Town of Lake Santeetlah Sewer Study

March 8, 2017

PREPARED FOR

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
ADF	Average Daily Flow
ARC	Appalachian Regional Commission
CWMTF	Clean Water Management Trust Fund
DEH	North Carolina Division of Environmental Health
DEQ	North Carolina Department of Environmental Quality
DHHS	North Carolina Department of Health and Human Services
DWR	North Carolina Division of Water Resources
EP	Effluent Pump
GIS	Geographic Information System
GP	Grinder Pump
gpd	Gallons per Day
GPS	Global Positioning System
LAU	Land Application Unit
LDP	Large Diameter Pipe
LPP	Low Pressure Pipe
LRM	Land Resources Management (soil subconsultant)
LSS	Licensed Soil Scientist
LTAR	Long Term Application Rate
MHI	Median Household Income
mg/l	Milligrams per Liter
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OWPB	Onsite Water Protection Branch
PDF	Peak Daily Flow
PS	Provisionally Suitable
SHWT	Seasonally High Water Table
SSDI	Subsurface Drip Irrigation
STE	Septic Tank Effluent
STEG	Septic Tank Effluent Gravity sewer
STEP	Septic Tank Effluent Pump sewer
US	Unsuitable

Acronyms/Abbreviations	Definition
USDA	United State Department of Agriculture
USFS	United States Forest Service

Executive Summary

The Town of Lake Santeetlah currently relies on onsite wastewater treatment systems (OWTS), most of which are located at individual residences. Because the Town was platted prior to the adoption of modern sewage rules, parcels are typically too small to include sufficient area for repairing malfunctioning systems. Additionally, some systems - particularly the older systems - are known to not comply with modern design and installation standards. A previous engineering study recommended that the Town build a sewer system and connect to the wastewater system for Town of Robbinsville, about 5 miles away. The costs and other implications associated with this option were untenable for residents and Town leaders, who have repeatedly expressed an interest in identifying other, less expensive and more adaptable wastewater management options for properties in need of alternatives. The Appalachian Regional Commission (ARC) provided a grant to the Town for a study of such alternatives and Tetra Tech Engineering, P.C. (Tetra Tech) was hired to conduct the study along with our subcontracted soil science consultant, Land Resources Management (LRM).

The project team initially conducted an evaluation of existing conditions within the Town, including a review of Lake Santeetlah water quality monitoring data, an analysis of the Town's residential water system flows, a cursory site evaluation of all developed parcels and their OWTS options, a review or Graham County Health Department permit records for about half of the parcels, and a preliminary soil/site evaluation of undeveloped parcels that could host shared (cluster) wastewater treatment drainfields. Using this information, the team developed conceptual designs and costs for community-scale cluster systems for comparison with other options. After multiple meetings with community leaders and stakeholders, Tetra Tech developed a set of recommendations to help the Town move forward with a more proactive wastewater management approach while respecting the community's reluctance to the Town providing full wastewater services at this time.

Lake Water Quality

The North Carolina Division of Water Resources (DWR) has been monitoring water quality in Lake Santeetlah periodically for several decades. Monitoring data from sampling locations closest to the Town do not appear to show negative impacts from OWTS or other land-based activities. However, the sampling locations are out in the open lake, relatively far from the shoreline. Additional sampling, especially nearshore during high use periods in Town (e.g., holidays) are recommended to shed more light on the potential public health and environmental impacts of OWTS and also help identify hotspots that could help prioritize areas in Town for proactive wastewater management.

Town Water System and Water Use

Tetra Tech reviewed water use data from billing records for individual residences, along with data from the main water meters as reported to DWR as part of the Town's annual Public Water Supply Plan. The data showed clear and expected differences in water use seasonally and between different types of properties - full time residences, seasonal/part-time residences, and rentals. Overall median and mean residential flow rates appeared to be reasonable and well within typical design guidelines, although several properties had extraordinarily high readings that suggest leaks, metering problems, meter reading/billing problems, or the like. Additionally, the main meters read significantly higher flows than did the cumulative individual meter readings. This again may suggest meter or reading problems and/or water loss within the distribution piping network. Collectively, the difference between the real flows (main meter readings assuming they are accurate) and the amount billed is called "non-revenue water" and

should be a priority for the Town to minimize. Town staff and stakeholders recognize that there are some problems with their water system. Tetra Tech recommends that the Town consider applying for an Asset Management grant from DWR in order to assess the condition of their system with a focus on reducing non-revenue water. These relatively new grants - which may not always be available - provide up to $150,000 for water or wastewater system asset management activities, with relatively small requirements for matching funds.

Developed Parcel Evaluation

LRM conducted a cursory evaluation of all developed parcels in Town and generated a parcel map with ratings for each property in terms of their onsite options for wastewater management, with the most limited lots receiving a “red” rating and least limited lots a “green” rating. Using this information along with our partial review of Graham County Health Department permits (database of findings being delivered to the Town as part of the project), Tetra Tech developed an aerial prioritization classification for four main areas of Town, as indicated below. Based on this analysis, the West End was the highest priority for management, with the South Side being the lowest.

Collection Zone	% Moderately Limited Sites	% Most Limited Sites	Total % Limited Soils/Sites	% Repaired Systems	Availability of Repair Sites	Priority
North Shore (west)	24%	51%	76%	41%	Limited	3
North Shore (east)	29%	58%	87%	26%	Limited	2
South Side	33%	50%	83%	13%	Good	4
West End	25%	69%	94%	29%	Very Limited	1

Undeveloped Parcel Evaluation

LRM also sampled soils during field evaluations of available, undeveloped parcels in Town. In general most of the internal (i.e., not waterfront) parcels were found to be capable of hosting cluster drainfields. Additionally, the total amount of property required - even to provide wastewater treatment service for the entire Town - was only a fraction of that available. The soil textures in the studied area range from sandy loams to loams/sandy clay loams; these textures receive a moderate loading rate for OWTS design. The main site characteristic of concern for Lake Santeetlah is depth to weathered bedrock. Although the topography of Town is generally moderate to steep, most of the internal parcels featured more gentle slopes.

Cluster System Evaluation

Based on the discussion above, and discussions with Town leaders and stakeholders, it appears that a “distributed” wastewater management approach, which recognizes a range of scales from OWTS to shared systems to small and large cluster systems, is appropriate for the Town. Tetra Tech conducted a

conceptual design and costing exercise to provide a vision and idea of cost implications of potential future treatment and dispersal of most parcels using cluster systems on shared property.

Engineering cost estimates are provided below. Based on these costs, we estimated that the typical residential customer could have a sewer rate of $30 to $100 per month, depending on how the capital costs are funded (the lower rates assume that capital costs would be funded up front, e.g., via property assessment or connection fee).

Collection Zone	# of Homes	Treatment Zone	Required Area (ac)	Total Cost	Unit Cost (w/ land purchase)	Unit Cost (w/o land purchase)
North Shore (west)	37	1A	0.6	$453,647	$12,261	$9,017
North Shore (east)	31	1B	0.5	$391,413	$12,626	$9,400
South Side	24	2A	0.4	$353,008	$14,709	$11,375
West End	52	2B	0.8	$648,297	$12,467	$9,390

Nevertheless, these costs and rate estimates are only provided for comparative purposes. Cluster systems can be phased in over time as dictated by demand. For example, a cluster system could start as two or three homeowners with malfunctioning OWTS sharing an off-site system. As additional properties with malfunctioning systems wish to connect, the cluster system can be incrementally increased in size/capacity using modular systems and adding drainfield zones, as needed. Small cluster systems (with treatment areas sited near to the properties to be served) will be the least expensive option as compared with individual OWTS repair or replacement or fully centralized service (e.g., connection to Robbinsville).

Recommendations

Based on extensive engagement with the community through Town staff, the Town Council, and the Town's Sewer Committee, Tetra Tech's recommendations focus on incremental steps that the Town can take to:

1. Raise awareness among residents and elevate the discussion about wastewater management, through a public education campaign
2. Better understand existing onsite wastewater systems in the Town and any problems using field inspections, additional permit review, and property owner survey
3. Better understand local impacts of onsite systems on water quality, by increasing sampling locations especially nearshore during high use periods
4. Provide options for individual property owners and groups of property owners, by sharing information, facilitating discussions, and brokering access to land for small cluster systems
5. Take proactive steps to mitigate potential future problems with onsite systems, by securing access to potential cluster sites via purchase, long term lease, etc.

The following specific steps are recommended for the Town to move forward:

Step	Timeline	Responsible Parties
Approve sewer study	March 2017	Town Council
Establish standing wastewater committee for Town	March 2017	Town Council, Sewer Committee
Presentation to community	Summer 2017	Sewer Committee, potentially with Tetra Tech
Implement community awareness campaign	(see table in Section 5.1)	Sewer Committee with Town Staff
Refine Lake Santeetlah water quality monitoring program	May 2017 and ongoing	Sewer Committee, Town Staff and potential municipal, State, and Federal partners
Complete Health Department file review and system database	2017	Sewer Committee with potential Staff or consultant support
Develop an existing system inspection program	Summer 2017	Sewer Committee, Town Staff and potential municipal, State, and Federal partners
Discuss and pursue access arrangements with cluster system property owners	2017-2018	Sewer Committee, Town Staff, Town Council
Develop adaptable medium- and long-term infrastructure plan	2017-ongoing	Sewer Committee, Town Staff, Town Council, potentially with consultant
Assess potential funding sources (note potential asset management grant for water system inventory)	2017-ongoing	Sewer Committee, Town Staff, Town Council, potentially with consultant

1.0 INTRODUCTION

1.1 Project Background

The Town of Lake Santeetlah received a grant from the Appalachian Regional Commission (ARC) for a Sewer Feasibility Study in the Spring of 2015. The grant is administered jointly by the ARC (Julie Lawhorn) and the ARC Program Manager with the North Carolina Department of Commerce (Olivia Collier).

The overall objective of the study was to develop a plan for improving wastewater management in the Town of Lake Santeetlah by evaluating existing conditions and recommending a wastewater management road map for the Town to move forward, along with more detailed information to support funding, design, and permitting of selected project(s). This study was preceded by an earlier Preliminary Engineering Report (not located) that reportedly recommended connecting to the sewer system for the Town or Robbinsville. However, community leaders felt that this alternative was unnecessary, too expensive, and otherwise undesirable. This current study, therefore, sought to identify other more flexible and affordable alternatives to widespread sewering.

1.2 Community Profile

The Town of Lake Santeetlah, in Graham County, North Carolina (Figure 1) includes over 200 homes and several small businesses (e.g., marina) and institutional facilities (e.g., Town administrative building) located on an approximately 130-acre peninsula on Lake Santeetlah. The Town of Lake Santeetlah is located approximately six miles northwest of the Town of Robbinsville (Figure 2). The town was organized in 1989 as Santeetlah; in 1999, its name was changed to Lake Santeetlah. A detailed parcel map of the town is provided in Appendix A.

As of the 2000 census, there were 67 residents, 38 households, and 25 families residing in the town full time. In the 2010 census, the full-time population was 45 persons. A number of homes in the Town are second (summer) homes and/or rentals.

The Santeetlah lake project was completed in 1928 by damming the Cheoah River and flooding the Santeetlah valley. At normal full pool, the lake has an area of approximately 2,881 acres, is located at an elevation of 1,941 feet MSL, and has approximately 76 miles of shoreline. The lake is classified by the State as a Class B Trout water, maintained for primary recreation, and also supplies the Rhymer's Ferry electrical generating facility on Cheoah Lake, downstream of the dam. A number of Town residents own boats and recreate on Lake Santeetlah. In addition to benefitting their personal use of the lake, town residents understand that the lake's excellent water quality is critically important to maintaining property values and enhancing economic opportunities in the Town and greater Graham County region. The Town of Robbinsville has reportedly considered using Lake Santeetlah as a water supply[1].

The Town of Lake Santeetlah consists of a single large cluster of residences and businesses on the lake, adjacent to a predominantly rural landscape, much under the control of the United States Forest Service (USFS). Development in the town began in the early 1960s, mainly consisting of modest cottages along

[1] http://www.townofrobbinsville.com/robbinsville-news/ accessed February 16, 2017

the north shore of the peninsula. The completion of the current water system in 1995 (which includes five water supply wells, water processing and control building, five well houses and 4,000 feet of pipeline located on USFS property) occurred simultaneously with a new round of typically higher-end construction. The 26-28 room lodge, which had operated only sporadically during the preceding decades, was converted into a sales office for an upscale lakefront development called Santeetlah Lakeside.

Based on the 2011-2015 American Community Survey 5-Year Estimates, Median Household Income (MHI) is about $62,500, although there is a wide range of incomes reported for residents.

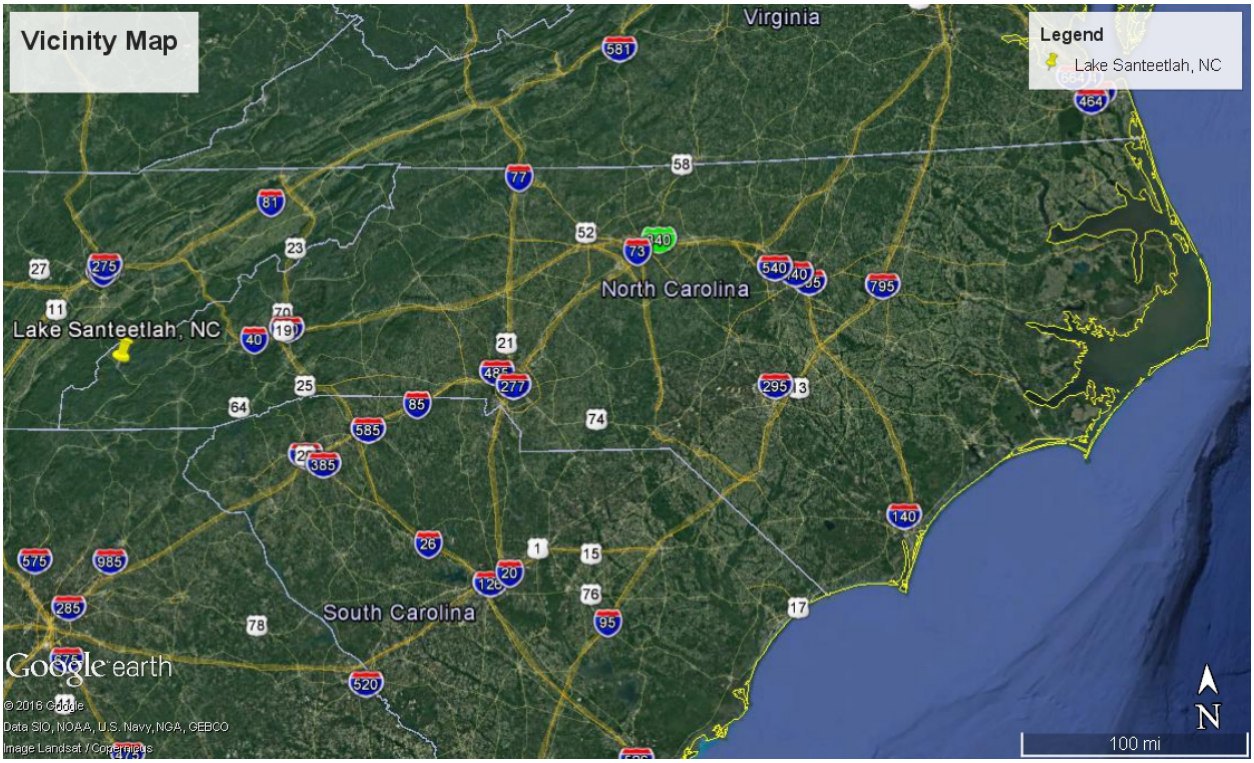

Figure 1. Town of Lake Santeetlah vicinity map

Figure 2. Town of Lake Santeetlah regional map

As implied, the Town owns and operates its own public water supply, treatment, and distribution system. Operation of the system is contracted with a local operator although billing and related functions are administered by Town staff. Water rates are reported to be $103.75 per quarter base rate plus $3 per 1,000 gallons of consumption. Wastewater management in the Town relies mostly on subsurface onsite and decentralized wastewater systems, with most homes on individual onsite wastewater systems. There is a small cluster system (media filter followed by surface drip irrigation) installed and permitted for the aforementioned Santeetlah Lakeside development. Although this system has an active permit, it is not currently in use. The old lodge also has its own subsurface wastewater system in the same general vicinity of Santeetlah Lakeside.

Existing onsite wastewater systems in the Town vary in terms of their design and installation quality. Graham County Environmental Health staff and local leaders and residents report a wide range of system types from old steel tanks (what could best be described as a cesspool or seepage pits) to modern septic systems, including some advanced treatment and dispersal (e.g., T&J Panel) systems which became popular for new development and repairs starting in the late 1990s. The lots in Lake Santeetlah were platted prior to modern State regulations regarding onsite systems, notably resulting in most lots being small and not having a designated repair area in case the original system malfunctions. Residents repeatedly expressed a need to have a range of options for dealing with repairs to individual onsite systems, but expressed a reluctance to implementing a fully centralized, publically-owned and operated community system.

2.0 LAKE SANTEETLAH WATER QUALITY

The North Carolina Division of Water Resources (DWR) has been monitoring water quality in Lake Santeetlah since 1975. Figure 3 shows the locations of sampling points within the vicinity of the Town of Lake Santeetlah. ALCOA monitors water quality below the dam but does not monitor within the lake. The Graham County Health Department was not aware of any water quality monitoring done by the County.

Constituents measured by DWR have varied over time. Table 1 provides summary statistics for relevant characteristics available at the two closest sampling points to the Town. The data suggests that water quality near the Town has remained similar in terms of nutrients, sediment, and algal response across the entire monitoring period. Although none of the results indicate immediate concerns in terms of public health or biological integrity, additional sampling at nearshore areas (i.e., closer to the Town shoreline) would be needed to determine whether onsite systems are causing acute impacts to water quality.

Fecal coliform, secchi depth (which measures water clarity), phosphate, and ortho-phosphate have not been collected at these locations since 1995. As recent as 2014, oxygen and temperature data were collected at location 37D for multiple depths; this data could be used to develop depth profiles.

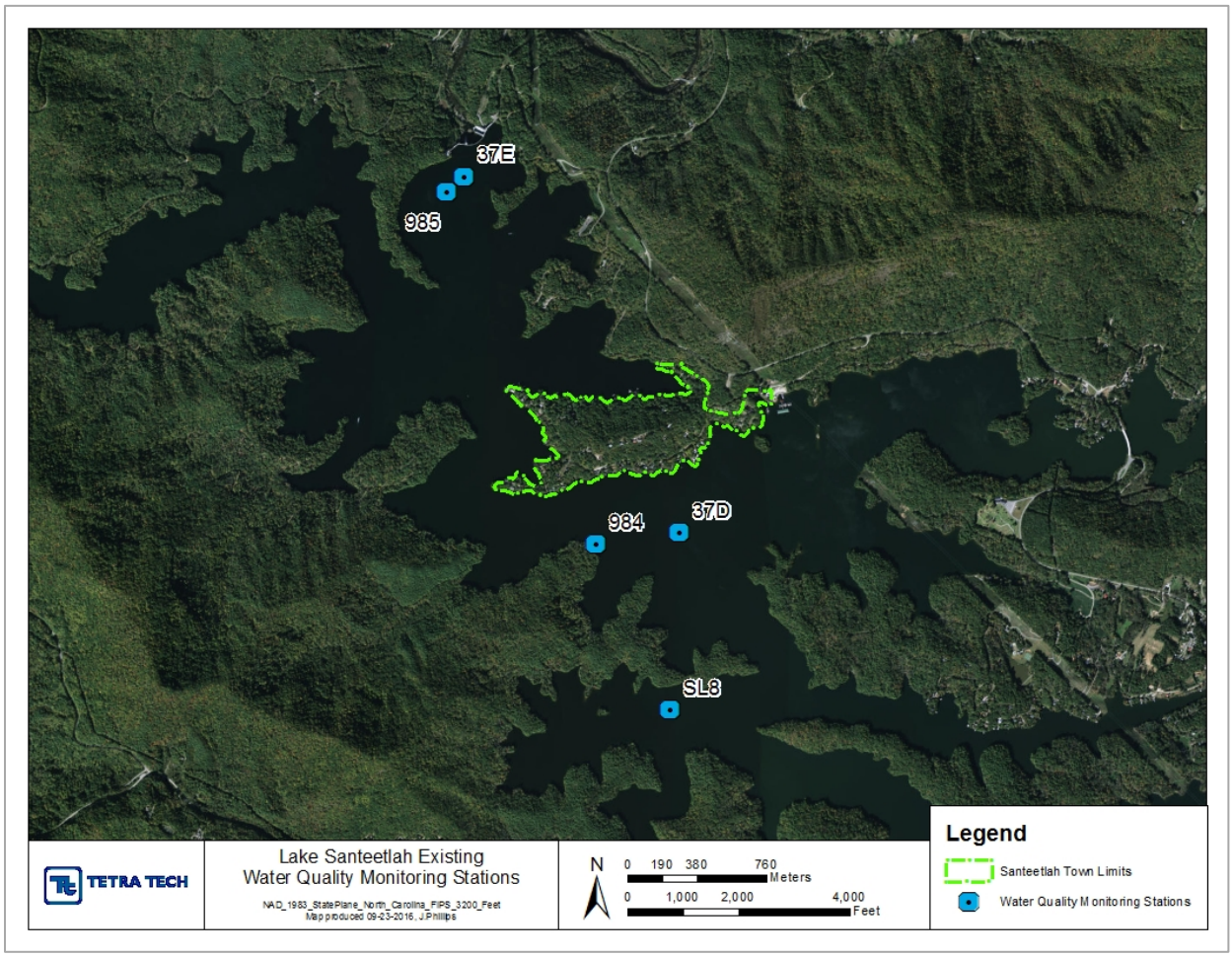

Figure 3. DWR monitoring locations

Table 1. Summary of DWR water quality monitoring data at locations 984 and 37D

Constituent/Parameter	ID 984: 21NC01WQ-G9840000 8/28/1975 - 8/2/1995					ID 37D: 21NC03WQ-LTN037D 6/16/2004 - 10/01/2014)				
	Count	Min	Max	Mean	Median	Count	Min	Max	Mean	Median
Ammonia-nitrogen (mg/L)	16	0.005	0.050	0.021	0.018	13	0.010	0.020	0.011	0.010
Chlorophyll a (µg/L)	16	2.000	12.000	4.438	4.500	13	1.100	5.800	3.292	2.800
Depth, Secchi disk depth (m)	12	1.830	5.800	3.658	3.550	0	N/A	N/A	N/A	N/A
Dissolved oxygen (DO) (mg/L)	95	1.000	10.500	7.036	7.800	191	0.700	10.500	7.336	7.900
Fecal Coliform (#/100 mL)	10	0.500	30.000	7.050	5.000	0	N/A	N/A	N/A	N/A
Nitrate-nitrite as N (mg/L)	16	0.005	0.160	0.046	0.025	13	0.010	0.070	0.025	0.010
Kjeldahl nitrogen (mg/L)	16	0.050	0.400	0.153	0.150	13	0.100	0.200	0.138	0.100
Orthophosphate as P (mg/L)	14	0.005	0.025	0.011	0.005	0	N/A	N/A	N/A	N/A
Phosphate as P (mg/L)	20	0.005	0.090	0.018	0.010	0	N/A	N/A	N/A	N/A
Total phosphorus (mg/L)	0	N/A	N/A	N/A	N/A	12	0.010	0.020	0.012	0.010
Total suspended solids (mg/L)	7	0.500	3.000	1.786	2.000	8	3.100	3.100	3.100	3.100
Turbidity (NTU)	4	0.500	2.000	1.025	0.800	11	0.500	2.800	1.427	1.700

3.0 DETAILED EVALUATION OF EXISTING PARCELS

3.1 Water Flow Data Evaluation

We understand that the Town bills residents for water on a quarterly basis. Tetra Tech was provided the three most recent quarters' water consumption for property addresses by the Town. Additionally, as a public water supply, the Town is required to update its water supply plan with DWR on an annual basis. Billing data was generated by quarterly readings of mechanical water meters at each property, while the DWR data was generated by monthly readings of the Town water system's main meters at the supply. Water consumption data was evaluated for the following:

- Overall flows for estimating wastewater treatment capacity needs
- Variation in water usage seasonally
- Variation in water usage by property/customer/customer type (the Town also identified 39 rental houses in the community, as well as full-time resident properties, and - by subtraction - seasonal/part time use properties)
- Discrepancies between main meter readings and individual consumers' cumulative meter readings

A small number of properties were reported to be served by individual wells. These are summarized in Table 2.

