GROUNDWATER RESOURCES STUDY

for the

TOWN OF MINDEN
MONTGOMERY COUNTY, NEW YORK

February 2012

Prepared by:

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Prepared for:

Town of Minden

TABLE OF CONTENTS

FIGURES

PLATES

(24x36-inch maps located in back)

1.0 INTRODUCTION

1.1 Goals and Objectives

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

In order to preserve the groundwater resources of Minden for today and the future, the following Groundwater Resources Study has been prepared by the New York Rural Water Association (NYRWA). This report inventories and maps the groundwater resources and aquifers of Minden, identifies the vulnerability of groundwater to pollutants, 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New York Rural Water Association has utilized a variety of published and unpublished data sources for this report and plan.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 and the New York State Department of Environmental Conservation's Water Well Program. In addition, test borings from the New York State Department of Transportation were compiled. Details of compiled subsurface data are summarized on Plate 1 contained within this report. NYRWA also interviewed water well drillers to learn about local drilling conditions.

A number of published and unpublished geologic maps were reviewed. A digital version of the Montgomery County Soil Survey and the New York State Geologic Map were utilized for analyses and mapping. Plate 5 from the United States Geological Survey Water-Resources Investigations Report 88-4091 was digitized. In addition, elevation data for Minden were taken from digital elevation models (DEMs). This information was then used to derive slope data and hillshading images. Parcel mapping was provided by Community Planning and Environmental Associates. Other digital data were downloaded from the New York State GIS Clearinghouse. Finally, New York Rural Water Association conducted on-site activities in Minden to map surficial geologic materials and unconsolidated aquifers. A global positioning system (GPS) device was used to capture the geospatial coordinates of such features.

2.0 SETTING

2.1 Topography and Physiography

As illustrated on Figures 1 and 2, Minden spans three different physiographic regions: the Appalachian Plateau, the Appalachian Uplands, and the Mohawk Valley. Each of these physiographic regions has distinctive topographic relief, landforms, and geology. The Appalachian Plateau occupies the southwest corner of Minden. Here, elevations range from 1,100 to 1, 600 feet above sea-level. The boundary of the Appalachian Plateau is a steep slope known as the Onondaga-Helderberg Escarpment. This feature has formed from more resistant limestone bedrock (see Section 2.3 below). Most of the Appalachian Plateau in Minden is occupied by slopes exceeding 25 percent.

The Appalachian Uplands are a broad region that comprises the majority of Minden. The topography of this region is highly variable. Elevations increase westerly from 295 feet at the mouth of Otsquago Creek at Fort Plain to as much as 1,100 feet above sea level at the base of the Onondaga-Helderberg Escarpment. The region has been deeply dissected by Otsquago Creek and its tributaries. Steepest slopes occur along the Otsquago Creek valley and along NW-SE trending hills that have been streamlined by glacial erosion.

The Mohawk Valley Physiographic Region occupies the northern portion of Minden. This region is characterized by steep northeast-facing slopes in excess of 25 percent that lead to a narrow flat flood plain along the Mohawk River. Elevations range from 850 feet along NYS Route 5S to 300 feet above sea-level along the Mohawk River.

2.2 Drainage

The Town of Minden resides within the Mohawk River Basin. Approximately 63 percent of the Town's land area drains into the Otsquago Creek (Figure 3). This stream has its headwaters in the Appalachian Plateau region of the Town of Springfield in Otsego County and the Town of Stark in Herkimer County. It flows into the Mohawk River at Fort Plain. About 25 percent of Minden eventually drains into Canajoharie Creek (Figure 3). This Mohawk River tributary has its origins in the Otsego County towns of Cherry Valley and Springfield as well as the Town of Sharon in Schoharie County. It flows into the Mohawk at Canajoharie. The remaining 12 percent of Minden either drains directly into the Mohawk River or through small tributaries that reach the Mohawk River (Figure 3).

2.3 Bedrock Geology

2.3.1 Beekmantown, Trenton, and Black River Groups

Figure 4 is a map of the bedrock formations underlying the Town of Minden. These formations are also shown on the Figure 2 cross-section. The oldest rocks that outcrop in Minden are those of the Beekmantown, Trenton, and Black River Groups. These rocks outcrop in the northern portion of the Town, near the New York State Thruway. Fisher (1970) shows a number of faults intersecting these rocks, indicating that these formations are at complex relations locally. The

