New York City
Department of Environmental Protection

Findings of Study to Determine the Potential Need for a Community Wastewater Management System for the Hamlet of Shokan

June 2016

Prepared in accordance with Section 3.3 of the Revised 2007 Filtration Avoidance Determination, which states: "the City will study the potential need for a community wastewater management system for the Hamlet of Shokan."

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1. Introduction

Shokan is located in the Ashokan basin of the Catskill/Delaware System of the NYC water supply. Wastewater from homes and businesses in Shokan is treated by individual septic systems.

Section 3.3 of the Revised 2007 Filtration Avoidance Determination (FAD) for New York City's Catskill/Delaware Water Supply System (May 2014) contained a provision whereby DEP was to study the potential need for a community wastewater management system for the hamlet of Shokan, NY. In October 2013, DEP submitted a plan that described DEP's scope of the study that included water quality monitoring, land-use analysis, and a review of development history.

The objective of the study was to determine whether or not the septic systems in the area impact surface water that drains to the Ashokan Reservoir and to estimate the number of properties in the study area that could support an on-site wastewater treatment system. DOH provided clarification and confirmation of the scope of the study in June 2014. This report assesses the various septic repair programs already in place and describes the findings of the water quality and land use analysis to determine the potential need for a community wastewater management system for Shokan.

2. Background

Generally, the west of Hudson watershed is sparsely developed and does not warrant centralized wastewater infrastructure. Most communities rely on individual septic systems to treat and dispose of sanitary waste. However, a number of hamlets and villages — often older, historic centers located along streams, in narrow valleys and characterized by small lots — need other wastewater management options. To respond to this need, DEP has provided funding to select areas where centralized wastewater treatment is needed to protect water quality.

Shokan

Shokan is located in the Town of Olive in Ulster County. Shokan is located entirely within the Ashokan drainage basin and covers an area of 3.9 square miles (Figure 1). Shokan was populated in large part following the construction of the Ashokan reservoir over 100 years ago. As such, the area is not located within a narrow valley as are many of the other historic population centers. As a result of being outside a valley and developed later than many other communities, Shokan benefits from somewhat larger lot sizes than some of the historic centers in the watershed.

As of the 2010 census, the population of Shokan was 1,183 with an average household size of approximately 2.3 persons per household. The study focused on the more developed portions of Shokan. Based on the number of residential parcels, there are approximately 965 people in the study area.

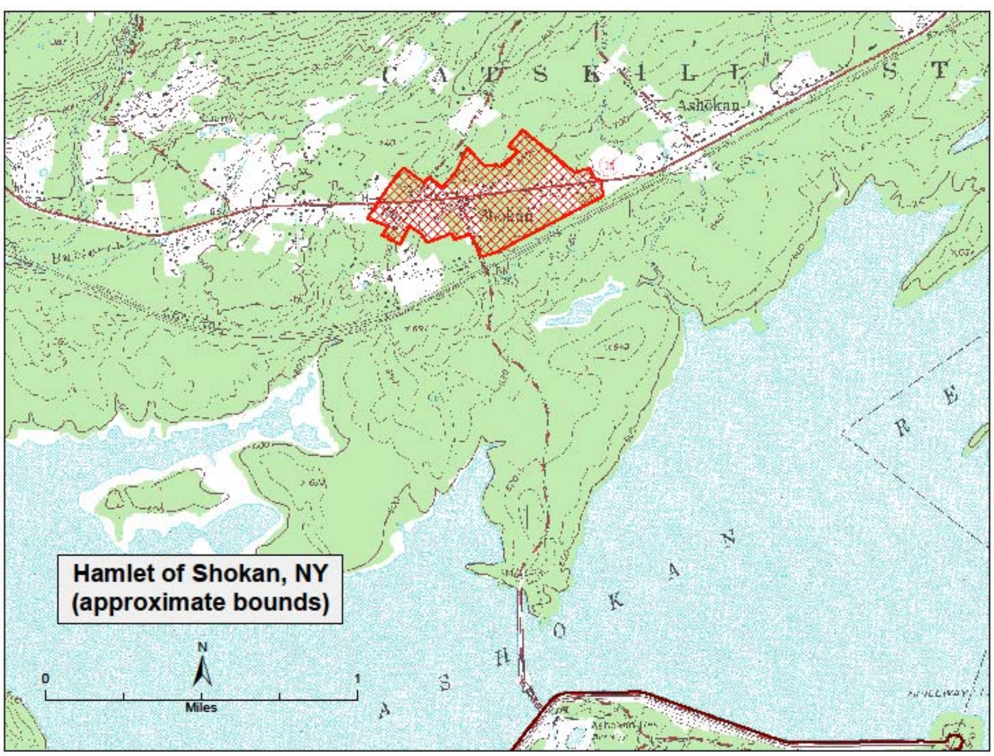

Figure 1 Hamlet of Shokan, NY in the Ashokan drainage basin.