Table 2. Properties with individual wells (information provided by Town)

Name	Old Address	New Address	Comments
Alizadeh	9 Thunder Island	Thunder Island	Well and water meter
Kelman	833 Sequoyah	833 Sequoyah	No meter
Harding Hohenschultz	581 Black Bear	581 Black Bear	No meter
Pavuk	408 Santeetlah Point	408 Santeetlah Point	meter # 19510613
Jack Matzko	855 Island Drive	855 Island Drive	No meter
Hubbells	1 Indian Trail	1 Indian Trail	No meter
Brickell	322 Thunderbird Trail	322 Thunderbird Trail	No meter
Dr. Plymale	901 Snowbird Trail	901 Snowbird Trail	No meter/Could not find well
Vernon Hill	760 Cherokee Trail	366 Cherokee Trail	Well and water meter
Goodall	382 Thunderbird Trail	382 Thunderbird Trail	Well Capped On Meter
Humphlett	706 Cherokee Trail	50 Cherokee Trail	No meter

Individual residence water consumption statistics are summarized in Table 3 and monthly flow data from the main water meters are summarized in Table 4. Graphical representation of the data is provided in Figure 4. Table 3 shows that full-time residents have higher overall average water consumption but that part-time and rental homes typically have higher peak flows. It makes sense that homes in full time use would have higher average flows as compared with homes in part time use as the latter are only occupied periodically and even if their periodic daily flows are high, when averaged with zero flows during other times, the resulting daily averages are low. In contrast, when these homes are occupied, it is more likely

during holidays and other events when the occupancy and water use is relatively high. Average flows for rental homes approach those for full-time residences during high use times of year (e.g., Q2 and Q3). Table 4, which is based on the main water meters, shows a clear seasonal water use tendency. It should be noted that this seasonal water use is generally beneficial with respect to onsite system performance in that the higher use summer months are typically drier and feature higher evapotranspiration rates which helps assimilate wastewater effluent without hydraulic drainfield malfunctions. Studies have also shown that onsite systems receiving significant periods of rest (e.g., like seasonal use residences in Lake Santeetlah would during the winter) have a tendency to rejuvenate, especially if the systems are overloaded or undersized when in active use.

Overall the average flow rates for residents in Lake Santeetlah appear to be within the range generally expected, although some of the peak flows (e.g., 734 gpd *average* at one rental residence in Q3) are extraordinarily high and should be routinely investigated when discovered after meter reading and billing (Town stakeholders indicated that irrigation systems which can result in high flows are generally rare in the town). By way of comparison, the State typically requires the use of 120 gpd per bedroom (e.g., a three-bedroom house is allocated a design flow rate of 360 gpd). However, the appropriate unit flow rate to use for design is highly dependent on:

- The specific system component being designed/sized
- The number of facilities (e.g., homes) on the system
- Seasonal considerations

Referencing the tables as well as Figure 4, it should also be noted that the data from the main water meters typically showed significantly higher flows than the cumulative flows from the customers' meters (in other words, the Town may not be collecting revenue for a significant part of the water being produced and delivered). This could be the result of:

- Inaccurate, incorrectly calibrated, or inadequately read or adjusted (e.g., by flow multipliers) individual water meters
- Inaccurate, incorrectly calibrated, or inadequately read main water meters
- Leaks or other losses between the main water meters and customer services

For planning purposes, we have assumed the standard 120 gpd/bedroom standard for design; however, we note that most community systems can be designed based on actual daily flows rather than these prescriptive standards. If actual flow data are to be used to support design and permitting, daily flow measurements (versus monthly or quarterly) are preferred and, in some cases, required. Accordingly, the Town should work on resolving differences between main and individual water meter readings. If community-scale wastewater systems are planned in the future, daily main meter readings may be necessary.

Table 3. Statistical summary of individual water consumption data (all flow data is quarterly average in gallons per day) for 2015

Statistic	Period[1]	All	Full-Time	Part-Time	Rentals
Count		187	13	137	37
Mean Daily Flow	Quarter 1	14.0	30.0	15.7	9.8
	Quarter 2	43.6	133	36.8	52.0
	Quarter 3	60.2	90.6	50.5	106
	Quarter 1-3	41.8	84.9	34.0	56.0
Median Daily Flow	Quarter 1	0.0	26.7	0.0	1.1
	Quarter 2	26.2	131	22.0	29.7
	Quarter 3	34.3	70.7	31.5	68.5
	Quarter 1-3	15.7	66.3	13.0	21.6
Maximum Daily Flow	Quarter 1	468	81.1	468	82.2
	Quarter 2	399	350	399	284
	Quarter 3	734	237	610	734
	Quarter 1-3	734	350	610	734

[1] Q1 = Jan-Mar, Q2 = Apr-Jun, Q3 = Jul-Sep

Table 4. Summary of average and peak daily flow by month for 2015

Month	Days	Avg. Daily Flow (gpd)	ADF/Home[1] (gpd)	Peak Daily Flow (gpd)	PDF/Home[1] (gpd)
Jan	31	12,000	60	16,000	80
Feb	28	15,000	75	25,000	125
Mar	31	16,000	80	20,000	100
Apr	30	13,000	65	15,000	75
May	31	14,000	70	16,000	80
Jun	30	29,000	145	31,000	155
Jul	31	27,000	135	32,000	160
Aug	31	29,000	145	30,000	150
Sep	30	8,000	40	10,000	50
Oct	31	11,000	55	1,000[2]	5
Nov	30	9,000	45	11,000	55
Dec	31	8,000	40	1,000[2]	5
Year	365	15,937	80	17,277	86

[1] Based on 200 homes (note that reported PDF for October and December 2015 appear erroneous)

[2] Reported Peak Daily Flows for these months are clearly in error, as by definition, they would have to be less than Average Daily Flows for the same time period.

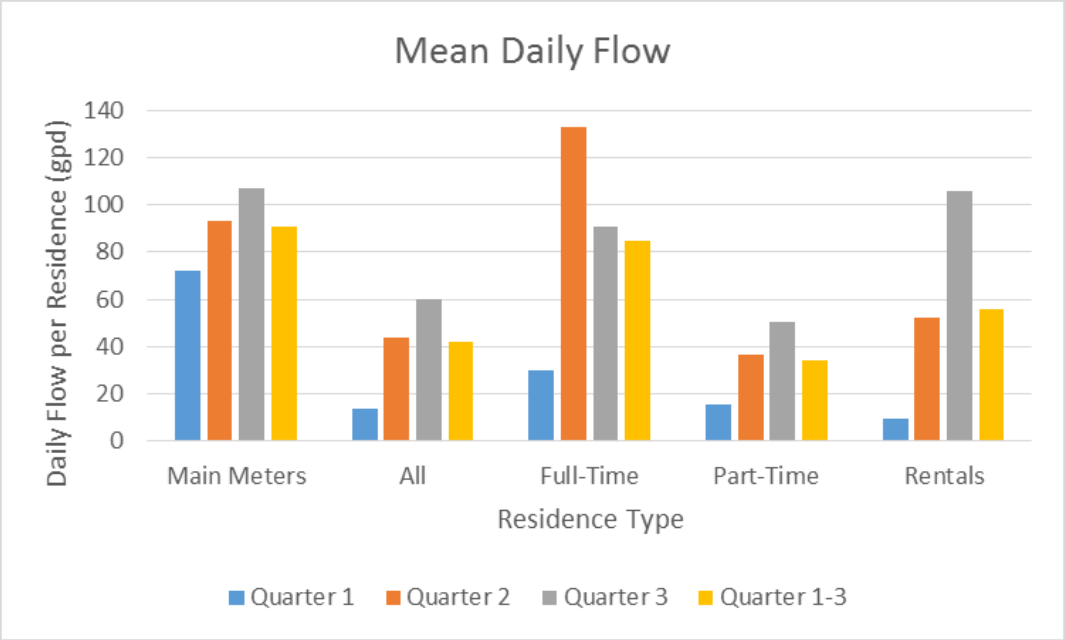

Figure 4. Summary of mean daily flow per residence measurements

3.2 Soil/Site Evaluations

Tetra Tech subcontracted with a local soil science consultant, Land Resources Management (LRM), based in Asheville and with an office in Murphy, NC, which conducted the soil/site evaluations. There were two main efforts associated with the subcontract soils work:

1. Cursorily evaluate existing developed parcels in Town and assign priority ratings to each based on soil characteristics, limiting site characteristics, setbacks to wells, surface waters and property lines, and availability of land on the property for repair or replacement onsite systems.
2. Preliminary soil/site evaluations, including dispersal capacity estimates, for existing undeveloped parcels within the Town boundaries. Note that Tetra Tech contacted the USFS about potentially siting a decentralized cluster wastewater system on their property; initial USFS feedback suggested that such a use would not be likely to be approved by USFS.

3.2.1 Methods

During the fall of 2015 and winter/spring 2016, Anthony Tipton and Walker Ferguson, of LRM, conducted evaluations of all parcels within the town limits. The evaluation consisted of background research, field evaluations, and meetings with the Graham County Health Department. Parcels were screened and classified based on their existing septic system and feasibility of a repair system.

Fieldwork was conducted using the following tools and methods. A 3-inch hand auger, a sharp shooter spade, and a tile probe were used to examine the soil. A Suunto clinometer was used to measure site slope. A Thales MobileMapper CE GPS unit was used to navigate properties and locate soil borings. All successful probes and boring attempts were flagged and labeled in the field.

Recommendations were based on, but not limited to, observations made and data collected on topography, landscape position, parent material, underlying geology, and soil characteristics. Soil

characteristics include, but are not limited to, depth to a seasonal high water table (SHWT), depth to a restrictive horizon (e.g., rock), total soil depth, soil horizonation, soil structure, soil color, clay mineralogy, bulk density, consistence, plasticity, stone content, and percent sand, silt, clay, and mica. They follow the guidelines set forth in the North Carolina Administrative Code-Rules for Sewage Treatment and Disposal Systems, Title 15A Subchapter 18A, Section .1934 through .1970, amended October 1st, 2011. Grading which occurs subsequent to this fieldwork renders the soil investigation in the graded area null and void.

This preliminary soil investigation is intended for general planning purposes only. Recommendations for system type are based on preliminary soils data. Additional sample points and detailed soils descriptions are needed for permitting. This study does not contain enough soils information to site septic systems and obtain permits from the Graham County Health Department.

Table 5 is a summary chart of system type and Long Term Acceptance Rate (LTAR) that results in the estimated amount of area needed for each system at varying LTARs. The value for the area is the minimum needed. Larger areas are typically required when the elevation contours are not uniform or site characteristics (e.g., deep gullies) render some of the area unusable. Estimated size requirements for larger (i.e., cluster) systems can be calculated by multiplying the required areas below by the number of houses connected to the system.

Table 5. Minimum area needed for various onsite systems at representative LTARs

System Type	LTAR (gpd/sf)	Minimum Area Needed for a 3-Bedroom House	Minimum Area Needed for a 4-Bedroom House
Gravel	0.6	4,000 square feet (0.09 acres)	5,400 square feet (0.12 acres)
	0.5	4,800 square feet (0.11 acres)	6,400 square feet (0.15 acres)
	0.4	6,000 square feet (0.13 acres)	8,000 square feet (0.18 acres)
25 Percent Reduction	0.6	3,000 square feet (0.06 acres)	4,000 square feet (0.09 acres)
	0.5	3,600 square feet (0.08 acres)	4,800 square feet (0.11 acres)
	0.4	4,500 square feet (0.10 acres)	6,000 square feet (0.13 acres)
8-inch LDP	0.6	6,000 square feet (0.13 acres)	8,000 square feet (0.18 acres)
	0.5	7,200 square feet (0.16 acres)	9,600 square feet (0.22 acres)
	0.4	9,000 square feet (0.21 acres)	12,000 square feet (0.28 acres)
10-inch LDP	0.6	4,800 square feet (0.11 acres)	6,400 square feet (0.15 acres)

	0.5	6,000 square feet (0.13 acres)	7,700 square feet (0.17 acres)
	0.4	7,200 square feet (0.16 acres)	9,600 square feet (0.22 acres)
Subsurface Drip Irrigation	0.3	2,400 square feet (0.05 acres)	3,200 square feet (0.05 acres)
	0.2	3,600 square feet (0.08 acres)	4,800 square feet (0.07 acres)
	0.1	7,200 square feet (0.17 acres)	9,600 square feet (0.22 acres)

In general, areas with soil depth greater than 36 inches and slopes between 0 and 40 percent are provisionally suitable (PS) for conventional septic systems. Conventional septic systems include: gravel trenches, gravelless plastic chambers, and EZ Flow systems. The plastic systems receive a 25 percent reduction in size compared to gravel systems and are collectively referred to as “25 percent reduction” systems in this discussion.

Areas with soil depth greater than 36 inches and slopes between 41 and 65 percent are PS for septic systems with 15 to 18 inch trench widths. These systems are gravelless 10 or 12-inch plastic pipes wrapped in geotextile fabric. These systems are known as large diameter pipe (LDP). In most cases, LDP systems are comparable to conventional systems with regard to installation and cost. This site discussion includes LDP systems in the areas referred to as potentially suitable for conventional drainfields.

Areas with less than 36 inches of soil depth are unsuitable (US). These areas can be reclassified PS if saprolite thickness is sufficient. Saprolite (friable weathering rock) is viewed as having a 2:1 ratio to soil. The state of North Carolina requires 12 inches of soil between the trench bottom and a restrictive horizon. If only saprolite exists below the trench bottom, 24 inches of saprolite would be required for the site to receive a PS classification.

Areas with insufficient soil and saprolite depths for conventional systems and LDP systems may be considered PS for Low Pressure Pipe (LPP) and Subsurface Drip Irrigation (SSDI) septic systems. The minimum soil depth for an LPP system would be 24 inches on a zero percent slope. The soil depth requirement for the SSDI system is 18 inches. Sites with soil depths less than 18 inches can be reclassified PS under certain circumstances by a Licensed Soil Scientist (LSS).

3.2.2 Town of Lake Santeetlah Discussion

The soil textures in the studied area range from sandy loams to loams/sandy clay loams. These textures receive a moderate (0.45- 0.6) Long Term Application Rate (LTAR) in septic design.

Table 5 provides an indication of the impacts LTAR can have on the footprint of septic system drainfield.

The main soil characteristic of concern for Lake Santeetlah is depth to weathered bedrock. Existing parcels are also very limited in size and available space for a septic system.

The topography of the studied area is moderate to steep. Slopes greater than 65 percent are unsuitable for septic system design in the state of North Carolina (15A NCAC 18A, .1940).

The majority of the lots in the town are repair exempt due to being platted and recorded prior to July 1, 1982 (15A NCAC 18A .1945(b)(1)). Lots that have been modified in size (change of acreage on plat) will not have the repair exemption.

The screening assessment of existing developed parcels was conducted using site maps (provided by the Graham County Mapping Department), GIS mapping, and best professional judgment. Available space was often used as a deciding factor in many of the lot classifications. No individual permit data was collected or used in the screening (although permit and other data was collected and used in a separate assessment described in Section 3.3). The results of the screening assessment are summarized in Figure 5. Color coding of individual developed parcels on this map is summarized below.

- **Least Limited Lots (Green on Map)** - These lots have been identified as having the least limitations for an onsite repair to an existing septic system. In general these lots are larger in size and have lower development density.
- **Slightly Limited Lots (Yellow on Map)** - These lots have been identified as having some limitations for an onsite repair to an existing septic system. In general these lots are more limited in available space due to smaller lots sizes, or slightly higher development density. Setbacks from the lake are more of a concern and may require some modifications, or pretreatment to increase the probability of a conventional onsite repair.
- **Limited Lots (Pink on Map)** – These lots have been identified as having limitations for an onsite repair to an existing septic system. Engineered systems may be required for repair systems. In certain instances an offsite repair system may be required.
- **Most Limited Lots (Orange on Map)** - These lots have been identified as having the most limitations for an onsite repair to an existing septic system. An engineered system will be required if any type of onsite repair is possible. A high percentage of these lots will require offsite repair areas.

Figure 5 also includes a summary of the assessment of vacant lots. Vacant Lot Designations (evaluated for individual or small cluster septic systems) are coded as follows:

- V* - These lot are very limited on septic repair options.
- V+ - These lots offer some offsite septic options.
- V^ - These lots offer the most offsite septic options available.

Finally, selected vacant parcels were identified and matched as potential cluster soil treatment systems with different areas of the town, based on their size and their proximity to those areas. The vacant parcels which were preliminarily identified for their potential to host cluster treatment and dispersal systems are summarized below.

- **North Shore** – LRM recommends the North Shore lots utilize Area 1 (see Figure 5) for future offsite drainfield repair systems and/or cluster systems. Area 1 is located to the south of the lakefront lots and is approximately 3.5 acres in size and has fairly gentle slopes. The majority of this area could be designed for a subsurface drip irrigation system with a Long Term Acceptance Rate (LTAR) of 0.3. If this area is used for conventional systems the LTAR would be 0.5. The use of a subsurface drip irrigation system allows for higher gallons per day (gpd) of wastewater to be treated and disposed of than conventional drainfields. There are a limited number of individual lots that could be used for small clusters/individual repair systems.
- **South Side** - LRM recommends the South Side lots utilize Area 4 (see Figure 5) for future offsite drainfield clusters. Area 4 is located to the north of the lakefront lots and is approximately 5.0

acres in size and has fairly gentle slopes. The majority of this area could be designed for a subsurface drip irrigation system with a LTAR of 0.3. If this area is used for conventional systems the LTAR would be 0.5. The use of a subsurface drip irrigation system allows for higher gpd of wastewater to be treated and disposed of than conventional drainfields. There are numerous individual lots (especially on the east side) that could be used for small clusters/individual repair systems. The lots on the South Side are steeper than the majority of the lots in the other two areas.

- **West End** –LRM recommends the West End lots utilize Area 2 (see Figure 5) for future offsite drainfield clusters. Area 2 is located to the east of the lakefront lots and is approximately 5.6 acres in size and has fairly gentle slopes. The majority of this area could be designed for a subsurface drip irrigation system with a LTAR of 0.3. If this area is used for conventional systems the LTAR would be 0.5. The use of a subsurface drip irrigation system allows for higher gpd of wastewater to be treated and disposed of than conventional drainfields. The West End is very limited in individual lots for use of small clusters/individual repair systems.

Based on the preliminary soil and wastewater assessment, it appears that the town contains multiple undeveloped parcels which have adequate soil conditions for permitting onsite wastewater systems. LRM recommends the town consider a strategic acquisition effort of the parcels identified in this report. If the town can acquire several of the parcels indicated, LRM believes this will allow the town to consider onsite wastewater systems as: 1) A short term solution to potential failing septic systems. 2) A possible long term goal of allowing for a community wastewater system. If multiple cluster systems or a community system is being considered, LRM feels areas 1, 2, and 4 should be considered for a large Subsurface Drip Irrigation System permitted through the Department of Health and Human Services (DHHS) or a Surface Drip Irrigation System permitted through the Department of Environmental Quality (DEQ). Additional soils work and design flow specifics will be required to determine the most economical approach for permitting and design.

It should also be noted that Tetra Tech contacted USFS to inquire about the possibility of using Forest Service land for hosting community/cluster systems, much like the Town's existing wellhead and water system; however, USFS indicated that wastewater treatment and dispersal would not be a compatible use.

Due to the preliminary nature of the soil study, the delineations and recommendations provided should not be used to locate or permit any type of wastewater systems.

