PAEONIAN SPRINGS WATER & WASTEWATER BOUNDARY AND TREATMENT ALTERNATIVES

Technical Memorandum

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1.0 INTRODUCTION

Paeonian Springs is an unincorporated residential community located in Loudoun County, Virginia (County) at the intersection of Route 9 (Charles Town Pike) and Route 7 (Harry Byrd Highway).

The Paeonian Springs Community (Community) currently has no public water distribution system or sanitary sewer system. Individual parcels are served by private wells for drinking water and individual, on-site wastewater treatment facilities such as septic systems, alternative on-site sewage (AOSS), pump and haul, and pit privy systems.

Based on health department records, existing wells within the Community are aging (median age of 40 years) and many are too shallow and do not have proper casings. The average age of the on-site wastewater systems is 41 years. In 2017, due to aging systems and historic failures, the Community applied to the Loudoun County Community Water and Wastewater Assistance Program (Program). A boundary was created for the purposes of the application, which included 216 parcels. Figure 1-1 shows the initial Paeonian Springs Boundary, created by the Community for the purposes of the water and wastewater feasibility study.

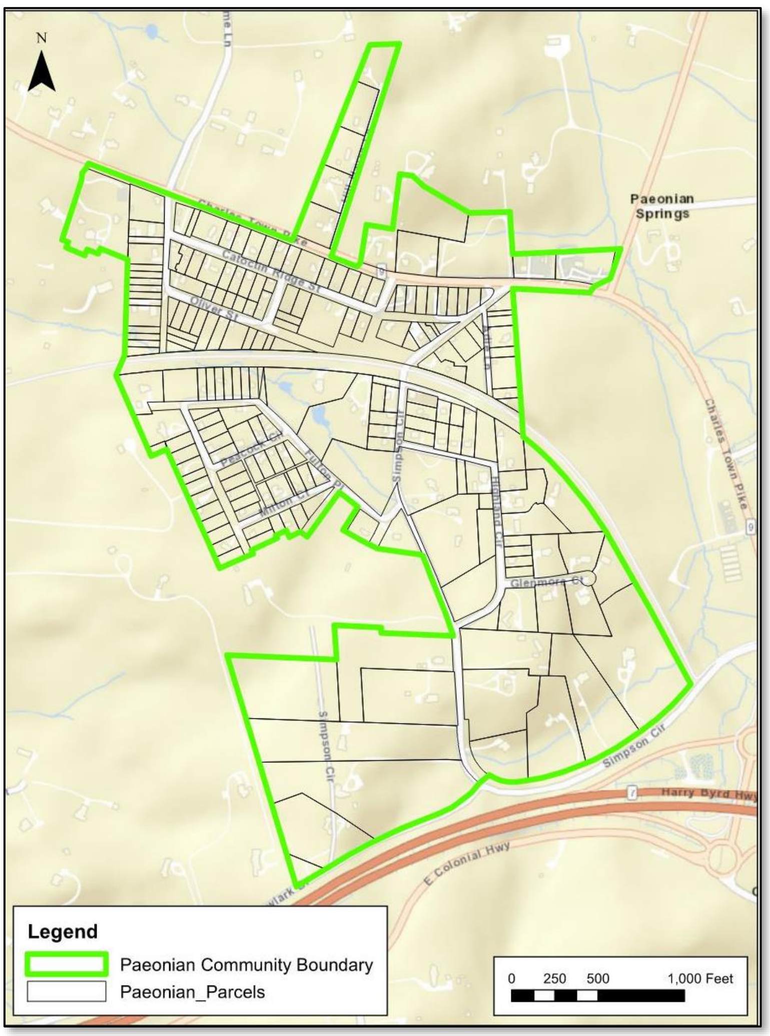

Figure 1-1– Paeonian Springs Community Boundary

In 2019, under a separate task order, Dewberry completed a Study (Feasibility Study) to determine the technical feasibility of water and wastewater solutions for the Community. As mentioned above and shown in Figure 1-1, the service area considered in the initial feasibility study was based on the application to the Program submitted by the Paeonian Springs Community Representatives. The Study included an overview of the existing Community characteristics, review of applicable state and local codes, standards and regulations relating to water and wastewater systems, analysis of the Community's estimated current and future demand flows, evaluations of the existing water and wastewater systems and preliminary alternatives and cost estimates for alternate Community solutions and system layouts. During the development of the feasibility study, specific areas of the Community were identified to have a public health need based on health department records.

In the Feasibility Study, for the water system, a communal well and water distribution system was determined to be the preferred alternative. For the wastewater system, it was determined that a low-pressure sewer system with an interim pump station and force main could be utilized to carry the wastewater to a treatment system and drainfield.

The County's 2019 Comprehensive Plan (Section 6-4.6-F) allows for connections to nearby municipalities for communities within Rural Policy Areas and recent developments with the Virginia Department of Environmental Quality (VDEQ) have identified surface discharge as a potential solution for wastewater treatment. This has the potential to provide alternative solutions for public water and wastewater service for the Community.

With these recent developments, Loudoun Water tasked Dewberry with development of a Technical Memorandum (TM) to act as an addendum to the previously prepared Paeonian Springs Feasibility Study. The purpose of this technical memorandum is to:

- Review the parcels that have challenges solving water and/or wastewater issues with individual on-site systems and utilize this information to develop revised service area boundaries for both water and wastewater to provide communal solutions

- Determine the feasibility of connecting Paeonian Springs to a nearby municipality (Town of Hamilton or Town of Purcellville) for both water and wastewater service

- Determine the feasibility of providing a wastewater treatment system with surface water discharge

Evaluation for the Paeonian Community began with determination of a new service area boundary for both water and wastewater as described in the subsequent section.