3. Monitoring Plan

3.1 Objective

The purpose of the water quality monitoring portion of the study was to identify whether or not the leachate from septic systems impacts stream water quality in the area. In order to differentiate between human influence and background fecal concentrations originating from wildlife, a microbial source tracking technique (MST), i.e., analysis for Bacteroidales, was employed.

3.2 Sampling location

Sampling occurred at a new site location (SHOKAN). The SHOKAN sampling site was selected for the study due to the conditions of the catchment area providing a good representation of the Hamlet of Shokan. The SHOKAN sampling site captures input from a portion of Shokan with land use that might be expected to produce potential water quality impairments, if they exist. The catchment included 52 residential properties and 11 commercial properties These conditions include:

- high density of development;
- relatively low number of vacant parcels; and
- a mix of both commercial and residential land uses.

The stream site drains a large portion of the hamlet of Shokan, and is a tributary of the Ashokan Brook, which flows into the East Basin of the Ashokan Reservoir. Figure 2 shows the catchment area that drains toward the SHOKAN sampling site. Figure 3 shows a photo of the stream that was sampled.

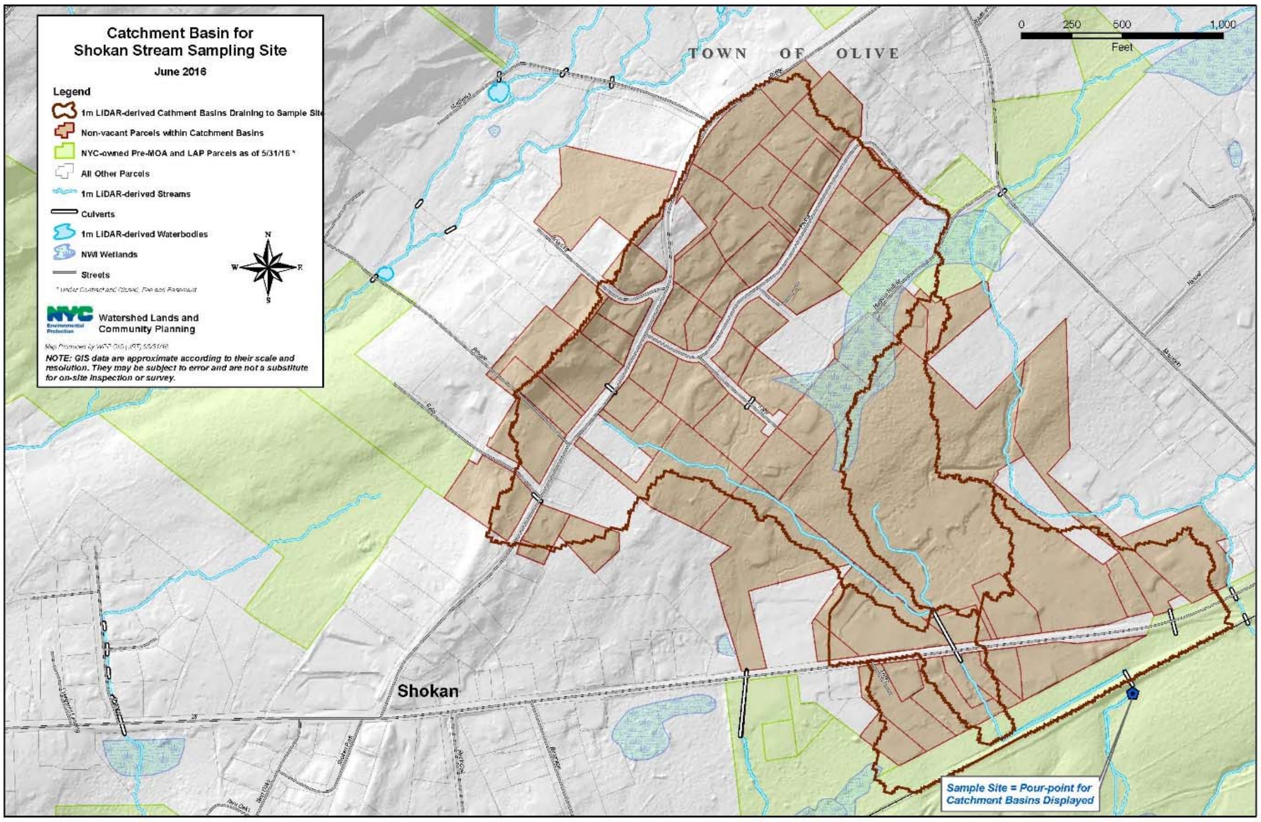

Figure 2 Map of sample location (SHOKAN).

