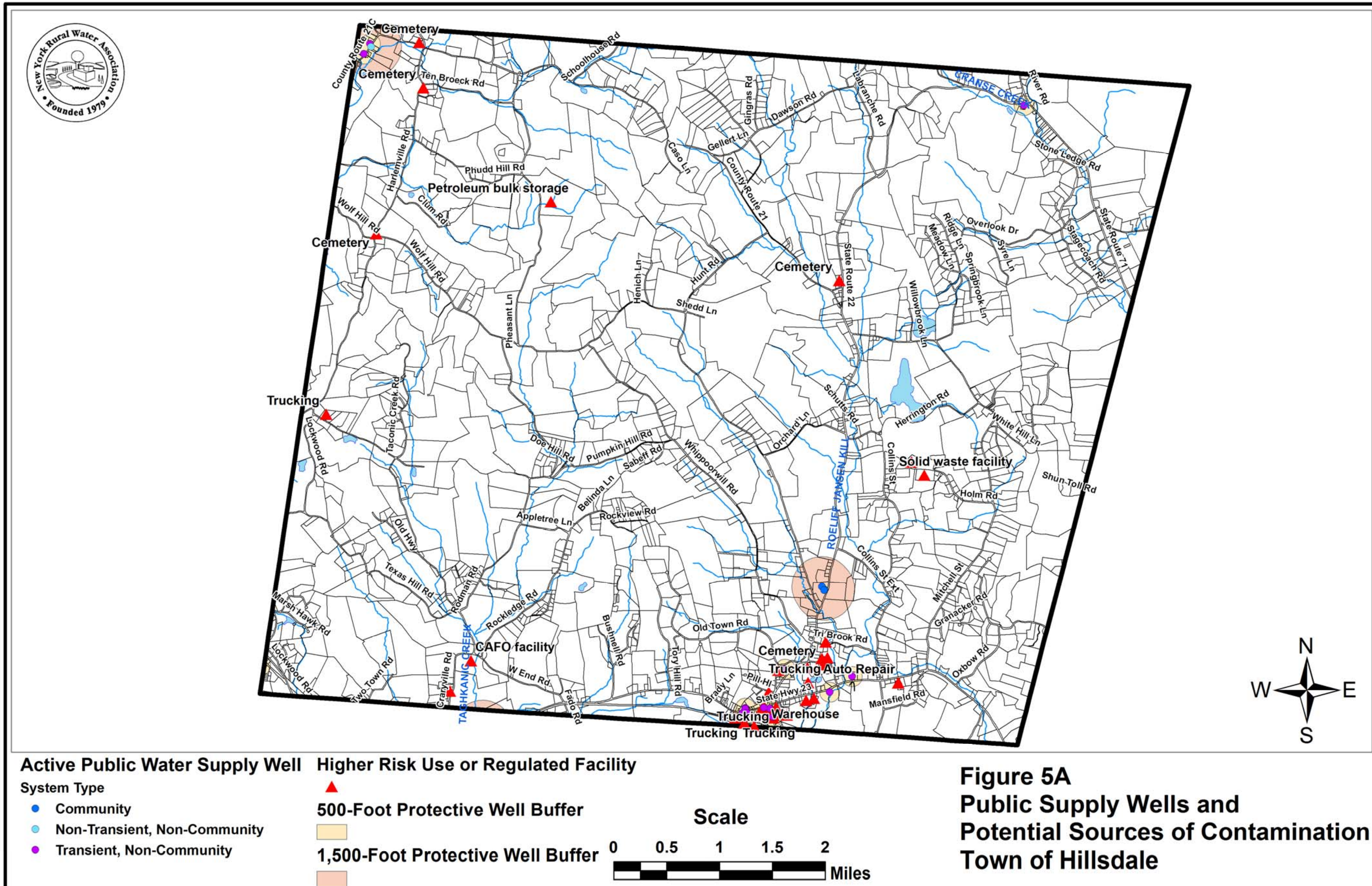


Figure 5A
Public Supply Wells and Potential Sources of Contamination
Town of Hillsdale

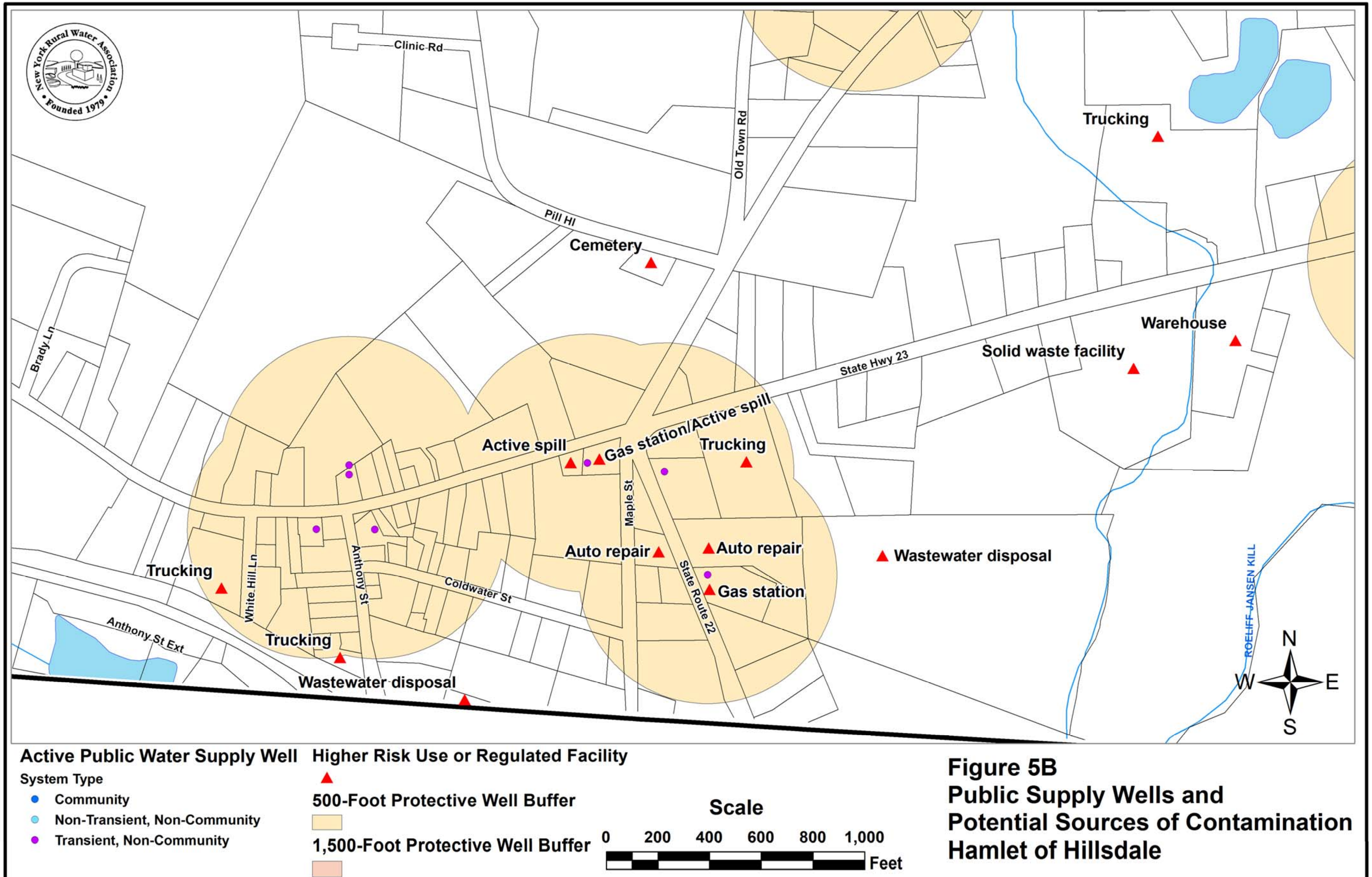


Figure 5B
Public Supply Wells and Potential Sources of Contamination Hamlet of Hillsdale

Based upon a search of the United States Environmental Protection Agency's Safe Drinking Water Information System (SDWIS), no public water system in Hillsdale has had a health-based violation. The 2004 Source Water Assessments conducted by the NYSDOH did indicate levels of nitrate above 5 mg/l for the Hillsdale Fire Company No.1. Although below the drinking water Maximum Contaminant Level (MCL) of 10 mg/l, this level is above the action level of 5 mg/l that often leads to more extensive monitoring. The Source Water Assessment also indicated that the Hillsdale Country Diner relied upon filters due to petroleum. A 1991 spill occurred at a gas station across the street (see Figure 5B).

