New River Valley Regional Wastewater Study
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I. EXECUTIVE SUMMARY

Scope

The improvement of water quality in the streams and groundwaters of the New River Valley via the development of public wastewater collection, treatment and disposal infrastructure is one of the most challenging issues facing local governments within the New River Valley Planning District (NRVPD). Many miles of rivers and streams in the NRVPD have water quality violations due to bacteriological impairments (fecal coliform and *Escherichia coli*). The collection, treatment, and disposal of wastewater are one way to address a portion of the human cause of these bacteriological impairments.

Localities in the New River Valley face water quality issues in areas within their jurisdiction because many areas have clusters of housing that currently have no acceptable means of wastewater treatment. In fact, many households are currently discharging into inadequate septic systems, affecting environmental quality as well as public health.

The presence of approved wastewater collection and treatment systems is essential for the enhancement of public health, protection of the environment, successful economic development initiatives, and an increase in new housing production. Some of the most common problems resulting from the lack of this vital infrastructure include, but are not limited to, the following:

- Numerous environmental and public health problems arising from the use of failed, overstressed, and/or poorly maintained on-site septic tank/drain field systems;
- An inability to accommodate new housing production due to shallow depths of soil to bedrock and/or high groundwater conditions on potential building lots thereby preventing the approval of septic tank/drainfield systems;
- The lack of public wastewater collection and treatment systems limits the ability of planners and local officials to market portions of the NRVPD to potential industrial prospects. Economic development activities are underway throughout the New River Valley in an effort to attract new industries, create jobs, and diversify the local economy. In many cases, the ability to market the region to a particular industrial prospect is directly linked to the availability of public wastewater collection and treatment services. Potential industries expect public wastewater collection and treatment to be available. Moreover, the prospect of developing mass septic tank/drainfield systems to accommodate industrial users is problematic due to costs and the resulting land area requirements.

Purpose

With generous funding provided by the Southern Rivers Watershed Enhancement Program, the New River Valley Regional Wastewater Study is intended to address water quality improvement through the development of sewage collection and treatment alternatives. The Study's goals include identifying the need for sewer service in the region, identifying and prioritizing projects, finding and identifying funding sources for these projects, and eliminating the health hazards and environmental problems associated with inadequate septic systems and straight pipe discharges to streams. The study also identifies projects that due to their remote location, topographic situations, small size or soil conditions, will benefit from non-traditional de-centralized wastewater systems (DWS). It is envisioned that the Study will serve as a road map for future implementation of sanitary sewer collection, treatment and disposal projects in the New River Valley.

Methods

During the course of this Study, the Design Team examined over 134 projects. These projects were analyzed and prioritized based on the degree of health hazard, elimination of water quality problems, the number of customers served, construction cost per connection, facility availability, as well as residential and industrial growth potential.

Conclusions

The project rankings led to a recommendation to pursue 20 centralized projects and 6 de-centralized projects.

The 20 centralized projects will serve more than 3,135 connections at a cost of $67,404,744. The 6 de-centralized projects will serve 424 connections at a cost of $5,562,970.

Recommendations

There is very little grant funding available for sanitary sewer projects, despite the urgent need that has been identified in this Study. It is imperative that additional grant funding be established to help solve this critical environmental and public health threat, such that the New River Valley can benefit from a cleaner, healthier and more economically viable future. DHCD and the Governor should recognize this study as an example of the water quality issues and solutions in the Southern Rivers region of the state and recommend that the General Assembly fund the Southern Rivers Program to provide matching and leverage funding to undertake the primary priority projects.

Table 1 - Cost Summary Centralized Systems (Primary Priority)

Project ID	County	Project Name		Project Cost	Estimated Number of Equivalent Connections
F-4	Floyd	EPPERLY MILL ROAD	$	1,223,066	35
G-1	Giles	MARVILLE	$	2,673,112	108
G-2	Giles	ROUTE 100-INGRAM VILLAGE/ONEY/MUTTER	$	6,495,423	297
M-11	Montgomery	PRICES FORK	$	3,015,480	125
M-12	Montgomery	YELLOW SULPHER ROAD TO TOWN OF CHRISTIANSBURG	$	1,755,130	42
M-13	Montgomery	PEPPERS FERRY RD (Rt. 114) - CHRISTIANSBURG WEST TO VICKER SWITCH RD.	$	5,267,990	118
M-15	Montgomery	PEPPERS FERRY RD (Rt. 114) - COAL HOLLOW RD TO McCORMICK RD.	$	573,820	26
M-16	Montgomery	NW RT 460 BY-PASS - ELLET RD.	$	3,094,650	115
M-20	Montgomery	RINER PHASE 1 FAIRVIEW CHURCH RD., RINER RD NORTH OF UNION VALLEY RD.	$	3,676,790	149
M-23	Montgomery	SHAWSVILLE - BUILDOUT EXISTING SERVICE AREA	$	2,271,230	172
M-24	Montgomery	IRONTO / I81 EXIT 128 - BUILDOUT EXISTING SERVICE AREA	$	2,472,730	79
P-1	Pulaski	THORNE SPRING BRANCH PHASE 1	$	4,130,568	212
P-4	Pulaski	ALUM SPRING ROAD PHASE 1	$	3,565,770	219
P-9	Pulaski	PONDLICK BRANCH / MOUNT OLIVET PHASE 1	$	3,794,440	126
P-12	Pulaski	ROUTE 100 - DUBLIN / COMMERCE PARK	$	5,870,358	208
P-13	Pulaski	BACK CREEK AREA	$	4,219,852	120
P-14	Pulaski	EAST DUBLIN / STONERIDGE DRIVE	$	5,246,722	427
P-16	Pulaski	BELSPRING / GATE 10 ROAD	$	4,067,791	133
P-21	Pulaski	NORTH CLAYTOR LAKE	$	4,343,684	257
P-33	Pulaski	SOUTH DUBLIN	$	2,238,002	167
		Total	**$**	**69,996,608**	**3,135**

Table 2 - Cost Summary Decentralized Systems (Primary Priority)

Project ID	County	Project Name		Project Cost	Estimated Number of Equivalent Connections
DC-6	Giles	RIPPLEMEAD	$	1,821,400	140
DC-7	Giles	RAM WAYSIDE	$	618,870	50
DC-8	Giles	SNIDERTOWN	$	407,400	24
DC-10	Giles	STAFFORDSVILLE	$	597,800	40
DC-13	Montgomery	McCOY	$	1,347,500	100
DC-18	Pulaski	PAINTERS WOODS	$	770,000	70
		Total	**$**	**5,562,970**	**424**

II. INTRODUCTION

Purpose

In 2007 the Virginia General Assembly allocated funds to improve water quality in the streams and groundwaters of the "Southern Rivers" region of Virginia. The Department of Housing and Community Development was allocated $17,000,000 for the Southern Rivers Watershed Enhancement Program (SRWEP) to improve water quality in non-Chesapeake Bay watersheds. Generally, this program was designed to target the construction, expansion or enhancement of publicly-owned wastewater treatment systems to provide measurable community development benefits.