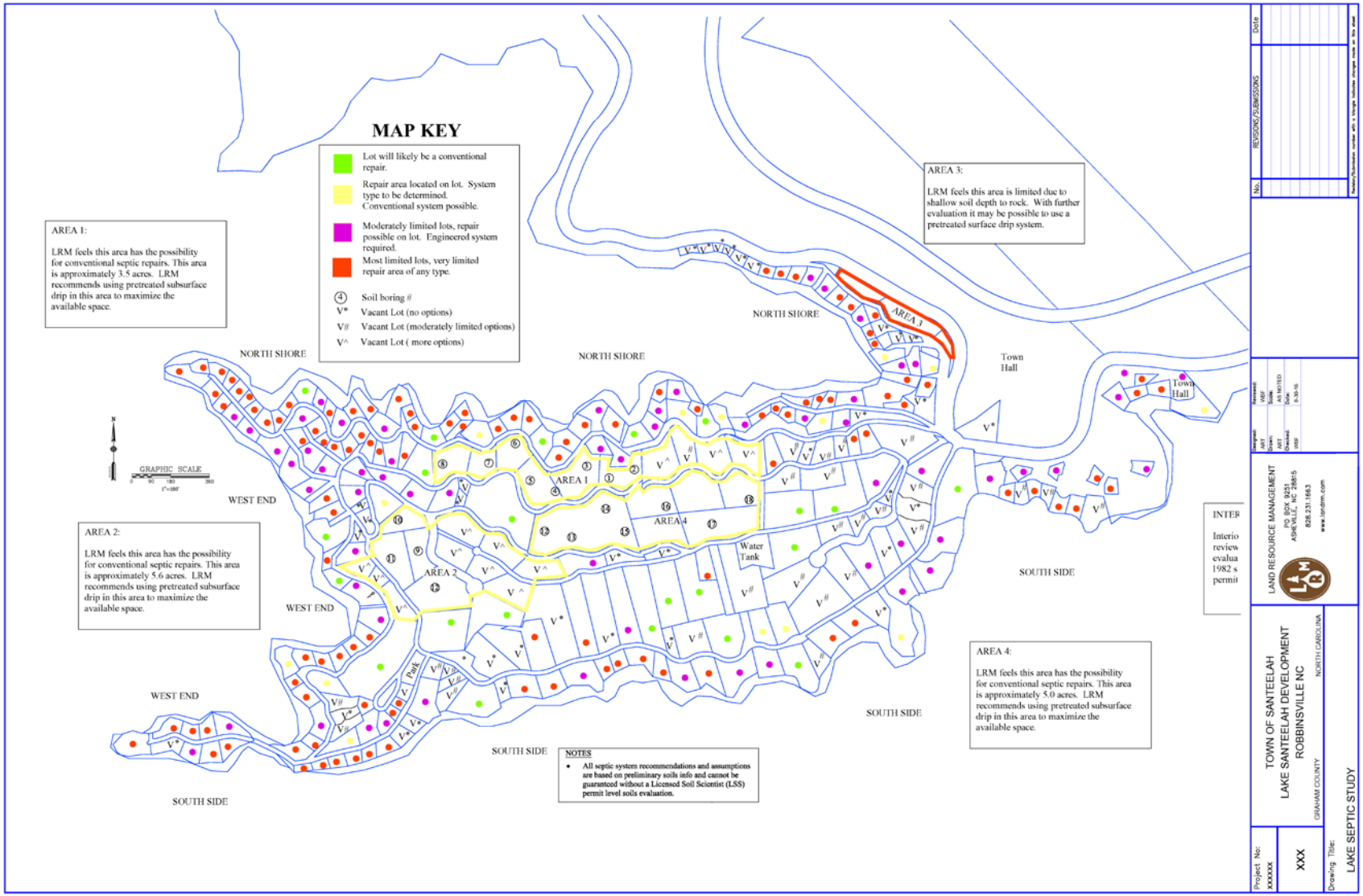

Figure 5. Parcel evaluation map

3.3 Permit Record Review

In an effort to better characterize the wastewater systems serving existing developed parcels and to determine the quality and availability of information about systems in Town, Tetra Tech spent about three days reviewing hard copy files at the Graham County Health Department. Before the paper search began, a desktop analysis was conducted to determine current and past ownership information for all parcels in the Town of Lake Santeetlah. Collected data included owner name and date of purchase. This information is important in determining the state of onsite septic systems because Graham County permits are in paper format and are arranged by the last name of the applicant. The owner information was publicly available and was accessed via three different Graham County governmental websites.

The Town of Lake Santeetlah recently changed its address system to conform to 911 standards. First, the Graham County GIS Parcel Viewer[2] was used to determine the current and historical addresses of all occupied parcels. Then the historical address was used to search the Graham County tax assessor property records database.[3] This property records search produced sales information for each parcel in the form of a list of deed transactions. Finally, the Graham County register of deeds database[4] was searched for each transaction to determine the transaction date and parties involved.

Once parcel ownership information was compiled, a site visit was conducted to search the Graham County Health Department's records for relevant onsite system permits. As previously mentioned, onsite system permits are in paper format and are organized by the applicant's last name. The list of current owners was cross-referenced with the permit files in alphabetical order, followed by the most recent prior owners, and so on as time permitted.

The following data was collected, when available, for about half of the properties in town. We estimate that it would take three to four more days at the Health Department to mine the rest of the records and document the data similarly.

- Parcel number
- Current/historical address
- Year built
- # Beds/Baths
- Current owner/date
- Previous owners/dates
- Septic tank size
- Pump tank size
- Design #bedrooms/flow
- New system permit date/type
- Malfunction/repair permit dates/types

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[2] The Graham County GIS Parcel Viewer can be accessed from: http://www.grahamcounty.org/grahamcounty_departments_mapping_splash.html

[3] Tax assessor sales information: http://taxsearch.grahamcounty.org/BasicSearch.aspx

[4] Register of deeds transaction search: https://cotthosting.com/ncgraham/LandRecords/protected/v4/SrchBookPage.aspx

- Other system details and notes

The data is stored in a Microsoft Excel database which is being provided to the Town. A printout of the database is provided in Appendix B. The data was used to supplement the cursory soil/site analyses presented in Section 3.2 and further support prioritization of systems and sites (summarized in Section 3.4).

3.4 System Vulnerability and Prioritization

Tetra Tech used the information gleaned from the efforts described in Sections 3.2 and 3.3 to prioritize four main areas of the Town, summarized in Table 6. The locations of each "collection zone" area and the area's most likely cluster system site are shown in Figure 6.

Table 6. Parcel prioritization summary

Collection Zone	% Moderately Limited Sites	% Most Limited Sites	Total % Limited Soils/Sites	% Repaired Systems	Availability of Repair Sites	Priority
North Shore (west)	24%	51%	76%	41%	Limited	3
North Shore (east)	29%	58%	87%	26%	Limited	2
South Side	33%	50%	83%	13%	Good	4
West End	25%	69%	94%	29%	Very Limited	1

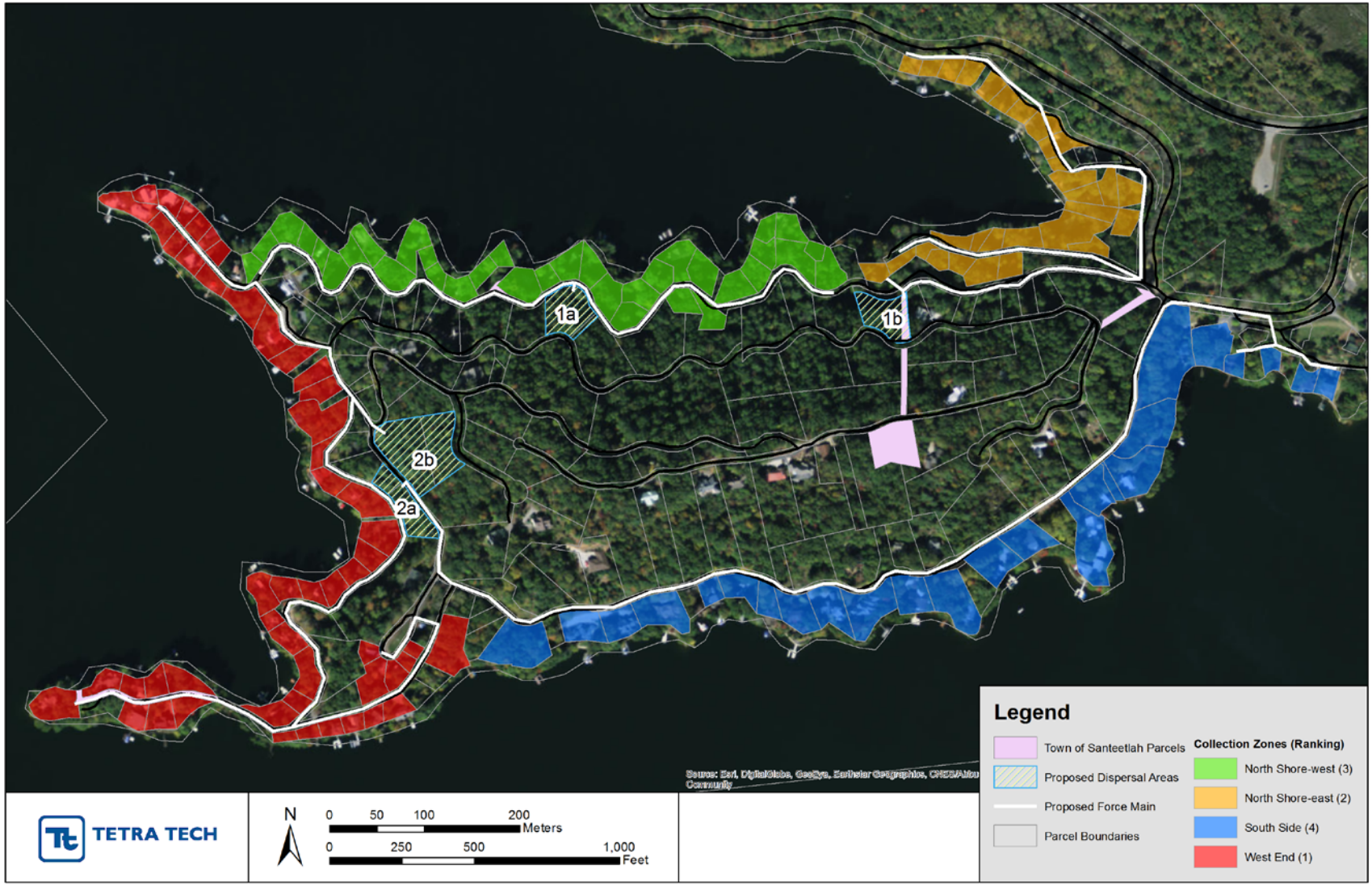

Figure 6. Collection zones and treatment areas

4.0 CONCEPTUAL INFRASTRUCTURE AND MANAGEMENT OPTIONS

Many wastewater options are available to communities seeking to improve onsite wastewater management. Options range from continuing to use onsite systems (perhaps with improved management of those systems) to using cluster systems where wastewater from multiple properties are treated in common onsite or offsite systems to fully centralized systems serving the entire community or conveyed to a neighboring community (Figure 7). Figure 8 illustrates the choice that many communities, like Lake Santeetlah, are faced with. In this figure, the traditional centralized sewer extension on the left is analogous with the previously proposed interconnection with Robbinsville's sewer system, while the distributed system management option on the right shows how a combination of continued onsite treatment and clustering provides more flexibility. Clustering provides a viable alternative when individual onsite options are limited, and it mitigates risk if failures increase or regulations or enforcement change. Cluster systems and individual onsite systems can co-exist as part of a distributed systems approach to wastewater management.

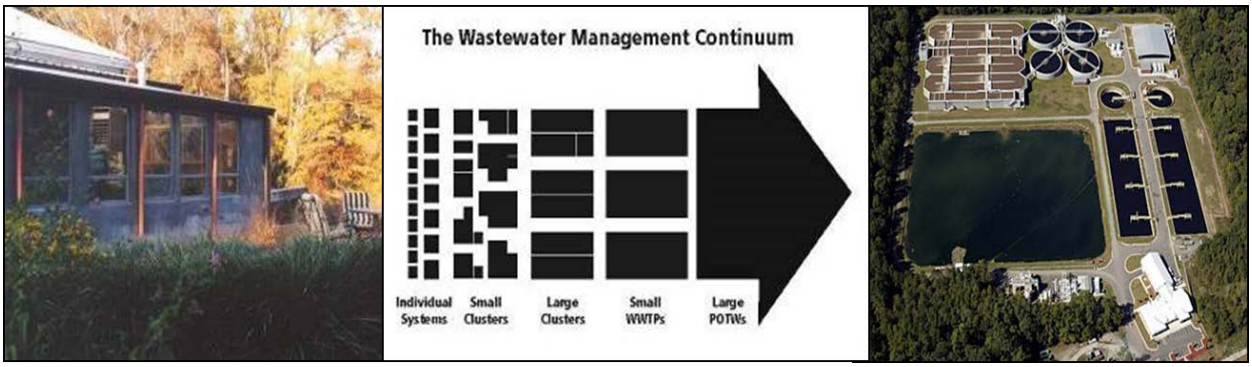

Figure 7. Wastewater management options

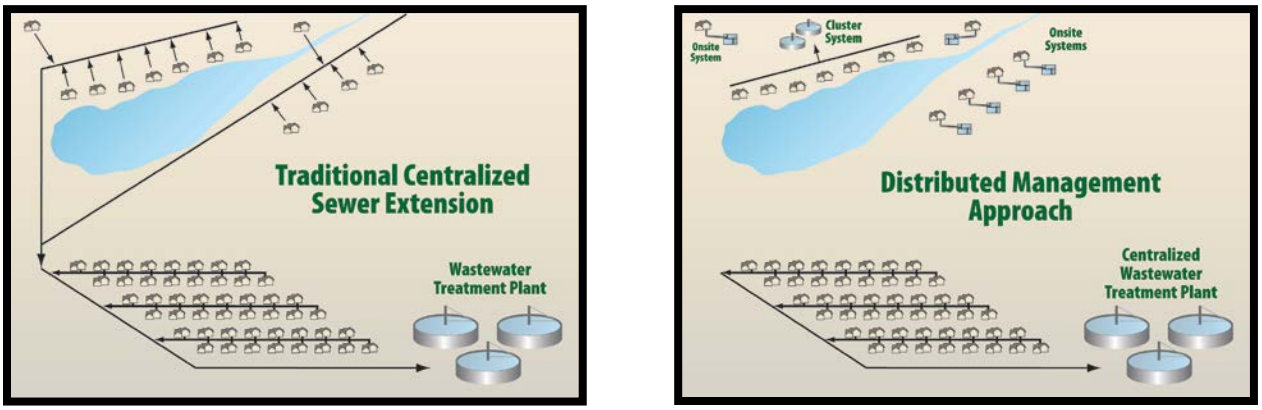

Figure 8. Distributed (right) versus traditional centralized sewer (left)

Figure 9 further illustrates the flexibility associated with a distributed wastewater management approach. Traditional centralized systems require large sunk costs by communities, often predicated on optimistic predictions for future growth that may or may not come to realization. Distributed systems, on the other hand, allow for a variety of adaptive funding mechanisms to develop needed wastewater infrastructure. The ability of distributed systems to be installed modularly allows for a "right-sized, just-in-time" approach

to installing wastewater infrastructure. This means, as shown in the figure, that treatment capacity can more closely match the need (e.g., as additional individual onsite systems malfunction, cluster system treatment capacity can be easily increased to match the need).

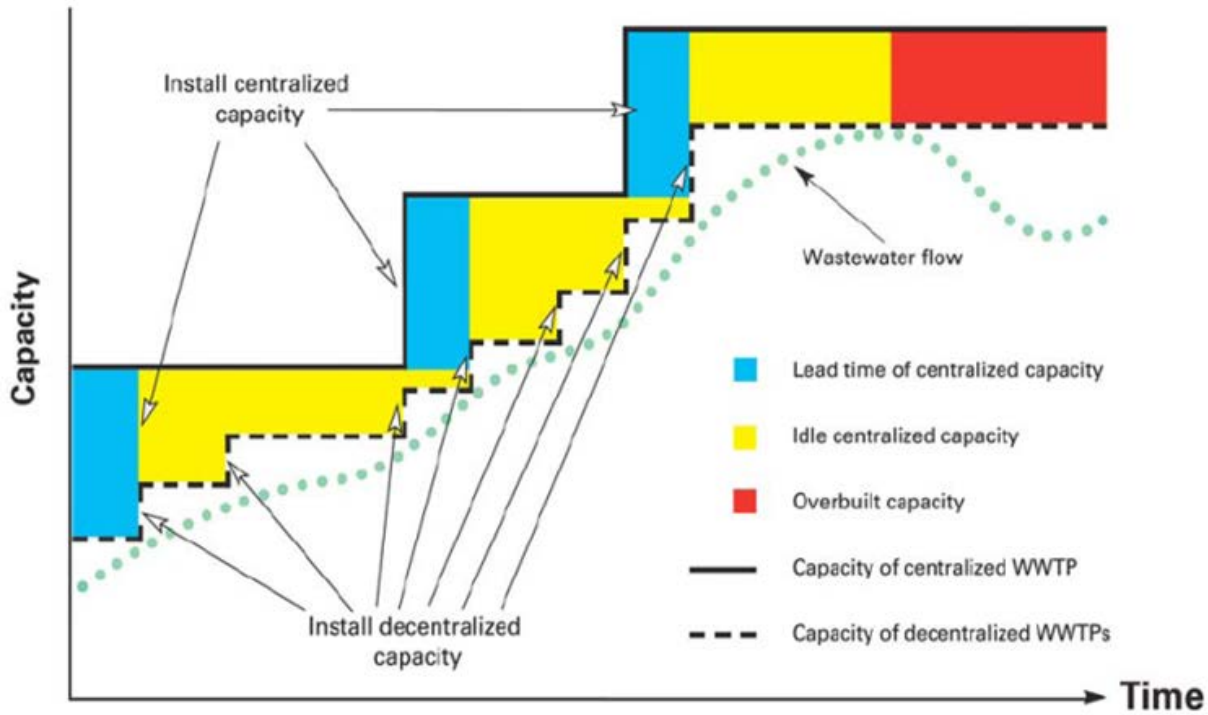

Figure 9. Flow versus capacity for centralized and decentralized wastewater systems

Table 7 illustrates another substantial benefit of distributed wastewater management versus traditional centralized collection, conveyance, and treatment: energy demands. The energy intensity (energy used per flow treated) for well-planned and designed distributed systems are almost always significantly lower than the energy demands for centralized treatment systems. This of course results is lower operational costs, in addition to reliability and environmental benefits.

Table 7. Energy demand for decentralized and centralized wastewater systems

System Type	Reuses	Estimated Power	Units
Conventional Gravity Septic System	Aquifer Recharge	0.0	kWh/MG
Pumped / Pressurized Drainfield System	Aquifer Recharge	200.0	kWh/MG
Gravity Collection to Recirculating Filter (RF)	Irrigation	520.0	kWh/MG
Gravity Collection to RF and UV Disinfection	Unrestricted	580.0	kWh/MG
Pressure Sewer to RF and UV	Unrestricted	780.0	kWh/MG
Centralized California WWTPs (CEC, 2005)	Not Specified	1,500 to 5,800	kWh/MG

4.1 Individual Onsite Systems

As suggested in the discussion above, continued reliance on individual onsite systems is feasible and likely to be a significant element of the Town's wastewater management system moving forward at least for the near future. Individual onsite systems can range from conventional septic tank-drainfield systems, to systems with advanced treatment (i.e., pre-treatment in addition to a septic tank), or to systems with advanced drainfields (the commonly-used T&J Panel system in Lake Santeetlah includes some advanced treatment and improved dispersal within the drainfield). Finally, onsite water reuse or low/no-discharge systems can be viable onsite options. These include composting toilets, urine diversion systems, separate graywater (water from sinks and showers) treatment systems, and the like.

The Town has expressed a desire to have more options for addressing inadequate or malfunctioning septic systems onsite. Appendix C provides documentation and links to resources for various types of alternative onsite and cluster systems. Note that any such system requires approval by the appropriate regulatory authorities. In North Carolina, all wastewater treatment systems follow one or more of three main regulatory pathways depending on how the treated effluent is ultimately released to the environment.

- Systems with *subsurface* dispersal of effluent (e.g., septic drainfields, T&J Panel, subsurface drip irrigation, low pressure pipe) are permitted by the Graham County Health Department under authority by DHHS. Large systems (defined as those with design flows of 3,000 gpd or more, e.g., roughly 10-home cluster) or those treating industrial process wastewater must first be approved by the Onsite Water Protection Branch (OWPB) of the Division of Environmental Health (DEH) of DHHS.
- Systems with *ground surface* dispersal of effluent (e.g., spray irrigation, surface drip irrigation) are permitted by DWR's Land Application Unit (LAU), regardless of system size.
- Systems which *discharge directly to surface waters*, are permitted by the National Pollutant Discharge Elimination System (NPDES) permitting unit of DWR.

As a general rule, onsite and decentralized treatment system options follow the hierarchy listed above. In other words, the first option that must be considered is a subsurface system; if a subsurface system is not

viable, a surface dispersal system can be considered; if neither are viable, in some cases an NPDES permit may be issued.

4.2 Small Cluster Systems

When individual onsite systems are not viable or not preferred by homeowners, two or more properties can share a wastewater system, either “onsite” - that is on property owned by one or more of the homeowners - or “offsite”. All cluster systems, regardless of size, have three major components:

- *Collection* - this describes how wastewater is taken from the house and conveyed to the treatment system
- *Treatment* - this describes the processing of the wastewater before it is discharged or dispersed
- *Dispersal* - this describes how the treated wastewater effluent is ultimately released to the environment

For small clusters especially, collection is typically simple gravity sewer from the home to a “main” to the treatment area. In some cases a small pump station (usually called a “lift station”) may be required. Where pumping is definitely needed, low pressure sewers are often used. These require a pumping unit at each home (sometimes two homes can share a pumping unit). There are two main types of low pressure collection sewer types. Grinder pump (GP) systems collect raw sewage from the house and grind and pump it into the common sewer main *en route* to the treatment area. Effluent pump (EP) systems pump septic tank effluent (STE) into the main rather than grinded raw sewage. These are typically called septic tank effluent pump or STEP systems. STEP can be combined with septic tank effluent gravity (STEG) sewers where some properties require pumping but others do not. In general, EP systems are preferred over GP systems. Grinder pumps are more expensive than effluent pumps and have shorter lives. Historically, they have been notorious for clogging or binding since they are processing raw sewage. Because they require a septic tank onsite, STEP and STEG transfers some costs directly to the homeowner. However, they tend to be reliable, because they are processing septic tank effluent, which should be free of larger objects that can cause problems in GP systems.

Treatment in small clusters can consist of simple septic tank treatment or include advanced treatment depending on the size of the cluster and the soil/site characteristics. Likewise, dispersal system type can vary depending on size and, especially, soil/site characteristics. As a general rule, larger cluster systems usually demand more sophisticated treatment and dispersal technologies mainly because larger systems represent a correspondingly higher overall risk. It is also important to note that advanced treatment and dispersal is usually affordable for larger clusters due to economies of scale.

Town stakeholders have expressed an interest in options for two or three adjacent property owners that may be experiencing onsite system problems. System selection and design (for any decentralized system) is extremely site specific so must be addressed either with the Health Department or a consultant; however, sharing a system and eliminating property line setback requirements for adjacent property owners is viable and may make the difference between having room for individual systems or shared small cluster systems and not having room. DHHS was unable to provide an example homeowners’ agreement; however, an attorney should be able to readily develop such an agreement.