3.2 Individual Homeowners

Outside of a community water system, residents in Hillsdale receive their drinking water from individual wells. The vast majority of these homeowner wells have drilled wells completed in the bedrock. Figure 6 is a map of where water wells have been drilled since 2000. Drilling activity peaked in 2006, when 22 new wells were drilled in Town.

4.0 GROUNDWATER OCCURRENCE

Groundwater is subsurface water that fills (saturates) all the voids in the rock or soil. Groundwater 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. Groundwater also occurs in cracks (fractures) found in rock. This is known as secondary porosity. Most of the water in bedrock is found in fractures.

4.1 Bedrock

Bedrock in the Town of Hillsdale is the source of groundwater for the vast majority of residents and businesses. In bedrock, steel casing is set through the overburden (unconsolidated deposits) and into the first few feet of sound rock. The remainder of the well is left as an open borehole in the rock. Although the median depth of bedrock wells in Hillsdale is 405 feet (Table 2), well depths range from 45 to 930 feet (Figure 7). Deepest wells in excess of 600 feet deep are found in higher elevations such as White Hill and Kijk-Uit Mountain (Figure 8). In contrast, well depths in lower elevation areas such as the lower Roeliff Jansen Kill valley in the vicinity of Hillsdale hamlet are typically from 100 to 200 feet (Figure 8).

The median depth of casing is 40 feet. Casing depths reportedly range up to 266 feet. Note that water well drilling regulations promulgated by the NYSDOH now specify a minimum of 20 feet of casing, 19 feet below grade.

The median yield of bedrock wells in Hillsdale is 5 gallons per minute (gpm) and 45 percent of wells yield less than the 5 gpm required by FHA for new home loans (Figure 9). Thirteen percent of drilled wells in Hillsdale yield 1 gpm or less (Figure 9). NYSDOH does not recommend the use of wells with yields of 1 gallon per minute or less for any homes with four or more bedrooms.

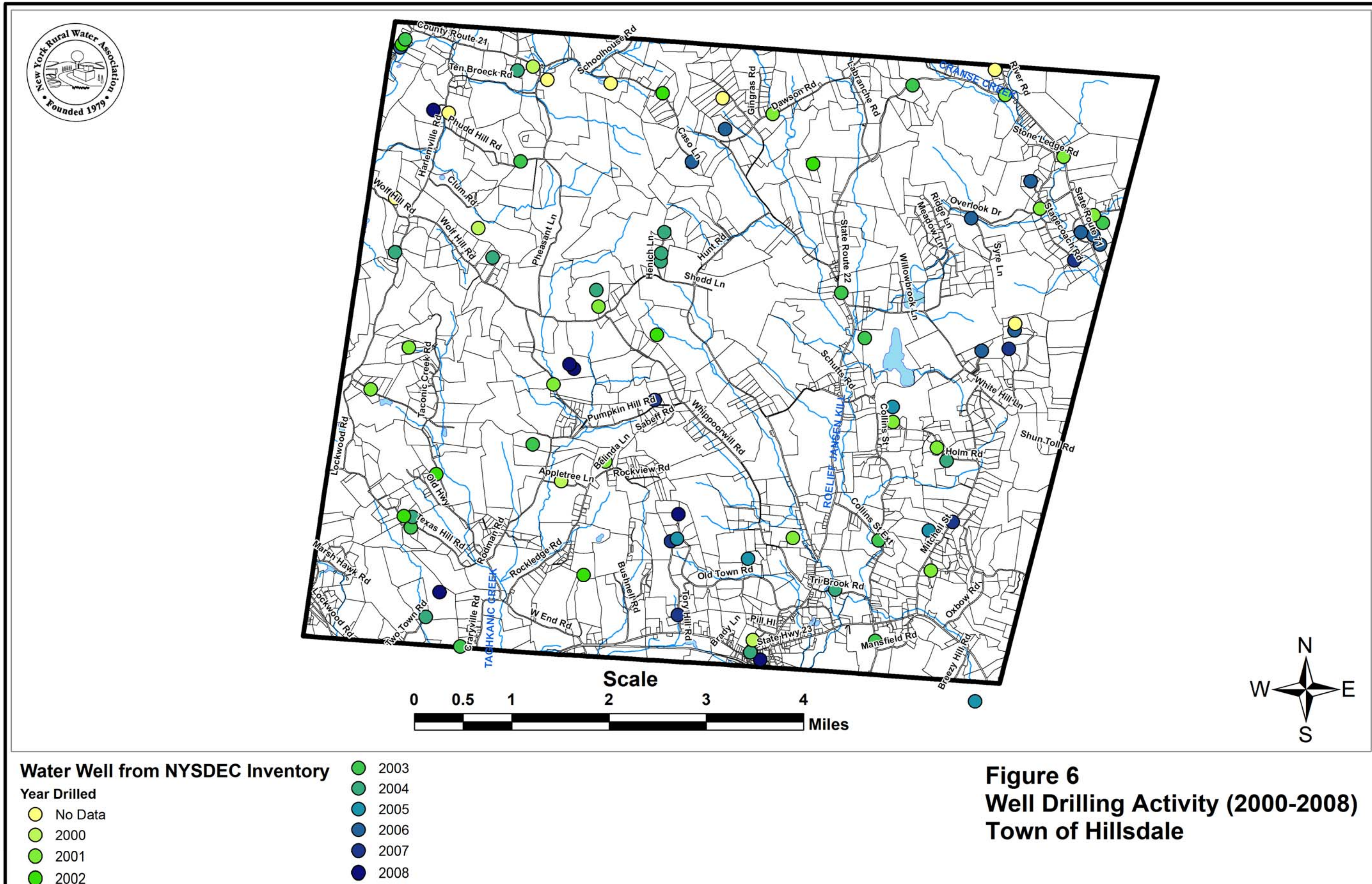


Figure 6
Well Drilling Activity (2000-2008)
Town of Hillsdale

Formation	# of Wells	Median Well Depth (feet)	Median Well Yield (gallons per minute)
Austerlitz Phyllite	3	405	1
Balmville Limestone	5	325	8
Elizaville Formation	15	400	3.5
Everett Formation	6	568	10
Walloomsac Formation	45	405	5
Wappinger and Stockbridge Groups	17	250	10
All Wells	91	405	5