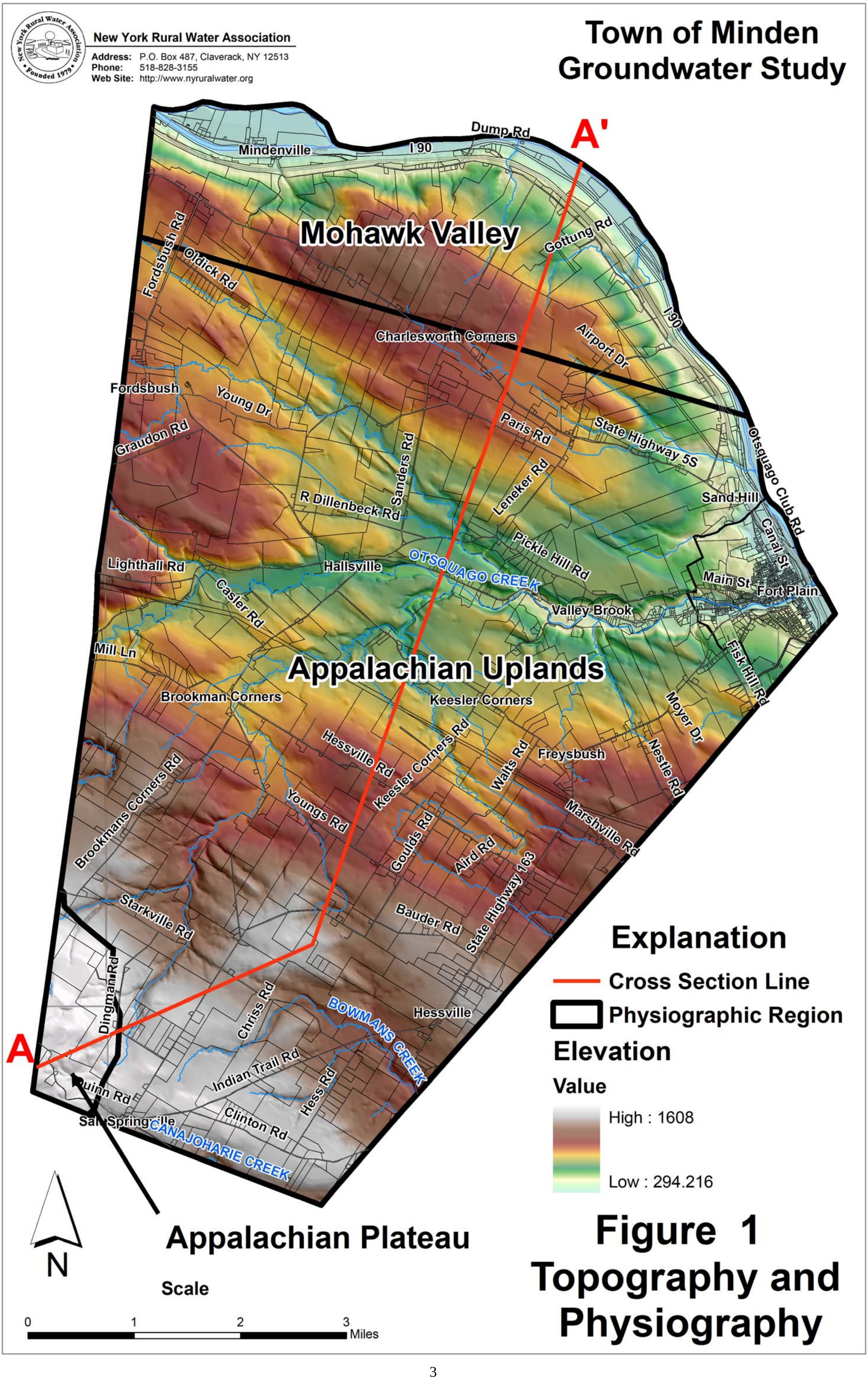


Figure 1 Topography and Physiography

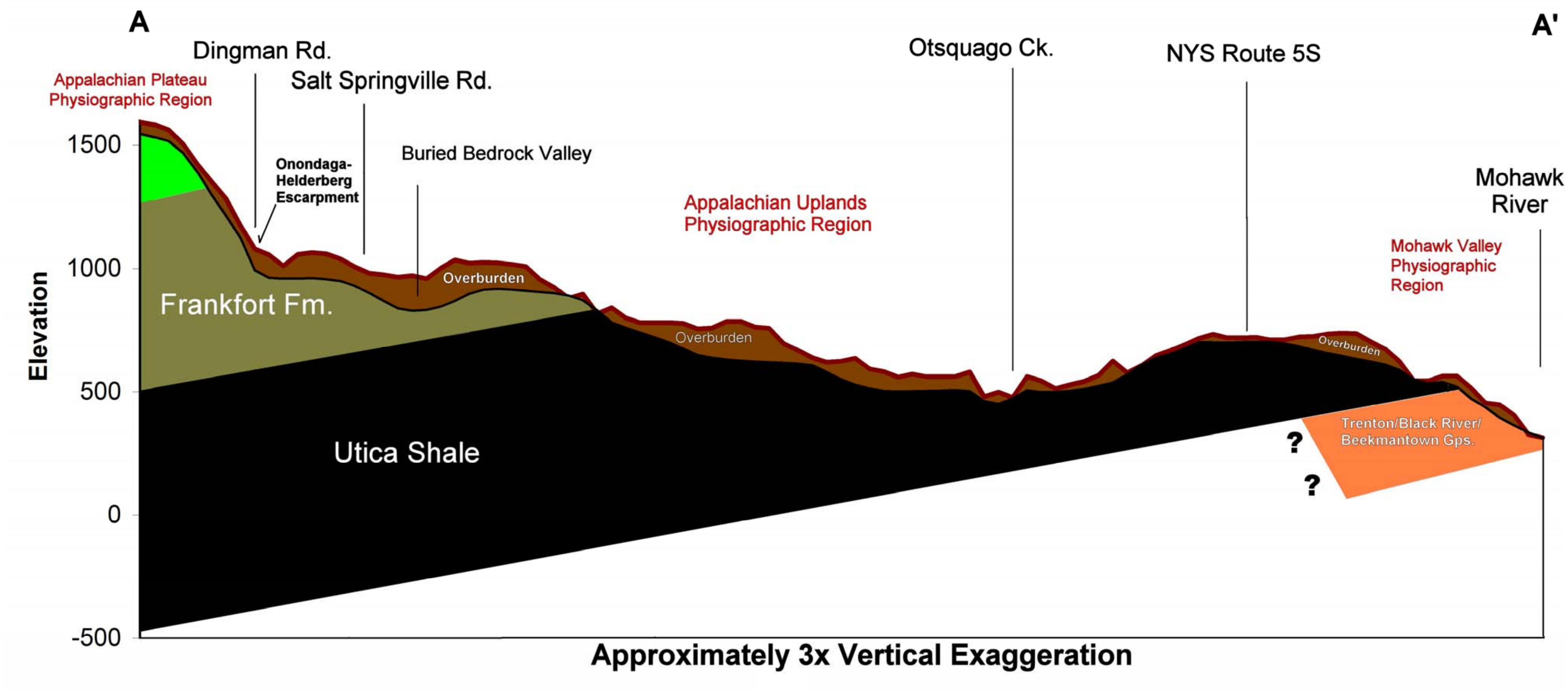


Figure 2. Generalized Geologic Cross-Section

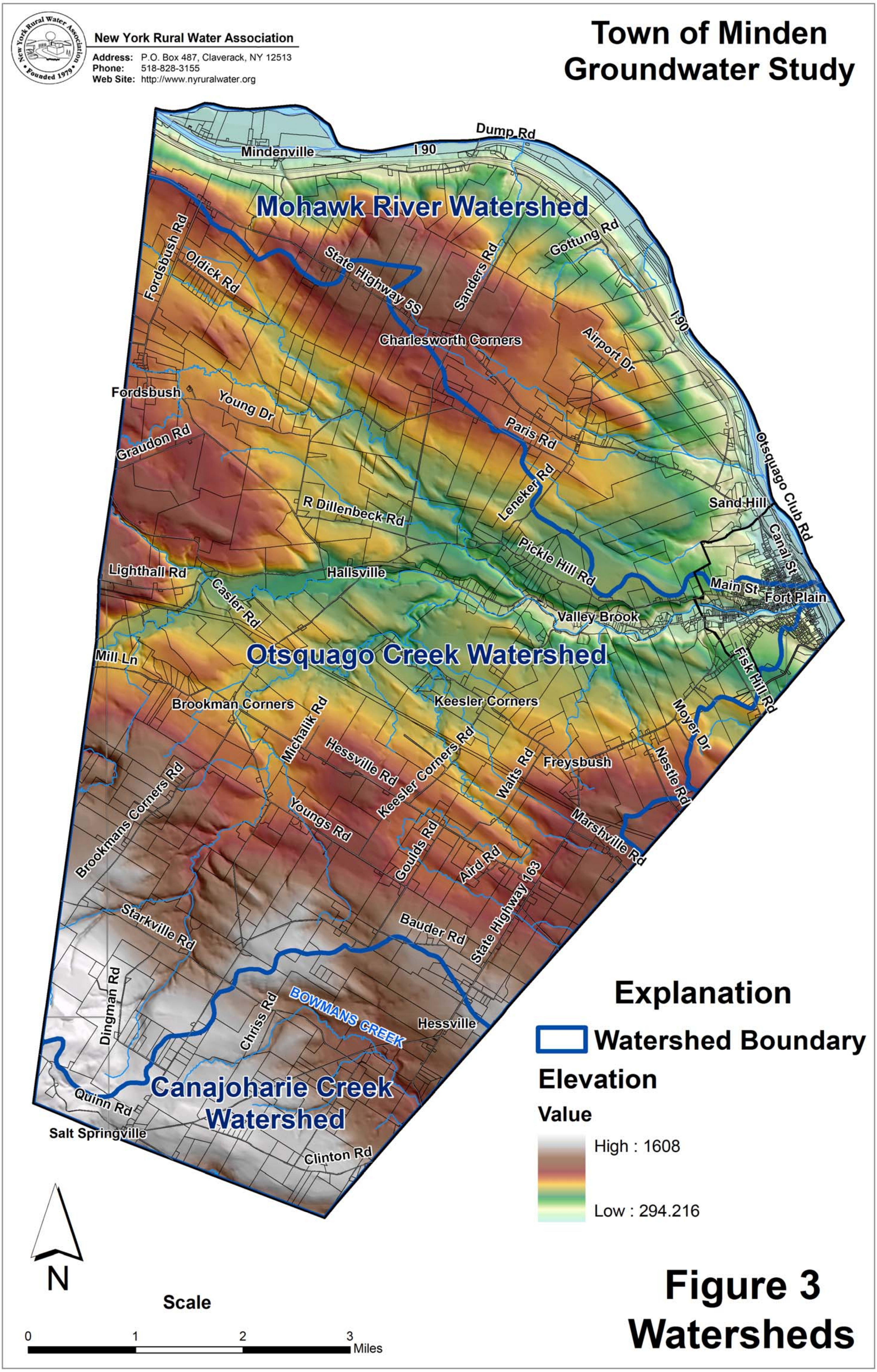
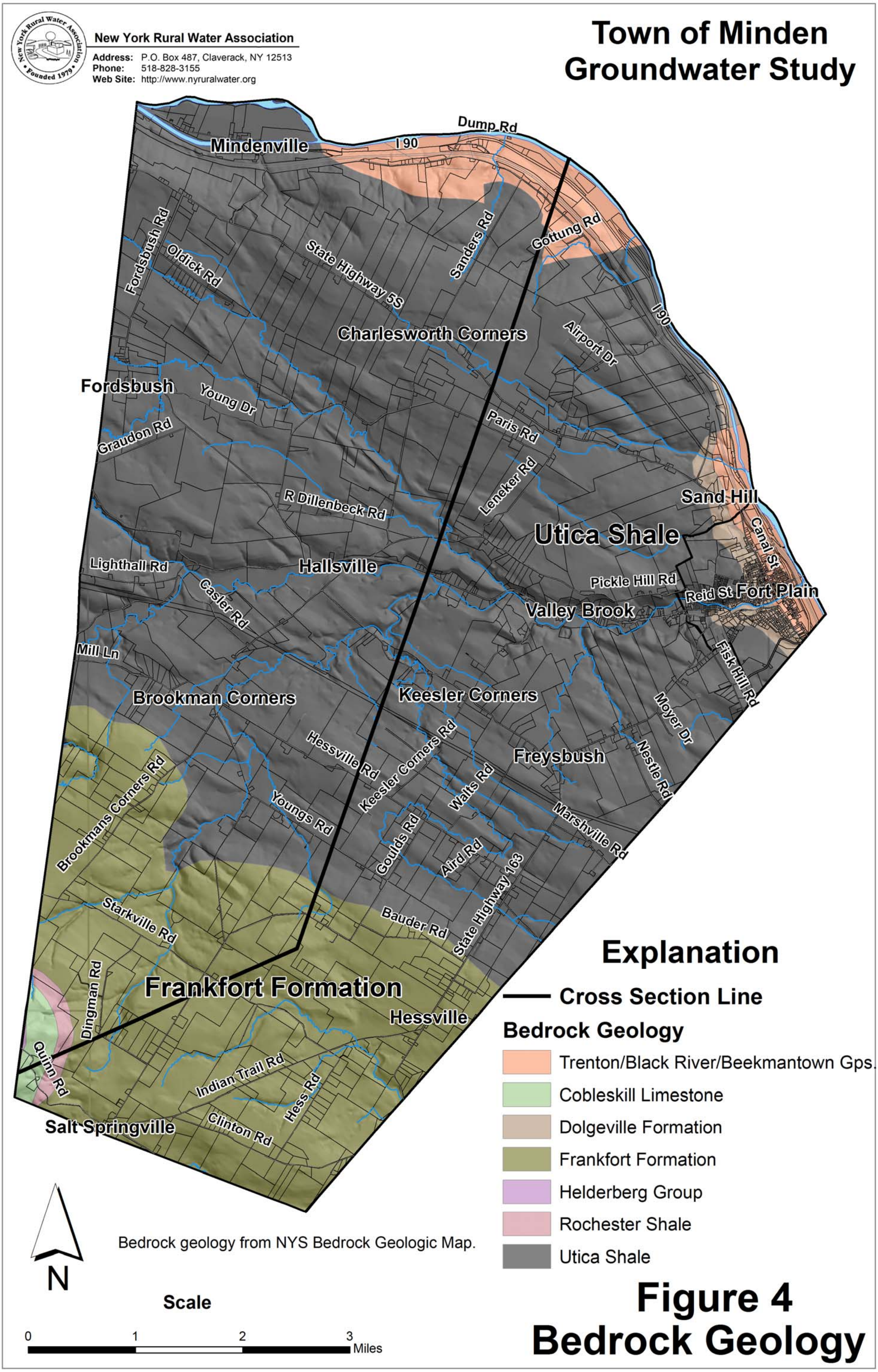