4.3 Large Cluster Systems

In accordance with the Scope of Work, Tetra Tech conducted a study looking at the engineering feasibility and probable costs associated with using relatively large cluster systems for handling all or most of the

wastewater flow from the Town. As previously indicated (refer back to Figure 6), the Town was split into four main collection areas, and those collection areas were matched with undeveloped parcels identified by the soil science consultant as viable for hosting cluster treatment systems. Characteristics of, including costs associated with, the four main collection and treatment systems are summarized in Table 8. Detailed cost breakdowns are provided in Appendix D.

Table 8. Characteristics of four main collection and treatment systems

Collection Zone	# of Homes	Treatment Zone	Required Area (ac)	Total Cost[1]	Unit Cost (w/ land purchase)[1]	Unit Cost (w/o land purchase)
North Shore (west)	37	1A	0.6	$453,647	$12,261	$9,017
North Shore (east)	31	1B	0.5	$391,413	$12,626	$9,400
South Side	24	2A	0.4	$353,008	$14,709	$11,375
West End	52	2B	0.8	$648,297	$12,467	$9,390

[1] Land cost assumed at $50,000/acre based on information provided by John Garland (+ 20% safety factor). Note that property appraisal data lists land values at $200,000/acre even for interior lots.

Based on these cost estimates, if the community chooses to implement a cluster system, a loan (or property owner assessment) could fund the initial land and capital costs, and a rate structure could be set to cover the debt service and operational costs. Example sewer rates were developed using the UNC Environmental Finance Water and Sewer Rates Analysis Model. Two scenarios were examined with the results included in Table 9.

For the first scenario, it was assumed that capital costs would be financed by a loan with a 3 percent interest rate and 20-year term. For the second scenario, it was assumed that capital costs would be paid upfront (e.g., by a property assessment).

For the financed capital cost scenario, a base sewer rate of $40 per month was assumed with block rates set in order to meet debt service and operating expenses. The example rates are listed in the third column in Table 9. For a household using 3,000 to 5,000 gallons of metered water per month, sewer rates could range from $70 to $100 per month.

For the scenario where capital costs would have already been paid, a base sewer rate of $15 per month was assumed with block rates set in order to meet operating expenses. The example rates are listed in the fourth column in Table 9. For a household using 3,000 to 5,000 gallons of metered water per month, sewer rates could range from $30 to 45 per month.

Both scenario estimates assume that:

- Homeowners would be responsible for costs of their on-lot components (septic tank and pumping unit) which is about half the overall capital cost
- Rates would escalate at an average of 0.5% annually

- Rates would only be paid by customers on cluster systems; residents remaining on their onsite systems would not pay

Table 9. Example sewer rate structure

Rate Category	Gallons/month	Rate (financed capital costs)	Rate (with capital costs paid upfront)
Cost per account (includes 1,000 gal)			
Base Rate	1,000	$40.00	$15.00
Cost per 1,000 gallons			
Block rate 1	1,001-5,000	$15.00	$7.50
Block rate 2	>5,000	$40.00	$15.00

Although these rate estimates are very preliminary in nature they provide useful information about the range of potential costs associated with various options.

Note that there is at least one fairly large cluster system installed and permitted within the Town limits, for Santeetlah Lakeside. Tetra Tech researched its permit and looked at the system several times during visits to the community. The Santeetlah Lakeside system appears to be have been fully installed, but never commissioned by the State (it is unclear whether installation has been certified by an engineer). However, the system is permitted, with renewal of its permit occurring just recently in 2016. The system consists of pretreatment using an AquaPoint BioClere trickling filter system with treated effluent dispersed via a surface drip irrigation system (therefore the permitting authority is DWR-LAU).

Tetra Tech inquired with the DWR Regional Office in Asheville about the Lakeside system and confirmed that the system can be used after startup inspection without going through the entire approval process again. Although we were unable to make direct contact with the owner, the situation is pretty straightforward. Lakeside is permitted for 4,120 gallons per day which was based on "26 bedrooms on 13 residential lots, a private bathhouse restroom and a 1,500 square foot food stand". For comparison, the system could handle 34 residential bedrooms OR a 103-seat restaurant, based on its permitted flow, although it is possible that additional facilities could be added if flow monitoring during operation suggests that actual flows are less than the design flows (which is not unusual). Furthermore, there would likely be no problem changing the use of the system, for example, to serve a "downtown" area, as long as the flow rate comes in at or below 4,120 gpd. It is unclear how much work would be required to get the system operational, but we suspect that it would not be excessive. Most of the costly work should have been in design and original construction. The only other issue would be getting wastewater to the site. The location of the Lakeside system is also identified on Figure 5 and the collection/conveyance design should be relatively straightforward.

4.4 Offsite Centralized Wastewater Treatment

Tetra Tech did not examine this option in detail. We were informed by the Town that a connection to Robbinsville's sewer system had been previously studied, but no report could be located. Anecdotally, an estimated cost of $5M was communicated to us (approximately $25,000 per home), which is believable if not a bit low given the challenging layout and installation expected in the rugged mountain terrain and the topography between Lake Santeetlah and Robbinsville. It is our understanding that this option is not considered viable by the community and our analysis of distributed system options suggests that costs for the Robbinsville connection would be at least twice as high (Table 10). Additionally, community stakeholders report that the earlier report is over 10 years old and that the conveyance system would have to take a different and less direct route today than was assumed when the study was conducted. For these reasons, no further discussion of centralized sewer connection is provided in this report. Figure 10 provides an example graphical representation of the relationship between the cost of a system and the number of homes on a system for Lake Santeetlah cluster and centralized approaches.

Table 10. Cost comparison (all costs per home/connection) for major wastewater management options

System Type	Unit Cost (w/o land purchase)
Cluster (STEP, aerobic pretreatment and drip)	$9,000-12,000
Advanced onsite system repair/replacement	$15,000-20,000
Centralized system connection to Robbinsville	~$25,000 ??

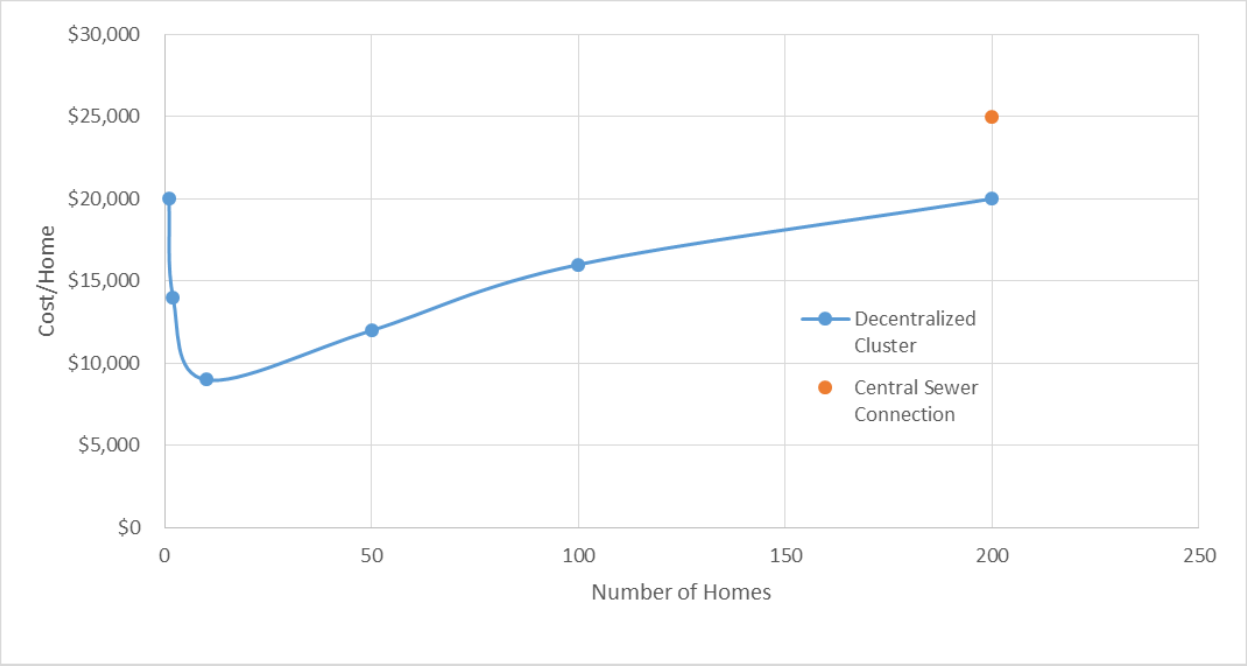

Figure 10. Example cost curve for system cost versus number of homes served

5.0 CONCLUSIONS AND RECOMMENDATIONS

Tetra Tech's analysis suggests that the Town of Lake Santeetlah has legitimate concerns about the status of onsite wastewater systems in the town. The concern is supported by the fact that some of the housing stock (and, accordingly, their wastewater systems) is relatively old, and all parcels were platted before the adoption of modern onsite sewage regulations which require that 100 percent repair/replacement system area be set aside on each parcel. Accordingly, many of the lots are small and have little or no options for making system repairs onsite. Malfunctioning systems and historical repairs are documented both in Health Department files, as well as anecdotally in discussions with Health Department staff and Town residents.

Centralized treatment via connection to the Robbinsville sewer system is likely to be prohibitively expensive compared with alternatives that keep wastewater management within the town. Our preliminary probable engineering cost estimates suggest that cluster system costs would be reasonable and comparable to - or less than - the costs that individual property owners currently pay for repairs, assuming they have an onsite repair option available. Subsurface dispersal systems appear to be viable, particularly where individual property owners or clusters of properties convey their wastewater to undeveloped off-site properties located "inland" (i.e., not waterfront). Soil/site evaluation results suggest that off-site systems using these parcels for dispersal could be permitted and the amount of area needed to handle all the wastewater from the town (now or in the future) is modest relative to what appears to be available as undeveloped tracts.

Based on extensive engagement with the community through Town staff, the Town Council, and the Town's Sewer Committee, Tetra Tech presents the recommendations highlighted in the following sections. As discussed in community meetings and conference calls, our recommendations focus on incremental steps that the Town can take to:

6. Raise awareness among residents and elevate the discussion about wastewater management
7. Better understand existing onsite wastewater systems in the Town and any problems
8. Better understand local impacts of onsite systems on water quality
9. Provide options for individual property owners and groups of property owners
10. Take proactive steps to mitigate potential future problems with onsite systems

5.1 Increasing Community Awareness through Education and Outreach

Tetra Tech reviewed a variety of options available to improve public awareness in the Town of Lake Santeetlah. Training, a property owner survey, stakeholder involvement, providing property owner resources, and a property owner "honor roll" emerged as promising next steps, as described below. An awareness campaign that includes these strategies as well as more traditional outreach would provide a well-rounded approach to public outreach.

5.1.1 Training

A recent literature review of studies on the effectiveness of educational programs in changing citizen behaviors relating to pollution prevention found that programs that encourage ownership of pollution problems tend to be more effective at changing behavior than more passive, traditional educational

programs. The study indicated that intensive training can be especially effective in changing the behavior of participants.

In light of these findings, Tetra Tech recommends that the Town of Lake Santeetlah conduct outreach and education that includes training in onsite wastewater treatment. The training program will ensure that property owners understand what an onsite system is, how it works, how it is maintained, and why it is important to replace and/or maintain it properly.

Training property owners has multiple benefits. It is common for residents and other property owners to be unaware of where their systems are and the need for periodic maintenance. Residents can risk injury or death from exposure to hydrogen sulfide and other gases generated in the tank without training on proper tank access. Training can ensure the safety of property owners while getting the word out on why it is important to have a functioning system. Training workshops can also provide continuing education credits to real estate professionals, which may interest at least some of the Town's property owners.

The content of the training and outreach materials is an important consideration. Education should cover the basic components of septic systems and their maintenance. It will also be important that property owners understand the benefits of a functional septic system, including prevention of odors, safety, property value, and protection from property damage. Education about the water quality impacts from malfunctioning systems should also be part of any education campaign. Practical steps on replacing a system and finding reliable contractors should also be included. In general, property owners should be given all the information they need to understand the importance of a well-functioning system and be able to install and maintain one if they choose.

Applicable training resources are identified in Appendix E.

5.1.2 Property Owner Survey

As the first step in the outreach and education program, Tetra Tech recommends conducting a brief survey that would function as both an educational tool and a means for collecting information. The survey would gather the following information:

- Frequency that the property is used by owners
- Frequency that the property is used by renters
- Wastewater system type
- Age of system
- Frequency/history of system maintenance
- Additional information regarding property owner's knowledge of their system and concerns
- Property owner's interest and availability in future training workshops
- Whether property owner is a real estate professional in need of continuing education (related to training workshop)

The survey can help encourage property owners to assess their own knowledge of their systems and motivate them to gain a better understanding of the maintenance needs and potential impacts of failing systems. This step will also help the Town evaluate the citizen knowledge base and tailor outreach and education to specific needs.

For a community like the Town of Lake Santeetlah with seasonal populations, Tetra Tech recommends that surveys be conducted using several different instruments, including on-line surveys communicated through email, paper surveys provided at meetings, paper surveys delivered door to door, and even face

to face or phone interviews for a smaller group of citizens who may otherwise not be able to participate. Citizen volunteers or elected officials can help with distributing the survey – including door to door and phone communication. Volunteer participation encourages the community to talk to each other, build trust on the topic of wastewater management, and further motivate citizens to learn more.

5.1.3 Stakeholder Involvement

Another effective approach to outreach is involving stakeholders in program planning and decision-making. Tetra Tech recommends forming a steering committee (perhaps the existing Sewer Committee) that can provide input on the logistics for and approach to the training workshop. The committee can help involve the community directly and provide direct input on any funding or incentive program or other decision-making that occurs later.

5.1.4 Online Homeowner Resource Page

The Town should create a webpage linked from its homepage that provides residents and property owners direct access to Lake Santeetlah specific information on wastewater management (e.g., this report, the Excel database) and links to other useful information (see Appendices C, E and G). These could include:

- General educational materials
- Regulatory and other contact information
- Contact information for system vendors, installers and inspectors
- Fact sheets and case studies (see Appendix G)
- Model property owner agreements
- Excel permit database
- Feedback and system update forms
- Report and presentations from this project

5.1.5 Honor Roll

Another effective outreach strategy is organizing an “honor roll” that recognizes property owners who have upgraded their systems or keep up with routine maintenance. For example, the Ten Mile Lake Association in Minnesota includes a citizen honor roll in each fall newsletter[5], recognizing those residents who have upgraded their septic systems or installed new systems.

5.1.6 Awareness Campaign

In concert with the above strategies, Tetra Tech recommends that the Town implement a broader awareness campaign that also includes more traditional forms of outreach, such as mailings, information booths, or brief presentations during community meetings to provide supplemental education, especially to those property owners that will not attend the workshops or stakeholder involvement meetings.

To summarize, the recommended education and outreach steps include:

[5] http://www.tenmilelake.elks2406.com/newsletter/archive/2015_fall.pdf

- Conduct property owner survey to determine ideal workshop format, length, and timing
- Create a property owner onsite wastewater resource page linked from the Town's homepage
- Create a property owner steering committee to provide input and help engage community
- Organize training workshop that educates property owners on how onsite systems work, how to maintain their systems, and why they need to function properly
- Implement an awareness campaign through mailings, information booths, or brief presentations during community meetings

The timeline in Table 11 is recommended for implementing the Awareness Campaign. The time periods specified are from when this report is approved.

Table 11. Awareness Campaign timeline

Item to be Completed	Time from Project Start Date to Item Completion
Stakeholder Involvement	
• Form steering committee, from sewer committee or other option	1 month
Create Resource Page on Internet	
• Create and populate page linked from Town webpage	2 months
Property Owner Survey	
• Develop survey	2 months
• Test survey	3 months
• Organize volunteers	3 months
• Distribute survey	4 months
• Collect surveys, analyze and communicate results	6 months
Training	
• Determine location, timing, materials, and instructors	6 months
• Advertise and register participants	8 months
• Conduct training	12 months
Honor Roll	
• Determine frequency and logistics	3 months
• Begin selection and posting	4 months
Other outreach materials	

- Identify outreach materials to distribute at events and through mailings — 2 months

5.2 Strengthening Understanding of Existing System Condition

During our discussions with Town stakeholders, Tetra Tech was encouraged by and strongly supports efforts to strengthen their understanding of existing onsite systems in the Town. In particular, stakeholders felt that the Excel permit database provides very useful information. Unfortunately, given how labor intensive our search of hard copy files was, and that this effort was not part of Tetra Tech's Scope of Work, we could not complete the effort. However, we support the Town's future efforts to do so as a first step in better understanding system condition.

As also discussed, the next step is field verification of system condition and performance, which can only be done by trained professionals under a well-established inspection and condition assessment protocol. Fortunately, the OWPB employs a staff person under the "319 program" (focused on reducing non-point source pollution) who has developed inspection and malfunction survey protocols and is available to work with local health departments and communities directly to support such efforts[6]. Additionally, our subcontracted soil scientist does system inspections and suggested that costs could vary from $75 to $200 per lot depending on scope, timing, and number of inspections to be done. Finally, note that North Carolina state law requires systems to be inspected at the time of property transfer. Information about the results of these property transfer inspections could be used to supplement other data about existing systems in Lake Santeetlah.

Under a voluntary inspection program, incentives for system inspection and repair/replacement could include the following:

- Create a "Septic System Honor Roll" or similar recognition program for systems verified to be working properly
- Identify support for a no-cost, professional, voluntary septic system inspection (e.g., funded by the Town)
- Consider forming a responsible management entity (RME) within the Town to conduct inspections and implement other improvements
- Work with Graham County and DHHS for program support
- Consider approaching the Town of Robbinsville for partnering, particularly if they are planning to use the lake as a water supply in the future
- Base system inspection frequency on system type, age, history, location (e.g., lake proximity), and other risk factors

The Town could also consider adopting an ordinance requiring regular system inspections (perhaps phased in over 5 years or so to provide time to build support), although the Council expressed greater support of voluntary rather than mandatory efforts.

[6] http://ehs.ncpublichealth.com/oswp/nps/index.htm

Items to check during inspections include:

Tanks

- Septic tank type and size
- Septic tank condition
- Septic tank settling quality
- Depth of solids in septic tank
- If pumped system, pump tank type, size, condition and solids depth
- Riser condition and any signs of groundwater infiltration or leakage
- Pump model
- Pump controls and float operation
- Tank access

Drainfield

- Type, number and length of drainlines
- History of repairs
- Indications of malfunctions
- Setback distances from surface waters, etc.
- Availability of repair area
- Signs of excessive water use or toxic chemical use in the house

5.3 Ongoing Water Quality Monitoring

The existing DWR monitoring locations function well for measuring ambient water quality near the Town of Lake Santeetlah. Additional sampling locations are necessary for providing a comprehensive assessment of how loading from onsite systems affect lake water quality. A sampling location is needed uplake of the Town to act as a baseline location, representing ambient water quality in the upper segment of the lake that may be less influenced by potential loading from the Town. Several nearshore sampling locations along the Town's border with the lake would help directly assess the existing loading from onsite systems. The recommended monitoring locations are shown in Figure 11. Monitoring recommendations are specified further in the following sections.

In discussions with community stakeholders, we understand that the Town owns a small strip of property above the high water line of the lake. This could provide an ideal way to access nearshore areas for sampling, as could shallow-draft boats such as skiffs and kayaks or canoes. Additionally, the Town should consider approaching the Town of Robbinsville for partnering on monitoring, particularly if they are planning to use the lake as a water supply in the future.

5.3.1 Constituents

At a minimum, the constituents currently measured at the existing DWR sampling locations should also be measured at the additional recommended locations. These are:

- Ammonia-nitrogen (mg/L)
- Chlorophyll a (µg/L)
- Depth, Secchi disk depth (m)
- Dissolved oxygen (DO) (mg/L)
- Fecal Coliform (#/100 mL)
- Nitrate-nitrite as N (mg/L)
- Kjeldahl nitrogen (mg/L)
- Orthophosphate as P (mg/L)
- Phosphate as P (mg/L)
- Total phosphorus (mg/L)
- Total suspended solids (mg/L)
- Turbidity (NTU)

Fecal coliform, or another broad spectrum indicator of human pathogens, should be collected at all locations. If lake modeling for nutrients and algal response is anticipated in the future, secchi disk depth and orthophosphate should be also be monitored at several locations representative of ambient lake conditions.

5.3.2 Sampling Frequency

For the additional recommended sites in Figure 11, the minimum sampling frequency for all constituents should be every 5 years with at least three samples during different months of the growing season and one sample each during the early spring and late fall. This frequency is similar to recent sampling frequencies used by DWR for most constituents at location 37D. It is also important to continue collecting dissolved oxygen and temperature depth profile data at all locations. If different entities conduct monitoring, the data will provide the most comprehensive assessment if the monitoring is coordinated and planned to capture seasonal and interannual variability.