Table 2. Summary of Bedrock Well Data

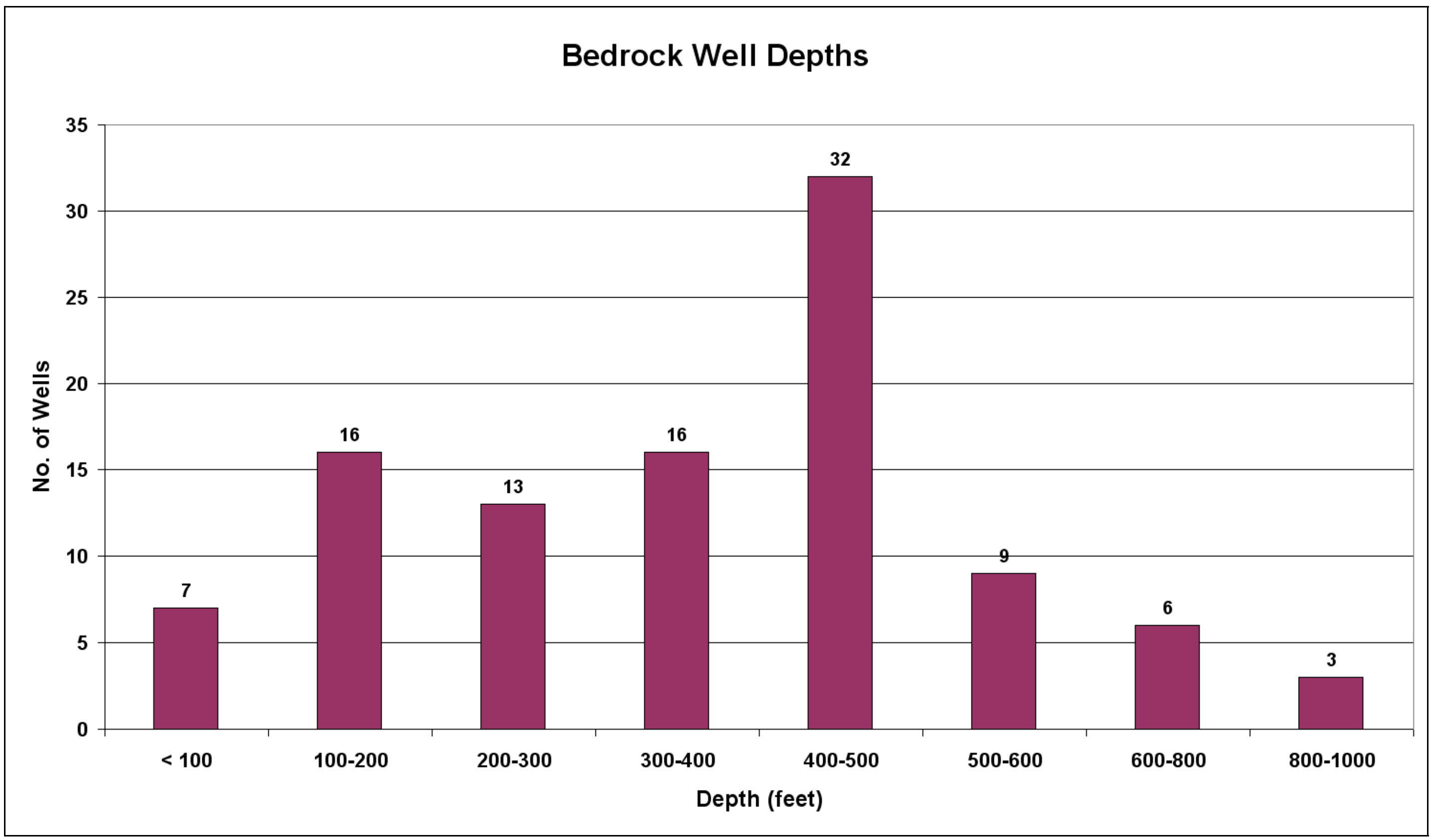


Figure 7. Distribution of Well Depths.