Figure 3
Watersheds



Bedrock geology from NYS Bedrock Geologic Map.

Figure 4
Bedrock Geology

Beekmantown, Trenton, and Black River Groups consist of various limestone and dolostone formations.

2.3.2 Utica Shale

Overlying the carbonates of the Beekmantown, Trenton, and Black River Groups is the Upper Ordovician Utica Shale. As shown on Figures 2 and 4, the Utica Shale is found beneath much of Minden and dips to the southwest. The Utica Shale measures approximately 700 to 800 feet thick in the Minden area and is comprised of three different members. In order from bottom to top (older to younger) these are the Flat Creek Member, the Dolgeville Member, and the Indian Castle Member.

The Flat Creek Member is dominantly dark gray to black shale and is believed by many to have the most natural gas reservoir potential due to its higher organic content (see discussion below). The Flat Creek has numerous fractures, many occurring as filled calcite veins (Selleck et al., 2011). The Flat Creek Member also has “sand injectite dikes” (Selleck et al., 2011). These are seams of volcanic ash, sand, and other materials that filled fractures and other openings.

The overlying Dolgeville Member has thin beds (“ribbons”) of limestone alternating with dark shale. The uppermost member, the Indian Castle, starts as interbedded shale with limestone and finishes as black shale. The Indian Castle has been reported to have thin layers of fossil and other debris.

It is important to note that there are several cemented to partially-cemented volcanic ash beds throughout the Utica Shale. These are found in all three members and can be traced laterally considerable distances.

Much interest has centered on the Utica Shale as a potential natural gas reservoir. Extraction of natural gas from the Utica Shale would involve horizontal drilling and high volume hydraulic fracturing (HVHF). These techniques differ significantly from so-called “conventional” methods that involve vertical drilling and hydraulic fracturing using significantly less water.

One of the important factors regarding natural gas production is the depth of burial of the organic-rich sediments. Organic sediments must be buried at significant enough depth for the organic material within the rocks to be "cooked" into natural gas. The Utica Shale is found at depths between 0 and 2,100 feet below the land surface in Minden. A literature search by NYRWA found that a depth of burial of 2,000 to 4,000 feet has been stated as necessary for favorable natural gas production. If this is true, if would appear that the Utica Shale is too shallow across Minden, even in the Appalachian Plateau region.

Another factor that may influence future drilling in shale is the degree of environmental review and analysis that would be necessary. The NYSDEC’s proposed GEIS for horizontal drilling and HVHF indicates that a site-specific environmental review would be necessary for any HVHF operation of less than 2,000 feet depth. The proposed GEIS also states that site-specific review is necessary if fracturing operations were to occur less than 1,000 feet below the base of the fresh water supply. As this report documents, the Utica Shale is the most widely utilized source of local drinking water. Given the Utica Shale's relatively shallow depth and use of a local water source in Minden, natural gas development would likely proceed in other places in New York State first.

2.3.3 Frankfort Formation

Overlying the Utica Shale is the Frankfort Formation. It outcrops in elevations generally above 850 feet above sea-level in the Appalachian Uplands region. The Frankfort Formation consists of interbedded shale, siltstone, and fine sandstone. The Frankfort Formation is believed to be nearly 600 feet thick in Minden.

2.3.4. Rochester Shale and Cobleskill Limestone

The Rochester Shale and the Cobleskill Limestone are only exposed within the Appalachian Plateau region. The Rochester Shale consists of gray to black shale with interbedded dolostone. Locally, the Cobleskill Limestone is actually a shaly dolostone.

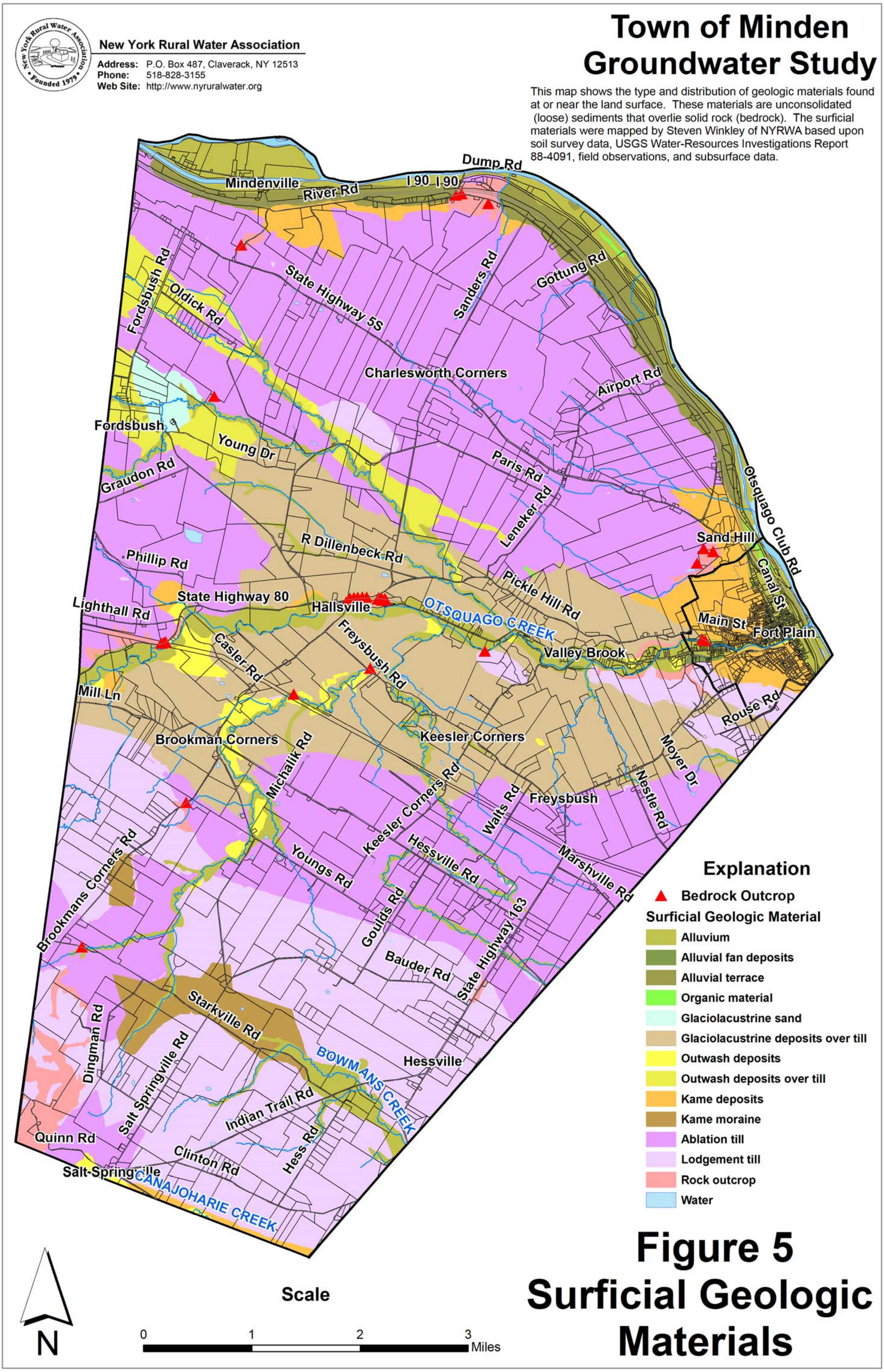
2.4 Surficial Geology

Surficial deposits are geologic materials that are found at or near 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 5 and Plate 2). This map was derived from examination of digital soils mapping, existing mapping by the United States Geological Survey, 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.