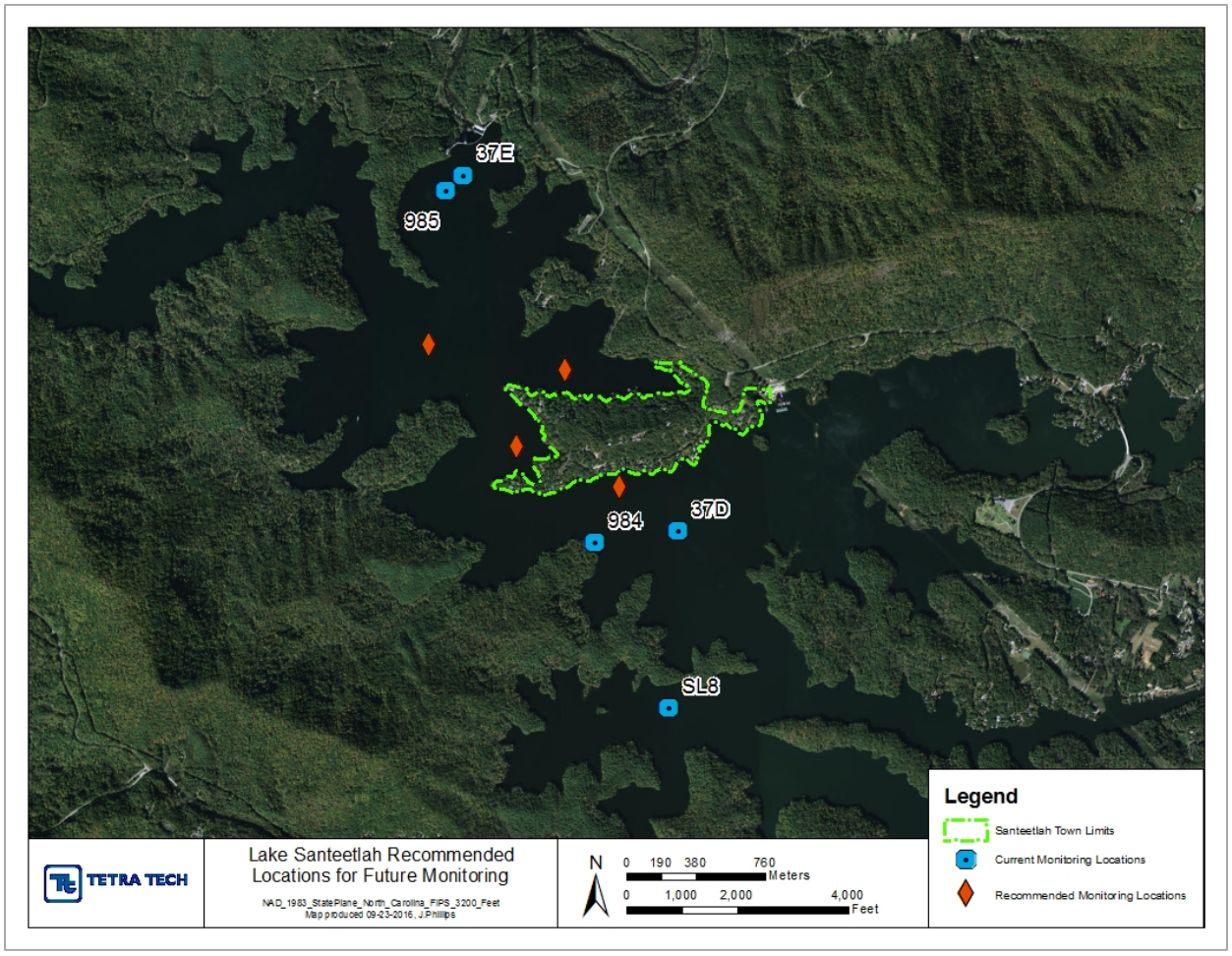

Figure 11. Recommended locations for future Lake water quality monitoring

We also recommend that nearshore lake water be sampled during heavy use periods (e.g., Labor Day, Independence Day weekend, October leaf viewing period, etc.), with results compared to existing background results from DWR. This additional sampling should be conducted during the same years as

the regular spring, summer, and late fall sampling described above. In summary, the recommended sampling frequencies are:

- Conduct sampling every 5 years – all locations sampled within same year (controls for annual variability)
- 3 sampling events at each location during the growing season
- 1 sampling event during the spring
- 1 sampling event during the fall
- 1 sampling event each during heavy use periods (select at least 3)

Following the first year of sampling, the frequency and constituents could be re-assessed and adjusted. A special study may be warranted at locations identified as hot spots. In that case, the Town should consider regular sampling of constituents found to have elevated concentrations at those hot spot locations.

5.3.3 Sampling Depth

Sampling depth for the additional open water site should be matched with DWR's procedures for determining sampling depth at the DWR sampling locations. For the nearshore sites, surface samples should be taken at a minimum.

5.3.4 Sample Analysis

Field technicians and labs employed in the collection and analysis of samples should be state-certified. DWR maintains lists of certified field sampling and lab analysis companies on their website[7].

5.4 Short-Term Community Infrastructure

In the short-term, Tetra Tech recommends that the Town work directly with homeowners requesting assistance with malfunctioning onsite systems to identify options for small clusters, either by helping facilitate discussions and agreements between adjacent property owners or by providing access to land for a dispersal system. For the latter approach to be viable, the Town will need to have access to the land. Accordingly, we recommend that the Town either purchase or enter into long-term access agreements (e.g., utility easements) with owners of undeveloped properties recommended for hosting cluster systems (see Section 4.3).

In scenarios where homeowners access property via the Town, we recommend that access agreements and financial arrangements be structured as simple leases, rather than having the Town assume responsibility for sewer service, at least in the short-term. Nevertheless, in order to preserve system capacity for other needy homeowners as well as potentially for a future community owned and operated system, the Town will need to assert and enforce design, installation, and management standards for any shared, small cluster systems sited on Town-controlled property.

[7] https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/laboratory-certification-branch/certified-laboratory-listings

Another immediate and related initial step at bolstering options for homeowners would be to discuss the owner's plans for the Santeetlah Lakeside system. This system is well-situated to treat wastewater from the Town administration building area if this area were to be considered for additional Town space or commercial establishment(s).

5.5 Medium-to-Long Term Community Infrastructure

The Town's medium to long term community infrastructure plans should build on short term plans and adapt to real-world conditions. For example, if the Town acquires access to cluster treatment sites, but no or few homeowners have used them, there is no reason to further develop the community's infrastructure at that time. If, on the other hand, demand for cluster system land from homeowners is high, then the Town should consider an ownership and operational model[8] that reflects the needs of the community both in terms of service to homeowners, but also to protect public health, the environment, and future Town infrastructure investments. Modular decentralized treatment systems can be implemented slowly over time as dictated by wastewater treatment needs and demand. For example, the first cluster might simply be two homeowners sharing a small system. If in the future additional homeowners needed to connect, additional small modular treatment units and drainfield zones could be added without impacting overall system performance or operation.

The Town should engage a consultant or other professional to help them develop and implement a medium-to-long term plan. This would likely be a relatively small effort, revisited on an as-needed or annual basis. Accordingly, we suggest an "on-call" contract with an engineering consultant to provide services as the Town needs or requests. Such a contract would also provide quick access to a consultant for other needs related to data gathering or management, education or monitoring plan development and execution, and design if needed. Refer to Appendix F for an example on-call contract.

5.6 Funding Options

Several funding and financing options exist that could support the Town's wastewater treatment improvement efforts. Regarding the cluster option, the town could apply for a grant from the Clean Water Management Trust Fund (CWMTF)[9]. Most projects receiving CWMTF grants can make a strong case for protecting water resources and providing conservation value. DEQ also offers grants for asset inventories, condition assessments of critical assets, and other components of critical assets with a limit of $150,000 over three years[10]. Although this asset management funding isn't available for inventorying private wastewater systems, it could be available to the Town if, in the future, the Town creates a sewer utility and begins managing systems. In the near term, this funding source could be used immediately to help the Town better understand, map, and assess its water system infrastructure. Additional funding, including Clean Water State Revolving Fund monies, may be used for decentralized wastewater systems.

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[8] See https://www.epa.gov/septic/septic-systems-guidance-policy-and-regulations

[9] http://www.cwmtf.net/

[10] http://portal.ncdenr.org/web/wi/assetinventory

All such funding is administered by the State Water Infrastructure Authority and administered by the NC Division of Water Infrastructure[11].

USDA Rural Development[12] provides grants and low-interest loans for wastewater treatment infrastructure. Grants[13] are also available for preliminary engineering, or pre-development, and other costs. Loan interest rates are based on the need for the project and the median household income of the area to be served.

DWR operates a 319 grant program for implementation of projects included in 319-eligible watershed restoration plans that benefit impaired waters. Currently, Lake Santeetlah is not impaired or upstream of an impaired waterbody. If these conditions change in the future and a watershed restoration plan is developed, 319 grants would provide another potential source of funding.

Finally the Appalachian Regional Council, which funded this project, may have funding programs that can be used for assistance with its implementation. The Town should also reengage with the Southwestern North Carolina Planning and Economic Development Commission who could be a valuable project partner in the future.

A variety of case study summary documents are provided in Appendix G. These document the experiences of other communities similar to the Town of Lake Santeetlah and can be used as a reference for the Town.

5.7 Recommended Next Steps

The following steps are recommended for the Town to move forward:

Step	Timeline	Responsible Parties
Approve sewer study	March 2017	Town Council
Establish standing wastewater committee for Town	March 2017	Town Council, Sewer Committee
Presentation to community	Summer 2017	Sewer Committee, potentially with Tetra Tech
Implement community awareness campaign	(see table in Section 5.1)	Sewer Committee with Town Staff
Refine Lake Santeetlah water quality monitoring program	May 2017 and ongoing	Sewer Committee, Town Staff and potential municipal, State, and Federal partners

[11] http://portal.ncdenr.org/web/wi

[12] https://www.rd.usda.gov/programs-services/water-waste-disposal-loan-grant-program

[13] https://www.rd.usda.gov/programs-services/water-waste-disposal-predevelopment-planning-grants

Complete Health Department file review and system database	2017	Sewer Committee with potential Staff or consultant support
Develop an existing system inspection program	Summer 2017	Sewer Committee, Town Staff and potential municipal, State, and Federal partners
Discuss and pursue access arrangements with cluster system property owners	2017-2018	Sewer Committee, Town Staff, Town Council
Develop adaptable medium- and long-term infrastructure plan	2017-ongoing	Sewer Committee, Town Staff, Town Council, potentially with consultant
Assess potential funding sources (note potential asset management grant for water system inventory)	2017-ongoing	Sewer Committee, Town Staff, Town Council, potentially with consultant

APPENDIX A. GIS MAP OF TOWN

GEOGRAPHIC INFORMATION SYSTEM MAP FOR TOWN OF LAKE SANTEETLAH

YELLOW CREEK/CHEOAH TOWNSHIP
GRAHAM COUNTY, NORTH CAROLINA

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)
1 inch = 100 ft.

ALAN C. CARVER
P.O. BOX 704
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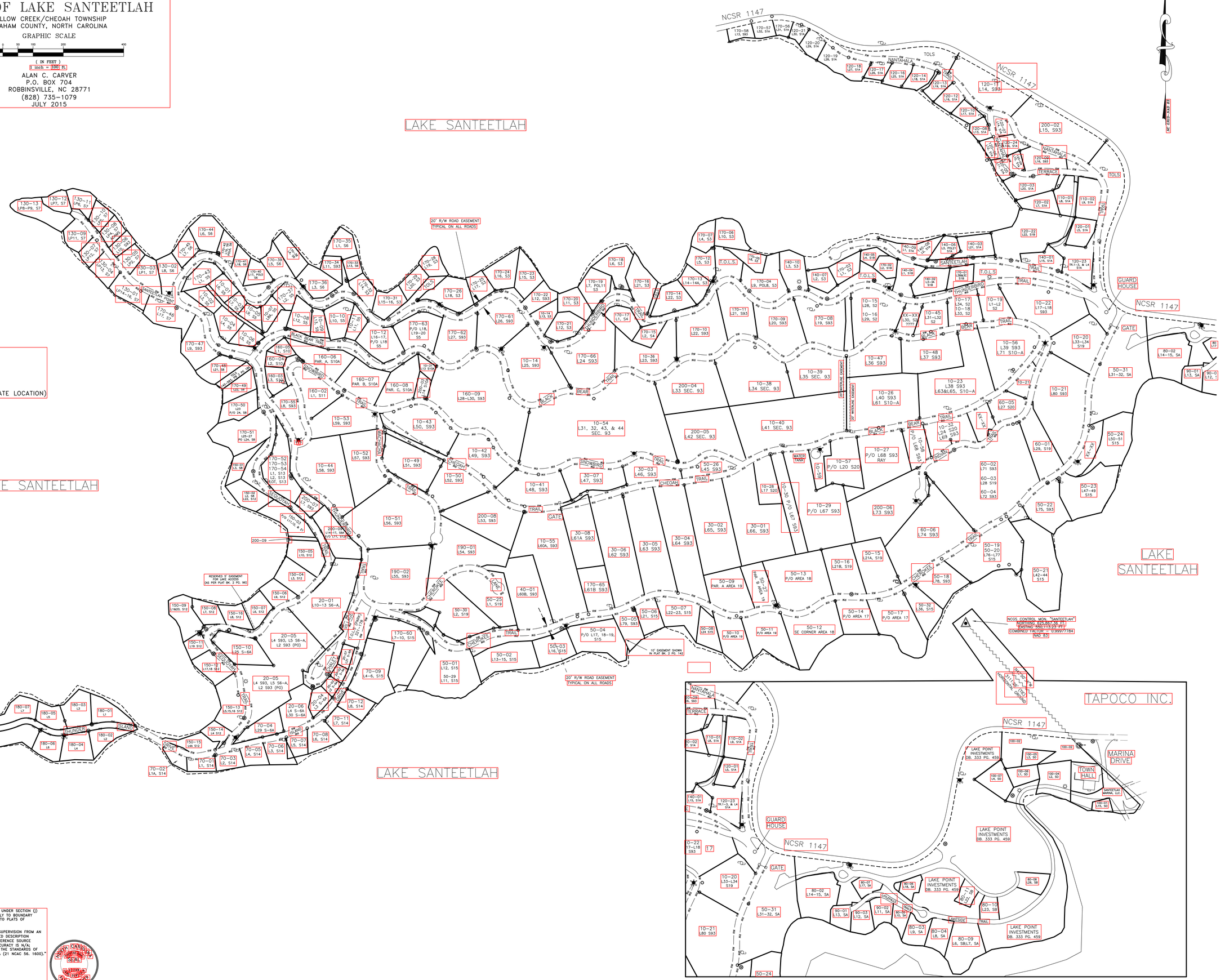
(828) 735-1079

JULY 2015



I CERTIFY THAT THIS PLAT IS EXEMPT FROM 47-30 UNDER SECTION (I) "THE PROVISIONS OF THIS SECTION SHALL NOT APPLY TO BOUNDARY PLATS OF AREAS ANNEXED BY MUNICIPALITIES NOR TO PLATS OF MUNICIPAL BOUNDARIES" AND

I CERTIFY THAT THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL SURVEY MADE UNDER MY SUPERVISION (DEED DESCRIPTION RECORDED IN BOOK N/A, PAGE N/A OR OTHER REFERENCE SOURCE THAT THE RATION OF PRECISION OR POSITIONAL ACCURACY IS N/A; AND THAT THIS MAP MEETS THE REQUIREMENTS OF THE STANDARDS OF PRACTICE FOR LAND SURVEYING IN NORTH CAROLINA (21 NCAC 56. 1600)."

THIS 31ST DAY OF JULY, 2015

ALAN C. CARVER, P.L.S., L-2969

NORTH CAROLINA PROFESSIONAL SEAL L-2969 LAND SURVEYOR ALAN C. CARVER

APPENDIX B. ONSITE SYSTEM PERMIT DATABASE

parcel number	current address	historical address	EYB	AYB	# Bed	# Bath	septic tank/system size	pump tank size	design flow	new system permit date	system type	length	offset from lake
564204930066	1 Cheoah Trl	1 Cheoah Trail	2011	2011	3	3.1	1050 gal/600 sf		3 bed/360 gpd	11/9/2009	10" LDP	240'	
564204000003	4 Thunder Island Dr	100 Thunder Island	1988	1984	3	2	1000 gal/600 sf			9/16/1983	ground absorption		
564204930008	2 Wachacha Trl	100 Wachacha Tr	2005	2005	3	2							
5642041B0001	205 Santeetlah Trl	101 Santeetlah Trl	1980	1962	2	2							
564204140003	858 Island Dr	105 Island Dr	1988	1969	3	2	1000 gal/400 sf	750	2 bed/240 gpd	2/18/2003	pump to PPBPS/T&J panel	16 panels	
5642041A0002	210 Santeetlah Trl	106 Santeetlah Trl	1981	1981	2	1							
564204000005	5 Thunder Island Dr	108 Thunder Island	1988	1986	4	2.1							
564204050008A	507 Black Bear Trl	11 Black Bear Trail	1980	1965	2	1							
5642041B0022	115 Nantahala Trl	11 Nantahala Ter	1980	1968	4	2.1	1000 gal				T&J panel	135'	
56420410A003	915 Snowbird Trl	113 Snowbird Trail	2007	2007	3	3	1000 gal/600 sf		3 bed/360 gpd	2/28/2006	T&J panel	23 panels	
564204150014	708 Cherokee Trl	114 Cherokee Tr	1993	1993	3	3.1							
564204000006	6 Thunder Island Dr	115 Thunder Island	1998	1998	3	3.2	1000 gal/400 sf	grinder	2 bed/240 gpd	6/16/1998	PPBPS/T&J panel	20 panels	> 50'
564204150016A	712 Cherokee Trl	118 Cherokee Tr	2004	2004	4	5.1	1000 gal/600 sf	grinder	3 bed/360 gpd	6/24/2004	pump to PPBPS/T&J panel	102'	
564204120010	818 Sequoyah Trl	118 Sequoyah Trl	1988	1988	6	4.1							
564204140004	856 Island Dr	119 Island Dr	2003	2003	4	3.2	1000 gal/400 sf	750	2 bed/240 gpd	2/18/2003	pump to PPBPS/T&J panel	16 panels	
5642041B0004	207 Santeetlah Tr	123 Santeetlah Tr	1980	1965	2	1							
5642041A0001	212 Santeetlah Trl	124 santeetlah Trl	1980	1962	2	1							
564204050002	357 Thnderbird Trl	13 Black Bear Trl	1980	1962	2	2	1000 gal		2 bed/240 gpd		PPBPS	12 panels	
564204030004	312 Thunderbird Trl	13 Moseley Way	1980	1962	2	1							
564204140002	854 Island Dr	131 Island Dr	1979	1979	3	1	360 sf			5/30/1978	conventional gravel	90'	
564204120003	824 Sequoyah Trl	132 Sequoyah Trl	1980	1968	3	1	1000 gal/600 sf	grinder	3 bed/360 gpd		T&J panel	24 panels	
5642046A0010	600 Chalet Vlg	14 Chalet Village	1980	1974	3	2							
564204000009	9 Thunder Island Dr	140 Thunder Island	1986	1986	3	2.1							
5642041B0002	302 Thunderbird Trl	140 Thunderbird Trl	1980	1965	2	1							
564204030001	304 Thunderbird Trl	144 Thunderbird Trl	1980	1965	2	2.1							
564204030010	310 Thunderbird Trl	15 Moseley Way	2006	2006	2	2.1	1000 gal/400 sf	1200	3 bed/360 gpd		PPBPS	17 panels/74'	> 50'
5642041A0017	137 Nantahala Trl	153 Nantahala Trl	1975	1963	2	1							
564204070001	404 Santeetlah Point Rd	16 Santeetlah Point Rd	2000	1985	3	2	1000 gal		3 bed/360 gpd				
564204120009	??	160 Sequoyah Trl	2005	2005	3	3.1	1000 gal/600 sf	grinder	3 bed/360 gpd	8/26/2005	T&J panel	24 panels	50' to panels, less to grinder pump
5642041A0016	139 Nantahala Trl	161 Nantahala Trl	1995	1963	3	1.1							
564204030002	209 Santeetlah Trl	163 Santeetlah Trl	1980	1965	2	1	1000 gal/400 sf		2 bed/240 gpd		PPBPS/T&J panel	16 panels	
564204150016B	714 Cherokee Trl	164 Cherokee Tr	1996	1996	3	3.1							
564204030003	218 Santeetlah Trl	164 Santeetlah Trl	1980	1970	2	1							
564204930028	931 Snowbird Trl	165 Snowbird Trail	2005	2005	3	3.1	1000 gal/600 sf		3 bed/360 gpd	4/19/2004	equal to gravel/equalizer infiltrator	138'	
564204930065	4 Cheoah Trl	17 Cheoah Trail	1999	1999	2	2.1	1000 gal/400 sf		3 bed/360 gpd	6/11/1999	LDP	159'	
564204930079	716 Cherokee Trl	174 Cherokee Tr	2013	2013	2	3.1	1000 gal	grinder	2 bed/240 gpd	10/24/2013	10" LDP	160'	50'
5642041A0019	141 Nantahala Trl	179 Nantahala Trl	1985	1985	3	3							
564204150021	718 Cherokee Trl	182 Cherokee Tr	1994	1994	2	3	1000 gal/400 sf	grinder	2 bed/240 gpd	1/23/1995	LDP	16 panels	50'
564204120006	826 Sequoyah Trl	182 Sequoyah Trl	1988	1975	2	3.1	1000 gal/150 sf		3 bed/360 gpd	8/22/1975	ground absorption		
5642041A0008	??	19 Nantahala Ter	1960	1960	2	1	1000 gal/600 sf		2 bed/240 gpd	10/19/1984	ground absorption	120'	
5642046A0025	833 Sequoyah Trl	193 Sequoyah Tr	1980	1976	2	2	1000 gal		2 bed/240 gpd		infiltrator	80'	
5642041A0018	143 Nantahala Trl	195 Nantahala Trl	2000	1964	2	1	1000 gal/576 sf	grinder	3 bed/360 gpd		PPBPS/50% reduction	24 panels/102'	> 25' to grinder pump
564204120008	828 Sequoyah Trl	196 Sequoyah Trl	1988	1965	3	3							
564204150022	720 Cherokee Trl	198 Cherokee Tr	1994	1994	4	3	1000 gal		2 bed/240 gpd	8/10/1992	permeable panel block system	18 panels	50'
564204210016	619 Thunderbird Mtn Rd	2 Lakeside Tr	1995	1976	5	3							
564204080025	390 Thunderbird Trl	2 Sequoyah Tr	1990	1965	3	2							
564204120007	830 Sequoyah Trl	206 Sequoyah Trl	2000	1968	3	2							
5642041A0025	145 Nantahala Trl	207 Nantahala Trl	1980	1968	2	1							
5642041A0007	127 Nantahala Trl	21 Nantahala Ter	1980	1963	3	2							
564204120001	832 Sequoyah Trl	214 Sequoyah Trl	1988	1967	3	1.1							
564204120019	834 Sequoyah Trl	216 Sequoyah Trl	2002	2002	2	2	1000 gal/400 sf		2 bed/240 gpd	6/21/2002	pump to PPBPS	16 panels	50'
5642041A0026	147 Nantahala Trl	217 Nantahala Trl	1975	1968	3	2							
564204150024	724 Cherokee Trl	228 Cherokee Tr	2009	2009	4	3.1	1500 gal	grinder	4 bed/480 gpd	3/6/2009	50% reduction/PPBPS	180'	
564204030008	308 Thunderbird Trl	23 Moseley Way	2000	1976	3	2							
5642041A0006	144 Nantahala Trl	23 Nantahala Ter	1985	1962	2	1							
564204070015	401 Santeetlah Point Rd	23 Santeetlah Point Rd	2000	1966	2	2	1000 gal/400 sf		3 bed/360 gpd	4/30/2012	PPBPS	22 panels	35'
564204120018	836 Sequoyah Trl	230 Sequoyah Trl	1995	1975	5	3							
5642041A0027	149 Nantahala Trl	231 Nantahala Trl	1980	1965	3	2	1000 gal	grinder	2 bed/240 gpd		Conventional for washing machine, rest pumps to PPBPS	10 panels	50'
564204220008	728 Cherokee Trl	236 Cherokee Tr	1997	1984	4	3							
564204030005	314 Thunderbird Trl	246 Thunderbird Trl	1985	1979	3	2							
564204050004	504 Black Bear Trl	25 Black Bear Ct	1980	1964	4	2	800 gal/180 sf		3 bed/360 gpd		LDP/SB2?? (permit was unclear about system type)	60'	
56420421000511	54 Little Falls Trl	25 Little Falls Tr	2008	2008	4	4.1							
564204030014	316 Thunderbird Trl	254 Thunderbird Trl	1985	1964	2	1							
564204220006	734 Cherokee Trl	256 Cherokee Tr	2008	2008	3	4.1	1000 gal/600 sf	grinder	3 bed/360 gpd	7/19/2007	PPBPS/T&J panel	112'	25'+ to grinder pump
5642046A0029	855 Island Dr	263 Sequoyah Tr	1988	1975	2	1							
564204050007	503 Black Bear Trl	28 Black Bear Ct	1980	1964	2	1	1000 gal/400 sf		2 bed/240 gpd		PPBPS	16 panels	> 50'
564204120005	844 Sequoyah Trl	280 Sequoyah Trl	1985	1968	2	2	1000 gal/400 sf		2 bed/240 gpd		PPBPS	16 panels	50'
564204030022	318 Thunderbird Trl	280 Thunderbird Trl	2005	1985	2	1							
564204040002	319 Thunderbird Trl	289 Thunderbird Trail	1980	1960	2	2							
564204050012	509 Black Bear Trl	29 Black Bear Trl	1997	1970	3	2							
564204220005	740 Cherokee Trl	292 Cherokee Tr	1991	1991	2	3.1	1000 gal/495 sf		2 bed/240 gpd	6/27/1991	conventional gravel trench	165'	60'
564204120004	846 Sequoyah Trl	292 Sequoyah Trl	1995	1969	3	1							
564204120004A	850 Sequoyah Trl	294 Sequoyah Trl	1988	1974	3	2.1							
564204220005PT	743 Cherokee Trl	297 Cherokee Tr	2007	2007	3	3.1	1000 gal/400 sf		2 bed/240 gpd	5/13/1992	PPBS/T&J panel	18 panels	
564204190021B	749 Cherokee Trl	299 Cherokee Tr	1995	1990	3	3	2 bed						
564204050005	505 Black Bear Trl	3 Black Bear Ct	1980	1963	2	2							
5642049300 6001	1 Cherokee Ln	3 Cherokee Ln	2007	2007	3	3	1311 gal/600 sf		3 bed/360 gpd	1/25/2007	LDP 10"	240'	
564204190021A	745 Cherokee Trl	301 Cherokee Tr	1995	1985	3	3	1000 gal		3 bed/360 gpd		gravel		
564204040001	321 Thunderbird Trl	301 Thunderbird Trail	1980	1963	2	1			2 bed/240 gpd		PPBPS/50% reduction		
564204030021	320 Thunderbird Trl	310 Thunderbird Trl	1980	1970	2	2							
564204030006	322 Thunderbird Trl	322 Thunderbird Trl	1990	1962	2	2							
564204220003	742 and/or 744 Cherokee Trl	330 Cherokee Tr	1995	1986	5	3	1000 gal/480 sf		5 bed/600 gpd		gravel	144'	