Three program priorities were identified: 1) to improve water quality and enhance community development by eliminating the direct discharge of untreated household wastewater into streams or groundwater, 2) to improve water quality and enhance community development by eliminating deficient household wastewater systems that threaten to pollute streams or groundwater, and 3) the construction, expansion or enhancement of publicly-owned and managed wastewater treatment systems that enhance community development and provide significant, documentable improvements in stream and groundwater water quality.

Cities and counties in the watersheds of Virginia that do not drain into the Chesapeake Bay were eligible for funding through the SRWEP. Three grant programs were developed for eligible localities: planning grants, managed on-site construction grants, and wastewater treatment system construction grants.

To address some of the issues of water quality in the New River Valley region, focusing on improving wastewater collection and treatment, the New River Valley Planning District Commission applied for a SRWEP planning grant in early 2008. The localities included in this application are: Floyd, Giles, Montgomery, and Pulaski counties, and the Towns of Floyd, Pembroke, Pearisburg, Narrows, Rich Creek, Glen Lyn, Blacksburg, Christiansburg, Dublin, and Pulaski. Figure 1 depicts a location map for the region.

The study resulting from the SRWEP planning grant is the New River Valley Regional Wastewater Study (NRVRWS). The intent of this NRVRWS is to address water quality improvement through the development of sewage collection and treatment alternatives, including traditional centralized systems and de-centralized wastewater systems (DWS). The study identifies specific projects, prioritize them and provides project costs. This study serves as a road map for sewer projects in the New River Valley over the next twenty years.

This study included the cooperative development of an overall project list to be evaluated. The development of the project list was facilitated by the Advisory Management Team (AMT), consisting of members representing the PDC, the local health districts, funding agencies, local watershed groups, sewer providers, local government representatives, concerned citizens and the Design Team. The AMT met monthly throughout the project to advise the Design Team on various aspects of the project including project selection/evaluation, study contents, criteria for the ranking matrix and the timetable of activities.

Scope

Thompson & Litton, in association with Maxim Engineering was commissioned to prepare this study with emphasis on projects that illustrate the urgent need for sewer facilities in the region, such that funding can be secured for projects that will have a maximum positive impact on the health and environmental quality within the New River Valley Planning District. As a planning document, the study only evaluates each project in sufficient detail to assemble cost estimates. The design team made use of the available planning documents for each county as well as River Basin Studies, preliminary engineering reports and comprehensive master plans.

Uniform cost estimating methodology was developed to prepare estimates for the projects studied herein. Recognizing that construction costs may vary to some degree within the study area, uniform unit pricing has been used to justify cost estimates. Unit pricing was developed by averaging recent bid data from the study region.

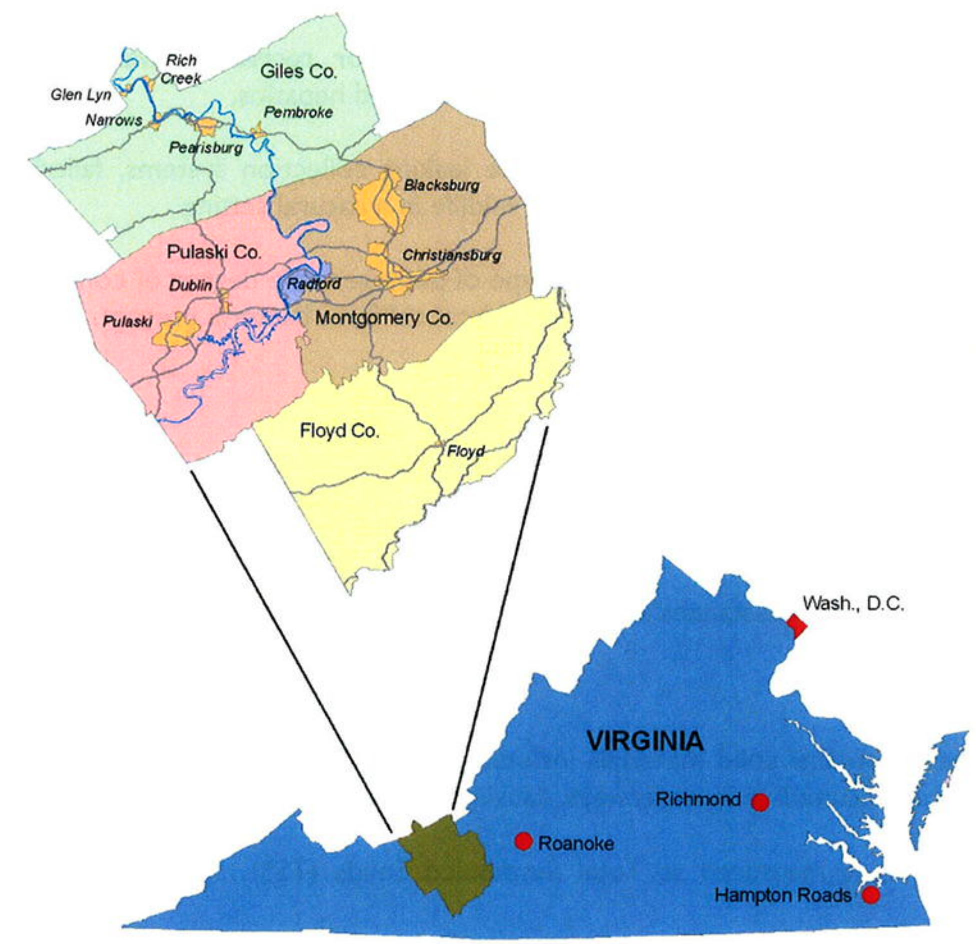

Figure 1- Location Map

III. WASTEWATER PRIMER

Water leaving a home ("wastewater") has much different characteristics than water entering a home ("potable water"). This section explains, in simple terms, the definition of wastewater and it's various components.

Wastewater contains the following components...microorganisms, toxic substances, solids, organic material, and nutrients...each of which must be addressed by a treatment system prior to discharge into the environment. Each component can be more fully described as follows:

Microorganisms

Microorganisms in wastewater include bacteria, viruses and protozoans. Some of these microorganisms are helpful in breaking down the contaminants in wastewater, while others can cause disease. Disease causing microorganisms are called pathogens.

People who come in contact with contaminated drinking or recreation water risk infection and development of diseases such as cholera, typhoid, dysentery and hepatitis.