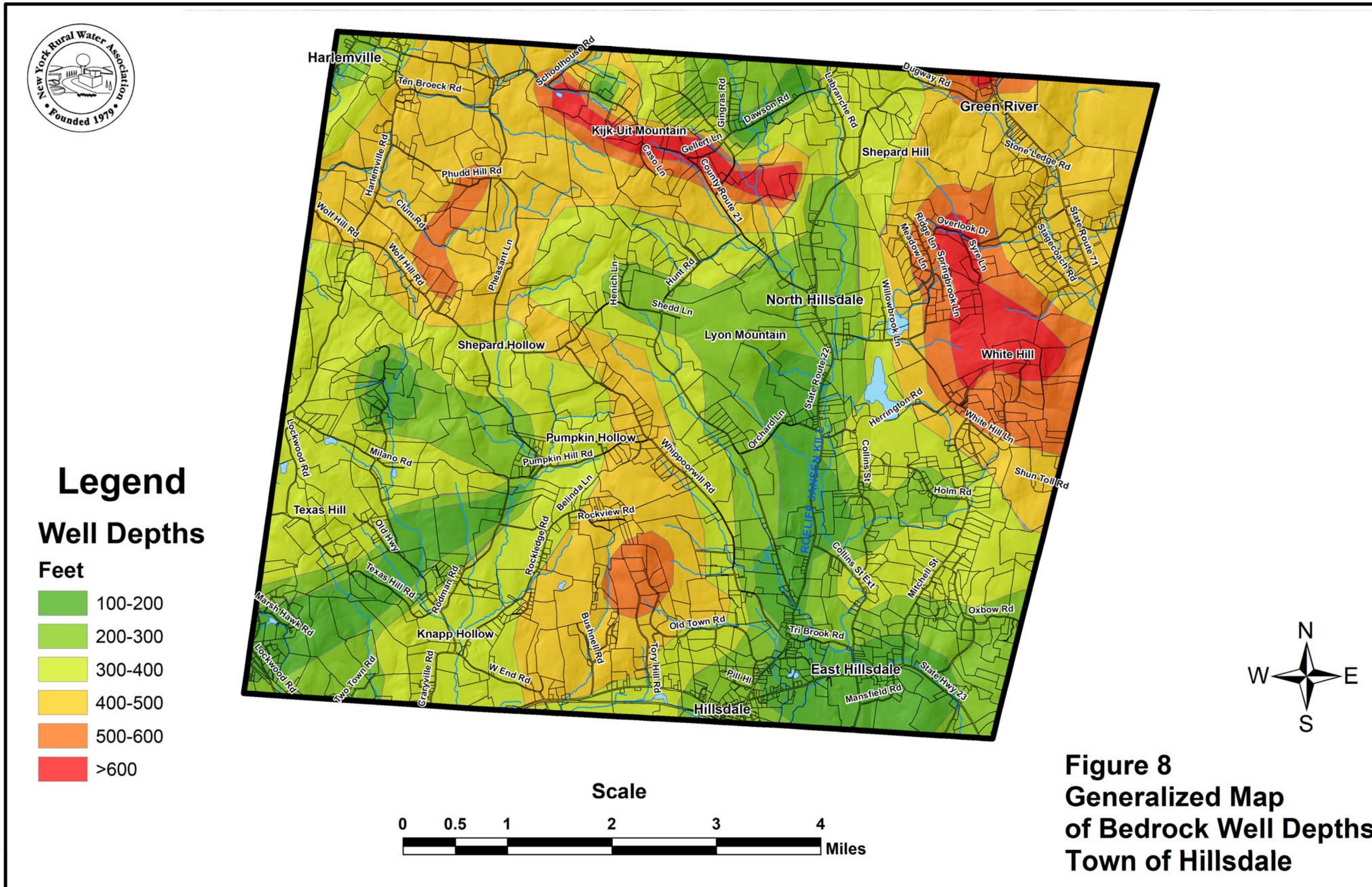


Figure 8
Generalized Map of Bedrock Well Depths Town of Hillsdale

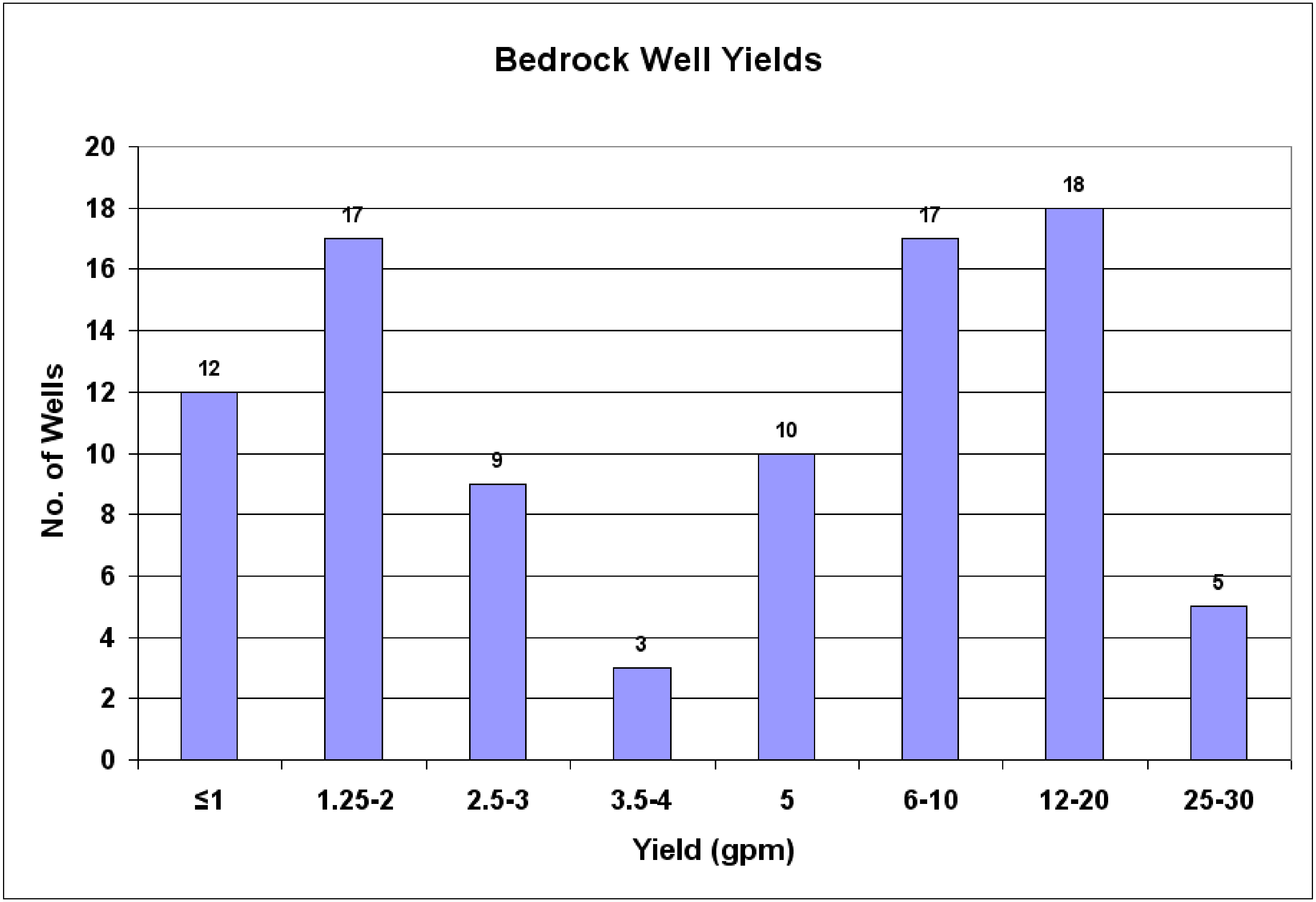


Figure 9. Distribution of Bedrock Well Yields.

As indicated on Figure 10 and Plate 3, there is some variation in bedrock well yields across Hillsdale. Much of this variation is due to the type of bedrock. The carbonate rocks of the region (including the Balmville Limestone) often have significantly higher permeability due to the presence of openings that have been enlarged and opened through dissolving of the rock material. In some instances, dissolution of the rock can lead to karst features, including caves, springs, sinkholes, and disappearing streams. Drillers have noted such voids in Hillsdale.

Due to its enhanced permeability, well yields in the Stockbridge-Wappinger Group carbonates are significantly higher than those in the Austerlitz, Elizaville, or Walloomsac formations (see Table 2). The median yield in the Stockbridge-Wappinger Group carbonates is 10 gpm. Although there is limited data, the median yield in the Everett Formation is similar to that of the Stockbridge-Wappinger Group. This is attributed to the degree of fracturing.

Due to reduced permeability, the availability of groundwater in the Austerlitz, Elizaville, and Walloomsac formations is significantly less. The median yield in these argillites of the Slate Hills Region is just 3.5 gpm. Fifty-seven percent of all wells drilled in these three formations yield less than 5 gallons per minute.

Wells intersecting subsurface fracture zones can produce significantly more water. These zones are often reflected by linear features visible on aerial photography and topographic maps. NYRWA has mapped these features on Figure 10 and Plate 3.

Unfortunately, water quality data is not reported to NYSDEC or other agencies for residential wells in Columbia County. As expected, water from the Wappinger-Stockbridge Group is characteristically hard. Sixty-eight percent of residents in nearby Ancram that were surveyed and utilized the carbonates for their water supply source report hard water. Arnow (1951) had reported that well water from the shaly (argillitic) rock in Columbia County is relatively soft. However, a majority of residents in Ancram reported hard water. This could be due to the presence of sulfate minerals in the water. Accordingly, a higher percentage of residents in Ancram also reported odor problems with water from the Walloomsac Formation.

4.2 Unconsolidated Aquifers

Comparatively fewer wells in Hillsdale have been completed in unconsolidated (sand and gravel) aquifers. Unconsolidated aquifer wells are largely restricted to the Agawamuck Creek, Green River, and Roeliff Jansen Kill valleys in Hillsdale (Plate 4). Wells that are completed in the unconsolidated deposits for private, residential use are typically left as open ended casing. The casing is terminated in the water-bearing material. Such construction is sufficient for many purposes. The median yield for these types of wells in Hillsdale is 10 gpm.

Unconsolidated deposits are capable of producing very high yields if wells are finished with a properly sized and developed screen. A well screen is a filtering device that permits water to enter the well but prevents the unconsolidated material (sand, etc.) from entering the well. Screening is placed in the well and the casing is generally pulled back to expose the screen to the unconsolidated material. Screens are typically made of stainless steel and have openings referred to as slots.

New York Rural Water Association • Founded 1979 •

Legend

- Low Well Yield Area
- Linear Feature
- Fault

Bedrock Well Yield

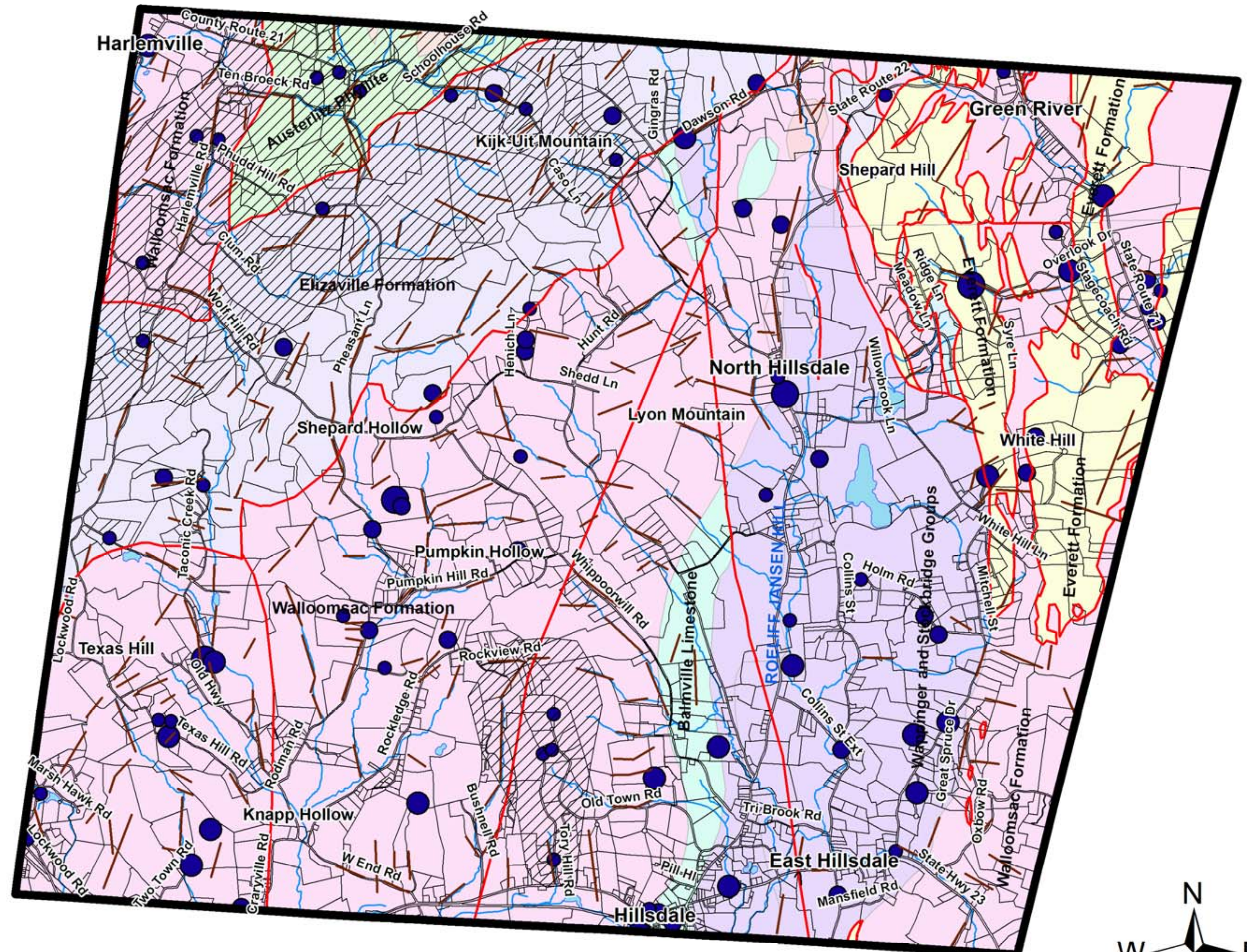
gpm

- < 5 gpm
- 5 - 12
- 15- 20
- 25 - 30

Bedrock Geology

Formation

- Austerlitz Phyllite
- Balmville Limestone
- Cheshire Quartzite and Dalton Formation
- Elizaville Formation
- Everett Formation
- Melange
- Rensselaer Graywacke
- Taconic Breccia
- Walloomsac Formation
- Wappinger and Stockbridge Groups