parcel number	current address	historical address	EYB	AYB	# Bed	# Bath	septic tank/system size	pump tank size	design flow	new system permit date	system type	length	offset from lake
564204030007	324 Thunderbird Trl	330 Thunderbird Trl	1990	1962	2	1.1							
564204220004	750 Cherokee Trl	332 Cherokee Tr	1995	1980	3	2.1							
564204030009	306 Thunderbird Trl	34 Moseley Way	1980	1960	2	1							
564204030011	326 Thunderbird Trl	344 Thunderbird Trl	1980	1961	3	1							
564204150005	874 Island Dr	35 island Dr	1988	1973	2	2							
564204930078	760 Cherokee Trl	366 Cherokee Tr	2004	2004	3	3.1	1000 gal/400 sf	grinder	2 bed/240 gpd	10/20/2003	PPBPS/T&J panel	70'	
5642041A0020	129 Nantahala Trl	37 Nantahala Ter	2010	1963	3	1							
564204070013	407 Santeetlah Point Rd	37 Santeetlah Point Rd	1988	1969	3	2	1000 gal/600 sf	grinder	3 bed/360 gpd		pump to PPBPS	24 panels	50'
56420421000513	20 Marina Dr	38 Little Falls Tr	2007	2007	4	3.1							
564204030012	328 Thunderbird Trl	380 Thunderbird Trl	1980	1961	1	1							
564204930077	770 Cherokee Trl	384 Cherokee Tr	1996	1996	3	3.1	1000 gal		3 bed/360 gpd	3/30/1995	conventional gravel	100'	50'
564204050013	513 Black Bear Trl	39 Black Bear Trl	1980	1970	1	2							
564204930064	7 Cheoah Trl	39 Cheoah Trail	2004	2004	3	2.1	1000 gal		3 bed/360 gpd	9/16/2003	LDP/T&J panel	240'	
564204030013	330 Thunderbird Trl	392 Thunderbird Trl	1980	1961	2	1							
56420421000501	20 Lakeside Trl	4 Lakeside Tr	2004	2004	2	2.1							
564204070001P2	406 Santeetlah Point Rd	40 Santeetlah Point Rd	2015	2015	2	2.1	1000 gal	grinder	2 bed/240 gpd	8/18/2014	50% reduction/PPBPS	75'	
5642041A0015	202 Santeetlah Trl	40 Santeetlah Trl	1980	1965	2	1							
564204030015	334 Thunderbird Trl	408 Thunderbird Trl	1999	1996	3	3	1000 gal/400 sf		2 bed/240 gpd	6/6/1995	PPBPS	11 panels	50'
564204050003	501 Black Bear Trl	41 Black Bear Ct	1985	1965	2	2							
564204050006	502 Black Bear Trl	42 Black Bear Ct	1980	1966	2	1	1000 gal/400 sf		2 bed/240 gpd		25% reduction/IQ4	100'	
564204080003	800 Sequoyah Trl	42 Sequoyah Trl	1990	1960	3	1	1000 gal	grinder	2 bed/240 gpd		PPBPS/T&J panel	68'	
564204030016	336 Thunderbird Trl	422 Thunderbird Trl	2007	2007	2	1.2	1000 gal/340 sf		2 bed/240 gpd		PPBPS	10 panels	38'
564204030017	338 Thunderbird Trl	434 Thunderbird Trl	1964	1964	2	1	1000 gal		2 bed/240 gpd		pump to PPBPS	12 panels	50'
564204150042	776 Cherokee Trl	438 Cherokee Tr	1985	1975	2	2.1							
564204020028	563 Black Bear Trl	441 BlackBear Trl	1985	1985	2	2							
564204100003	905 Snowbird Trl	45 Snowbird Trail	1980	1965	2	1							
564204930075	778 Cherokee Trl	464 Cherokee Tr	1996	1996	2	2							
564204190029	1 Indian Trl	47 Indian Tr	1989	1989	2	3	800 gal/402 sf		2 bed/240 gpd	6/29/1988	Gravel?? (permit unclear)	134'	
564204150048	780 Cherokee Trl	472 Cherokee Tr	2000	1985	4	3.1							
564204150050	782 Cherokee Trl	476 Cherokee Tr	1985	1980	3	2							
564204930010	408 Santeetlah Point Rd	48 Santeetlah Point Rd	1999	1999	2	3.1	1000 gal/400 sf			6/3/1999	T&J panel	16 panels	50'
564204030018	340 Thunderbird Trl	480 Thunderbird Trl	1996	1996	2	2	1000 gal		2 bed/240 gpd	2/1/1996	PPBPS	14 panels	
564204030019	342 Thunderbird Trl	482 Thunderbird Trl	1985	1965	2	1	1000 gal/400 sf	grinder	2 bed/240 gpd		T&J panel	16 panels	
564204030020	344 Thunderbird Trl	484 Thunderbird Trl	1980	1980	2	2							
564204060015	346 Thunderbird Trl	490 Thunderbird Trl	1980	1962	2	1	1000 gal/400 sf		2 bed/240 gpd		EEE ZZZ Lay/gravel	80'	25' to gravel, 45' to EEE ZZZ Lay
564204150012	706 Cherokee Trl	50 Cherokee Tr	1990	1971	3	1	1050 gal/480 sf	grinder	4 bed/480 gpd		50% reduction/PPBPS/T&J	31 panels	
564204020034	571 Black Bear Trl	501 Black Bear Trl	1980	1974	3	2							
564204100002	907 Snowbird Trl	51 Snowbird Trail	1967	1967	2	1	1000 gal		2 bed/240 gpd		PPBPS	34'	
564204020001	573 Black Bear Trl	515 Black Bear Trl	2009	1963	2	2							
564204060014	348 Thunderbird Trl	526 Thunderbird Trl	1980	1962	3	2	1000 gal/400 sf		2 bed/240 gpd		PPBPS	10 panels	48'
5642041A0005	??	53 Nantahala Trl	1980	1962	1	1							
564204060013	350 Thunderbird Trl	532 Thunderbird Trl	1985	1961	3	2	1000 gal/400 sf		2 bed/240 gpd		pump to PPBPS	10 panels	50'
564204060001	352 Thunderbird Trl	534 Thunderbird Trl	2005	1961	3	2	1000 gal/400 sf		2 bed/240 gpd		PPBPS	10 panels	50'
564204190033	581 Black Bear Trl	537 Black Bear Trl	1988	1988	3	3	800 gal/513 sf		2 bed/240 gpd	12/2/1988	SB-2 gravel-less pipe system with fiberglass tank	114'	
564204060003	356 Thunderbird Trl	538 Thunderbird Trl	1980	1964	3	2							
564204070004	410 Santeetlah Point Rd	54 Santeetlah Point Rd	2015	2015	2	3	1000 gal	grinder	2 bed/240 gpd		50% reduction/PPBPS	70'	> 25' to grinder pump
5642041A0011	131 Nantahala Trl	55 Nantahala Ter	1980	1960	3	2							
564204070012	409 Santeetlah Point Rd	55 Santeetlah Point Rd	1988	1965	3	2							
564204100001	909 Snowbird Trl	55 Snowbird Trail	1985	1975	2	1							
5642046A0005	610 Chalet Vlg	56 Chalet Village	1975	1969	2	2							
564204050010B	515 Black Bear Trl	57 Black Bear Trl	1980	1968	2	2	1000 gal/400 sf		2 bed/240 gpd		chamber	100'	
564204060004	358 Thunderbird Trl	574 Thunderbird Trl	1990	1963	3	3	1000 gal/400 sf		2 bed/240 gpd		chamber/infiltrator	100'	44'
56420410A171	580 Black Bear Trl	576 Black Bear Trl	1985	1973	3	2							
564204060005B	360 Thunderbird Trl	582 Thunderbird Trl	1998	1964	2	1	1000 gal/400 sf	750+	2 bed/240 gpd		PPBPS	14 panels	
564204060017	362 Thunderbird Trl	588 Thunderbird Trl	1999	1960	2	1							
564204070011	411 Santeetlah Point Rd	59 Santeetlah Point Rd	1980	1966	3	2.1							
564204090004	612 Chalet Vlg	60 Chalet Village	1975	1966	3	2							
56420421000509	30 Lakeside Trl	60 Lakeside Tr	2006	2006	4	3.1							
564204080002	812 Sequoyah Trl	60 Sequoyah Trl	1980	1968	2	1							
564204050011	516 Black Bear Trl	61 Black Bear Trl	1980	1970	2	1	1000 gal		3 bed/360 gpd		PPBPS	50'	
5642041A0012	133 Nantahala Trl	61 Nantahala Ter	1961	1961	2	2							
5642046A0003	609 Chalet Vlg	62 Chalet Village	1985	1965	2	1							
564204060018	364 Thunderbird Trl	626 Thunderbird Trl	1980	1962	3	2	1000 gal		2 bed/240 gpd			14 panels	> 45'
564204050016	517 Black Bear Trl	63 Black Bear Trl	2005	2005	3	3							
56420410A001	911 Snowbird Trl	63 Snowbird Trail	2007	2007	2	2.1	1000 gal/600 sf		3 bed/360 gpd	3/10/2006	25% reduction/EZ Flow	150'	
56420410A165	586 Black Bear Trl	630 Black Bear Trl	1973	1973	3	2	1000 gal/600 sf		3 bed/360 gpd		BIO A36 by Infiltrator	150'	
564204060019	366 Thunderbird Trl	634 Thunderbird Trl	1985	1964	2	2	1000 gal/400 sf		2 bed/240 gpd		PPBPS	14 panels	45'
564204090002	607 Chalet Vlg	64 Chalet Village	1975	1964	1	1							
564204060006	368 Thunderbird Trl	644 Thunderbird Trl	1965	1965	2	1							
564204060007	370 Thunderbird Trl	646 Thunderbird Trl	1980	1960	2	2	800 gal		2 bed/240 gpd			53'	50'
564204110001	902 Snowbird Trl	66 Snowbird Trail	1965	1965	4	2							
564204930040	587 Black Bear Trl	664 BlackBear Trl	1998	1998	3	3	1000 gal/900 sf		2 bed/240 gpd	8/13/1998	infiltrator	100'	
564204930063	??	67 Cheoah Trail	2011	2011	1	1.1	1000 gal/600 sf		3 bed/360 gpd	3/11/2006	LDP 10"	240'	
564204930071	3 Indian Trl	67 Indian Tr	1997	1997	3	3.1	1000 gal/600 sf		3 bed/360 gpd	11/26/1996	EEE ZEE Lay/conventional gravel	150'	
564204930068	589 Black Bear Trl	671 Black Bear Trl	1995	1995	3	3.1	1000 gal/400 sf		2 bed/240 gpd	7/15/1995	LDP	160'	
564204050001	367 Thunderbird Trl	673 Thunderbird Trl	1980	1962	1	1	1000 gal/400 sf		2 bed/240 gpd		PPBPS	14 panels	
564204070005	412 Santeetlah Point Rd	68 Santeetlah Point Rd	2003	2003	3	2	1000 gal	750	2 bed/240 gpd		PPBPS/T&J panel		50'-70'
564204070017	374 Thunderbird Trl	7 Santeetlah Point Rd	1980	1969	2	1							
564204000007	7 Thunder Island Dr	7 Thunder Island Dr	2006	1994	4	4	1000 gal		3 bed/360 gpd			60'	50'
564204120012	816 Sequoyah Trl	70 Sequoyah Trl	1992	1992	2	2	1000 gal/400 sf	grinder	2 bed/240 gpd	11/9/1992	PPBPS	70'/16 panels	
564204000001	1 and/or 2 Thunder Island Dr	70 Thunder Island	1988	1985	3	2	1000 gal/600 sf		3 bed/360 gpd		T&J panel	23 panels	
564204930009	376 Thunderbird Trl	700 Thunderbird Trl	1995	1995	3	3.1							

parcel number	current address	historical address	EYB	AYB	# Bed	# Bath	septic tank/system size	pump tank size	design flow	new system permit date	system type	length	offset from lake
564204000002	3 Thunder Island Dr	71 Thunder Island	1988	1984	3	1							
564204090001	605 Chalet Vlg	72 Chalet Village	1975	1970	2	2							
564204140006	864 Island Dr	73 Island Dr	1997	1997	3	3	1000 gal		2 bed/240 gpd	8/28/1991	LDP	40'	50'
564204080021	378 Thunderbird Trl	730 Thunderbird Trl	1995	1965	3	2	1000 gal	grinder	2 bed/240 gpd		PPBPS/T&J panel	34'	
5642041A0014	133 Nantahala Ter	74 Nantahala Ter	1960	1960	3	2							
564204200017	599 Black Bear Trl	741 Black Bear Trl	1989	1975	3	2	500 gal/150 sf		2 bed/240 gpd	6/18/1974	ground absorption		
5642041A0013	135 Nantahala Trl	75 Nantahala Ter	1962	1962	2	1	1000 gal		2 bed/240 gpd		PPBPS	10 panels	50'
564204080022	380 Thunderbird Trl	750 Thunderbird Trl	2005	1986	4	2							
5642042100058A	32 Lakeside Trl	76 Lakeside Tr	2010	2010	3	3.1	1000 gal/200 sf	grinder	2 bed/240 gpd	1/28/2010	50% reduction/PPBPS/T&J	16 panels	25' to grinder pump, 50' to panels
5642041B0003B	300 Thunderbird Trl	76 Thunderbird	1980	1975	3	2							
564204080023	382 Thunderbird Trl	768 Thunderbird Trl	2005	1980	3	3.1							
564204930047	6 Cheoah Trl	78 Cheoah Trail	2004	2004	1	2	1000 gal/400 sf		2 bed/240 gpd	12/8/2003	PPBPS/T&J panel	16 panels	
564204070006	414 Santeetlah Point Rd	78 Santeetlah Point Rd	2000	1965	3	2	1000 gal/400 sf	750	2 bed/240 gpd		pump to PPBPS/T&J panel	60'	
564204050009	506 Black Bear Trl	8 Black Bear Ct	1980	1969	3	2							
564204060008	402 Santeetlah Point Rd	8 Santeetlah Point Rd	1988	1962	3	2							
564204070008	418 Santeetlah Point Rd	81 Santeetlah Point Rd	1993	1966	3	2.1							
564204130001	392 Thunderbird Trl	812 Thunderbird Trail	2008	1963	3	2.1	1000 gal		3 bed/360 gpd		PPBPS	24 panels	
564204070007	416 Santeetlah Point Rd	82 Santeetlah Point Rd	1990	1961	2	2							
5642041A0021	204 Santeetlah Trl	84 Santeetlah Trl	2005	1964	3	2							
56420410A002	913 Snowbird Trl	85 Snowbird Trail	2002	2002	1	1	1000 gal/400 sf		2 bed/240 gpd	9/20/2002	chamber/infiltrator	100'	
5642041B0003	203 Santeetlah Trl	87 Santeetlah Trl	1980	1965	1	1							
564204210004	12 Marina Dr	88 Marina Dr	1963	1963	2	1							
5642041A0009	125 Nantahala Trl	9 Nantahala Ter	1980	1963	2	1							
564204140005	860 Island Dr	91 Island Dr	2007	2007	3	3	1500 gal/600 sf	grinder	3 bed/360 gpd		PPBPS/T&J panel	24 panels	
564204000004	??	93 Thunder Island	2002	2002	2	3	1000 gal/400 sf		2 bed/240 gpd	5/16/2002	PPBPS/T&J panel	16 panels	
5642041A0003	208 Santeetlah Trl	98 Santeetlah Trl	2000	1961	3	1	1000 gal/300 sf	grinder	2 bed/240 gpd		PPBPS	16 panels	
564204930054	4 Wachacha Trl	99 Wachacha Tr	2008	2008	3	3.1	1000 gal/360 sf	grinder	3 bed/360 gpd	9/4/2007	PPBPS	28 panels/120'	

parcel number	current address	failures/repairs 1	date	failures/repairs 2	date2	notes
564204930066	1 Cheoah Trl					
564204000003	4 Thunder Island Dr					
564204930008	2 Wachacha Trl					
5642041B0001	205 Santeetlah Trl					
564204140003	858 Island Dr					unclear from permits whether this system is at 856 or 858 Island Dr
5642041A0002	210 Santeetlah Trl					
564204000005	5 Thunder Island Dr					
564204050008A	507 Black Bear Trl					
5642041B0022	115 Nantahala Trl	repaired/replaced system, but no mention of prior system	9/1/1988			
56420410A003	915 Snowbird Trl					
564204150014	708 Cherokee Trl					
564204000006	6 Thunder Island Dr					application indicates that site is exempt from repair, likely due to limited space
564204150016A	712 Cherokee Trl					replaced in 2004, previous system from 1986 but limited info available
564204120010	818 Sequoyah Trl					
564204140004	856 Island Dr					unclear from permits whether this system is at 856 or 858 Island Dr
5642041B0004	207 Santeetlah Tr					
5642041A0001	212 Santeetlah Trl					
564204050002	357 Thnderbird Trl	repaired/replaced system	7/10/1996			
564204030004	312 Thunderbird Trl					
564204140002	854 Island Dr					
564204120003	824 Sequoyah Trl	installed system across the street on lot 5 Sequoyah Trl	8/26/2005			no prior permits available
5642046A0010	600 Chalet Vlg					
564204000009	9 Thunder Island Dr	site evaluation for a new system, but no CA or OP	6/10/1996			
5642041B0002	302 Thunderbird Trl					
564204030001	304 Thunderbird Trl					
564204030010	310 Thunderbird Trl	replaced/repaired system	6/29/2006			
5642041A0017	137 Nantahala Trl					
564204070001	404 Santeetlah Point Rd	IP, but no CA or OP	6/17/2005			no construction authorization or operations permit
564204120009	??					
5642041A0016	139 Nantahala Trl					
564204030002	209 Santeetlah Trl	repaired/replaced	12/18/1998			no prior permits available
564204150016B	714 Cherokee Trl					
564204030003	218 Santeetlah Trl					
564204930028	931 Snowbird Trl					
564204930065	4 Cheoah Trl					
564204930079	716 Cherokee Trl					repair exempt
5642041A0019	141 Nantahala Trl					
564204150021	718 Cherokee Trl					
564204120006	826 Sequoyah Trl					
5642041A0008	??					
5642046A0025	833 Sequoyah Trl	repaired system, pumped and crushed old tank	12/11/2000			denied expansion permit on 10/9/01
5642041A0018	143 Nantahala Trl	repaired/replaced system	4/29/2015			
564204120008	828 Sequoyah Trl					
564204150022	720 Cherokee Trl					
564204210016	619 Thunderbird Mtn Rd					
564204080025	390 Thunderbird Trl					
564204120007	830 Sequoyah Trl					
5642041A0025	145 Nantahala Trl					
5642041A0007	127 Nantahala Trl					
564204120001	832 Sequoyah Trl					
564204120019	834 Sequoyah Trl					
5642041A0026	147 Nantahala Trl					
564204150024	724 Cherokee Trl					one system for two 2-bed houses, second house at 733 cherokee trail
564204030008	308 Thunderbird Trl					
5642041A0006	144 Nantahala Trl					
564204070015	401 Santeetlah Point Rd					permit indicats that only metal tank was present prior to system installation
564204120018	836 Sequoyah Trl					
5642041A0027	149 Nantahala Trl	system repaired, fiberglass tank installed and existing metal tank destroyed	7/5/1996			Conventional gravel added to service washing machine due to overly stressed system and limited repair space
564204220008	728 Cherokee Trl					
564204030005	314 Thunderbird Trl					
564204050004	504 Black Bear Trl	original system failed, only room for 180 sf to be added	3/30/1988			sanitarian asked that washing machine not be used due to state of system
56420421000511	54 Little Falls Trl					
564204030014	316 Thunderbird Trl					
564204220006	734 Cherokee Trl					repair exempt, drain field installed within 10' of property line upon approved variance request
5642046A0029	855 Island Dr					
564204050007	503 Black Bear Trl	site evaluation for a repair, but no further permits	6/15/2000			
564204120005	844 Sequoyah Trl	replaced, old septic system pumped and crushed or removed	3/23/2006			
564204030022	318 Thunderbird Trl					
564204040002	319 Thunderbird Trl					
564204050012	509 Black Bear Trl	CA for repair/expansion but no OP	8/25/2005			
564204220005	740 Cherokee Trl					
564204120004	846 Sequoyah Trl					
564204120004A	850 Sequoyah Trl					
564204220005PT	743 Cherokee Trl					3 bed home hooked to existing wastewater system
564204190021B	749 Cherokee Trl					
564204050005	505 Black Bear Trl					
56420493006001	1 Cherokee Ln					
564204190021A	745 Cherokee Trl	installed new tank, old tank pumped and removed	3/1/2004			
564204040001	321 Thunderbird Trl	repair permit issued but not completed	9/23/2015			
564204030021	320 Thunderbird Trl					
564204030006	322 Thunderbird Trl					Krauskopf tried in 88 to expand beyond 2 bed, denied for inusfficient soil depth. Brickell tried again in 09, outcome unknown
564204220003	742 and/or 744 Cherokee Trl	max available space was used to repair/expand a failing system	7/31/1987			