The main sources of waterborne pathogens include leaking collection systems, failed septic systems, failed treatment, feedlot runoff, and fecal wastes of wildlife in a natural setting.

As it is not practical to test wastewater for each type of pathogen, the degree of contamination of water by human and animal wastes is gauged by the level of fecal coliform bacteria present.

Toxic Substances

Toxic substances found in wastewater can include pesticides, herbicides, paints, solvents and heavy metals. These substances are often disposed of unknowingly by homeowners who flush them into the wastewater collection system.

Many of these common toxic substances are known to cause cancer or other human health problems.

Solids

Wastewater typically contains solid materials including sand particles, grit, clay, wood, fecal waste and food. These solids can accumulate in waterways, causing fouling and damage to higher order organisms.

The presence of solids is measured as Total Suspended Solids (TSS)...these are solids that will not readily settle out.

Organic Material

Organic materials are derived from plants and animals, and come mainly from feces and kitchen wastes. This material is a source of food for the bacteria in wastewater. As organic material is broken down (decomposes), oxygen in the water is consumed, making less available for aquatic life. This can result in fish kills or otherwise impair aquatic life.

Concentrations of organic matter are measured as Biochemical Oxygen Demand (BOD).

Nutrients

Nutrients in wastewater include nitrogen and phosphorous, both of which can have a negative impact on receiving waters.

Phosphorous is the limiting nutrient in aquatic ecosystems. The addition of phosphorous results in excessive algae and plant growth. As these plants die, they deplete dissolved oxygen and harm the aquatic community.

Nitrogen comes from domestic, industrial and agricultural sources and undergoes a cyclic process where various forms of nitrogen, including ammonia, are produced. Ammonia is extremely toxic to aquatic organisms. Nitrate, another form of nitrogen can cause methemoglobinemia (when found in drinking water sources), a serious health effect in infants and pregnant or lactating women.

IV. WATER QUALITY AND GEOLOGY

The New River Basin covers over 3,000 square miles in Virginia, almost 8% of the Commonwealth's total land area. The New River traverses approximately 87 miles in Virginia, running through three of the four counties in the Planning District on its way to West Virginia. Almost 400 miles of the New River and its tributaries in Virginia are considered impaired due to high levels of fecal coliform or E. coli, possibly due to failing or deficient wastewater systems. More than 1,400 square miles of the New River watershed make up the New River Valley Planning District and are the focus of this study.

Impairment listing of surface waters in the New River Valley result from a violation of one of several possible criteria, including but not limited to benthic macroinvertebrates, bacterial, temperature, or dissolved oxygen levels. The impaired classification of a body of water is determined by monitoring station testing as indicated by the Clean Water Act. Once a waterbody has been classified as impaired, a Total Maximum Daily Load (TMDL) Development is required. TMDL Developments establish a maximum pollutant load capacity and/or a benthic health standard of an impaired body of water, establish the probable stressor, or stressors, causing the impairment, and determine plausible implementation plan(s) that will result in the meeting of existing water quality standards. The document, *Guidance for Water Quality-Based Decisions: The TMDL Process* (United States Environmental Protection Agency, 1999), states:

> *According to Section 303(d) of the Clean Water Act and EPA water quality planning and management regulations, States are required to identify waters that do not meet or are not expected to meet water quality standards even after technology-based or other required controls are in place. The waterbodies are considered water quality-limited and require TMDLs.*
>
> *...A TMDL is a tool for implementing State water quality standards, and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the*

allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis for States to establish water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards.

TMDL Developments have been prepared for a portion of Back Creek in Pulaski County, Crab Creek in Montgomery County, the Dan River and its tributaries in Floyd County, Dodd Creek in Floyd County, Mill Creek in Montgomery County, Peak Creek in Pulaski County, Stroubles Creek in Montgomery County, and Wilson Creek in Montgomery and Floyd Counties. Of the above listed TMDL Developments, all but TMDL for Stroubles Creek was in response to a bacteriological impairment due to multiple monitoring station violations of the fecal coliform standard.

TMDL Developments are followed by TMDL Implementation Plans (IPs) which establish a staged implementation strategy that will result in the attainment of existing water quality standards. An IP identifies specific measures that must be taken to reduce pollution levels in the identified waterbody and a schedule of events to attain this required reduction in a staged manner. The schedule includes an impact and cost analysis of each step as well as monitoring to determine successful implementation of each step. Also included are suggestions to establish user education and desired involvement in the IP.

TMDL IPs have been established for Back Creek, Dodd Creek, Mill Creek and Stroubles Creek. Back, Dodd, and Mill Creeks' IPs include required bacteriological reductions in response to the violations of the fecal coliform standard. TMDL Reports, Implementation Plans and Implementation progress updates are available on DEQ's TMDL website at http://www.deq.virginia.gov/tmdl. A map illustrating the impaired streams in the New River Valley is presented in Figure 2. Table 3 provides a listing of these streams.

As many of the region's residents identify water quality as a top priority, there is a need in the New River Valley Planning District to examine the quality of water in the region's surface water, including streams, rivers, lakes, and ponds. The New River, along with Claytor Lake, supplies a large percentage of the water to residents of the region, including Pulaski County PSA, the Blacksburg/Christiansburg/VPI Water Authority and the City of Radford. Additionally, Montgomery County purchases some of the water it distributes to its residents from New River sources.

The planning district consists of Floyd, Giles, Montgomery and Pulaski Counties. Floyd County is located in the Blue Ridge Province, which is a relatively narrow zone of high mountains. The rocks underlying the area are granite, gneiss, and marble. Steep terrain and a thin soil covering result in rapid surface runoff and low ground water recharge. Water quality is generally good, and the pollution potential of ground water is low in this province. However, it should be noted, many residents in some of the more sparsely populated areas of Floyd, Giles, Pulaski and Montgomery counties still utilize springs as drinking water sources, which are highly susceptible to surface water influence and contamination.