3.3 Study Design

The water quality monitoring study design called for grab samples to be collected from the SHOKAN site twice monthly (routine, fixed frequency samples) for a year to characterize baseline conditions, and additional samples to be collected using autosamplers during selected storm events throughout the year (approximately five). Fecal coliform counts tend to be higher during storm events, whether from contamination or overland flow (e.g., wildlife sources). The storm samples therefore help to determine if contamination only occurs during storms, and, if so, MST may help determine if the source is human. Timing of storm events cannot be predicted more than a few days in advance.

Figure 3 A picture of the study stream.

In actuality, samples were collected for more than one and a half years (August 2014 - May 2016) and routine samples were often collected more frequently than twice monthly (routine n=55). A total of 72 storm samples were collected from 11 storms and samples covered the ranges of flows observed over the storm hydrograph, i.e., rising limb, peak, and falling limb of the hydrograph. Samples were selected from both baseline and storm samples for MST (in this case, *Bacteroides*) analyses based on fecal coliform concentrations and best professional judgment.

All samples were collected by DEP staff in accordance with appropriate and approved Standard Operating Procedures.

3.4 Analytes

Physical parameters used to measure water quality were analyzed including: temperature, pH, dissolved oxygen (DO), specific conductance, and turbidity. Additional analytes were selected based on their ability to help detect the presence of wastewater impacts from human sources. In particular, fecal coliforms and *Bacteroides* testing was performed. The fecal coliform results served as a screening tool to provide an indication of elevated concentrations, while

Bacteroides analysis was specifically used as a source tracking tool for human impact. Therefore, *Bacteroides* analysis was used only when fecal coliform counts were elevated.

Most recently, DEP has used molecular methods to analyze water samples for different types of *Bacteriodes*. *Bacteroides* is a genera of bacteria that can be analyzed genetically for sequences of DNA that indicate known sources. There are types of *Bacteroides* that have only been isolated from human sources, and markers for those types of bacteria were used in this study to help determine if the source of elevated fecal coliforms could be attributable to humans. Polymerase Chain Reaction (PCR) is used to amplify the organism's DNA for examination and identification.

Sample analysis was conducted by DEP staff or Source Molecular Laboratory in accordance with appropriate and approved Standard Operating Procedures.

3.5 Water Quality Findings

Physical Parameters

Physical parameters used to measure water quality were analyzed including: temperature, pH, DO, turbidity, and specific conductance. All parameters were analyzed for routine samples with the exception of turbidity. However, since the storm samples were collected by autosamplers over the duration of storms and brought to the lab at a later time, only turbidity and specific conductivity were measured from autosampler collected samples. Therefore, specific conductivity was the only parameter measured during both low flow and storm conditions. As a note, some of the routine samples happened to have been collected during precipitations events.

Results from the SHOKAN stream sampling were not uncharacteristic of a low flowing stream of this size, with the exception of specific conductivity. Temperature for the stream ranged between -0.2 and 21.7°C during this study (Table 1) with a mean of 6.91°C. Turbidity, pH, and DO had mean values of 26.61NTU, 7.14SU, and 11.1 mg/L, respectively.

Table 1 – Water quality physical parameter results from SHOKAN site August 2014 – May 2016.

	Temp (n=47)	pH (n=45)	DO (n=45)	Turbidity (n=81)	Sp Conductivity (n=133)
Unit	°C	SU	mg/L	NTU	µS/cm
Min	-0.2	6.48	7.8	0.5	81
Max	21.7	7.78	13.9	220	1160
Mean	6.91	7.14	11.1	26.61	235
Median	5.00	7.10	11.6	16.00	241

When 2015 data were compared for these parameters, the SHOKAN results were in line with the average results from 14 other streams sampled in the area (Table 2). Specific conductivity results for this study period; however, which includes both routine and storm sampling, had a range of 81 – 1160µS/cm and a mean of 235µS/cm (Table 1). When the 2015 data from SHOKAN and the other 14 streams were compared, the means for specific conductivity were 270.9 and 98.1, respectively, indicating a higher mean for the SHOKAN site.

Table 2 – Water quality physical parameter mean values for SHOKAN site and the combined mean of 14 other streams in the area (2015 data).

	Temp	pH	DO	Sp Conductivity
SHOKAN site	8.7	7.2	10.5	270.9
14 other streams	8.9	7.0	11.3	98.1

Turbidity analysis was conducted only during storm events at SHOKAN and therefore results could not be compared with other streams where turbidity analysis is conducted from routine flow.