2.4.1 Till

The principal material left by the advancing glacial ice sheet was glacial till. Till is commonly found in upland areas and underlies other deposits in valleys. Lodgement till was deposited beneath moving glacial ice. It is a dense and compact mixture of clay, silt, sand, cobbles, and boulders. The other type of till that is depicted on Figure 5 and Plate 2 is known as ablation till. It is looser and less compact. It formed from material that was within or on top of glacial ice and was deposited as the ice melted. It generally contains less clay and silt than lodgement till.



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This map shows the type and distribution of geologic materials found at or near the land surface. These materials are unconsolidated (loose) sediments that overlie solid rock (bedrock). The surficial materials were mapped by Steven Winkley of NYRWA based upon soil survey data, USGS Water-Resources Investigations Report 88-4091, field observations, and subsurface data.

Figure 5
Surficial Geologic Materials

2.4.2 Stratified Deposits

Some surficial materials formed as a result of deposition from glacial meltwater. These include kame deposits and outwash. Outwash is sand and gravel deposited on flat plains or deltas by meltwater beyond the ice margin. Accumulations of outwash deposits occur along Otsquago Creek and its tributaries. Kames are hills underlain by sand and gravel deposited by glacial meltwater in contact with glacial ice. Kame deposits occur along the Mohawk valley near Mindenville, Sand Hill, and Fort Plain. Kame moraine deposits are highly variable, composed of sand and gravel beds with boulders and lenses of silt and clay. These deposits mark the former position of a glacial ice margin.

As the glacial ice receded, a glacial lake formed in the Mohawk Valley and extended into the Otsquago Creek Valley. Silt and clay sediments were deposited into this lake, eventually draping existing till deposits to depths of up to 20 feet. In some locations, meltwater streams built small outwash deltas into this lake.

After deglaciation, modern-day drainage patterns developed. Alluvium, consisting of sand, gravel, and silt formed along floodplains. Some of these floodplains were above present-day levels. This is evident along the Mohawk River. Alluvial fans formed at the mouths of some upland streams. These consist of silt, sand, and boulders that accumulate in fan shaped landforms.

3.0 GROUNDWATER OCCURRENCE

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. Most of the water in bedrock is found in fractures.

3.1 Bedrock

Since 2000, 83 percent of water wells in Minden have been completed in bedrock. 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 Minden is 153 feet, bedrock well depths range from 40 to 500 feet (see Figure 6).

3.1.1 Bedrock Well Yields

The median yield of bedrock wells in Minden is 5 gallons per minute (gpm) and 42 percent of wells yield less than the 5 gpm required by FHA for new home loans (Figure 7). Seventeen percent of bedrock wells yield 1 gallon per minute or less (Figure 7). 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.