N
W E
S

Note:

Bedrock formation contacts digitized by NYRWA from Fisher et al. (1970), Zen and Ratcliffe (1971), and Ratcliffe (1974).

Scale

0 0.5 1 2 3 4 Miles

Figure 10
Map of Bedrock Well Yields
Town of Hillsdale

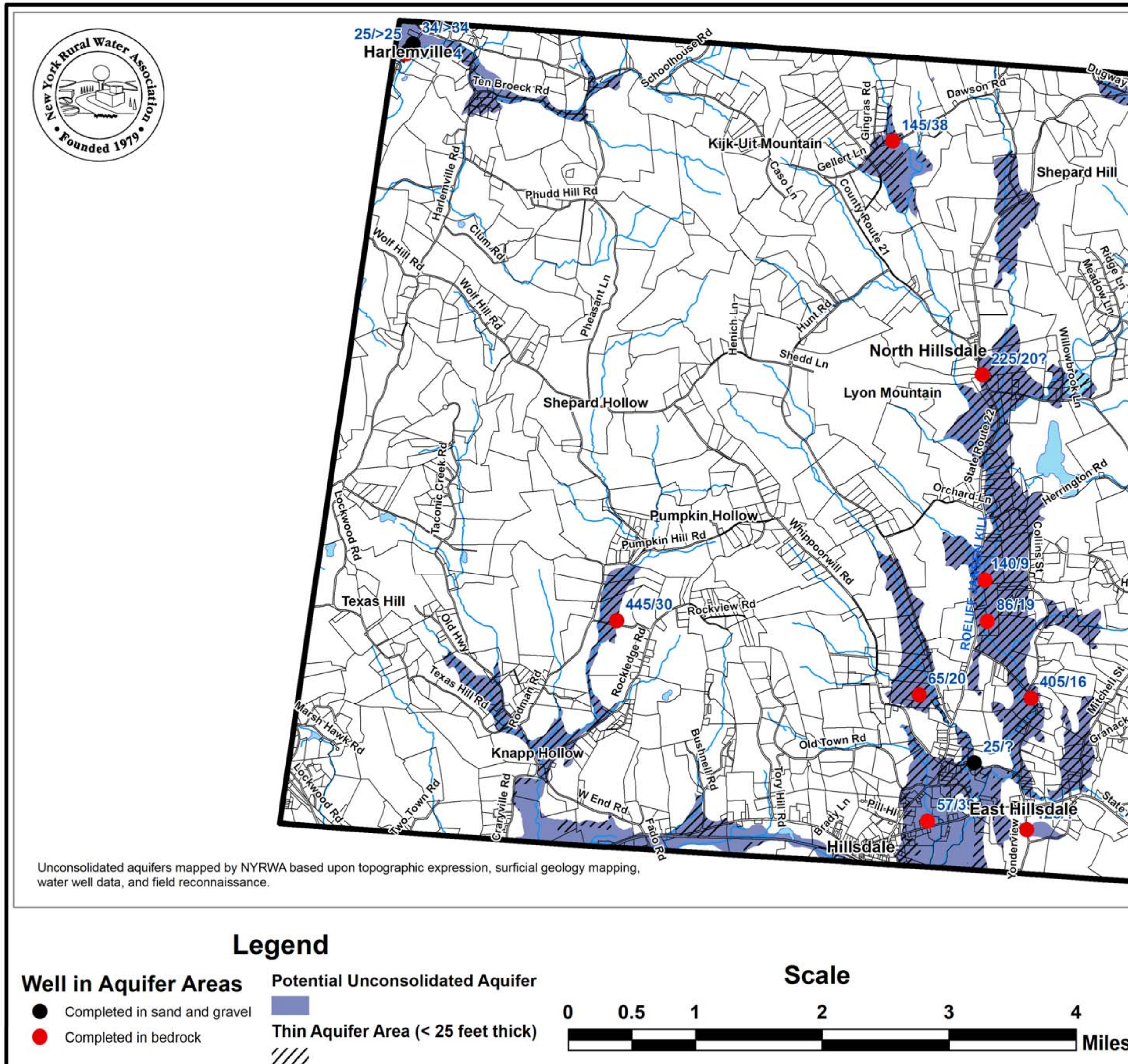


Figure 11
Potential Unconsolidated Aquifers
Town of Hillsdale

The distribution of water-bearing unconsolidated deposits is generally limited to areas along or near the valleys in Hillsdale. On Figure 11 and Plate 4, NYRWA has mapped the distribution of unconsolidated aquifers in the Town of Hillsdale. The boundaries of these aquifers were delineated by NYRWA on the basis of glaciofluvial deposits (see Plate 2) and available subsurface data. In general, only areas of glaciofluvial deposits believed to have adequate saturated thickness for well construction are included in aquifer boundaries. Areas of thinner sand and gravel deposits within aquifer areas are denoted by a diagonal overprint. Here, the thickness of sand and gravel is generally insufficient for high yield wells, but may yield enough water to shallow domestic wells or recharge underlying fractured bedrock.

In terms of quality, water from unconsolidated aquifers is very hard. Over eighty percent of Ancram residents with unconsolidated aquifer wells reported hard water. However, the water from unconsolidated aquifers has less reported problems with odor, staining, and sediment. Shallow sand and gravel wells are more prone to contamination from activities at the land surface. Such wells are also more susceptible to surface water contamination.

5.0 INVENTORY OF POTENTIAL CONTAMINANT SOURCES

Groundwater resources are susceptible to contamination from a variety of manmade sources. These include various industrial, commercial, residential, and agricultural uses and activities. Practices involving the handling, use, storage, and/or disposal of petroleum and other hazardous substances have the highest potential to contaminate groundwater. Once contaminated, groundwater is very difficult and costly to cleanup. It is best to reduce the likelihood of contamination through the use of environmentally-sound best management practices and/or structural methods.

Several potential sources of contamination are regulated by government agencies such as the NYSDEC. Some others are not. NYRWA has conducted an inventory of potential sources of contamination and Figures 5A and 5B are the result of this effort. Inclusion on this map does not mean that a particular use has resulted in groundwater contamination. It simply means that it has the potential to do so. As part of the inventory NYRWA used databases available from the NYSDEC and USEPA on regulated activities such as: wastewater dischargers (SPDES facilities); waste generators, transporters, and storers (RCRA); hazardous waste sites (Superfund); petroleum bulk storage facilities; and active spills.

NYRWA also used property classification codes from the New York State Office of Real Property Services to identify largely non-regulated uses that could be considered as potential contamination sources. These higher risk land uses such as gas stations, motor vehicle services, manufacturing, etc. are plotted on Figures 5A and 5B according to the property classification.

6.0 HYDROGEOLOGIC ANALYSES

In addition to inventorying groundwater resources, it is also very important to conduct analyses to determine the potential impacts of future development. With the aid of GIS, NYRWA utilized detailed groundwater resource mapping and digital elevation data to determine: (1) what areas of Hillsdale have hydrogeologic settings that are sensitive to future development; (2) what intensity of development is appropriate to preserve groundwater quality; and (3) what concentration of development can be sustained without seriously impacting related surface waters.