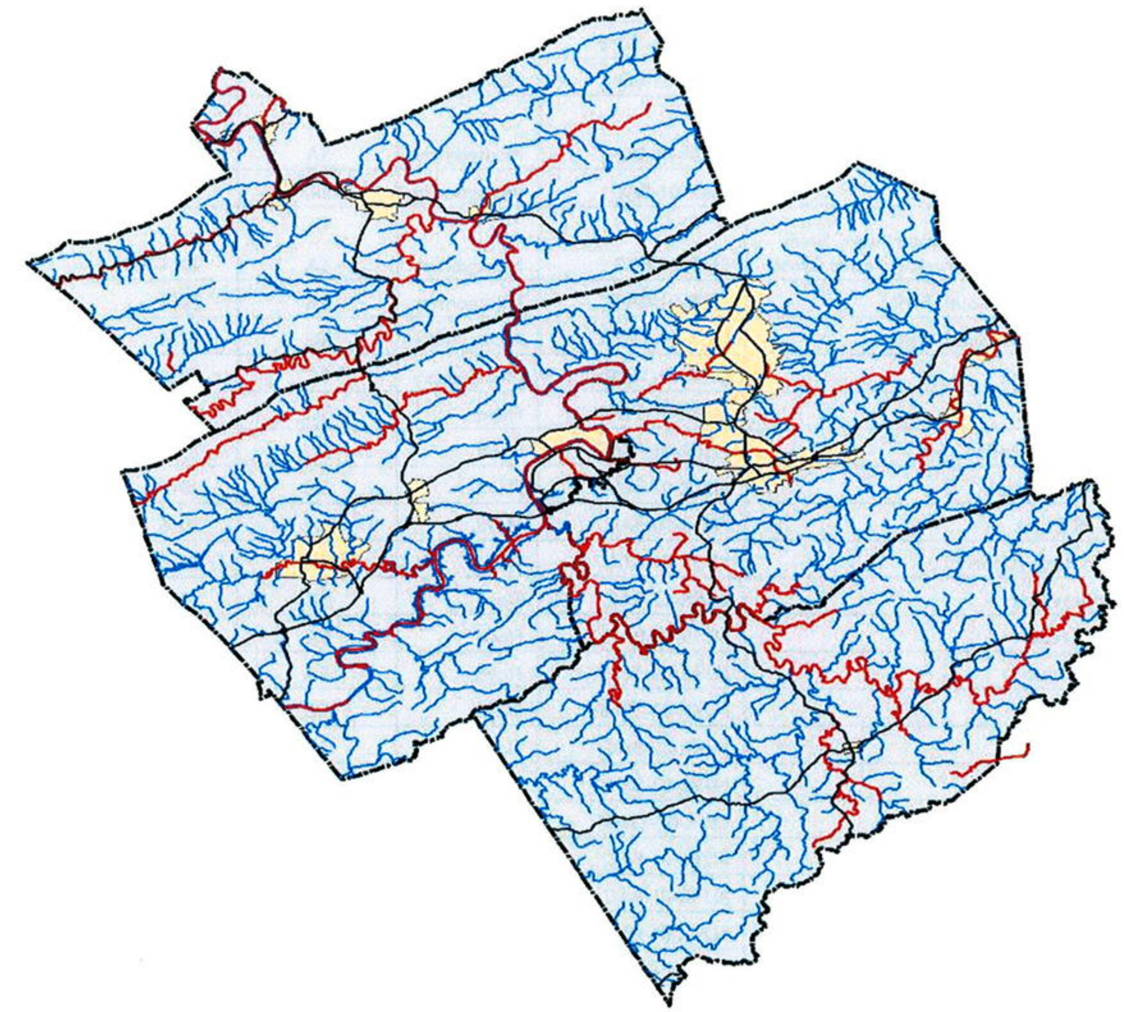

Figure 2 – Impaired Streams in New River Valley

Water Name	Cause group code	Location	Cause Category	TMDL Development Date
Meadow Creek	N21R-02-BAC	Montgomery	5A	2014
Stroubles Creek	N22R-02-BAC	Montgomery	5A	2014
Plum Creek	N18R-03-BAC	Montgomery	5A	2016
Brush Creek	N21R-05-BAC	Montgomery	5A	2016
Toms Creek	N22R-04-TEMP	Montgomery	5C	2020
Slate Branch	N22R-05-BEN	Montgomery	5A	2020
Unnamed Tributaries XEJ & XEH to Slate Branch	N22R-06-BEN	Montgomery	5A	2020
Roanoke River, North Fork	L02R-01-BAC	Montgomery	5A	2014
Roanoke River, Blackwater River, Smith Mtn. Lake, Tinker Creek, & Peters Creek	L12R-01-PCB	Montgomery	5A	2014-2016
Roanoke River, South Fork	L01R-01-BAC	Montgomery	5A	2016
Roanoke River, South Fork	L01R-01-TEMP	Montgomery	5C	2016
Bottom Creek	L01R-02-TEMP	Montgomery	5C	2020
Little River	N19R-01-TEMP	Floyd	5C	2014
West Fork Dodd Creek	N20R-01-TEMP	Floyd	5C	2014
Big Indian Creek	N21R-07-TEMP	Floyd	5C	2016
Laurel Creek	N21R-06-BAC	Floyd	5A	2016
Little River (Upper)	N19R-01-BAC	Floyd	5A	2016/2018
Meadow Run	N19R-02-BAC	Floyd	5A	2018
Pine Creek	N19R-03-BAC	Floyd	5A	2018
Pine Creek	N19R-03-TEMP	Floyd	5C	2020
Dodd Creek	N20R-02-TEMP	Floyd	5C	2020
Greasy Creek	N14R-02-BAC	Floyd	5A	2020
Meadow Run	N19R-02-BEN	Floyd	5A	2020
Rennet Bag Creek	L51R-01-TEMP	Floyd	5C	2014
Kimberling Creek	N26R-01-BAC	Giles	5A	2014
Rich Creek	N34R-01-BAC	Giles	5A	2014
New River	N24R-01-DDE	Giles	5A	2016
New River	N24R-01-DDT	Giles	5A	2016
Little Walker Creek	N27R-01-BAC	Giles	5A	2016
Adair Run	N35R-01-BAC	Giles	5A	2016
Wolf Creek	N32R-01-BAC	Giles	5A	2016/2018
New River	N24R-01-HEPOXID	Giles	5A	2018
Walker Creek	N25R-01-BAC	Giles	5A	2018
New River	N08R-01-BAC	Pulaski	5A	2016/2018