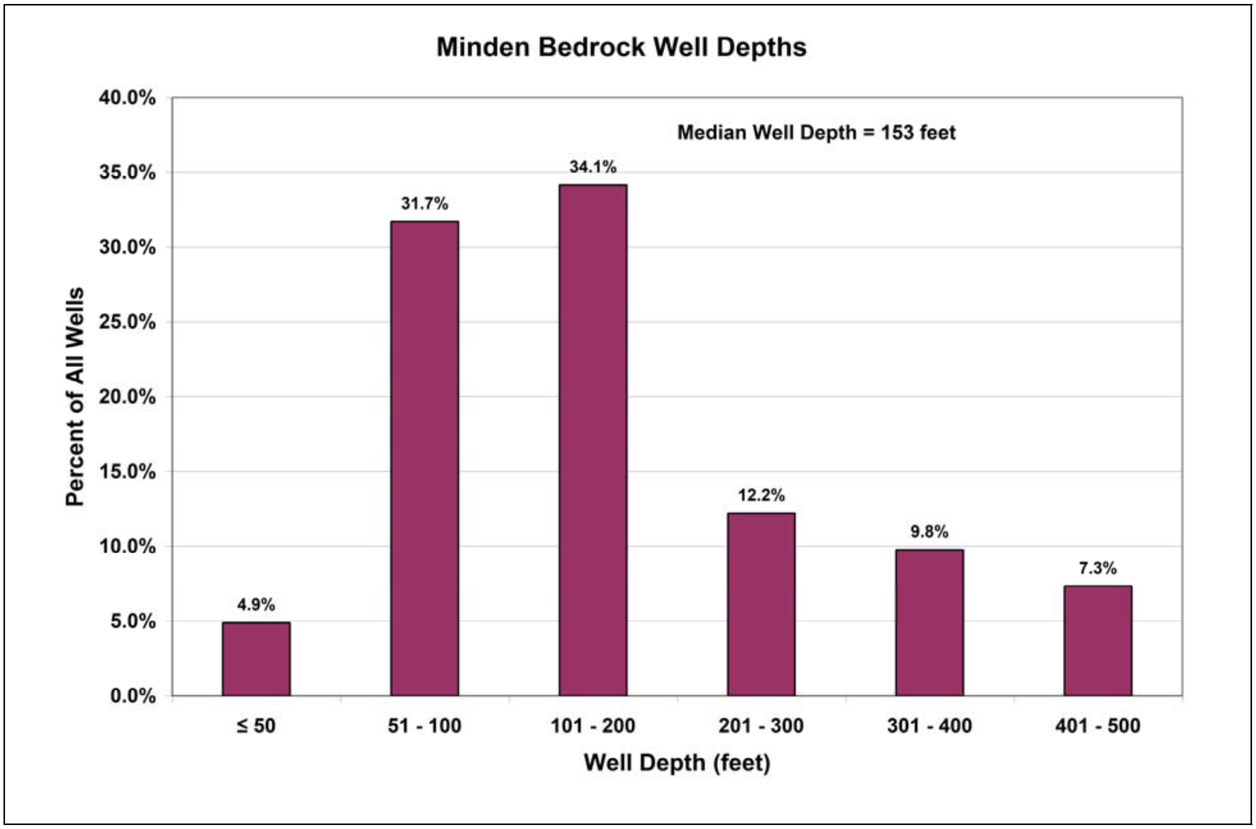


Figure 6. Bedrock Well Depths

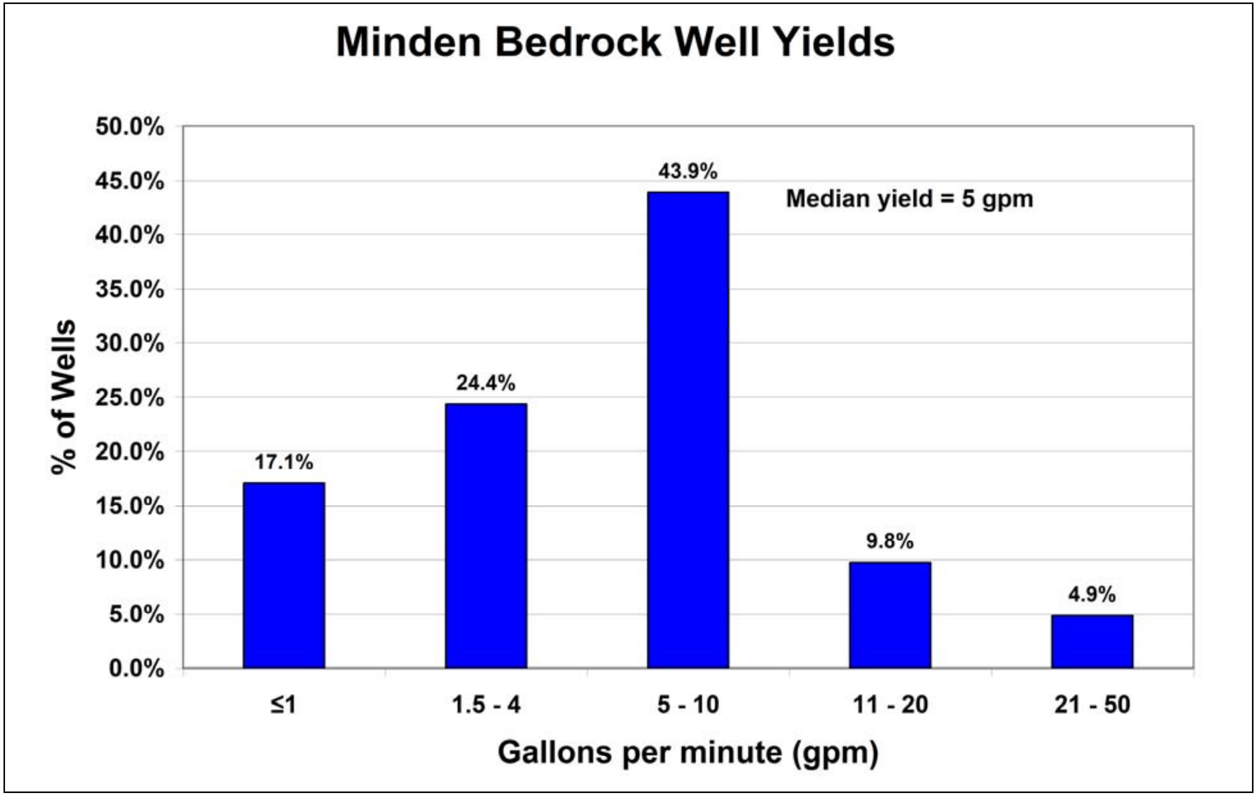


Figure 7. Bedrock Well Yields

As indicated on Figure 8, there is variation in bedrock well yields across Minden. Typically, this variation is largely due to the type of bedrock. However, in Minden, the median yield of each bedrock formation is the same (5 gpm). Instead, differences in well yield in Minden appear to be related more to the degree of fracturing of the local bedrock. Topographic lows in the top of bedrock surface often mark these areas of concentrated bedrock fractures. Linear features visible on aerial photography, satellite imagery, and topographic maps also can coincide with bedrock fracture zones. These features have been mapped on Figure 8.

Two notable areas of lower than average well yields have been documented by NYRWA based upon the available well data (Figure 8). The largest of these areas is situated along NYS Route 5S between Otsquago Creek and the Mohawk River. This area coincides with a high in the local topography of the top of the bedrock surface (Figure 9). Another area of lower than average well yields in situated between the hamlets of Hessville and Freysbush (Figure 8). This also corresponds to a local high in the bedrock surface topography (Figure 9). Lee Prime of Prime Well Drilling and Gerry Girard of American Well Drilling confirmed to NYRWA that yields in the vicinity of Hessville have historically been poor.

Well yields in the local bedrock vary considerable however based upon the local fracture distribution. For example, just one mile southwest of the poor yield area between Hessville and Freysbush lies an area of relatively high yields. This area corresponds to an apparent buried bedrock valley in the vicinity of Starkville Road (see Figure 9). Both Lee Prime and Gerry Girard noted the curious appearance of gravel seams within the shale bedrock here. This highly unusual occurrence may be indicative of highly fractured zones and/the injectite dikes that were previously described.

3.1.2 Bedrock Water Quality

Unfortunately little quantitative data exists on water well quality. Water quality analyses are not required for residential wells. Lee Prime and Gerry Girard discussed the water quality with NYRWA. Like yields, water quality in the bedrock is highly variable. In general, about one-half of wells drilled locally have issues with “sulfur”. This issue refers to the natural occurrence of hydrogen sulfide (rotten egg odor). Water can be hard in some places, depending upon the carbonate content of the rocks. Water softeners are in common use. Most problematic is the localized presence of salt and methane in some wells. Salt and methane have been reported in some wells located near Salt Springville and the Dingman Road areas. These locales are situated at the base of the Appalachian Plateau and the Onondaga-Helderberg Escarpment. It is possible that the more mineralized water here is the result of a regional groundwater discharge zone. Deeper groundwater from the Appalachian Plateau region may be forced upwards towards the land surface in this area.

3.2 Unconsolidated Aquifers

Comparatively few wells in Minden are completed in unconsolidated (sand and gravel) aquifers. Unconsolidated aquifers are not as widely distributed and many household well drillers prefer to complete wells in the underlying bedrock. Wells that are completed in the unconsolidated deposits for private, residential use are typically left as open ended casing. The casing is

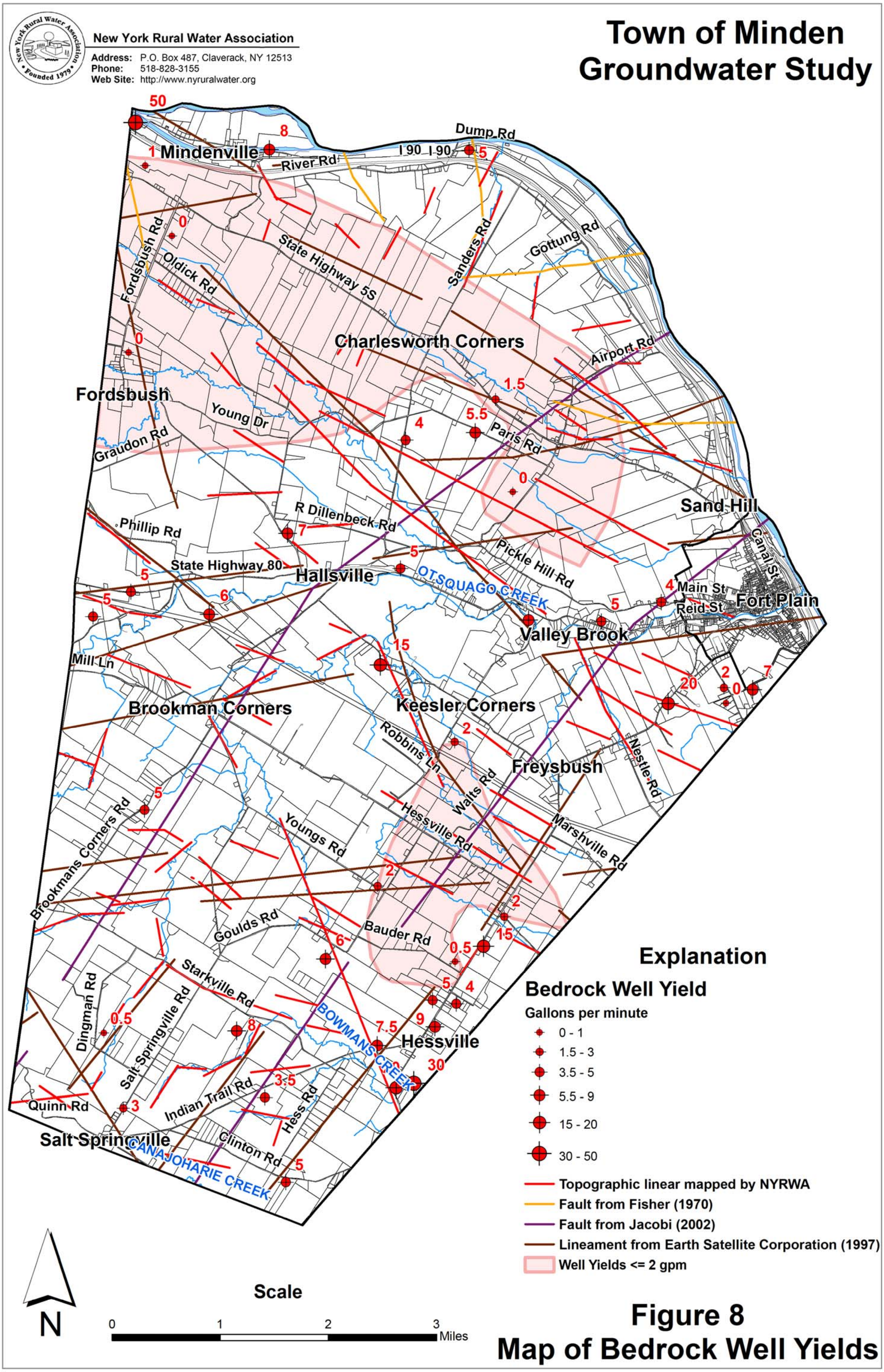
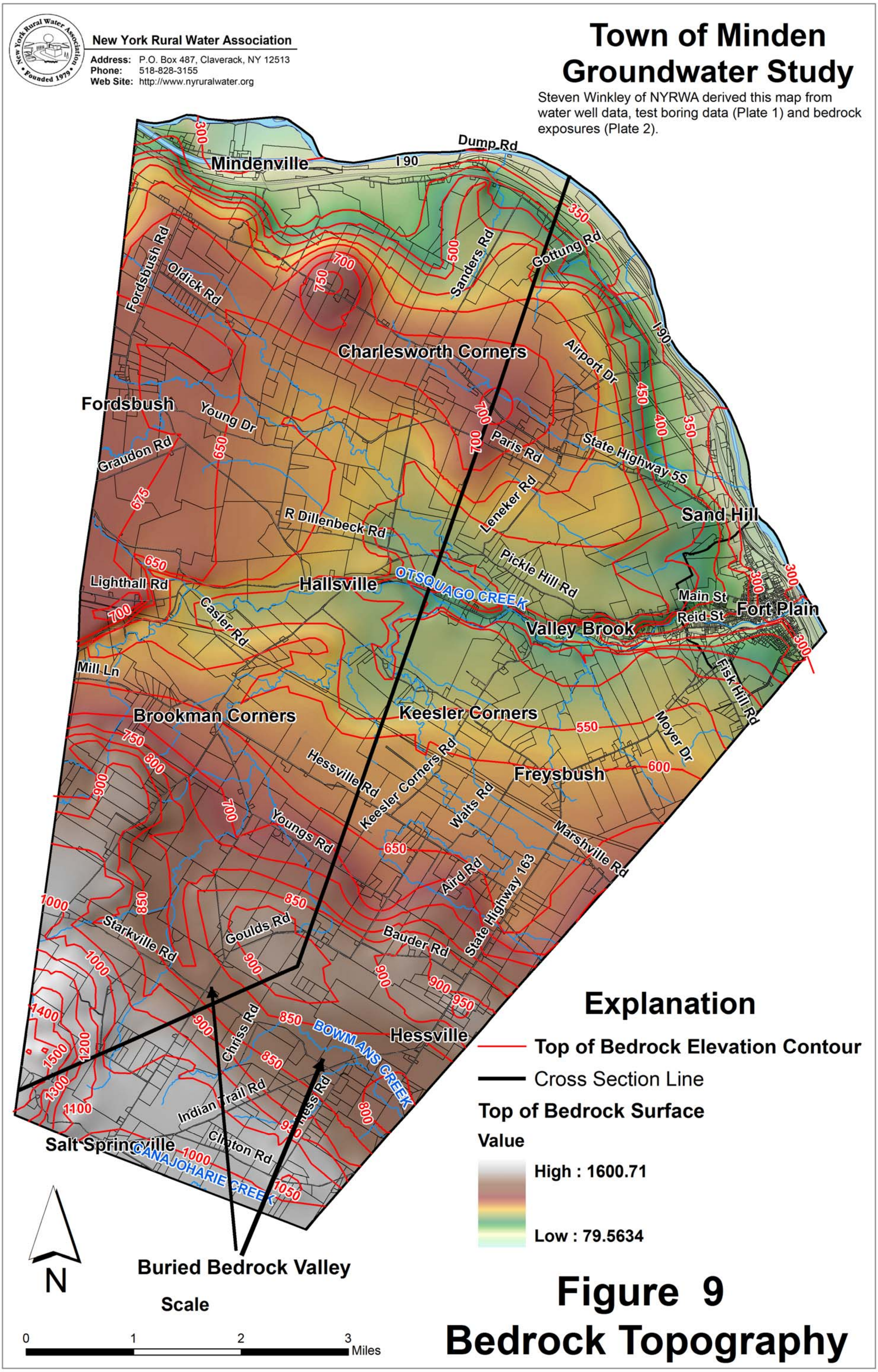