6.1 Hydrogeologic Sensitivity

The *hydrogeologic sensitivity* of a location is a relative measure of the ease and speed with which a contaminant could migrate into and within the upper-most water-bearing unit. High to very high hydrogeologic sensitivity ratings indicate that, in general, groundwater could be readily impacted by surface activities. Development activities that could contaminant groundwater include nitrates and bacteria from septic systems, nutrients from fertilization and irrigation of lawns, salts from deicing, and volatile organics and other contaminants from leaks and improper disposal of petroleum and other fluids. If possible, higher-risk land uses should be steered away from areas of high to very high hydrogeologic sensitivity.

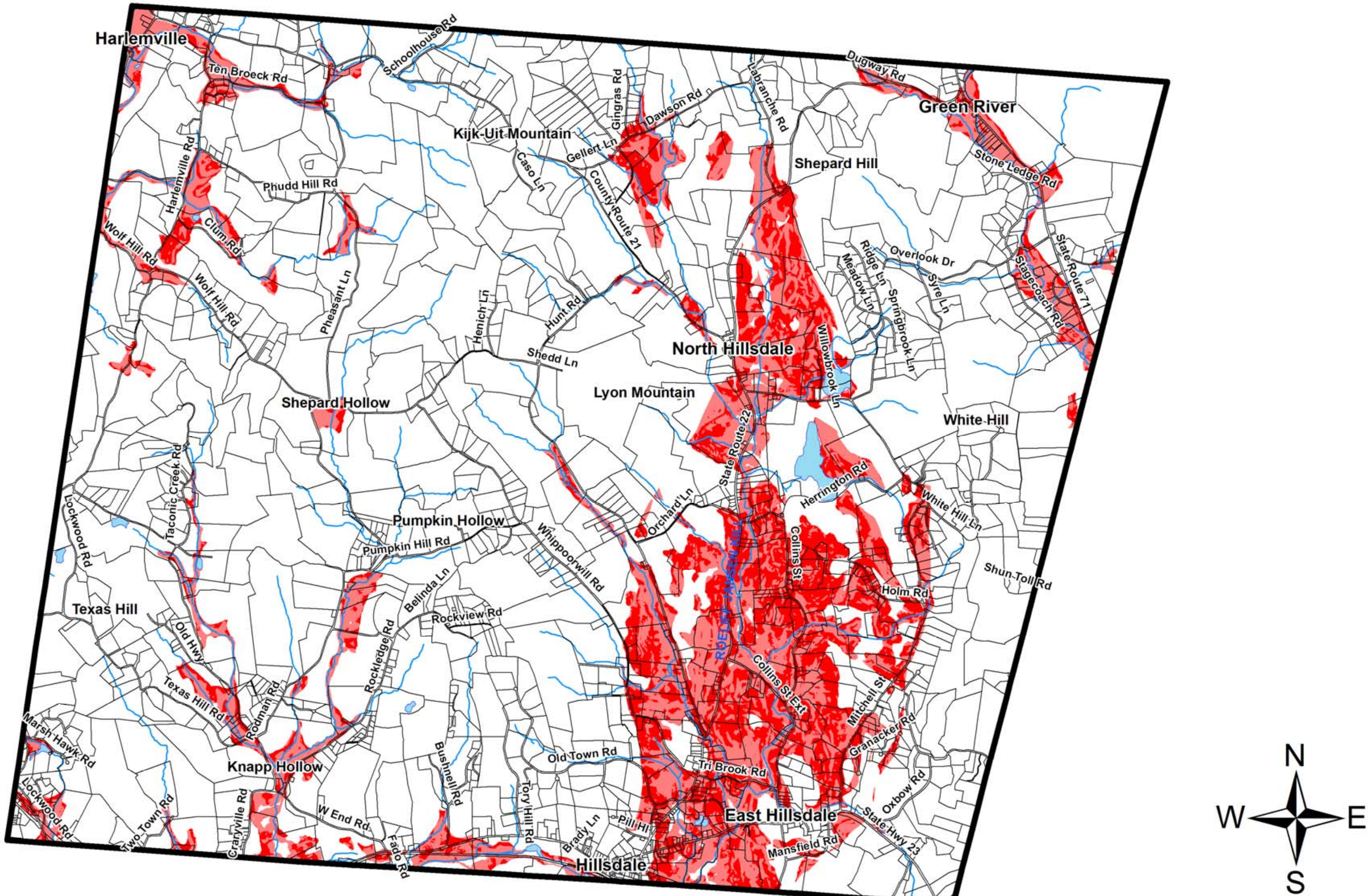
The hydrogeologic sensitivity is a function of the naturally occurring hydrogeologic characteristics of an area. The nature and extent of potential sources of groundwater contamination are not factored into hydrogeologic sensitivity ratings. Instead, the two factors controlling the hydrogeologic sensitivity are the site's geologic materials (the hydraulic characteristics of the uppermost water-bearing unit and the overlying soils) and the site's topographic position (the topographic factors influencing the vertical migration of groundwater). Areas with higher hydrogeologic sensitivity based upon geologic materials and topographic position ratings are mapped on Figure 12. NYRWA has detailed the methodology used to calculate hydrogeologic sensitivity ratings in Appendix A.

High to very high sensitivity is found chiefly in areas with coarse-grained soils with underlying unconsolidated or limestone/dolostone aquifers. Much of the Roeliff Jansen Valley area has high to very high hydrogeologic sensitivity. The exception is the streamlined, lower hills across the valley. These are covered by steep, less permeable till soils. Areas along the Agawamuck Creek, Green River, and Taghkanic Creek have higher sensitivity due to the unconsolidated aquifers here. Much of the Slate Hills and Southern Taconic Mountains regions have lower hydrogeologic sensitivity due to the lower permeability of the bedrock, the poor infiltration rates of the till soils, and the steeper slopes.

6.2 Recommended Minimum Lot Sizes

With the exception of the hamlets of Harlemville, Hillsdale, and North Hillsdale, the minimum lot size dictated by current zoning is three acres (in the hamlets it is one acre). NYRWA conducted hydrogeologic analyses in order to determine if current minimum lot sizes are adequate for dilution of septic effluent and for the conservation of baseflow.

Excessive nitrate loading of groundwater can occur if there is too high a density of septic systems in a given area. To avoid excessive nitrate loading, the spacing of homes must be large enough for natural groundwater recharge to adequately dilute the effluent from septic systems to acceptable levels. NYRWA has calculated the necessary lot sizes across Hillsdale to ensure that levels of nitrate not exceed a level of 5 mg/l.