parcel number	current address	failures/repairs 1	date	failures/repairs 2	date2	notes
564204030007	324 Thunderbird Trl	site evaluation for repair/replacement, but no CA or OP, mentions there is an existing system but no specifics	2/16/2000			
564204220004	750 Cherokee Trl					
564204030009	306 Thunderbird Trl					
564204030011	326 Thunderbird Trl					
564204150005	874 Island Dr	improvement permit denied	6/13/1988			
564204930078	760 Cherokee Trl					
5642041A0020	129 Nantahala Trl					
564204070013	407 Santeetlah Point Rd	repaired/replaced system	2/27/1999	replaced septic tank	7/10/2008	
56420421000513	20 Marina Dr					
564204030012	328 Thunderbird Trl					
564204930077	770 Cherokee Trl					
564204050013	513 Black Bear Trl					
564204930064	7 Cheoah Trl					
564204030013	330 Thunderbird Trl					
56420421000501	20 Lakeside Trl					
564204070001P2	406 Santeetlah Point Rd					
5642041A0015	202 Santeetlah Trl					
564204030015	334 Thunderbird Trl					installed new system in different location than original, but no mention of removing original
564204050003	501 Black Bear Trl	site evaluation for repair but no CA or OP	7/15/1996			
564204050006	502 Black Bear Trl	repaired/replaced system, pumped and removed old tank	11/7/2008			
564204080003	800 Sequoyah Trl	repaired system	2/20/2003			
564204030016	336 Thunderbird Trl	installed new panels and fiberglass tank	7/2/1996			
564204030017	338 Thunderbird Trl	site evaluation for repair says space is limited, no further permits	8/1/1996			site evaluation shows an existing metal tank within 50' of the lake
564204150042	776 Cherokee Trl					
564204020028	563 Black Bear Trl					
564204100003	905 Snowbird Trl					
564204930075	778 Cherokee Trl					
564204190029	1 Indian Trl					says depth of gravel under tile = 12-14", does this mean conventional gravel system?
564204150048	780 Cherokee Trl					
564204150050	782 Cherokee Trl					
564204930010	408 Santeetlah Point Rd	repaired/replaced system, installed new tank	5/1/2008			
564204030018	340 Thunderbird Trl					
564204030019	342 Thunderbird Trl	repaired/replaced system, installed in new location after obtaining an easement from Michael Danforth	1/23/2004			
564204030020	344 Thunderbird Trl					
564204060015	346 Thunderbird Trl	system repaired/replaced and small gravel system installed to service washing machine	10/20/1997			gravel system installed to service washing machine due to stressed system and limited repair area
564204150012	706 Cherokee Trl	unclear whether permit was for repair/replacement or new installation	7/16/2010			permit indicates repair, but original permit application indicates no existing system prior to 2010
564204020034	571 Black Bear Trl					
564204100002	907 Snowbird Trl	approved for expansion/repairs	9/9/2008			approved for expansion/repairs but never installed
564204020001	573 Black Bear Trl					
564204060014	348 Thunderbird Trl	repaired/replaced stystem	8/28/1996			
5642041A0005	??					
564204060013	350 Thunderbird Trl	repaired/replaced	7/10/1996			
564204060001	352 Thunderbird Trl	repaired system and replaced tank	10/18/1995	denied improvement permit	4/5/1999	
564204190033	581 Black Bear Trl					
564204060003	356 Thunderbird Trl					
564204070004	410 Santeetlah Point Rd	repaired tank	8/23/2012			CA for a repair in 1999 and a new system in 2009, but no OP
5642041A0011	131 Nantahala Trl					
564204070012	409 Santeetlah Point Rd					
564204100001	909 Snowbird Trl					
5642046A0005	610 Chalet Vlg					
564204050010B	515 Black Bear Trl	site evaluation to repair system and crush existing tank, but no CA or OP	6/26/2001			
564204060004	358 Thunderbird Trl	repaired/replaced	7/30/2001			prior permits unavailable
56420410A171	580 Black Bear Trl					
564204060005B	360 Thunderbird Trl	repaired/replaced system	3/5/2003			
564204060017	362 Thunderbird Trl					
564204070011	411 Santeetlah Point Rd					
564204090004	612 Chalet Vlg					
56420421000509	30 Lakeside Trl					
564204080002	812 Sequoyah Trl	denied improvement permit	5/22/1995			permit denied on 5/22/1995 and no prior permits available, could mean that there is no permitted system
564204050011	516 Black Bear Trl	repaired/replaced system	11/5/2009			
5642041A0012	133 Nantahala Trl					
5642046A0003	609 Chalet Vlg					
564204060018	364 Thunderbird Trl	site evaluation and improvement permit, but no OP	10/29/1998			original permit unavailable
564204050016	517 Black Bear Trl					
56420410A001	911 Snowbird Trl					
56420410A165	586 Black Bear Trl	replace/repair failing system	4/25/2012			
564204060019	366 Thunderbird Trl	repaired/replaced	10/28/1998			
564204090002	607 Chalet Vlg	site evaluation for a new system, but no CA or OP	5/17/1996			
564204060006	368 Thunderbird Trl					
564204060007	370 Thunderbird Trl	24' original system repaired and added 10'x20' bed	4/20/1992			certificate of completion says that site is extremely space limited and that water conservation measure must be used to protect system
564204110001	902 Snowbird Trl					
564204930040	587 Black Bear Trl					
564204930063	??					
564204930071	3 Indian Trl					
564204930068	589 Black Bear Trl					
564204050001	367 Thunderbird Trl	replaced/repaired system	11/30/1998			
564204070005	412 Santeetlah Point Rd	repaired/expanded, grinder pump added	3/4/2003			
564204070017	374 Thunderbird Trl					
564204000007	7 Thunder Island Dr	Expanded and grinder pump added	4/22/1994			
564204120012	816 Sequoyah Trl					
564204000001	1 and/or 2 Thunder Island Dr	site evaluation for repair, but no CA or OP	8/17/2001	repaired/replaced system	11/5/2001	
564204930009	376 Thunderbird Trl					

parcel number	current address	failures/repairs 1	date	failures/repairs 2	date2	notes
564204000002	3 Thunder Island Dr					
564204090001	605 Chalet Vlg					
564204140006	864 Island Dr	original SB-2 system replaced with current LDP system	2/21/1997			
564204080021	378 Thunderbird Trl	new/expansion/repair	1/25/2005			
5642041A0014	133 Nantahala Ter					
564204200017	599 Black Bear Trl					
5642041A0013	135 Nantahala Trl	site evaluation after IP, but no CA or OP	7/10/1996			
564204080022	380 Thunderbird Trl					
5642042100058A	32 Lakeside Trl					permit says that repair area will be connection to community sewer system
5642041B0003B	300 Thunderbird Trl					
564204080023	382 Thunderbird Trl					
564204930047	6 Cheoah Trl					
564204070006	414 Santeetlah Point Rd	system replaced	3/24/2000			
564204050009	506 Black Bear Trl					
564204060008	402 Santeetlah Point Rd					
564204070008	418 Santeetlah Point Rd					
564204130001	392 Thunderbird Trl	repaired/expanded	1/28/2008			
564204070007	416 Santeetlah Point Rd					
5642041A0021	204 Santeetlah Trl					
56420410A002	913 Snowbird Trl					
5642041B0003	203 Santeetlah Trl	site evaluation for repairs, but no IP, CA, or OP	6/14/2000			
564204210004	12 Marina Dr					
5642041A0009	125 Nantahala Trl					
564204140005	860 Island Dr	replaced/repaired system, pumps across island dr to separate lot	3/3/2005			
564204000004	??					
5642041A0003	208 Santeetlah Trl	installed new system, old system was located under house with all greywater discharging to surface	5/20/2009			
564204930054	4 Wachacha Trl					

APPENDIX C. RESOURCES FOR ONSITE AND CLUSTER SYSTEM TECHNOLOGY OPTIONS

RESOURCES FOR ONSITE AND CLUSTER SYSTEM TECHNOLOGY OPTIONS

North Carolina Onsite Water Protection Branch (http://ehs.ncpublichealth.com/oswp/)

Current Rules: http://ehs.ncpublichealth.com/rules.htm#oswprules

Approved Products: http://ehs.ncpublichealth.com/oswp/approvedproducts.htm

US Environmental Protection Agency (https://www.epa.gov/septic)

Advanced Technology for Onsite Treatment of Wastewater, Products Approved by State: https://www.epa.gov/septic/advanced-technology-onsite-treatment-wastewater-products-approved-state

Design Manual: https://www.epa.gov/septic/onsite-wastewater-treatment-and-disposal-systems

Decentralized Wastewater Treatment: Treatment Technologies, System Design, and Management Strategies: https://engineering.purdue.edu/watersheds/webinars/wastewater2010/

Other Resources: https://www.epa.gov/septic/technical-information-about-septic-systems

Decentralized Water Resources Collaborative (http://www.ndwrcdp.org/)

Performance and Costs for Decentralized Unit Processes: http://www.ndwrcdp.org/research_project_DEC2R08.asp

Analysis of Existing Community-Sized Decentralized Wastewater Treatment Systems: http://www.ndwrcdp.org/research_project_04-DEC-9.asp

Cluster Wastewater Systems Planning Handbook: http://www.ndwrcdp.org/research_project_WU-HT-01-45.asp

Additional resources under “Environmental Science and Engineering” category at http://www.ndwrcdp.org/research_by_category.asp

Manufacturers and Vendors with North Carolina approvals

American Manufacturing: http://www.americanonsite.com/

ANUA: https://anuainternational.com/products/clean-water/

AquaPoint: http://www.aquapoint.com/bioclere.html

BioKube: https://www.biokube.com/

Bio-Microbics: http://www.biomicrobics.com/products/

Clearstream: http://www.clearstreamsystems.com/

CULTEC: http://www.cultec.com/septic-systems.html

Delta/Pentair: http://www.deltaenvironmental.com/

E-Z Treat: http://www.eztreat.net/

FR Mahony: http://www.frmahony.com/

FujiClean USA: http://www.fujicleanusa.com/

Geoflow: http://www.geoflow.com/

Hoot Systems: http://hootsystems.com/

Infiltrator: https://infiltratorwater.com/

NoMound: http://www.nomound.com/

Norweco: http://www.norweco.com/html/Learning_Center/Strategies.htm

Orenco Systems: http://www.orenco.com/

PremierTech: https://www.premiertech.com/global/en/products/water-treatment/

T&J Panel: http://www.tjpanel.com/

APPENDIX D. CLUSTER SYSTEM ITEMIZED COST ESTIMATES

Title	Cost Estimate for Treatment Area 1A	
Project #		
Project Name	Town Sewerage Study	
Location	Lake Santeetlah, NC	
	Name	Date
Quantities	B. Tucker	7/20/2016
Revised by	B. Tucker	
Checked By	V. D'Amato	
Approved By	V. D'Amato	
Comments:	This sheet provides an opinion of probable construction cost based on the alternatives analysis of onsite wastewater design options.	
Project Site/Scenario:	Installation of a STEP collection system for 37 residences along the western half of the North Shore zone, and a community dispersal system that includes recirculating sand filter pretreatment and a subsurface drip system.	

TETRA TECH, Inc.

Item No	Description	Quant.	Unit	Unit Cost	Total
	On-Lot STEP Components				
	2" SCH 40 PVC to Forcemain (60 ft)	37	EA	$255.00	$9,435
	2" Check Valve	37	EA	$26.00	$962
	12" Valve Box	37	EA	$21.00	$777
	2" Ball Valve	37	EA	$73.00	$2,701
	Pump, controls, control panel, floats and electical	37	EA	$1,200.00	$44,400
	1500 gal divided STEP tank	37	EA	$1,475.00	$54,575
	Extra Labor/Equipment for STEP installation	37	EA	$700.00	$25,900
	Misc. PVC parts	37	EA	$34.00	$1,258
	Piping/Installation				
	2.0" SCH 40 PVC	2,010	LF	$3.22	$6,474
	2.5" SCH 40 PVC	595	LF	$4.90	$2,916
	Air/Vacuum Release	5	EA	$456.00	$2,280
	Toning Wire	2,605	LF	$0.10	$261
	Directional Boring	278	LF	$8.93	$2,478
	Labor and Equipment	2,605	LF	$5.20	$13,546
	Recirculating Media Filter				
	Filter Shell	1	LS	$20,000.00	$20,000
	Inlet Manifold	1	LS	$630.00	$630
	Recirculating Underdrain	1	LS	$1,700.00	$1,700
	Drip Underdarin	1	LS	$2,000.00	$2,000
	Dose Inlet Headers	1	LS	$3,400.00	$3,400
	Dose Effluent Headers	1	LS	$4,500.00	$4,500
	Recirculating Pump Components	1	LS	$16,800.00	$16,800
	Filter Installation	1110	SF	$22.00	$24,420
	Drip Dispersal				
	Headworks (pumps, controls, valves, etc.)	1	LS		$15,680
	Dispersal System (23,000 ft of tubing)	1	LS		$7,500
	System Intallation	1	LS		$9,400
	Construction Subtotal				$273,992
	Overhead				
	Land Acquisition	0.60	AC	$30,000	$18,000
	P&O on Labor & Materials (20%)	1.0	LS		$54,798
	Mobilization and stakeout (5%)	1.0	LS		$13,700
	Bonds and Insurance (4%)	1.0	LS		$10,960
	Engineering and Design (10%)	1.0	LS		$27,399
	Contingency (20%)	1.0	LS		$54,798
	Total Construction Cost				**$453,647**

Title	Cost Estimate for Treatment Area 1B	
Project #		
Project Name	Town Sewerage Study	
Location	Lake Santeetlah, NC	
	Name	Date
Quantities	B. Tucker	7/20/2016
Revised by	B. Tucker	
Checked By	V. D'Amato	
Approved By	V. D'Amato	
Comments:	This sheet provides an opinion of probable construction cost based on the alternatives analysis of onsite wastewater design options.	
Project Site/Scenario:	Installation of a STEP collection system for 31 residences along the eastern half of the North Shore zone, and a community dispersal system that includes recirculating sand filter pretreatment and a subsurface drip system.	

TETRA TECH, Inc.

Item No	Description	Quant.	Unit	Unit Cost	Total
	On-Lot STEP Components				
	2" SCH 40 PVC to Forcemain (60 ft)	31	EA	$255.00	$7,905
	2" Check Valve	31	EA	$26.00	$806
	12" Valve Box	31	EA	$21.00	$651
	2" Ball Valve	31	EA	$73.00	$2,263
	Pump, controls, control panel, floats and electical	31	EA	$1,200.00	$37,200
	1500 gal divided STEP tank	31	EA	$1,475.00	$45,725
	Extra Labor/Equipment for STEP installation	31	EA	$700.00	$21,700
	Misc. PVC parts	31	EA	$34.00	$1,054
	Piping/Installation				
	2.0" SCH 40 PVC	2,290	LF	$3.22	$7,376
	2.5" SCH 40 PVC	965	LF	$4.90	$4,729
	Air/Vacuum Release	4	EA	$456.00	$1,824
	Toning Wire	3,259	LF	$0.10	$326
	Directional Boring	233	LF	$8.93	$2,076
	Labor and Equipment	3,255	LF	$5.20	$16,926
	Recirculating Media Filter				
	Filter Shell	1	LS	$17,200.00	$17,200
	Inlet Manifold	1	LS	$560.00	$560
	Recirculating Underdrain	1	LS	$1,430.00	$1,430
	Drip Underdarin	1	LS	$2,000.00	$2,000
	Dose Inlet Headers	1	LS	$3,100.00	$3,100
	Dose Effluent Headers	1	LS	$4,900.00	$4,900
	Recirculating Pump Components	1	LS	$10,400.00	$10,400
	Filter Installation	930	SF	$22.00	$20,460
	Drip Dispersal				
	Headworks (pumps, controls, valves, etc.)	1	LS	$13,300	$13,300
	Dispersal System (8,500 ft of tubing)	1	LS	$6,200	$6,200
	System Intallation	1	LS	$8,200	$8,200
	Construction Subtotal				$238,310
	Overhead				
	Land Acquisition	0.50	AC	$25,000	$12,500
	P&O on Labor & Materials (20%)	1.0	LS		$47,662
	Mobilization and stakeout (5%)	1.0	LS		$11,916
	Bonds and Insurance (4%)	1.0	LS		$9,532
	Engineering and Design (10%)	1.0	LS		$23,831
	Contingency (20%)	1.0	LS		$47,662
	Total Construction Cost				**$391,413**

Title	Cost Estimate for Treatment Area 1B	
Project #		
Project Name	Town Sewerage Study	
Location	Lake Santeetlah, NC	
	Name	Date
Quantities	B. Tucker	7/20/2016
Revised by	B. Tucker	
Checked By	V. D'Amato	
Approved By	V. D'Amato	
Comments:	This sheet provides an opinion of probable construction cost based on the alternatives analysis of onsite wastewater design options.	
Project Site/Scenario:	Installation of a STEP collection system for 31 residences along the eastern half of the North Shore zone, and a community dispersal system that includes recirculating sand filter pretreatment and a subsurface drip system.	

TETRA TECH, Inc.

Item No	Description	Quant.	Unit	Unit Cost	Total
	On-Lot STEP Components				
	2" SCH 40 PVC to Forcemain (60 ft)	24	EA	$255.00	$6,120
	2" Check Valve	24	EA	$26.00	$624
	12" Valve Box	24	EA	$21.00	$504
	2" Ball Valve	24	EA	$73.00	$1,752
	Pump, controls, control panel, floats and electical	24	EA	$1,200.00	$28,800
	1500 gal divided STEP tank	24	EA	$1,475.00	$35,400
	Extra Labor/Equipment for STEP installation	24	EA	$700.00	$16,800
	Misc. PVC parts	24	EA	$34.00	$816
	Piping/Installation				
	2.0" SCH 40 PVC	370	LF	$3.22	$1,192
	2.5" SCH 40 PVC	2,410	LF	$4.90	$11,809
	3.0" SCH 40 PVC	1,570	LF	$6.44	$10,111
	Air/Vacuum Release	5	EA	$456.00	$2,280
	Toning Wire	4,355	LF	$0.10	$436
	Directional Boring	180	LF	$8.93	$1,607
	Labor and Equipment	4,350	LF	$5.20	$22,620
	Recirculating Media Filter				
	Filter Shell	1	LS	$13,500.00	$13,500
	Inlet Manifold	1	LS	$560.00	$560
	Recirculating Underdrain	1	LS	$1,500.00	$1,500
	Drip Underdarin	1	LS	$1,800.00	$1,800
	Dose Inlet Headers	1	LS	$2,400.00	$2,400
	Dose Effluent Headers	1	LS	$3,800.00	$3,800
	Recirculating Pump Components	1	LS	$10,300.00	$10,300
	Filter Installation	720	SF	$22.00	$15,840
	Drip Dispersal				
	Headworks (pumps, controls, valves, etc.)	1	LS	$11,700	$11,700
	Dispersal System (7,500 ft of tubing)	1	LS	$5,400	$5,400
	System Intallation	1	LS	$6,800	$6,800
	Construction Subtotal				$214,470
	Overhead				
	Land Acquisition	0.40	AC	$30,000	$12,000
	P&O on Labor & Materials (20%)	1.0	LS		$42,894
	Mobilization and stakeout (5%)	1.0	LS		$10,724
	Bonds and Insurance (4%)	1.0	LS		$8,579
	Engineering and Design (10%)	1.0	LS		$21,447
	Contingency (20%)	1.0	LS		$42,894
	Total Construction Cost				**$353,008**

Title	Cost Estimate for Treatment Area 2B	
Project #		
Project Name	Town Sewerage Study	
Location	Lake Santeetlah, NC	
	Name	Date
Quantities	B. Tucker	7/20/2016
Revised by	B. Tucker	
Checked By	V. D'Amato	
Approved By	V. D'Amato	
Comments:	This sheet provides an opinion of probable construction cost based on the alternatives analysis of onsite wastewater design options.	
Project Site/Scenario:	Installation of a STEP collection system for 52 residences along the West End, and a community dispersal system that includes recirculating sand filter pretreatment and a subsurface drip system.	

TETRA TECH, Inc.