Figure 8
Map of Bedrock Well Yields



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Steven Winkley of NYRWA derived this map from water well data, test boring data (Plate 1) and bedrock exposures (Plate 2).

Explanation

Top of Bedrock Elevation Contour

Cross Section Line

Top of Bedrock Surface

Value

High : 1600.71

Low : 79.5634

Figure 9
Bedrock Topography

terminated in the water-bearing material. Such construction is sufficient for many purposes. The median yield of such wells is 15 gpm. However, 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. Public water supply wells in sand and gravel are typically fitted with screens. Such wells are usually capable of producing hundreds of gallons per minute. For example, the Village of Fort Plain has a set of shallow screened wells situated off Witter Street in the Village.

The distribution of water-bearing unconsolidated deposits is generally limited to areas along or near the valleys in Minden. On Figure 10 and Plate 3, NYRWA has mapped the distribution of unconsolidated aquifers in the Town of Minden. The boundaries of these aquifers were delineated by NYRWA on the basis of surficial geologic boundaries (see Plate 2) and available subsurface data.

There are two types of unconsolidated aquifers: unconfined and confined. In a confined aquifer, the coarser-grained water-bearing deposits are overlain by finer-grained sediments such as clay, silt, or till. In Minden, such aquifers are located in bedrock channels that have been buried by a variety of glacial sediments. The buried bedrock valley in the Starkville Road is an example of a local confined aquifer. In contrast, unconfined aquifers are shallower and lack an overlying layer of fine-grained sediments. Unconfined aquifers in Minden are typically associated with outwash or kame deposits. Note that in some locales it is likely that both types of aquifers exist.

Areas of deeper sand and gravel deposits of sufficient distance from both surface water and potential sources of contamination have the highest potential for municipal well development.

4.0 HYDROGEOLOGIC ANALYSES

4.1 Hydrogeologic Sensitivity

The *hydrogeologic sensitivity* of a location is defined by NYRWA as a relative measure of the ease and speed with which a contaminant could migrate into and within the uppermost water-bearing unit. High to very high hydrogeologic sensitivity ratings indicate that, in general, ground water could be readily impacted by surface activities. Development activities that could contaminant ground water 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.