There are several possible explanations for the higher mean conductivity at the SHOKAN site. First, the SHOKAN stream and sampling location are very close to New York State Route 28 and a large commercial parking lot. These areas are treated with road salt and can therefore be significant sources elevating conductivity in the water samples. Not all of the other streams that are sampled are located this close to a direct source. Additionally, the SHOKAN site was targeted to be sampled during storm events, when it is most probable that elements known to increase conductivity would be washed into the stream. Moreover, storm samples were collected by an autosampler that collected samples throughout the storm, resulting in more than one sample collected during this time of increased transport. For example, in February 2015 (a time of road salt use), storm samples were collected and conductivity was measured (Table 3). As can be noted by the time scale in Table 3, the first flush of conductivity (likely flushing road salt from the adjacent Route 28 and parking lot) was captured and then decreased back to expected levels as the storm progressed. This type of autosampling was not performed at the other stream sites during this period and so higher peak values could have been missed.

Table 3 – Specific conductivity measurements from a February storm at SHOKAN.

Site	Date	Time	Specific Conductance(µS/cm)
SHOKAN	02/16/16	11:09	1160
SHOKAN	02/16/16	12:00	642
SHOKAN	02/16/16	13:30	310
SHOKAN	02/16/16	14:30	203
SHOKAN	02/16/16	15:30	156
SHOKAN	02/16/16	18:00	145
SHOKAN	02/16/16	21:30	167

Microbiological Parameters

As expected, routine (fixed frequency) stream samples yielded lower fecal coliform (FC) concentrations than those recovered during storm events. The maximum fecal coliform concentration for the routine sampling was 4,800 FC $100ml^{-1}$, while the maxima for the storm data was 72,000 (Table 4). As a note, there were occasions during routine sampling when there was rain, and there was one routine collection and six storm event samples that yielded “Too

Numerous To Count (TNTC)" results. TNTC results are not considered in the fecal coliform data analysis since the value is unknown. The mean and median values for the routine data were 167.0 and 10.0 FC 100ml^{-1}, respectively, whereas the storm data resulted in 5127.9 and 675 FC 100ml^{-1} for the mean and median, again demonstrating higher values during storm events.

Table 4 - Fecal coliform summary statistics for SHOKAN site August 2014 – May 2016.

Fecal Coliforms 100ml^{-1}	Routine Samples (n=55)	Storm Samples (n=72)
Min	<2 (non-detect)	<4 (non-detect)
Max	4,800	72,000
Mean	167.0	5,127.9
Median	10.0	675.0

From the 55 routine samples, two were selected for *Bacteroides* analysis due to their elevated FC concentrations. Both of the routine samples sent for testing were collected in June 2015 and tested positive for General *Bacteroides*, which is expected since it is present in the feces of warm blooded animals. One sample resulted in a TNTC FC concentration and the other was 4,800 (Table 5). The first sample, collected on June 2, 2015 was collected during a storm and was therefore influenced by transport from the precipitation event. MST results revealed no detection of the human marker from this sample. The second sample, collected June 15, 2015 was positive for the initial human marker (Hum 1) at a moderate level, and was tested for two additional markers (Hum 2 and Hum 3). Although at lower concentrations, both of the additional markers were also positive, suggesting that this site was likely being influenced by a human source of fecal bacteria at the time of sampling.

From the 72 storm samples, 12 were selected for *Bacteroides* analysis based on their elevated FC concentrations compared to other samples collected during the same storm events. The 12 samples were collected from storms that occurred in October, June, August, September, January, and April, and all tested positive for General *Bacteroides*, which is expected since it is present in the feces of warm blooded animals. Eight of the 12 samples (67%) were either non-detect or had an immeasurable (trace) amount of the human marker (Table 5). The remaining four samples (representing 3 storms), had low levels of the initial human marker (Hum1). One of the four samples (from June 27-28, 2015) was also examined for the two additional markers (Hum 2 and Hum 3) and they were positive at a low and trace level, respectively, while the other sample from the same event tested negative for the additional two markers.

Table 5 – Bacteroides results for samples with elevated fecal coliform concentrations at the SHOKAN site (August 2014 – May 2016)

Sample Date	FC ($100ml^{-1}$)	General *Bacteroides*	Hum 1	Hum 2	Hum 3	Source magnitude
Routine						
06/02/15*	TNTC	5.78E+04	neg	nt	nt	none
06/15/15	4800	7.85E+05	7.97E+04	8.07E+03	4.22E+02	moderate, low, low
Storms						
10/15/14	8400	7.86E+04	neg	nt	nt	none
10/16/14	5300	9.31E+04	neg	nt	nt	none
06/27/15	11000	6.77E+05	9.20E+02	nd	nd	low
06/28/15	5100	8.37E+05	7.14E+03	1.56E+03	<LOQ	low, low, trace
08/11/15	1800	1.33E+04	<LOQ	nt	nt	trace
09/29/15	72,000	9.18E+04	neg	nt	nt	none
09/29/15	45,000	8.22E+04	1.95E+03	nt	nt	low
10/28/15	4,200	9.98E+04	neg	nt	nt	none
10/28/15	4,700	1.87E+05	<LOQ	nt	nt	trace
01/10/16	800	2.96E+05	<LOQ	nt	nt	trace
01/10/16	610	2.94E+05	2.15E+03	nt	nt	low
04/07/16	530	2.84E+05	neg	nt	nt	none

*influenced by storm
nt – not tested
nd – non-detect
LOQ –limit of quantification

In response to the data indicating possible influence by a human sources, DEP assessed septic failures within the catchment area of the sample point. A commercial septic system near the sampling stream was identified as being in failure. The repair of this septic system was ultimately completed in September 2015. Since that time, when human marker was present the values were low or trace. As of June 1, 2016, there is one residential failure within the sample catchment area that is being addressed.