Table 3 – List of Impaired Streams in New River Valley

Water Name	Cause group code	Location	Cause Category	TMDL Development Date
Big Reed Island Creek	N14R-03-BAC	Pulaski	5A	2020
Little Reed Island Creek	N15R-01-BAC	Pulaski	5A	2020
Little Reed Island Creek	N15R-01-TEMP	Pulaski	5A	2020
Connelly's Run	N18R-02-BAC	Radford	5A	2016
New River, Claytor Lake, Peak Creek, & Reed Creek	N29R-01-PCB	Giles, Montgomery, Pulaski	5A	2014/2018
Little River	N21R-01-BEN	Floyd, Montgomery	5A	2020
Little River (Lower)	N21R-01-BAC	Floyd, Pulaski, Montgomery	5A	2014/2016
Roanoke River	L03R-01-TEMP	Montgomery	4C	
Claytor Lake	N16L-01-DO	Pulaski	4C	
Claytor Lake - Peak Creek	N16L-02-DO	Pulaski	4C	
Dodd Creek & West Fork Dodd Creek	N20R-01-BAC	Floyd	4A	2002
Mill Creek, Poplar Branch, Mill Creek UT (XDE & XDF)	N21R-03-BAC	Montgomery	4A	2002
Crab Creek	N18R-01-BAC	Montgomery	4A	2004
Crab Creek	N18R-01-BEN	Montgomery	4A	2004
Stroubles Creek	N22R-02-BAC	Montgomery	4A	2004
Wilson Creek & Wilson Creek, UT	L02R-02-BAC	Montgomery	4A	2006
Peak Creek	N17R-01-BAC	Pulaski	4A	2004
Peak Creek	N17R-01-BEN	Pulaski	4A	2004
Peak Creek	N17R-01-CU	Pulaski	4A	2004
Peak Creek	N17R-01-ZN	Pulaski	4A	2004
Back Creek	N22R-03-BAC	Pulaski	4A	2004
Back Creek	N22R-03-BEN	Pulaski	4A	2004

Table 3 (Contd.) – List of Impaired Streams in New River Valley

Giles, Montgomery and Pulaski Counties are located in the Valley and Ridge Province. The ridges and upland areas of these counties are generally covered by forests and are often underlain by sandstone and shale. The ground water moves slowly through these soils, and the pollution potential of ground water and surface water is low. It is a different story in the valleys, which are used for agricultural and residential lands. The valleys are underlain by shales and carbonate rocks, such as limestone and dolomite. These rocks are relatively soft and easily dissolved, and thus form karst. Characteristic features of karst include caves, sinking streams that disappear into holes in the bedrock, and sinkholes formed by the collapse of subsurface voids. The Department of Conservation and Recreation reports that karst underlies 50% or more of the New River watershed and an even larger proportion of the valley floors where population and development are concentrated. Ground water flows quickly through karst topography, and therefore receives very little filtration. Also, surface water and ground water sometimes intermingle, and this makes for an environment that is easily contaminated. This intermingling may explain why Walker Creek, which originates in Bland County and flows a long distance through sparsely populated areas of Giles County, is bacterially impaired throughout its entire length.

The College of Environmental Engineering at Virginia Tech estimates that one-half of all septic systems in Virginia are not functioning correctly. Surface water contamination can occur when the soil becomes clogged with waste particles causing the untreated wastewater in the drain field to make its way to the surface and eventually be washed into the stream during precipitation events. A more significant failure is when these pollutants move too quickly through the soil and pollute the groundwater. This type of failure occurs in soils with high permeability or in karst topography.

There are other factors which contribute to contamination: 1). The design life of septic systems averages thirty years. There are many systems in the New River watershed installed before 1980, which have exceeded their design life and may no longer be operating properly. 2). The density of septic systems in an area may also contribute to contamination. The Environmental Protection Agency has determined that as few as 40 systems per square mile (one system per 16 acres) can cause ground water contamination.

V. HEALTH RISK

By using water, impurities are added that pollute it. Common pollutants include human wastes, nutrients and household chemicals. Polluted water results in public health problems and damages aquatic ecosystems.

It is estimated that, in the United States, 10% of on-site septic systems have stopped working and that some communities report failure rates as high as 70%. In Virginia, one of the leading causes of impairment in our rivers and streams is violation of bacteria standards. Failing septic tanks are reported as a significant contributing source for these water quality problems. The federal Centers For Disease Control and Prevention estimates that 73,000 Americans are infected and 61 die each year from a virulent form of coliform bacteria.

The effects of this pollution can be far reaching, resulting in the degradation of our natural resources, increased costs for treating drinking water, illness and even death.

Disease causing organisms, also called pathogens, make water unsafe for drinking, recreation and most other uses. People who come in contact with contaminated water, whether by drinking or recreation, risk infection and development of diseases such as cholera, typhoid, dysentery, viral hepatitis A, salmonellosis, shigellosis, sporadic viral gastroenteritis, epidemic viral gastroenteritis, and amebiasis. Sources of waterborne pathogens (bacteria, viruses and parasites) include failed septic systems, straight pipes, leaking collection systems, failed treatment and feedlot runoff. These diseases may also be contracted through contact with any number of creatures that have been exposed to untreated waste, including dogs, cats, rats, flies, cockroaches, fleas and a host of others.

Other health risks from coming in contact with contaminated water include:

- Contact with toxins (pesticides, herbicides, paints, solvents, heavy metals...) Many of these substances are known to cause cancer and other serious human health problems.

- Contact with nitrate (from nitrogen) in water. High nitrate levels in groundwater can result from inadequately treated wastewater and can cause methemoglobinemia, a serious health problem for infants and pregnant or lactating women.

- Contact with synthetic cleaning products or other chemicals used around the house can be toxic to humans, pets and wildlife. These products can reach the ground surface or end up in the water.

- Flies and mosquitoes that are attracted to and breed in wet areas where wastewater reaches the surface can also spread disease.

Inadequate treatment of wastewater can also allow excess nutrients to reach streams, lakes and ponds, promoting algae or weed growth. Algal blooms and abundant weeds not only make the water body unpleasant for recreation (swimming, boating), but they also affect the water quality for fish and wildlife habitat. As plants die, settle to the bottom, and decompose, they use up oxygen that fish need to survive.

VI. WASTEWATER SYSTEMS

There are three basis types of wastewater systems available - conventional onsite systems, central systems, and decentralized systems. Each type is explained below.

CONVENTIONAL ONSITE SYSTEMS

The individual onsite septic system, consisting of a septic tank and drain field, has been the primary treatment and disposal system of domestic wastewater in rural areas in the New River Valley for many years. These systems, when properly situated, designed and maintained work well, but have a average life of thirty (30) years due to the soils becoming clogged with particle created in the purification process. When the soil becomes clogged, the inadequately-treated wastewater in the drain field comes to the surface and may be washed into the stream during precipitation events. This type of system failure is easily detected, and can be corrected although often at a high cost to the homeowner. The second type of failure is caused when the wastewater is washed through the soils so quickly that the bacteria is not killed. This failure type can occur either where the soil is highly permeable or where subsurface fracturing exists (karst topography). This type failure occurs underground and is difficult to detect. Ground water contamination can result if this type of septic system failure goes undetected, especially in concentrated communities. Ground water contamination is very expensive to clean up: therefore, prevention is essential to protecting this valuable natural resource. Regulating conventional onsite systems has been the responsibility of the Virginia Department of Health (VDH) for many years.