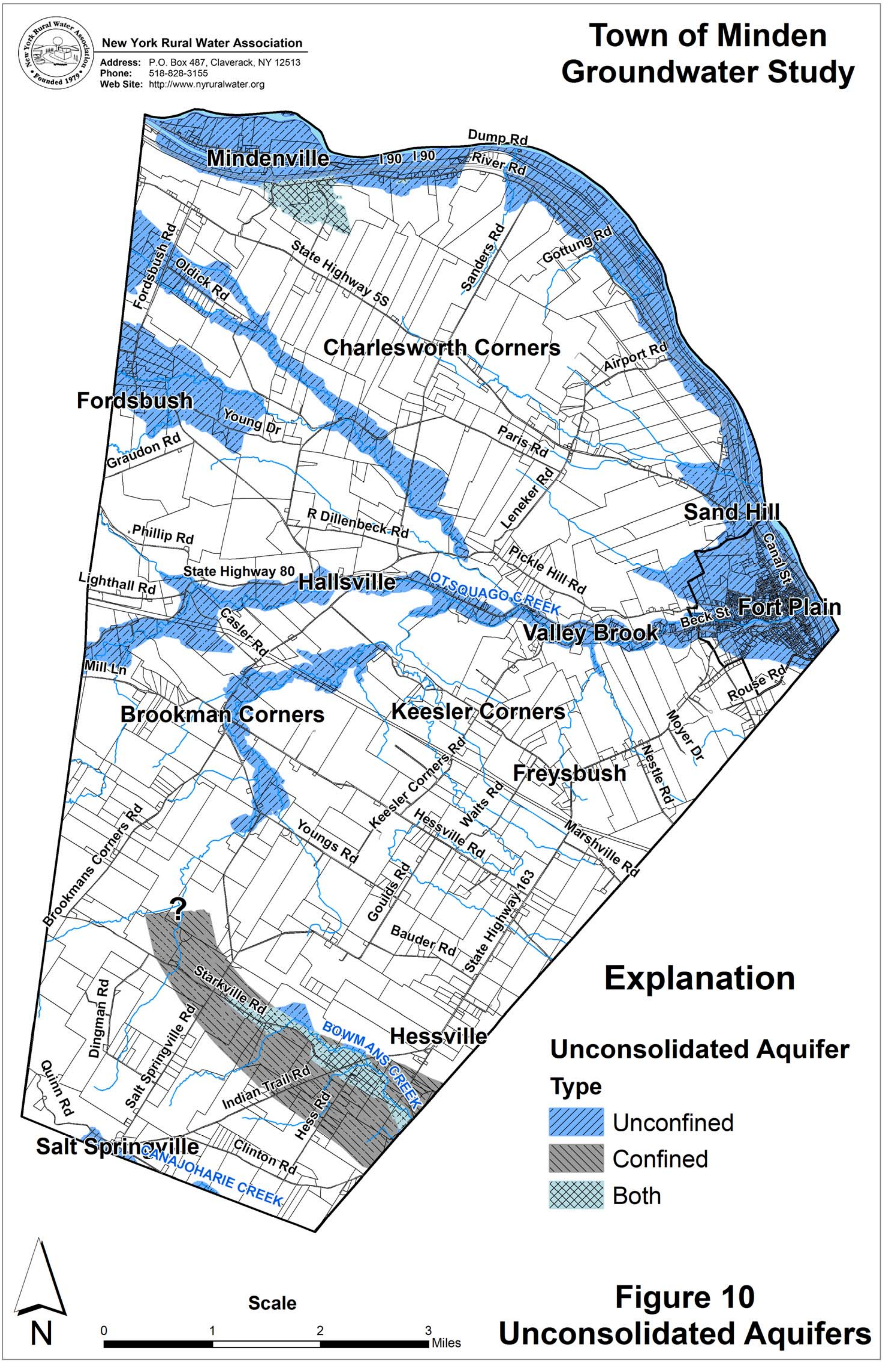


Figure 10
Unconsolidated Aquifers

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 local rate of recharge) and the site's topographic position (the slope of the land surface and the relative topographic position). Resultant hydrogeologic sensitivity ratings based upon geologic materials and topographic position ratings are mapped on Figure 11. Very high sensitivity is found chiefly in relatively flat topographic highs underlain by unconfined sand and gravel aquifers or carbonate bedrock. Lowest hydrogeologic sensitivities are found in steeply sloping or low-lying areas underlain by glacial till or fine-grained glaciolacustrine sediments.

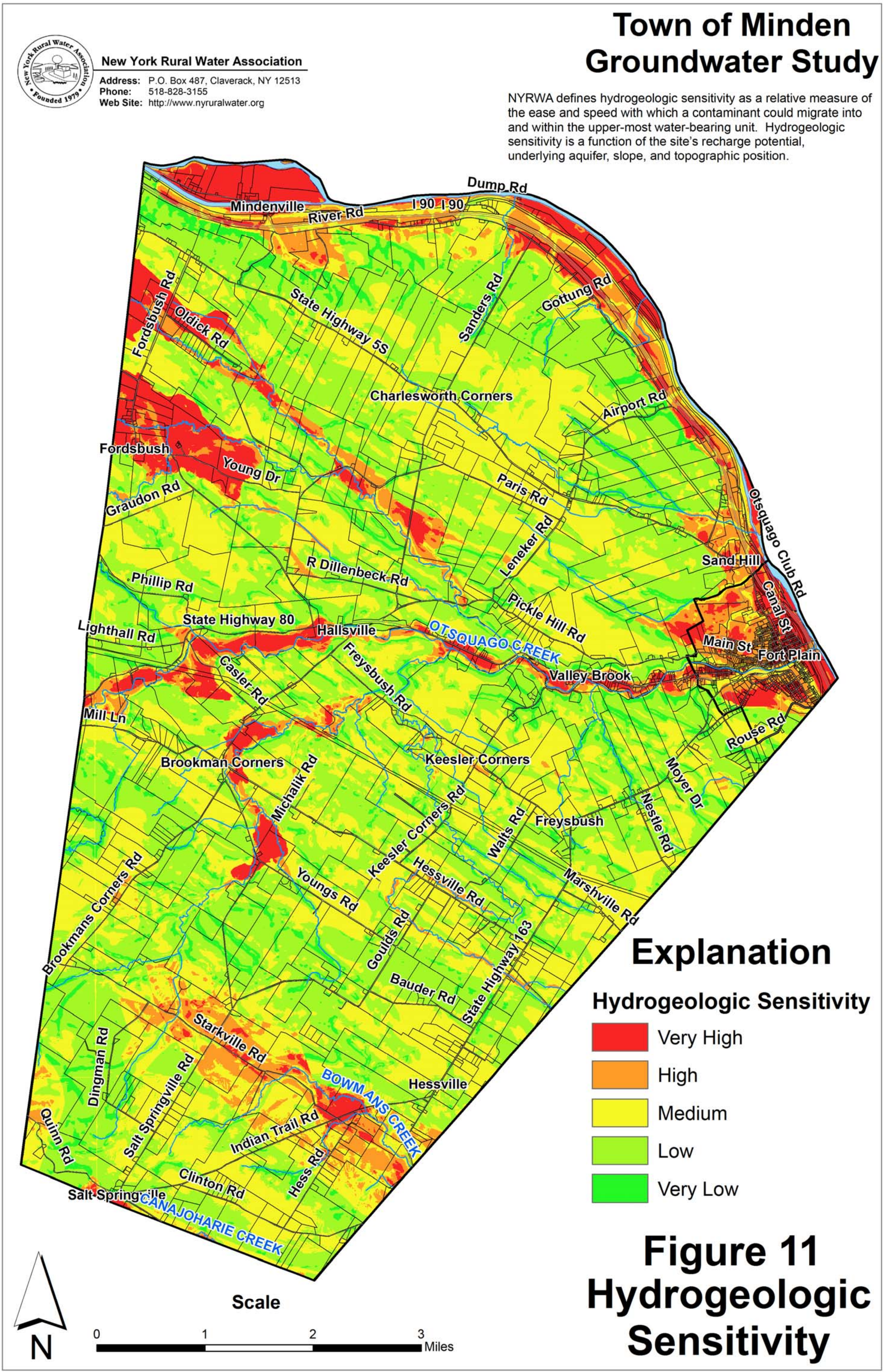
4.2 Recommended Minimum Lot Sizes

Future development in Minden will be largely in the form of residential construction with individual septic systems and private wells. Excessive nitrate loading of ground water 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.

The chief variable in determining adequate lot sizes to avoid nitrate loading is the annual groundwater recharge rate. NYRWA has calculated the estimated annual groundwater recharge rate across Minden based upon stream 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). BFI values are available for two local streams: Otsquago Creek and Canajoharie Creek (BFI values of 0.278 and 0.309 respectively).

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 total BFI for the gage watershed could then be calculated based upon multiplying the area for each surficial geologic material by its BFI value. By studying watersheds in the region that have BFI data and iteratively comparing the surficial geology percentages of these watersheds, local mean values of BFI were determined by NYRWA for each surficial geologic materials:

Mean annual groundwater recharge for Minden was calculated by NYRWA by multiplying a grid of local base flow index (BFI) surficial geologic materials values by a grid of local mean annual runoff values generated from Cohen and Randall (1998). The resulting map of estimated annual groundwater recharge is Figure 12.



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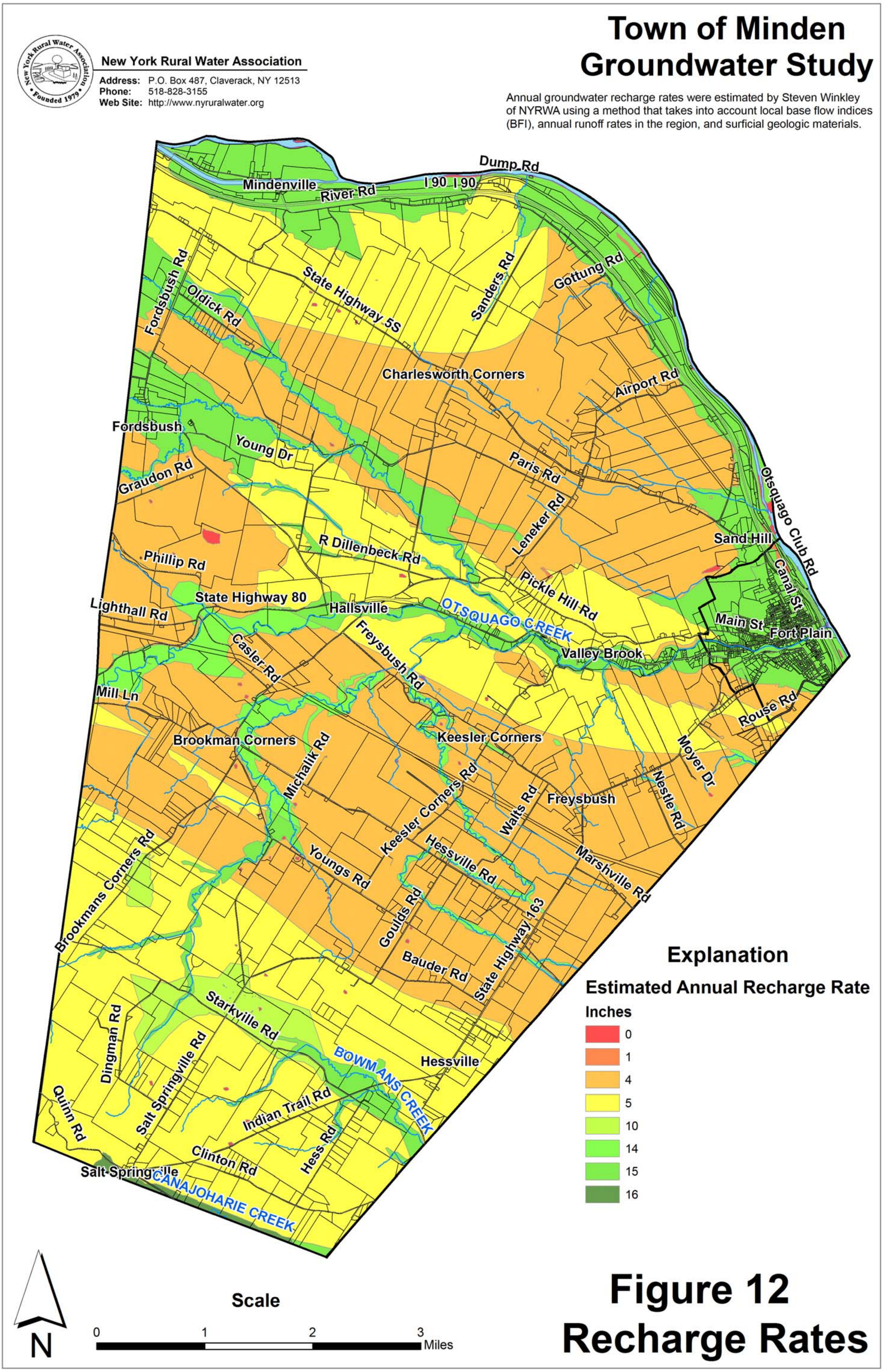
NYRWA defines hydrogeologic sensitivity as a relative measure of the ease and speed with which a contaminant could migrate into and within the upper-most water-bearing unit. Hydrogeologic sensitivity is a function of the site's recharge potential, underlying aquifer, slope, and topographic position.