4. Shokan Land Use Analysis

4.1 Land Use Methodology

The assessment of residential and commercial septic systems in the area was needed in order to quantify the properties that have either had their septic systems addressed or could have them addressed through one of the existing septic repair programs. This information is used to assess the degree to which the existing septic repair programs have addressed the needs for Shokan or if there is any unmet need.

DEP conducted a desktop analysis using GIS data to determine which sites in the study area may be able to support an on-site wastewater treatment system. A study area was outlined that included a total of 518 parcels. For each residential parcel, DEP used tax assessor data on bedroom counts and a daily design flow rate of 110 gpd per bedroom to determine flow. Using estimated percolation rates based on the soil hydrological group, DEP estimated the required trench length as outlined in Table 4A of NYSDOH Appendix 75-A. For commercial sites, design flows were calculated using flow rates outlined in Table B-3 of the NYSDEC Design Standards for Intermediate Sized Wastewater Treatment Systems, March 5, 2014 (NYSDEC Design Standard). Commercial uses were assessed in the field and used to develop estimated daily design flows.

Required trench lengths were then calculated using assumed percolation rates based on soil hydrological group and recommended sewage application rates outlined in Table E-1 of the NYSDEC Design Standard[1]. Once the required trench lengths were determined for both residential and commercial sites, DEP calculated the approximate square footage required to site an appropriate sized absorption field.

In order to determine whether adequate space was available for the calculated absorption field, DEP determined the amount of available space on each individual parcel. To determine the amount of available space, DEP used GIS data for each parcel and subtracted out the areas where a septic system could not be appropriately sited (e.g., steep slopes, poor soils, impervious surface) (See Figure 4). Using this data, DEP was able to generate a map identifying all restricted areas (Figure 5). The calculated required area for an absorption field was then compared to the available land area on-site after accounting for regulatory setbacks and exclusions listed in Appendix 75-A or the NYSDEC Design Standard to determine if the site could potentially support a compliant system.

The study sought to generate estimates on the location of conventional septic systems on each individual lot. Given the study's scope, it is therefore possible that some sites that were deemed unable to locate a conventional septic system may be able to locate a conventional septic system following a detailed on-site assessment (site-specific soil tests, setback measurements). Similarly, site-specific conditions that differ from the data set (e.g., USGS soil data,

[1] In calculating the absorption field, laterals were to be no more than 60 feet in length with a six foot spacing on center.