CENTRALIZED WASTEWATER SYSTEMS

Centralized wastewater systems are the most common type of publicly owned wastewater systems and contain collection lines and a centralized treatment facility. They are used to collect and treat large volumes of wastewater. The collection system typically requires large diameter pipes, deep excavation, and frequent manhole access. At the treatment facility, the wastewater is treated to standards required for discharge to a surface water body. The large amounts of bio-solids (sludge) generated are either land-applied, placed on a surface disposal site or incinerated.

DECENTRALIZED WASTEWATER SYSTEMS

Decentralized wastewater systems are collection, treatment and disposal systems designed to serve small communities that cannot be economically served by a centralized system. These systems are fairly new and provide permanent infrastructure when adequately managed. In order to protect their investments, developers and funding agencies usually require that these systems be owned and operated by a public utility.

Collection Systems

In most cases, sewage flows through the building sewer to an interceptor (septic) tank. The interceptor tank is the first and a very key component in decentralized wastewater systems. The interceptor tank is a watertight vessel that provides a quiet environment where the solids can settle. The solids, called septage, are subsequently disposed of at a central treatment facility or stabilized and land applied at an approved site. Tanks are equipped with risers to the surface for easy access and inspection, and generally require pumping about once every ten years.

The filtered effluent from the interceptor tank is conveyed to the treatment system through a common collection line. Thus, these collection lines are called effluent sewers. Effluent sewers have several cost advantages over centralized wastewater systems: (1) they are smaller in diameter, (2) they do not need to be installed as deep or on grade, and (3) they do not require manholes for access. There are two types of effluent sewers, gravity and pressure. Gravity systems are known as STEG, meaning septic tank effluent gravity, and pressure systems are known as STEP, for septic tank effluent pumping. Following collection, there are a number of treatment and disposal system alternatives that can be used to treat wastewater.

Treatment Systems

Alternative treatment systems include small aerobic treatment plants and bio-filtration systems using a variety of materials, such as sand, peat, synthetic textile, or open cell foam, as the filter medium.

Disposal Systems

When the treated effluent is dispersed into the soil for further treatment, it is called an "onsite" system, and is governed by the Virginia Department of Health (VDH). Permitting and sampling requirements for onsite systems are minimal, so it is a low-cost method of disposal. Dispersing treated effluent into the soil helps recharge the water table. Also, because the area serviced by a decentralized system is relatively small, the recharge applies to the area where the water was used. This is particularly important during times of drought.

There are several soil dispersal methods available including conventional gravel trenches, non-gravel trenches utilizing infiltration chambers or synthetic aggregate, low-pressure distribution, drip dispersal, and spray irrigation. The soil texture and depth to a restriction determine which dispersal method will work best for a project site. Designing an onsite system requires a detailed soil and site evaluation to be made at each site. This evaluation is often conducted jointly by a soil scientist and an engineer. Conducting the soil and site evaluation was not done for the projects listed in this study, since the scope of the study was only to identify where there was an urgent need for sewer facilities.

There is a current trend toward water conservation and re-use. Because of their small size, there are many possibilities for reusing the treated effluent from decentralized wastewater systems. These re-uses include plant irrigation in greenhouses, nurseries, or parks; irrigation of fairways and greens at golf courses; steam generating facilities; or other uses, such as car washes. The cost of preparing the effluent for re-use would be offset by a reduction in the need for clean, drinking water. Reuse systems are regulated by the Virginia Department of Environmental Quality (DEQ).

Finally, there are project areas where neither onsite dispersal nor reuse options exist. In such instances, a permit can be obtained from DEQ to allow the treated effluent to be discharged to surface waters, or to a dry ditch. The treated effluent must be disinfected before discharging it. Disinfection methods include chlorination and de-chlorination, ultraviolet (UV) light, and ozone. Permitting and sampling costs are always higher for discharging systems; but, more importantly, there is a concern right now that more stringent permit requirements for total nitrogen (TN) and total phosphorus (TP) will soon be placed at all wastewater treatment plants. Should this occur, even though the decentralized plants are small, the operating costs would increase significantly.

System Size

Decentralized systems can be designed for any size community. In this wastewater study, a cluster of fifteen homes was the minimum size community to be considered for a decentralized wastewater system.

Benefits

The primary benefit of decentralized wastewater systems is an improvement to the public health and environment in any area where they are used. These systems are not in competition with the central wastewater facilities, but can be used by a governing body (town or county) to complement "big pipe" systems. Decentralized systems can be installed in any community where conventional onsite systems are not an option. These systems can also be installed quickly in environmentally sensitive areas, without having to wait for several miles of a centralized system to be constructed, which may consist of several projects, before central sewer service is available to that community.

When decentralized systems are owned by a responsible management entity (RME), it becomes part of our nation's permanent infrastructure. The U.S. Environmental Protection Agency (EPA) requires that all new systems be owned and maintained by a public body, or other responsible management entity that annually demonstrates that it is fiscally responsible for maintaining the system. All decentralized systems must generate sufficient income to cover operation and maintenance costs. Proper maintenance guarantees that the homeowner receives the same full service as with central sewers. The only noticeable difference is that since the interceptor tank is generally located on the homeowner's property, a utility employee will periodically visit the tank to clean the effluent filter and measure the sludge and scum (floating material) buildup in the tank.

Beyond these primary benefits, however, there are secondary benefits of managed DWS, discussed as follows.

Benefits to public utilities:

1. DWS allow utilities to add sewer service to their other services, expanding both their customer base and their revenue base.

2. DWS are economical to install. An entire decentralized system (including collection, treatment, and disposal) often cost less that extending a conventional gravity sewer line, especially in less populated areas. DWS also conserve the capacity of the central treatment facility, thus avoiding the expense of a plant expansion.

3. DWS are economical to operate and maintain. They require routine maintenance every few months and their performance can be monitored and controlled using remote telemetry. Two or three employees can maintain DWS serving hundreds of homes.

4. DWS often allow utilities to acquire land for treatment facilities at minimum expense, as developers may deed over land for treatment in exchange for the benefits of a managed DWS.

Benefits to Homeowners:

1. Home sites become available in areas where central sewers do not exist and/or conventional septic systems do not work.

2. Homeowners are relieved of maintaining an onsite sewer system.

3. Monthly sewer rates are typically lower than with centralized systems because the costs of installing and maintaining the DWS are lower.

Benefits to Developers:

1. A prime residential location can be developed in a timely manner rather than waiting for a central sewer line to be extended.

2. Development density can also be increased by as much as 20% because homes can be sited on smaller lots than conventional systems require.