Legend

- High Hydrogeologic Sensitivity
- Very High Hydrogeologic Sensitivity

Scale

0 0.5 1 2 3 4 Miles

Figure 12
High Hydrogeologic Sensitivity
Town of Hillsdale

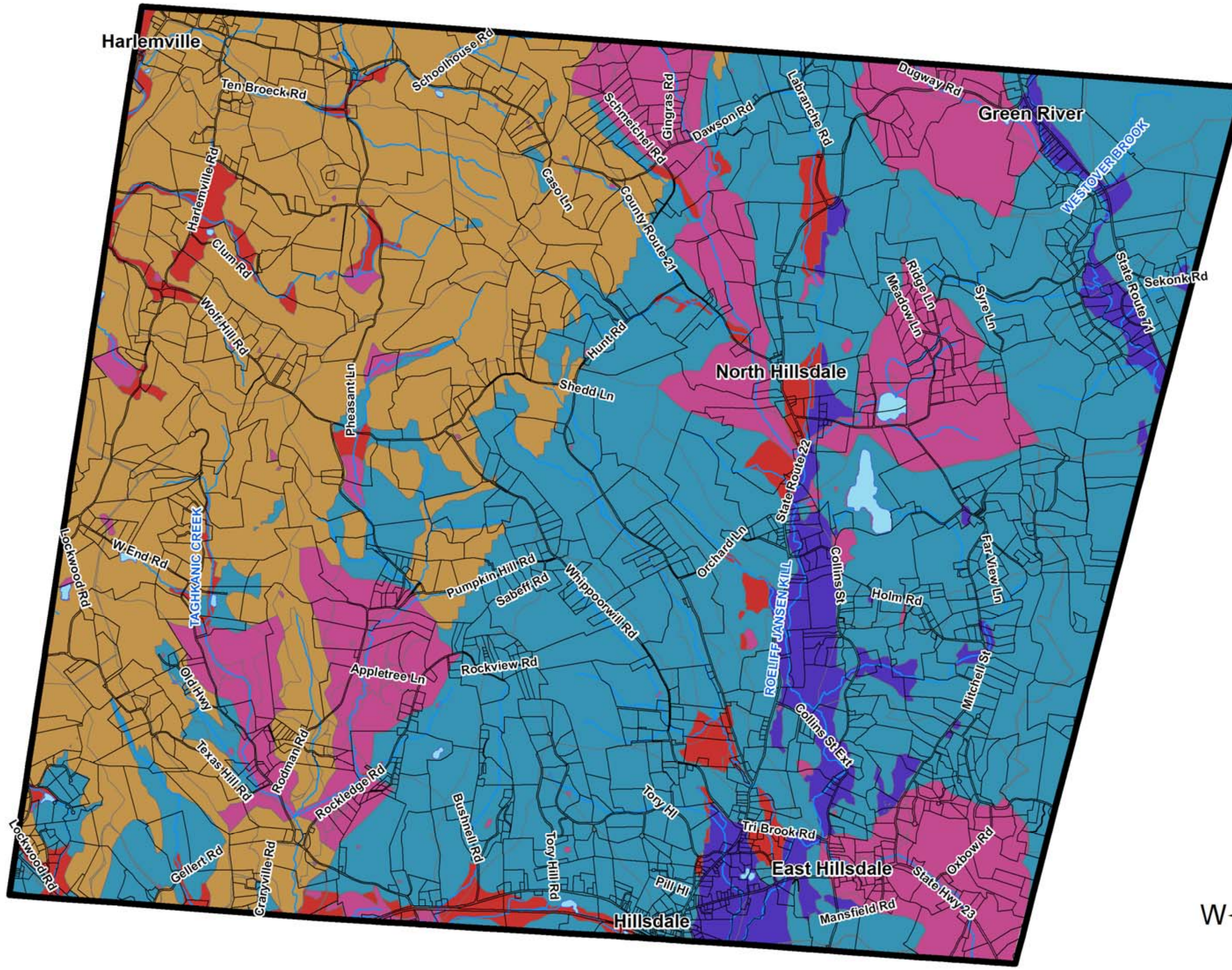
The methodology and results of this analysis are presented in Appendix C. The chief variable in determining the lot size to avoid nitrate loading is the annual groundwater recharge rate. Appendix B details the groundwater recharge rates in Hillsdale.

Excess withdrawal of groundwater can also lead to unacceptable consequences. Although most water that is withdrawn by wells is eventually returned to the environment through septic systems or discharges to streams, some is consumed and removed from the immediate environment. This water loss could lead to a reduction of groundwater held in storage and/or a decrease of natural groundwater discharge to streams and other surface water bodies. This discharge to streams, known as baseflow, sustains streamflow in the absence of precipitation. During prolonged dry periods, surface water flow is drastically reduced and the reduction in baseflow from groundwater withdrawals would be most noticeable. During drought, it is critical that sufficient streamflow is maintained for ecological resources and to dilute possible wastewater discharges.

In Hillsdale, NYRWA has used the conservation of drought baseflow as a standard to measure the sustainable yields of cumulative residential well pumping. In Appendix D, NYRWA details a methodology used to calculate a sustainable minimum lot size. This is the average number of acres per household in the basin or sub-basin such that 50 percent of the drought flow for the principal stream in the area is not exceeded by projected consumptive use. Results of this analysis are given in Appendix D.

Using GIS, NYRWA next compared the minimum lot sizes to safely dilute septic system effluent and the minimum lot size to avoid excess baseflow depletion. In order to protect groundwater, NYRWA selected the larger of the two calculated minimum lot sizes for a given location. This selected size is referred to as the recommended minimum lot size and is presented in Figure 13. Recommended minimum lot sizes range from 1 to 5 acres.

How do the recommended lot sizes compare to the actual minimum lot size permitted by present zoning? Results of this comparison are presented in Figure 14. In general, the permitted lot size of 1 acre in the hamlets is smaller than the recommended lot size. Also, the recommended minimum lot size across much of the Slate Hills region of Hillsdale is larger than the permitted minimum lot size.



Legend

Recommended Minimum Lot Size

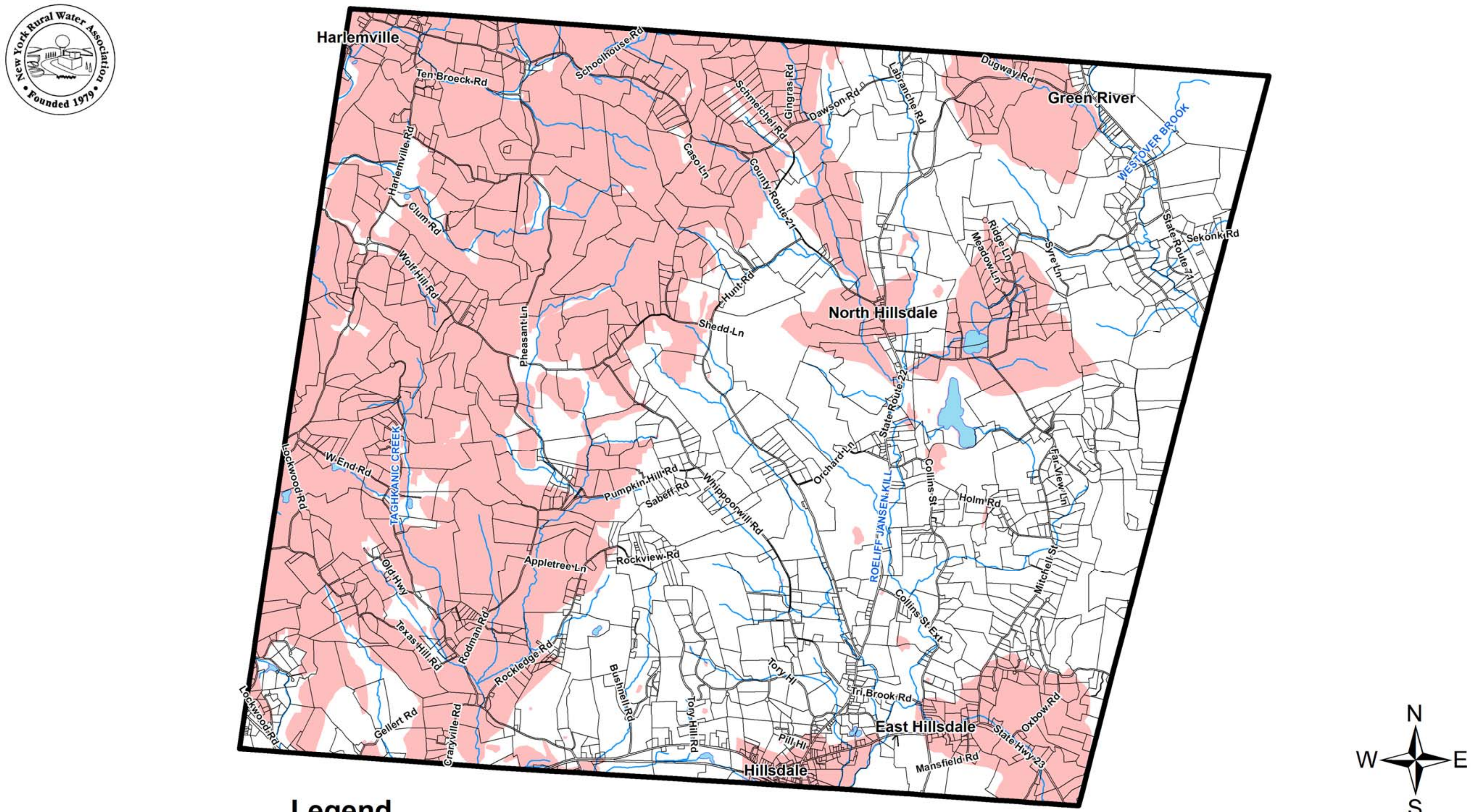
acres

- 1
- 1.5
- 2
- 3
- 4
- 5

Scale

0 0.5 1 2 3 4 Miles

Figure 13
Recommended Minimum Lot Sizes Based Upon Dilution of Septic Effluent and Conservation of Drought Baseflow



Legend

Recommended Minimum Lot Size > Minimum Lot Size Permitted by Zoning

Scale

0 0.5 1 2 3 4 Miles

Figure 14
Recommended Minimum Lot Size Versus Minimum Lot Size Permitted By Zoning

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 it is best suited. There are a number of groundwater protection measures that can be chosen. Some of these are regulatory in nature. Others are non-regulatory. The Town of Hillsdale must determine which measures are acceptable given local socioeconomic and political conditions. These measures could include: promulgation or amending of land use regulations, environmental review, open space planning, and education.