Explanation

Hydrogeologic Sensitivity

- 🟥 Very High
- 🟧 High
- 🟨 Medium
- 🟩 Low
- 🟩 Very Low

Figure 11
Hydrogeologic Sensitivity



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Annual groundwater recharge rates were estimated by Steven Winkley of NYRWA using a method that takes into account local base flow indices (BFI), annual runoff rates in the region, and surficial geologic materials.

Figure 12
Recharge Rates

For each computed annual recharge rate, NYRWA calculated the lot size that is necessary to dilute levels of nitrate to a level of 5 mg/l. The methodology to calculate this necessary lot area is an equation known as the modified Trela-Douglas nitrate dilution equation (Hoffman and Canace, 2001).

Based upon the nitrate loading analysis, three different minimum lot sizes are recommended for various areas of Minden. These lot sizes are two, five, and six acres. The distribution of the recommended minimum lot sizes for future development is shown in Figure 13. Note that the minimum lot size specified in the current zoning is two acres. Note that areas with building constraints such as steep slopes, wetlands, flood hazards, surface water are not shown on Figure 13. Existing lots that are completely developed are also not shown on Figure 13.

5.0 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 Minden must determine which measures are acceptable given local socioeconomic and political conditions. These measures could include: promulgation of land use regulations, environmental review, further studies, and education.

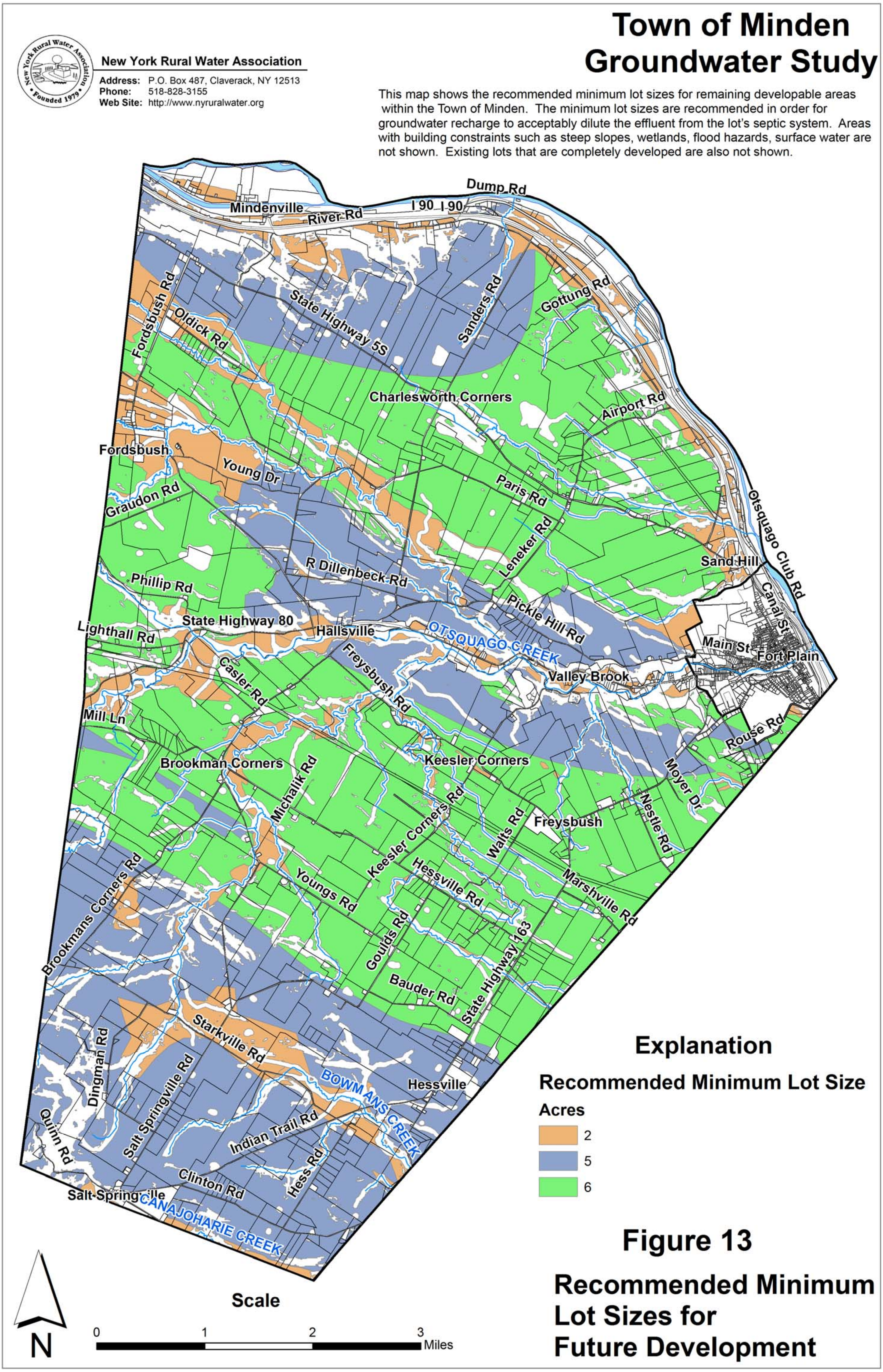
5.1 Land Use Regulations

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. Subdivision regulations in Minden could be amended to optimize protection of groundwater resources. For example, the following elements could be required for conditional 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.



This map shows the recommended minimum lot sizes for remaining developable areas within the Town of Minden. The minimum lot sizes are recommended in order for groundwater recharge to acceptably dilute the effluent from the lot's septic system. Areas with building constraints such as steep slopes, wetlands, flood hazards, surface water are not shown. Existing lots that are completely developed are also not shown.

Figure 13

Recommended Minimum Lot Sizes for Future Development

A hydrogeological study could be required for any new subdivision of a certain size. A hydrogeological study could also be performed for new subdivisions that overlie the lower well yield area as detailed in this report.

In addition, 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 ground water can be defined as any reductions in groundwater levels or changes in groundwater quality that limit the ability of a groundwater 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.

Many communities are now encouraging the use of so-called 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 groundwater 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 and wells are planned, the density of households across the parent parcel or parent tract should not exceed those indicated on Figure 13. 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. If there are existing wastewater discharges in the area, these should be considered in order to prevent excess nutrient loading.

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 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;
- 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.

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

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

- ☐ Adequacy of control measures to prevent ground water 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 ground water.

Zoning

Zoning regulates land uses, the density of land uses, and the siting of development. While considering amending current zoning, there are several points that the Town of Minden should consider with respect to groundwater resources. First, the recommended minimum lot size for dilution of septic effluent should be consulted. Second, uses of land with a higher-risk of groundwater contamination should be "steered-away" from areas of high hydrogeologic sensitivity as well as unconsolidated aquifers. This could be accomplished using 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.

5.2 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 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 Minden may wish to consider naming unconsolidated aquifer areas, sensitive hydrogeologic areas, etc. as CEAs.

5.3 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 officials, residents, contractors, and developers 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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