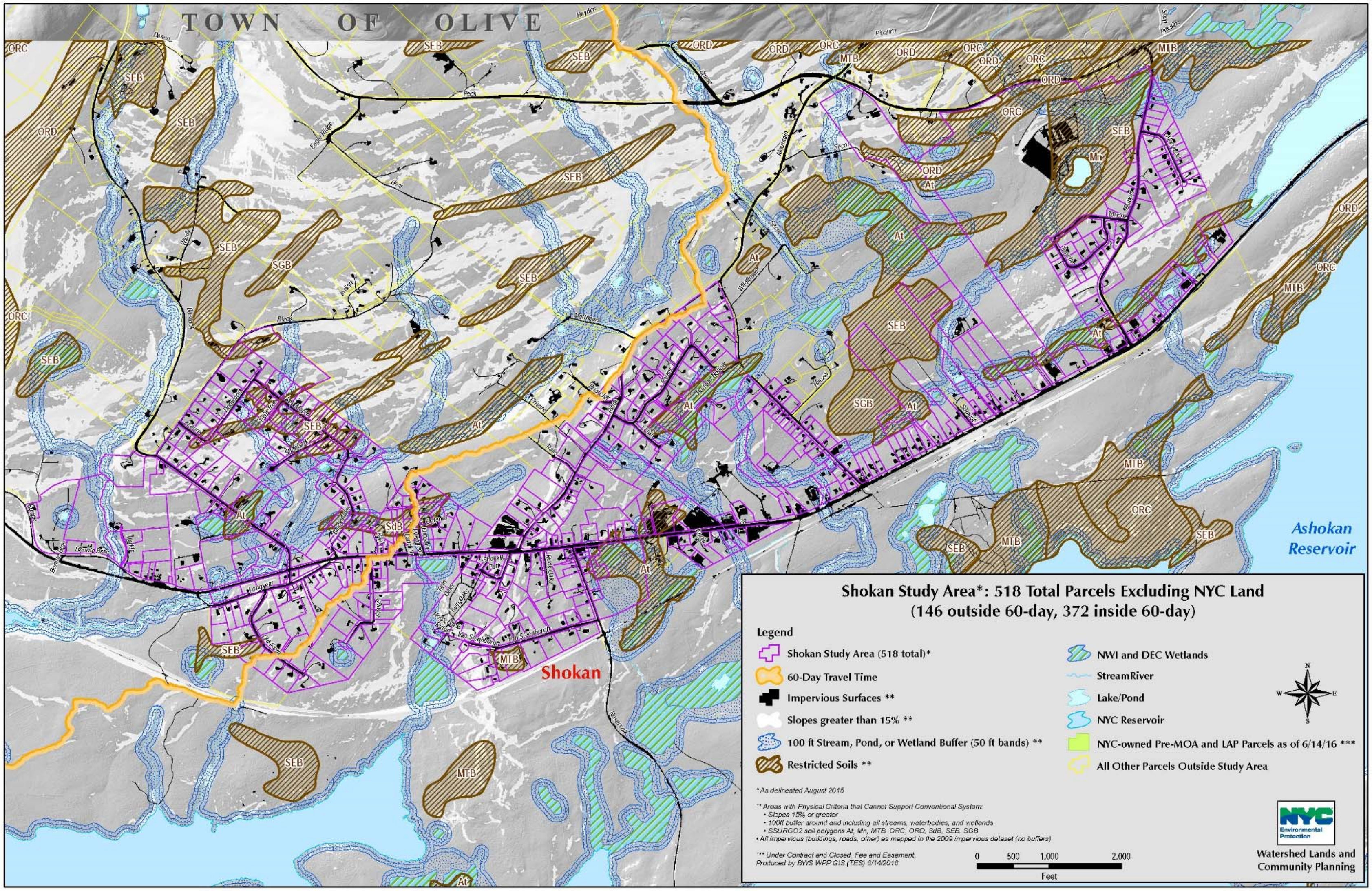

Figure 4 Shokan Septic Restrictions

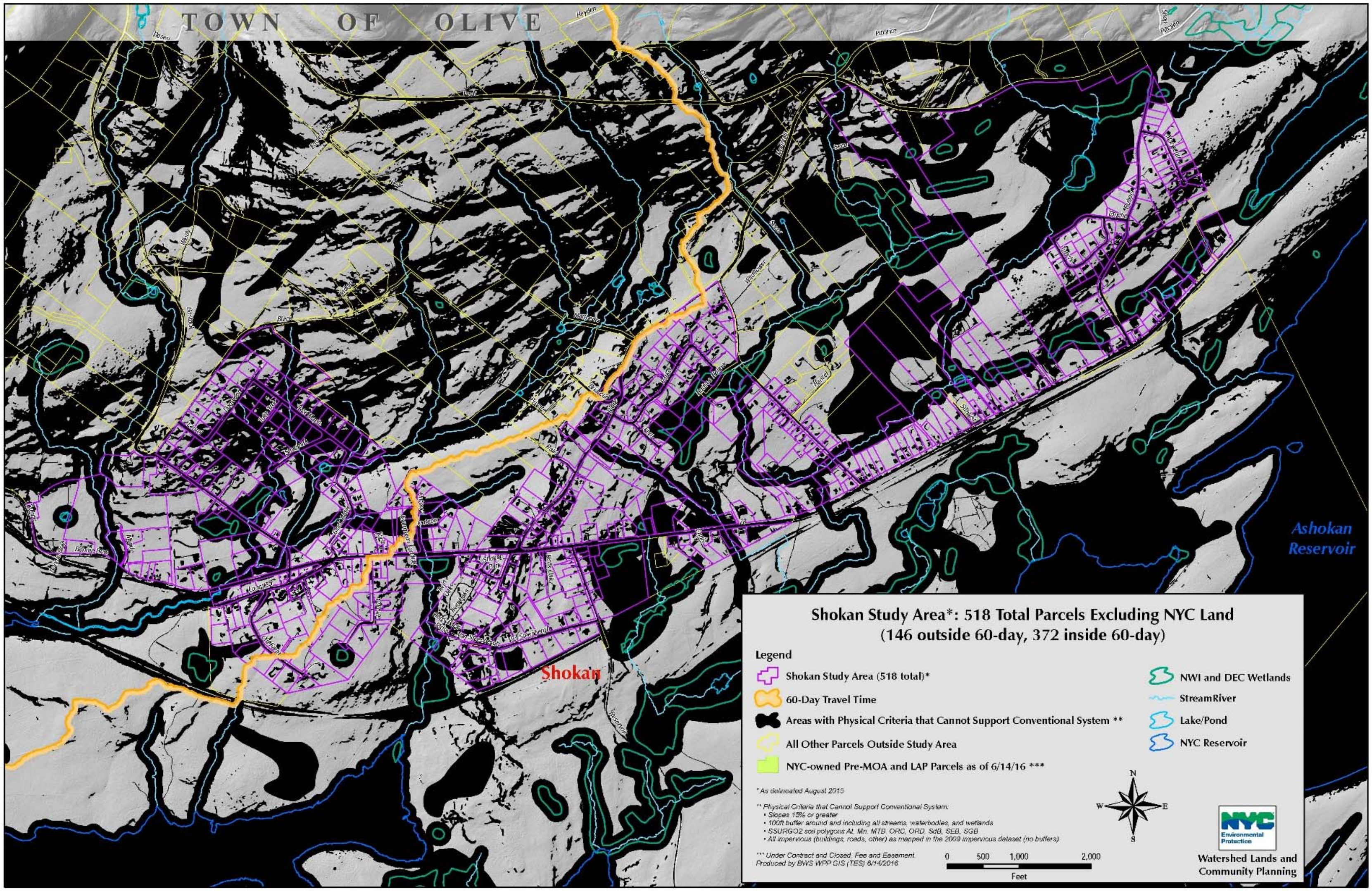

Figure 5 Shokan Septic Restrictions - Results

County parcel data) or specific site constraints (e.g., well location) may limit the ability of some sites from hosting a conventional system. Further, the analysis only considered sizing of conventional and raised systems, so it is possible that an excluded site would be able to support an acceptable alternate system.

As a GIS analysis, regulatory restrictions on the 10 year flood level or separation distances to wells, water service lines, house sewers, septic tanks, or effluent lines may impact the results. Given that the primary limitation for siting a septic system is the drainfield, the analysis did not take into consideration placement of other system components or orientation of system components (e.g., placing laterals parallel to contours). This was a desktop study and did not include on-site soil analysis or verification of potential site constraints.

4.2 Land Use Findings

A total of 518 parcels were located in the study area, which included 416 residential parcels, 48 commercial parcels, and 54 vacant lots (see Table 6). Based on current land use, DEP determined that 51 sites, or approximately 11% of developed sites, could potentially not support a fully compliant on-site wastewater system (See Figure 6). This includes 41 residential sites and 10 commercial sites[2].

Table 6 – Land Use Analysis

Type	Total Number	Mean Lot Size (acres)	Mean Usable Area (acres)
Residential	416	1.6	0.89
Commercial	48	5.0	1.71
Vacant	54	1.6	0.74
Total	518	1.9	

[2] Potential flow from vacant sites was not calculated as doing so would require too many assumptions to provide meaningful results.