3. The presence of a publicly owned and operated sewer system is a selling point to homeowners.

ONSITE WASTEWATER SYSTEMS

The individual onsite septic system, consisting of a septic tank and drain field, has been the primary treatment and disposal system of domestic wastewater in rural areas in the New River Valley for many years. These systems, when properly situated, designed and maintained work well, but have a average life of thirty (30) years due to the soils becoming clogged with particles created in the purification process. When the soil becomes clogged, the inadequately-treated wastewater in the drain field comes to the surface and may be washed into the stream during precipitation events. This type system failure is easily detected, and can be corrected although often at a high cost to the homeowner. The second type of failure is caused when the wastewater is washed through the soils so quickly that the bacteria is not killed. This failure type can occur either where the soil is highly permeable (beach sands) or where miniature subsurface fracturing exists (karst topography). This type of failure occurs underground and is difficult to detect. Ground water contamination can result if this type of septic system failure goes undetected, especially in concentrated communities. Ground water contamination is very expensive to clean up: therefore, prevention is essential to protecting this valuable natural resource.

VII. PRIORITIZATION

Scoring Criteria

Based on the existing needs and future sewer demands presented in this study, there is a significant need for sanitary sewer collection and treatment within the study area over the 20-year planning horizon. A need has been identified to rank the projects in order to maximize the benefits to the area.

Ranking criteria for centralized and decentralized sewer projects have been developed in order to assist in the prioritization of the proposed projects identified in this study. For centralized projects, these criteria were used in order to evaluate each project with respect to the number of households served, present worth per new residential connection, elimination of health hazards, elimination of water quality problems, available facilities, and residential / industrial growth potential. For decentralized projects, the criteria used to evaluate the projects were somewhat different and included elimination of health hazards, improvement to water quality, permitted water system, community involvement, utility willingness, financial support, and present worth cost per connection. The criteria employed for decentralized (DWS) projects differed from those used for centralized projects due to the fact that DWS projects are usually much smaller in scope and cost, they tend to be community-oriented projects, they do not always require discharge permits, and they are sometimes funded differently than centralized projects.

Each criterion was assigned a point value, which was used to measure how well a proposed project meets and/or addresses the intent of the criteria. A project could receive a maximum of 100 points if it meets or addresses all of the ranking criteria. Weighting factors are built in to each of the evaluation criteria based on their relative importance. The criteria were selected based on input from the Advisory Management Team and from funding agencies' existing methodologies for evaluating projects.

A threshold for determining primary priority projects was set at 65 out 100 points for centralized sewer projects and 55 out of 100 for decentralized sewer projects. These thresholds were determined by the AMT by evaluating the number of projects falling above and below a given set of threshold values. After scoring of all identified projects and determining which were above the threshold value, it was determined that a project's affect on eliminating water quality and health hazards were a driving force in their designation as a primary priority.

CENTRALIZED SEWER PROJECTS

Number of Equivalent Customers Served by the Project (20 points)

The total number of equivalent customers served by the project will be evaluated for each project. Since one of the objectives of this study is to serve new customers, projects that serve more customers will receive more points.

This criterion shall be evaluated in accordance with the following point system:

< 25 equivalent connections	=	0 points
26 – 100 equivalent connections	=	5 points
101 – 200 equivalent connections	=	10 points
201 – 300 equivalent connections	=	15 points
> 300 equivalent connections	=	20 points

Present Worth Per Connection (20 points)

The cost of sewer system ownership can be separated into two categories. The first category is capital cost, which is the measure of the cost to install a new system. Capital costs are composed of hard costs and soft costs. Hard costs include the price of new materials and the cost to install them, while soft capital costs are those that are related to the construction costs such as engineering, legal, right-of-way, and administrative costs. A second cost of ownership of sewer systems is the annual operation and maintenance (O&M) costs. This is the continuous cost of operating the system and keeping it in good repair. The present worth analysis provides a convenient mechanism for accounting for all of the costs in the system analysis. Present Worth, as used in this report, is defined as the amount of money that must be placed on deposit today at 8% interest for 30 years to pay all of the capital and O&M costs for the planning period.

The total present worth of the project will be evaluated with respect to the potential number of connections that will be served by the proposed project. The lower the cost per connection the more points the project will receive under this criteria due to the fact that less grant funding is required the lower the per connection cost.

This criterion shall be evaluated in accordance with the following point system:

< $15,000 per connection	=	20 points
$15,001 - $22,500 per connection	=	15 points
$22,501 - $30,000 per connection	=	10 points
$30,001 - $37,500 per connection	=	5 points
> $37,501 per connection	=	0 points

Elimination of Health Hazards (15 points)

If a proposed project will minimize/eliminate VDH identified septic system failures, a maximum of 15 points will be awarded. If a proposed project is situated in an area with homes older than 30 years which rely of septic systems, 10 points will be awarded. Proposed projects which do not target an identified health hazard or an area with assumed septic issues will be awarded 0 points with respect to this criteria.

Elimination of Water Quality Problems (20 points)

If a proposed project is situated in the watershed and is within the vicinity (i.e., adjacent to the impaired water) of an impaired stream it will be awarded 20 points. If a proposed project in situated in the watershed but is not in the vicinity of an impaired stream it will be awarded 10 points. Proposed projects which are not in the watershed of an impaired stream will be awarded 0 points with respect to this criteria.

Available Facilities (10 points)

Available facilities considers whether a proposed project will be connected to an existing system or whether it will be connected to another proposed project. If a proposed project can be connected to an existing wastewater treatment plant / collection system without requiring modifications to the existing facilities it will be awarded 10 points. If modifications / upgrades are required to the existing wastewater treatment plant or collection system prior to construction of the new facilities, the project will be awarded 5 points. If proposed treatment facilities or collection systems must be constructed in order to provide a connection point for the project being evaluated, then 0 points will be awarded.

Residential / Industrial Growth Potential (15 points)

If a proposed project will provide sewer service to an area that will support future residential / industrial growth it will be awarded 15 points. If a proposed project will provide sewer service to an area that will only support future residential or industrial growth it will be awarded 10 or 5 points, respectively. A project that will provide little to no potential for growth of any significance will be given 0 points.

DECENTRALIZED SEWER PROJECTS

Elimination of Health Hazards (20 points)

Proposed projects that correct health hazards as identified by the Virginia Department of Health or are located in karst terrain as shown on maps provided by the Virginia Department of Conservation and Recreation will be evaluated in accordance with the following point system:

Identified septic failures	=	20 points
Contaminated ground water	=	20 points
Located in karst terrain	=	15 points
Known older homes (>30 years) with septic systems	=	10 points
No known health hazards	=	0 points

Elimination of Water Quality Problems (20 points)

This intent of this study, which is funded through Southern Rivers Water Quality Improvement Fund, is to supplement the efforts of the Department of Environmental Quality's Total Maximum Daily Loads (TMDL) Program whereby stream samples are taken and analyzed for fecal coliform bacteria, oxygen reduction, and other pollutants. This criterion also evaluates a project's potential for improving ground water quality where karst terrain exists. The karst criterion can be used to add points to projects that are located in an impaired watershed but not in vicinity of an impaired stream. Each proposed project will be evaluated according to published TMDL information using the following point system:

In an impaired watershed and in vicinity of impaired stream	=	20 points
In impaired watershed but not in vicinity of impaired stream	=	10 points
In karst terrain	=	5 points
Not in impaired watershed and not in vicinity of impaired stream	=	0 points

Permitted Water Source (5 points)

Since the county governments have recognized that septic systems can contaminate ground water, they have, for the most part, either installed public water systems or helped to get private drinking water systems permitted. If a proposed project currently has a permitted water system, 5 points will be awarded. Projects that have no permitted water system will be awarded 0 points. The existence of a permitted water system is important as it provides a way to insure customer payment of sewer bills. Some funding agencies will not provide money for sewer projects where there is no permitted water system.