Item No	Description	Quant.	Unit	Unit Cost	Total
	On-Lot STEP Components				
	2" SCH 40 PVC to Forcemain (60 ft)	52	EA	$255.00	$13,260
	2" Check Valve	52	EA	$26.00	$1,352
	12" Valve Box	52	EA	$21.00	$1,092
	2" Ball Valve	52	EA	$73.00	$3,796
	Pump, controls, control panel, floats and electical	52	EA	$1,200.00	$62,400
	1500 gal divided STEP tank	52	EA	$1,475.00	$76,700
	Extra Labor/Equipment for STEP installation	52	EA	$700.00	$36,400
	Misc. PVC parts	52	EA	$34.00	$1,768
	Piping/Installation				
	2.0" SCH 40 PVC	2,781	LF	$3.22	$8,957
	2.5" SCH 40 PVC	1,690	LF	$4.90	$8,281
	3.0" SCH 40 PVC	175	LF	$6.44	$1,127
	Air/Vacuum Release	5	EA	$456.00	$2,280
	Toning Wire	4,646	LF	$0.10	$465
	Directional Boring	390	LF	$8.93	$3,483
	Labor and Equipment	4,646	LF	$5.20	$24,159
	Recirculating Media Filter				
	Filter Shell	1	LS	$28,000.00	$28,000
	Inlet Manifold	1	LS	$700.00	$700
	Recirculating Underdrain	1	LS	$1,700.00	$1,700
	Drip Underdarin	1	LS	$2,200.00	$2,200
	Dose Inlet Headers	1	LS	$4,800.00	$4,800
	Dose Effluent Headers	1	LS	$6,200.00	$6,200
	Recirculating Pump Components	1	LS	$16,900.00	$16,900
	Filter Installation	1560	SF	$22.00	$34,320
	Drip Dispersal				
	Headworks (pumps, controls, valves, etc.)	1	LS	$19,100	$19,100
	Dispersal System (23,000 ft of tubing)	1	LS	$15,700	$15,700
	System Intallation	1	LS	$17,500	$17,500
	Construction Subtotal				$392,640
	Overhead				
	Land Acquisition	0.80	AC	$30,000	$24,000
	P&O on Labor & Materials (20%)	1.0	LS		$78,528
	Mobilization and stakeout (5%)	1.0	LS		$19,632
	Bonds and Insurance (4%)	1.0	LS		$15,706
	Engineering and Design (10%)	1.0	LS		$39,264
	Contingency (20%)	1.0	LS		$78,528
	Total Construction Cost				**$648,297**

APPENDIX E. PROPERTY OWNER TRAINING RESOURCES

Property Owner Training Resources

US EPA/SepticSmart: https://www.epa.gov/septic

Decentralized Wastewater Treatment: Treatment Technologies, System Design, and Management Strategies: https://engineering.purdue.edu/watersheds/webinars/wastewater2010/

NC Onsite Water Protection Branch Non-Point Source Program Resources: http://ehs.ncpublichealth.com/oswp/nps/resources.htm (click on Training Materials)

NC State University Extension: http://www.soil.ncsu.edu/publications/extension.html (scroll to Septic Systems)

NC State University Extension Training: https://soils.ces.ncsu.edu/training/

NC State Department of Soil Science: http://www.soil.ncsu.edu/programs/septicsystem/ (note the Fletcher, NC training site in Buncombe County)

Certification program for NC Onsite Wastewater System Contractors and Inspectors: http://www.ncowcicb.info/

Certification program for NC Wastewater System Operators: https://deq.nc.gov/about/divisions/water-resources/operator-certification/wastewater-operator-certification

Decentralized Water Resources Collaborative: http://www.ndwrcdp.org/research_by_category.asp (click on “Training and Education”

APPENDIX F. EXAMPLE ON-CALL CONSULTING CONTRACT

MASTER SERVICES RETAINER AGREEMENT
TOWN OF LAKE SANTEETLAH WATER AND WASTEWATER ENGINEERING SUPPORT

THIS AGREEMENT, made as of the xxth day of xxxxx 2017, by and between the Town of Lake Santeetlah ("CLIENT") and Tetra Tech, ("CONSULTANT"), anticipates the execution of various written Work Orders on an attached Appendix "A" and sets forth the terms and conditions pursuant to which CONSULTANT will provide CLIENT with equipment, materials and labor required to assist CLIENT with various monitoring services.

WITNESSETH:

Tetra Tech has contracted with the Town of Lake Santeetlah hereinafter called CLIENT(s); and

WHEREAS:

Tasks and their completion will be associated with and conform to the requirements of each Work Order and each Work Order shall be subject to the terms and conditions of this Agreement. The services to be provided are acknowledged by both CLIENT and CONSULTANT to be intermittent such that applicable periods for performance of each Work Order shall be defined in each such Work Order.

NOW THEREFORE;

In consideration of the mutual undertakings and subject to the terms set forth below and intending to be legally bound, the parties agree as follows:

1. SCOPE OF WORK

The services which CONSULTANT may be requested to perform include, without limitation, the following: Engineering support; Regulatory support; Education and training; Engineering studies, Design engineering; Construction administration services; Preparation of reports; Preparation of funding and permit applications; Attending meetings; or other services at various locations on behalf of CLIENT. The particular services required of CONSULTANT at a given location shall be detailed in CLIENT'S request. The request, together with any manifest or other documents provided by CLIENT to CONSULTANT, shall also describe the actual work involved in the services.

2. TERM

This Agreement shall be in effect for one calendar year from the date set out herein above by CLIENT, and shall continue from year to year thereafter unless terminated. Either party may terminate this Agreement at any time, with or without cause upon thirty (30) days' prior written notice to the other. CLIENT may terminate, at any time, with or without cause and in whole or in part, an agreed upon request for services; provided, however, that if CLIENT terminates without cause, it shall compensate CONSULTANT for all work performed prior to actual receipt

of notice and all of CONSULTANT'S costs and expenses incurred as a result of the termination.

3. REPRESENTATIONS OF THE CONSULTANT

CONSULTANT represents that it has made the necessary commitment, and possesses the necessary professional capabilities, qualifications, capacities, skilled personnel, experience, expertise and financial resources to perform the tasks assigned under Work Orders in an effective, efficient and timely manner in accordance with the terms of the contract.

4. WARRANTY

CONSULTANT agrees to complete tasks associated with Work Orders in a professional and workmanlike manner in accordance with generally accepted practices for the nature of the services provided in furtherance of the Work Orders. Any negligent errors or omissions in the Work Orders performed by CONSULTANT which are reported to CONSULTANT within one (1) year after completion and acceptance of the WORK shall be corrected by CONSULTANT without compensation to the CONSULTANT. CONSULTANT will use its best efforts to assure that WORK performed hereunder will be prosecuted with due diligence and any information required hereunder processed in accordance with generally accepted standards for such WORK performed by the same or a similar business. CONSULTANT further warrants that the data and information delivered hereunder will be of acceptable quality and sufficiently complete for the needs of CLIENT and CLIENT.

This paragraph shall survive termination of this Master Services Retainer Agreement.

5. ACCEPTANCE OR CORRECTION OF DEFECTS

CONSULTANT shall notify CLIENT when a task has been completed. If the WORK conforms to all of the requirements of the Work Order and Master Services Retainer Agreement, CLIENT shall accept the WORK. CLIENT will accept or reject the WORK within thirty (30) days after CONSULTANT'S notification that the WORK is completed. If the WORK or any part thereof does not conform to all of the requirements of this Master Services Retainer Agreement or specific Work Order, CONSULTANT shall, within five (5) working days of receipt of CLIENT's request and without compensation, correct all nonconforming WORK or provide CLIENT a mutually acceptable written plan for correction of the nonconforming WORK. If CONSULTANT fails to make the requested correction, CLIENT, by contract or otherwise, may make such correction and CONSULTANT shall be liable for any costs incurred, provided that CLIENT shall not unreasonably reject WORK that substantially complies with the material requirements of the Master Services Agreement and Work Orders.

6. MEASUREMENT FOR PAYMENT AND PAYMENT FOR WORK

Invoices shall be prepared by CONSULTANT, for each work order separately, and submitted to CLIENT on or about the end of each month covering the amount and value of the WORK satisfactorily performed by CONSULTANT up to the date of such invoice. The WORK performed, if not readily measurable, may be estimated. The estimate of WORK performed may be

made by strict measurement, or by estimate, or partly by one method and partly by another. Estimates shall be based on cumulative total quantities of WORK performed.

Work orders under this agreement may be issued as either fixed price or time and materials, not to exceed without written authorization. A time and materials rate schedule is attached.

CONSULTANT shall submit monthly and the final billing in original to:

Town of Lake Santeetlah
4 Marina Drive
Lake Santeetlah, NC 28771

Review by CLIENT of CONSULTANT'S invoice for the WORK performed will be within ten (10) calendar days of its receipt. Should any corrections be necessary, the invoice will be returned to CONSULTANT for revision.

Within thirty (30) calendar days after receipt of a correct invoice, CLIENT will pay CONSULTANT the approved invoice amount less the aggregate of all payments previously made or credited to CONSULTANT.

Any amounts otherwise payable under this Master Services Retainer Agreement may be withheld, in whole or in part, if CONSULTANT is in default of any material Master Services Retainer Agreement condition. CLIENT will pay such withheld payments if CONSULTANT cures all defaults in the performance of this Master Services Retainer Agreement.

7. INSURANCE

All insurance coverage carried by CONSULTANT shall extend to and protect CLIENT and their co-owners and joint ventures (if any) in the project covered hereby or in connection with which the WORK or operations covered or contemplated by this Master Services Agreement and Work Orders are to be performed to the full amount of such coverage, which coverage shall not be less than the following:

a. Worker's Compensation and Occupational Disease Insurance to comply with the laws of the state in which the WORK is performed and Coverage B, Employer's Liability Insurance with a limit of not less than $1,000,000.

b. Comprehensive General Liability Insurance covering operations performed under the Work Orders and Master Services Retainer Agreement, including coverage of liability assumed in this Agreement, with minimum limits of $1,000,000.00 for bodily injury for each occurrence and $1,000,000.00 for property damage for each occurrence.

c. Automobile Liability Insurance covering all owned, nonowned and hired motor vehicles used in connection with the Work Orders including minimum limits of $1,000,000.00 for bodily injury each person with $3,000,000.00 aggregate total for each occurrence, and $1,000,000.00 for property damage liability each occurrence.

d. All policies of insurance held or obtained by CONSULTANT and each of its SUBCONSULTANTs, whether required by this Master Services Agreement or individual Work Orders or not, shall be sufficiently endorsed to waive any and all claims by the underwriters or insurers against either CLIENT or CLIENT, its and their co-owners and joint ventures (if any) and its and their officers, directors, agents, employees and invitees, for injuries, deaths, losses or damages covered by such policies. Insurance provided in compliance with subparagraphs b, c, d, e, and f above shall include CLIENT and CLIENT as additional named insured

e. CONSULTANT shall furnish CLIENT with certificates of the above insurance coverage upon request.

8. LAWS AND REGULATIONS

CONSULTANT agrees to comply with all federal, state and local laws and regulations with regard to the performance of this Master Services Retainer Agreement and individual Work orders and the employment of CONSULTANT'S employees and to pay all federal, state and local taxes and contributions arising from such employment. CONSULTANT agrees to indemnify and hold CLIENT and CLIENT harmless from and against any and all actions, claims, damages and costs resulting from CONSULTANT'S failure to comply with such laws and regulations to the extent allowable by state law. CONSULTANT agrees to perform the WORK in a safe manner and adhere to all applicable federal and state safety standards and regulations. CONSULTANT hereby acknowledges that it shall inspect the WORK area in order to be fully informed of all existing conditions at the WORK site which may create a safety hazard, including those conditions to which federal, state and local safety and health laws and regulations may be applicable.

9. QUALIFICATIONS AND CONDUCT OF PERSONNEL

Each of CONSULTANT'S employees performing WORK under this Master Services Retainer Agreement or individual Work Orders shall be well qualified for the duties the employee is performing and shall equal or exceed the average efficiency of all employees in each discipline performing under this Master Services Retainer Agreement.

WORK required under this Agreement shall be performed by CONSULTANT and under the sole supervision, management, direction and control of CONSULTANT. CLIENT shall look to CONSULTANT for results only, and shall have no right at any time to direct or supervise CONSULTANT or CONSULTANT'S agents or employees in the performance of the WORK.

10. FORCE MAJEURE

Neither party shall be deemed in default of this Agreement or any Order hereunder to the extent that any delay or failure in the performance of its obligations (other than the payment of money) results, without its fault or negligence, from any cause beyond its reasonable control, such as acts of God, acts of civil or military authority, embargoes, epidemics, war, riots, insurrections, fires,

explosions, earthquakes, floods, adverse weather conditions, strikes, or lock-outs, and changes in laws, statutes, regulations or ordinances, and ministerial actions or omissions by regulatory authorities or their representatives, unless such omission or action shall have been caused or contributed to by the responsible party hereunder.

If any such force majeure condition occurs and continues for a period of more than fourteen (14) days, then the party experiencing such condition shall give immediate written notice to the other party which may then elect to: (1) terminate the affected service requested or any part thereof, (2) suspend the affected service or any part thereof for the duration of the force majeure condition and resume performance once the force majeure condition ceases.

11. INDEMNIFICATION

Each party shall defend, indemnify, protect and hold harmless the other, its co-owners, and its and their officers, directors, agents, employees and invitees, and CLIENT from and against injuries to or illnesses or death of any and all persons and losses of or damages to property caused by, resulting from, to the extent occurring in connection with or arising out of, the negligent performance or nonperformance of this Agreement or operations covered or contemplated hereby, wheresoever or howsoever caused, and from and against all liabilities, claims, actions and judgments herefor, together with costs and expenses (including attorneys' fees) incurred in connection therewith except for such that result from the sole negligence or willful misconduct of either party and/or CLIENT to the extent allowable by law.

12. DOCUMENTATION, RECORDS, AUDITS

CONSULTANT, when requested by CLIENT, shall provide CLIENT with copies of all documents relating to the services performed, including any test results, laboratory analyses, the handling of material hereunder and the related licenses and permits issued by governmental authorities as required for performance of services by CONSULTANT. CONSULTANT shall maintain true and correct records in connection with each service performed and all transactions related thereto and shall retain all such records for twenty-four (24) months after the end of the calendar year in which the last service pursuant to this Agreement was performed. CLIENT may, at its expense, from time to time during the term of this Agreement, and at any time after the date the services were performed up to twelve (12) months after the calendar year in which the last services were performed, request through an independent CPA firm an audit of all records of CONSULTANT. Any error or discrepancy disclosed as the result of such audit shall be promptly corrected and any monies due either party shall be promptly paid by the other.

(a) OWNERSHIP OF DOCUMENTS Drawings, specifications, reports, programs, manuals, or other documents, including all documents on electronic media, prepared under this Agreement shall become the property of CLIENT. These documents will not be used for any purpose other than those authorized under this Agreement without the written authorization of CLIENT.

(b) When Tetra Tech creates any copyrightable material(s), or invents any patentable property, CLIENT shall retain a royalty-free, nonexclusive and irrevocable license to reproduce,

publish, recover or otherwise use the material(s) or property. Any reuse, modification(s) or changes to the material(s) or property is at CLIENT's own risk.

13. CHANGES

CLIENT may, in a written directive, make changes within the general scope of this Master Services Retainer-Agreement or Work Order, to the following: (1) Services to be performed, (2) Deliverables, and (3) Schedule. If any such change requires an increase or decrease in the cost of or in the time required for the performance of any part of the Work Orders, or otherwise affects any other provision of this Master Services Retainer Agreement, an equitable adjustment shall be made in the (1) price, (2) performance schedule, and (3) in such other provisions of this Agreement as may be so affected, and this Agreement shall be changed or modified in writing accordingly. Any claim by CONSULTANT for adjustment under this clause must be asserted within thirty (30) days from the date of receipt by CONSULTANT of written order or within such further time as may at any time be agreed upon in writing by the parties; provided, however, that CLIENT, if it decides that the facts justify such action, may receive and act upon any such claim at any time prior to final payment under this Agreement.

14. INSPECTION

CLIENT, or its authorized representative, has the right, at reasonable times, to inspect, or otherwise evaluate the WORK performed. If any inspection or evaluation is performed by CLIENT, on the premises of CONSULTANT, CONSULTANT shall provide and shall require lower tier CONSULTANTs to provide all reasonable facilities and assistance for the safety and convenience of CLIENT'S representatives in the performance of their duties. All inspections and evaluations shall be performed in such a manner as will not unduly delay the WORK.

15. ASSIGNMENT AND SUBCONTRACTING

This Master Services Agreement and Individual Work Orders shall be binding on the parties hereto, their successors and assigns. CONSULTANT shall notify CLIENT of any work to be subcontracted.

16. TERMINATION

If any or all of the WORK to be performed under this Agreement be abandoned by CONSULTANT; or if the Agreement, Work Orders; or if CONSULTANT becomes insolvent and unable to meet its payroll or other current obligations; or be adjudicated as bankrupt, have an involuntary petition in bankruptcy filed against it, make an assignment for the benefit of creditors, file a petition for an arrangement, composition or compromise with its creditors under any applicable laws; or have a trustee or other officer appointed to take charge of its assets; or if CLIENT reasonably determines that CONSULTANT is refusing or failing to perform a material portion of the WORK required hereunder; or is not meeting schedule requirements resulting from events under CONSULTANT′S control; or that CONSULTANT is performing WORK under the Agreement in bad faith or not in accordance with the terms thereof, and if CONSULTANT fails to remedy or give reasonable assurances that it will be remedied such default within ten

calendar days after receipt by a written notice of default from CLIENT; CLIENT may either withhold only the amounts related to WORK not performed to the satisfaction of CLIENT under the Agreement or terminate CONSULTANT'S right to proceed with all or any portion of the WORK.

Thereupon, CLIENT shall have the right to complete such WORK by whatever method CLIENT may deem expedient including employing another CONSULTANT.

In the event CLIENT shall terminate the prime contract, for any reason, this Master Services Retainer Agreement or Work Order shall terminate upon written notification with effect from the date of the prime contract termination date.

17. NONDISCRIMINATION

CONSULTANT agrees to abide by all federal and state laws, regulations, and policies regarding nondiscrimination in employment.

18. DISPUTES

The validity and the effect of this Agreement (and Work Orders), its interpretation, operations and all questions arising with respect to performance shall be determined by CLIENT. Any unresolved disputes shall be decided by arbitration, in accordance with the rules and procedures of the American Arbitration Association. One arbitrator shall be chosen by each party hereto and a third will be chosen by the other two arbitrators.

19. COMPLIANCE WITH CLIENT RULES AND REGULATIONS

CONSULTANT hereby agrees to comply in all respects with CLIENT rules, regulations, and all other city, county, State and Federal regulatory laws regarding performance of the work hereunder.

20. ENTIRE AGREEMENT

The terms and conditions set forth herein constitute the entire understanding of the parties relating to the provision of services by CONSULTANT to CLIENT and shall be incorporated in all work orders and authorizations unless otherwise so stated therein. This Agreement may be amended only by a written instrument signed by both parties.

TOWN OF LAKE SANTEETLAH	**TETRA TECH**
By _____	By _____
Title _____	Title _____
Date _____	Date _____

TOWN OF LAKE SANTEETLAH WATER AND WASTEWATER ENGINEERING SUPPORT

WORK ORDER NO. _____

WORK ORDER TITLE _____

Date of Authorization: _____

Start Date: _____

Completion Date: _____

Contract Type and Amount: _____

Statement of Work:

Town of Lake Santeetlah
(CLIENT)

Signature: _____

Name: _____

Title: _____

Date: _____

Tetra Tech
(SUBCONTRACTOR)

Signature: _____

Name: _____

Title: _____

Date: _____

APPENDIX G. CASE STUDIES FOR SIMILAR COMMUNITIES

Case Studies for Similar Communities

Water Environment Research Foundation

When to Consider Distributed Systems in an Urban and Suburban Context: www.werf.org/distributedwater. The following summaries are attached:

- Bethel Heights, Arkansas
- Piperton, Tennessee
- Warren, Vermont
- Wickford Village, Rhode Island
- Independent Communities Maintain Character, Independence with Distributed Systems (brochure)

Responsible Management Entities (RME) Guidance Fact Sheets: http://www.werf.org/i/c/KnowledgeAreas/DecentralizedSystems/RMEsite/RMEs_2.aspx

Business Attributes of Successful Responsible Management Entities: http://www.ndwrcdp.org/research_project_04-DEC-4SG.asp

University of North Carolina - Environmental Finance Center (UNC-EFC)

Government Financing for On-Site Wastewater Treatment Facilities in North Carolina: http://www.efc.sog.unc.edu/reslib/item/government-financing-site-wastewater-treatment-facilities-north-carolina

The following UNC-EFC case study summaries are attached:

- **Nags Head Township Septic Health Initiative**. Although in a very different geographical area from Lake Santeetlah, this program includes several elements that Lake Santeetlah is considering. It is also an area with many rental and seasonally used properties.
- **Unifour Septic Tank Repair Program**.
- **Buncombe County Straight Pipe Elimination and Septic Repair Program**.
- Summary table of case studies

US Environmental Protection Agency

Case Studies and Demonstration Projects: https://www.epa.gov/septic/septic-systems-case-studies-and-demonstration-projects (entire document is attached - see the tables below for quick characteristics of each case study in the document)

Community case study	Inadequate, poor, or no treatment	Poor soils, slopes, site conditions	Population growth in the project area	Risks to the environment/ public health	Real/potential surface water contamination	Real/potential groundwater contamination
Fairfax County	●		●		●	●
Jamestown	●	●	●	●	●	●
Albemarle Region		●	●	●	●	●
Keuka Lake	●				●	●
Lake Panorama		●		●		
Hamilton County	●				●	●
Monroe County	●	●	●	●	●	●
The Sea Ranch	●				●	
Auburn Trails	●	●				
Otter Tail Lake	●			●	●	
Peña Blanca	●				●	●
Blacksburg			●			
Phelps County	●					
Shannon City	●			●	●	

Community case study	Inspections	Maintenance reminders	Database	Reporting/ recordkeeping	Maintenance contracts	Licensed svc. providers	Permitting	Performance monitoring	Management entity	Water quality monitoring
Fairfax County	●	●	●	●	●					
Jamestown	●	●	●	●	●	●				
Albemarle Region	●	●	●	●	●	●	●	●	●	●
Keuka Lake	●	●	●	●	●	●	●	●	●	
Lake Panorama	●	●	●	●	●	●				
Hamilton County	●	●	●	●	●	●	●			●
Monroe County	●	●	●	●	●	●	●	●		●
The Sea Ranch	●	●	●	●	●		●	●	●	●
Auburn Trails	●	●	●	●		●		●	●	●
Otter Tail Lake	●	●	●	●	●	●				
Peña Blanca		●	●	●	●	●	●		●	
Blacksburg	●	●	●	●	●	●	●	●	●	●
Phelps County	●	●	●	●	●	●	●		●	●
Shannon City	●	●	●	●	●	●	●	●	●	●