7.1 Land Use Regulations

The Town of Hillsdale does have a comprehensive set of land use regulations, including subdivisions regulations, site plan review, and zoning.

7.1.1 Subdivision Regulations

Subdivision regulations in Hillsdale could be further amended to optimize protection of groundwater resources. For example, the following elements could be required for conditional approval of a subdivision:

- 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 would be in the plats and documents for final approval as well.

A hydrogeological study could be required for new subdivision involving a certain number of lots that relies upon either on-site groundwater withdrawals and/or on-site sewage disposal. Such a study could also be necessary for areas identified in this study as low-yield areas.

Standards may be added to subdivision regulations that specifically cover wells. These standards can specify 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. An adverse impact to groundwater can be defined as any reductions in groundwater levels or changes in groundwater quality that limit the ability of a groundwater user to withdraw groundwater. 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.

7.1.2 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 has reviewed the Town of Hillsdale Site Plan Review requirements that are included in the zoning law and recommends the following site plan elements are added to the site plan submission requirements:

- 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.
- The location(s) of all public water systems and other groundwater users within 1,500 feet of the proposed development boundaries;
- 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;
- 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 groundwater 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.

Submittal of a site plan *and* a hydrogeological study could be required for any proposed project in Hillsdale that has projected on-site groundwater withdrawals and/or on-site sewage disposal flows equal to or exceeding a certain amount (1,000 or 2,000 gallons per day (gpd) perhaps).

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

- Adequacy of control measures to prevent groundwater or surface water contamination.
- The proposed use will not result in reductions in groundwater levels or changes in groundwater quality that limit the ability of a groundwater user to withdraw groundwater.

7.1.3 Zoning

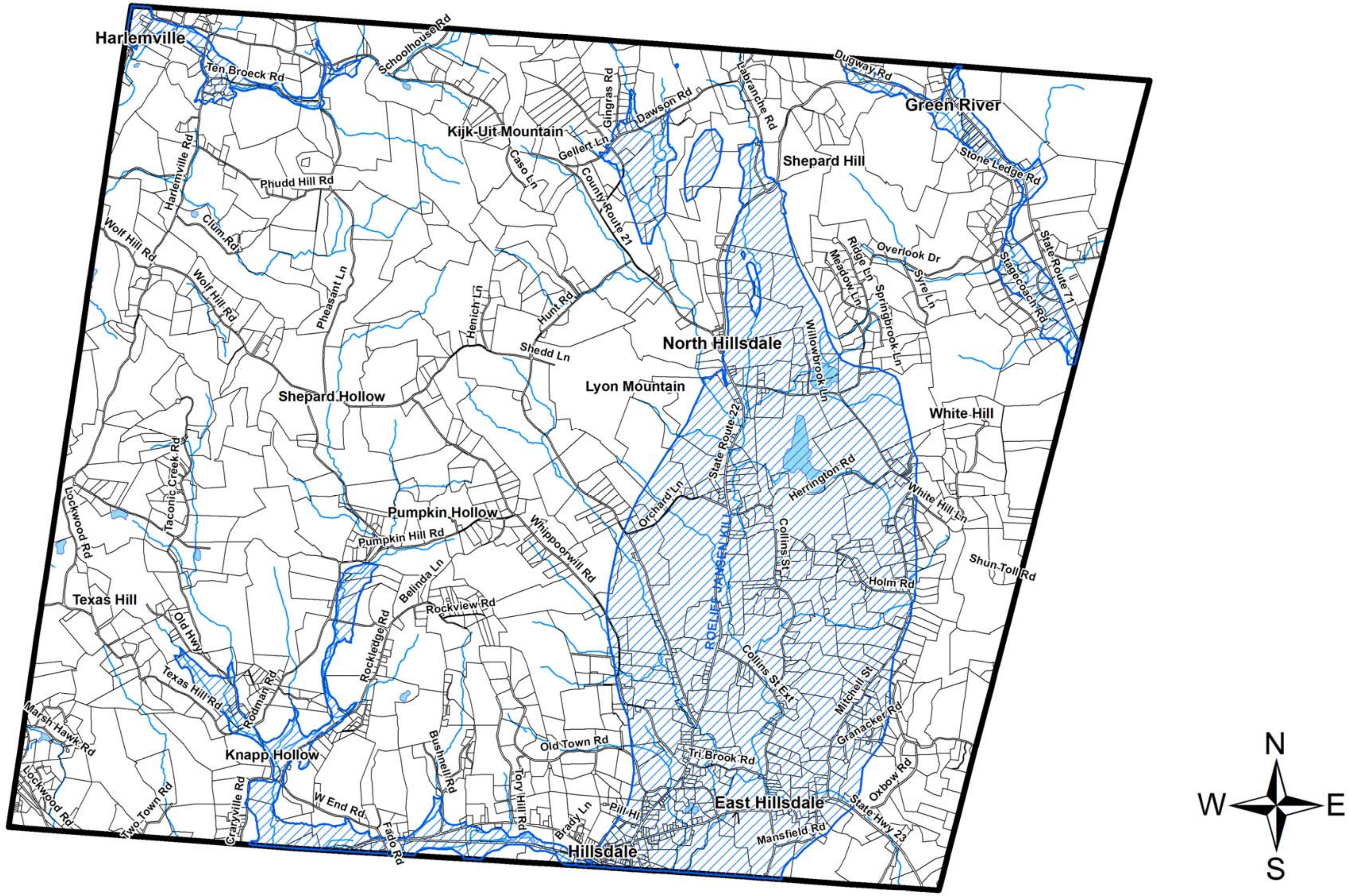
Zoning regulates land uses, the density of land uses, and the siting of development. There are two major zoning revisions that the Town of Hillsdale should consider with respect to groundwater resources. First, the Town may wish to consider adjusting minimum lot sizes for those areas where the minimum lot size permitted by zoning is less than the recommended minimum lot size (see Figure 14).

Second, uses of land with a higher-risk of groundwater contamination should be “steered-away” from areas of high hydrogeologic sensitivity (Figure 12). This could be accomplished by making the Aquifer (AQ) Overlay District in Section 5.1-5 of the zoning law effective. To do this, the Town must adopt a map of the Aquifer Overlay District. Figure 15 is a proposed Aquifer Overlay District map. Included within the proposed boundaries of the overlay district are unconsolidated aquifers and areas underlain by the Stockbridge-Wappinger Group carbonates and the Balmville Limestone.

7.2 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. An aquifer, watershed, wetland, 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



Legend

Proposed Aquifer Overlay District

Scale

0 0.5 1 2 3 4 Miles

Figure 15
Proposed Aquifer Overlay District
Town of Hillsdale

impact of any Type I or Unlisted Action on the environmental characteristics of the CEA when determining the significance of a project.

The Town of Hillsdale may wish to consider naming its Aquifer Overlay District as a CEA.

7.3 Open Space Planning

As growth continues in the Hudson River Valley, the Town of Hillsdale should consider developing an open space preservation plan. Open space is defined as land that is not intensively developed for residential, commercial, industrial or institutional use. An open space preservation plan would identify parcels that have certain features or serve particular functions. The plan would also recommend short-term and long-term actions to initiate open space preservation. Groundwater resources would be one of several open space needs that would be addressed.

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.

7.4 Education

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

- Informing residents about the results of this study;
- 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).

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