Existing permitted water system or available within 1 year	=	5 points
Not available	=	0 points

Community Involvement (15 points)

Projects will be evaluated based on current community involvement in trying to solve their existing wastewater problems. Projects in communities demonstrating watershed group activities and organized citizen initiatives, including surveys, water quality monitoring, community meeting, etc., will be awarded 15 points. Projects in communities exhibiting evidence of citizen initiatives such as public meetings, requests for assistance, etc., will be awarded 10 points. Sometimes a project area may have an organized watershed group, but its efforts are focused on water quality issues other than wastewater pollution. In such a case, the project will only be awarded 5 points. Those communities not represented by a watershed group and not expressing interest in water quality will receive 0 points.

Organized citizen initiatives and watershed group activity	=	15 points
Organized citizen initiatives in improving water quality	=	10 points
Watershed group activity but not addressing wastewater	=	5 points
No watershed group or citizen initiative	=	0 points

Utility Willingness (10 points)

Utility willingness considers whether the local public service provider (city, town, or PSA) is willing to own and operate a decentralized system (DWS). This meets the qualifications of a Responsible Management Entity (RME) as set forth by the US Environmental Protection Agency in its Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems.

The criteria shall be evaluated in accordance with the following point system:

Utility has expressed a willingness to operate a DWS	=	10 points
Utility is unwilling to operate a DWS	=	0 points

Financial Support (10 points)

If a proposed project has had prior financial expenditures (planning, studies, etc.), or if funding has been requested or committed, it will be awarded 10 points. Projects that have shown no financial support will receive 0 points.

Present Worth Cost per Connection (20 points)

If a proposed project has a low present worth cost per connection (less than $15,000) the project will be awarded 20 points. If a proposed project has a present worth cost per connection between $15,001 - $17,500, it will be awarded 10 points; and projects with a present worth cost per connection between $17,501-$20,000 will receive 5 points. Projects where the present worth cost per connection is greater than $20,000, 0 points will be awarded.

<$15,000 per connection	=	20 points
$15,001-$17,500 per connection	=	15 points
$17,501-$20,000 per connection	=	10 points
>$20,000 per connection	=	0 points

Table 4 - Matrix Scoring Summary - Centralized Projects

Equivalent Connections		**Score**	**(20 Points Total)**
i.	≤ 25 Equivalent Connections	0	Points
ii.	26-100 Equivalent Connections	5	Points
iii.	101-200 Equivalent Connections	10	Points
iv.	201-300 Equivalent Connections	15	Points
v.	>300 Equivalent Connections	20	Points
Present Worth Per Connection		**Score**	**(20 Points Total)**
i.	>$37,501 Per Connection	0	Points
ii.	$30,001-$37,500 Per Connection	5	Points
iii.	$22,501-$30,000 Per Connection	10	Points
iv.	$15,001-$22,500 Per Connection	15	Points
v.	<$15,000 Per Connection	20	Points
Elimination of Health Hazard		**Score**	**(15 Points Total)**
i.	Identified Septic Failures	15	Points
ii.	Known Older Homes (> 30 Yrs.) with Septic Systems	10	Points
iii.	No Older Homes with Septic Systems or Failures	0	Points
Elimination of Water Quality Problems		**Score**	**(20 Points Total)**
i.	In Watershed and Within Vicinity of Impaired Stream	20	Points
ii.	In Watershed and Not Within Vicinity of Impaired Stream	10	Points
iii.	Not in Watershed or Within Vicinity of Impaired Stream	0	Points
Available Facilities		**Score**	**(10 Points Total)**
i.	WWTP/Collection System Capacity Available	10	Points
ii.	WWTP/Collection System Upgrades Required	5	Points
iii.	WWTP/Collection System Not Available	0	Points
Potential Growth - Residential/Industrial		**Score**	**(15 Points Total)**
i.	Industrial and Residential Growth Potential	15	Points
ii.	Residential growth potential only	10	Points
iii.	Industrial growth potential only	5	Points
iv.	No growth potential	0	Points

Table 5 - Matrix Scoring Summary - Decentralized Projects

Elimination of Health Hazard		**Score**	**(20 Points Total)**
i.	Identified Septic Failures	20	Points
ii.	Contaminated Ground Water	20	Points
iii.	Located in Karst Terrain	15	Points
iv.	Known Older Homes (> 30 Yrs.) with Septic Systems	10	Points
v.	No Older Homes with Septic Systems or Failures	0	Points
Elimination of Water Quality Problems		**Score**	**(20 Points Total)**
i.	In Watershed and Within Vicinity of Impaired Stream	20	Points
ii.	In Watershed and Not Within Vicinity of Impaired Stream	10	Points
iii.	Located In Karst Terrain	5	Points
iv.	Not in Watershed or Within Vicinity of Impaired Stream	0	Points
Permitted Water System (> 15 connections)		**Score**	**(5 Points Total)**
i.	Existing Permitted Water System or Available within 1 Year	5	Points
ii.	Not Available	0	Points
Community Involvement		**Score**	**(15 Points Total)**
i.	Both Activity & Initiatives	15	Points
ii.	Organized Citizen Initiatives	10	Points
iii.	Watershed Group Activity	5	Points
iv.	No Activity or Initiatives	0	Points
Utility Willingness		**Score**	**(10 Points Total)**
i.	Available or Planned Responsible Mgmt Entity	10	Points
ii.	No Responsible Mgmt Entity	0	Points
Financial Support		**Score**	**(10 Points Total)**
i.	Prior Expenditures	10	Points
ii.	Project Funding Requested or Committed	10	Points
iii.	None of the Above	0	Points
Present Worth Per Connection		**Score**	**(20 Points Total)**
i.	>$20,000 Per Connection	0	Points
ii.	$17,501-$20,000 Per Connection	10	Points
iii.	$15,001-$17,500 Per Connection	15	Points
iv.	<$15,000 Per Connection	20	Points