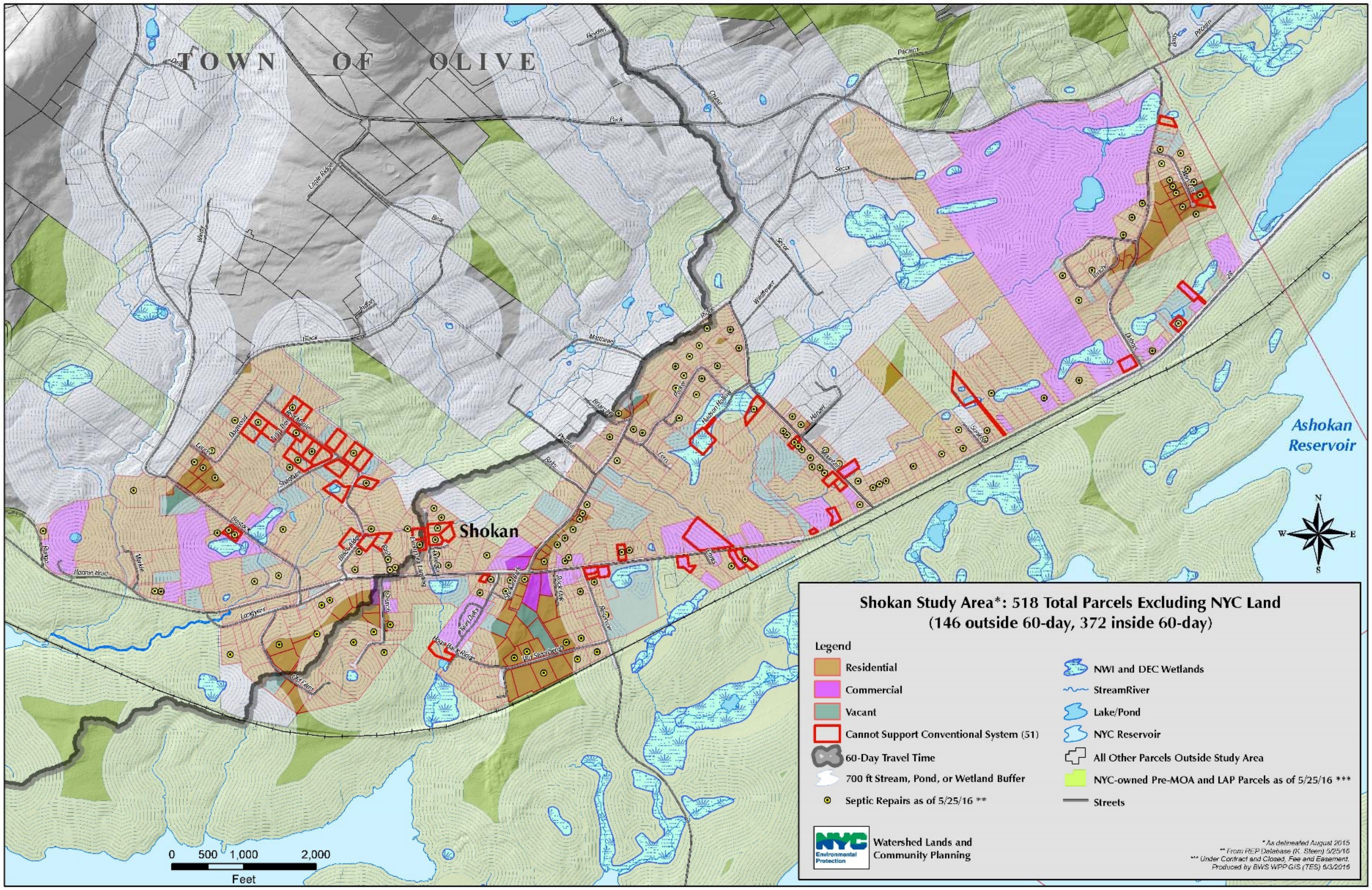

Figure 6 Septic Repairs and Potentially Undersized Lots

5. Shokan Septic Systems

5.1 Existing Septic System Programs

Wastewater from homes and businesses in Shokan is treated by individual septic systems. Properties within the 60-day travel time or 700 feet of a watercourse are eligible to participate in the septic repair programs managed by the Catskill Watershed Corporation (CWC). Under existing Program Rules, 100% of parcels within the Shokan study area are eligible to participate in either the Septic Remediation and Replacement Program or Small Business Septic Program.

Additionally, beyond the individual septic repair programs, the Shokan area was also identified as a candidate for CWC's Cluster System Program. This program allows the municipality the opportunity to combine wastewater flow from several septic systems and provide proper wastewater treatment on an off-site lot.

5.2 Septic Repairs

Since 1997, approximately 35% of the septic systems in Shokan have repaired or replaced their septic system. Of the approximately 163 septic system repairs, nearly all of them were residential. Based on an approximate average cost of $20,000 for projects within the Septic Repair Program, it can be estimated that approximately $3 million has been spent on septic repairs within the study area. There is currently one outstanding residential NOV within the study area that is being monitored by DEP staff and addressed accordingly.

As noted above, Shokan was identified as an eligible area for the Cluster System Program Septic, which provides opportunities beyond the individual septic repair programs. Since the start of the Cluster System Program, CWC has identified properties within this priority area that would be eligible for the program. Following the identification of an eligible site, CWC contacted municipal officials within the town to ensure that they are aware of the availability of this additional program. To date, municipal officials have opted to continue to have wastewater treated on the individual property owner lots within this priority area rather than combine wastewater onto a community site.

5.3 Septic Pump-outs

Neither the County nor Town require tracking of septic pump-outs. As such, data on septic pumping within the area of interest is limited. CWC does have data on pump-outs based on the systems that are able to participate in the Septic Maintenance Program. Based on a review of that data thru June 2015, there is no evidence that systems are being pumped more frequently than typically recommended (i.e., once every 3-5 years).

6. Conclusion

The land-use analysis found the majority of sites were able to support an on-site wastewater system. The water quality results do not suggest human pathogens are a significant source of pathogens in the surface water.

The existing septic repair programs that are funded by DEP and managed by CWC have been successfully implemented. Through these programs, significant capital investments have been made to improve wastewater treatment in Shokan. Residents and businesses have availed themselves of these programs and therefore improved wastewater treatment within the area. As septic failures have been identified, CWC has taken the steps necessary to ensure wastewater is treated properly.

Given the findings, it appears that the existing programs adequately address septic issues as they arise. DEP will continue to fund these septic repair programs as a means to protect water quality. In the event that several sites would be identified in the future as being unable to locate a conventional septic system or alternate treatment unit, the community could take advantage of the opportunity to participate in the cluster system program, which would allow them to collect wastewater from a variety of sites and treat it at a suitable location.