2.0 SERVICE AREA DETERMINATION

2.1 Introduction

Three boundaries were developed for the Paeonian Springs Community: a wastewater service area boundary, a water service area boundary, and a combined (water and wastewater) service area boundary.

The determination of a new service area boundary was based on review of property records, health department records, the original application information as well as well tests and a soil study. As noted above, in the Feasibility Study, areas of the Paeonian Springs Community were found to have a public health need. This section will present the analysis and criteria used to determine both the water and wastewater service area boundaries for the Community.

2.2 Community Evaluation Approach

2.2.1 Parcel v. Property Approach

The process of determining a service boundary for the Community required in-depth evaluation of the Community. As mentioned previously, the Community includes 216 individual parcels. However, throughout the Community, some groups of parcels comprise a single property, defined as adjacent parcels with one identified owner. That is, multiple parcels were transferred under a single sale. Individual parcel tax information lists each parcel as being part of a multi-parcel sale. For example, a property located on Highland Circle, outlined in blue in Figure 2-1 below, has a single owner and is made up of four (4) individual parcels, each of which is outlined in red in the figure and each parcel has a unique PIN as noted in the figure caption. The majority of these multi-parcel properties have structures on the adjacent parcels as well as private water and wastewater systems.

The process of determining a service boundary for the Community required in-depth evaluation of the parcels within the Community. As mentioned previously, the Community includes 216 individual parcels. However, throughout the Community, some groups of parcels comprise a single property with one owner. For example, a property located on Highland Circle, shown in Figure 2-1 below, has a single owner and is made up of four (4) individual parcels, each of which is outlined in red in the figure below. The majority of these multi-parcel properties have structures on the adjacent parcels as well as private water and wastewater systems.

Figure 2-1–Example Property (PINs 307254158000, 307254152000, 307254146000, 307254240000)

These multi-parcel properties are a critical factor when determining how to approach the system evaluation related to the service area boundaries and estimating future flows and demands. Throughout this discussion, property refers to a single address, which may include multiple parcels, and parcel refers to an individual piece of land with a unique Parcel Identification Number (PIN).

Two approaches were identified for the evaluation:

1. Evaluate properties with a single address, which may be comprised of multiple parcels; or

2. Evaluate individual parcels with unique Parcel Identification Number (PIN).

Advantages and disadvantages for both approaches are summarized below.

Approach 1: Evaluate properties based on the single address. This approach includes evaluation of only 122 properties and would ignore any parcel boundaries within property lines. This approach would ensure that any service area boundary that is developed does not divide properties (single address) by including some parcels while excluding others from a single property. However, this approach only evaluates the current build-out and configuration of the Paeonian Community and does not take into account the potential that these combined parcels being sold separately in the future. Design by this approach risks potentially under designing the system, resulting in utility infrastructure that cannot meet future demands.

Generally, these multi-parcel properties cannot be individually sold and developed as they do not meet minimum property area requirements to allow for a structure, private on-site water and wastewater systems and required setbacks. However, the zoning of these properties allows for a smaller minimum area should public utilities be available. Therefore, these individual parcels may be developed once utilities are provided should planning and zoning allow development based on historic parcel size requirements and regulations.

Approach 2: Parcel-by-parcel evaluation. This approach considers all 216 parcels within the Community individually, regardless of whether they share an owner with an adjacent parcel. This eliminates conflicts with the first approach associated with the new system potentially being undersized and failing to be able to meet future needs.

Based on consideration of both methods, as well as discussions with Loudoun Water and Loudoun County, it was determined that Approach 2, the parcel-by-parcel approach, will be utilized for evaluation of the Paeonian Springs Community and development of the service area boundaries. Since separate development of grouped parcels is possible in the future, the more conservative Approach 2 was the only approach that guaranteed that the service boundary determination and the resulting system design accounted for all possible future flows.

FUTURE DESIGN IMPLICATIONS

Although the parcel-by-parcel approach is being utilized for determination of the service area boundaries, the implications for design of public water and wastewater systems from both approaches will need to be considered. Design of any future water distribution systems or sewage collection and treatment systems will require an understanding of the potential future build-out in the Paeonian Springs Community.

demand flows for design of the system also will be affected by the approach taken since a parcel-by-parcel approach will result in a greater number of required connections than a property. A breakdown of these differences is outlined in Section 2.8 of this TM.

2.3 Service Area Determination Criteria

EXISTING SYSTEM & PARCEL CHARACTERISTICS

To determine service area boundaries for water and sewer, initial screening criteria were developed to aid in evaluation of each parcel and their individual needs for a communal solution. The screening was conducted for both the water and wastewater systems to develop two separate service boundaries.

The evaluation included key system features for existing, private water and sewer systems, and parcels such as system age, history of failure, parcel size, available reserve drainfield area, setback requirements, parcel topography and soil quality. An iterative process was designed to properly screen parcels for the purpose of delineating a boundary capturing parcels with the most significant potential public health need.

Figure 2-2 shows key considerations made when determining the boundary for wastewater systems. It should be noted that the process is not purely linear and engineering judgment was used in developing final boundaries.

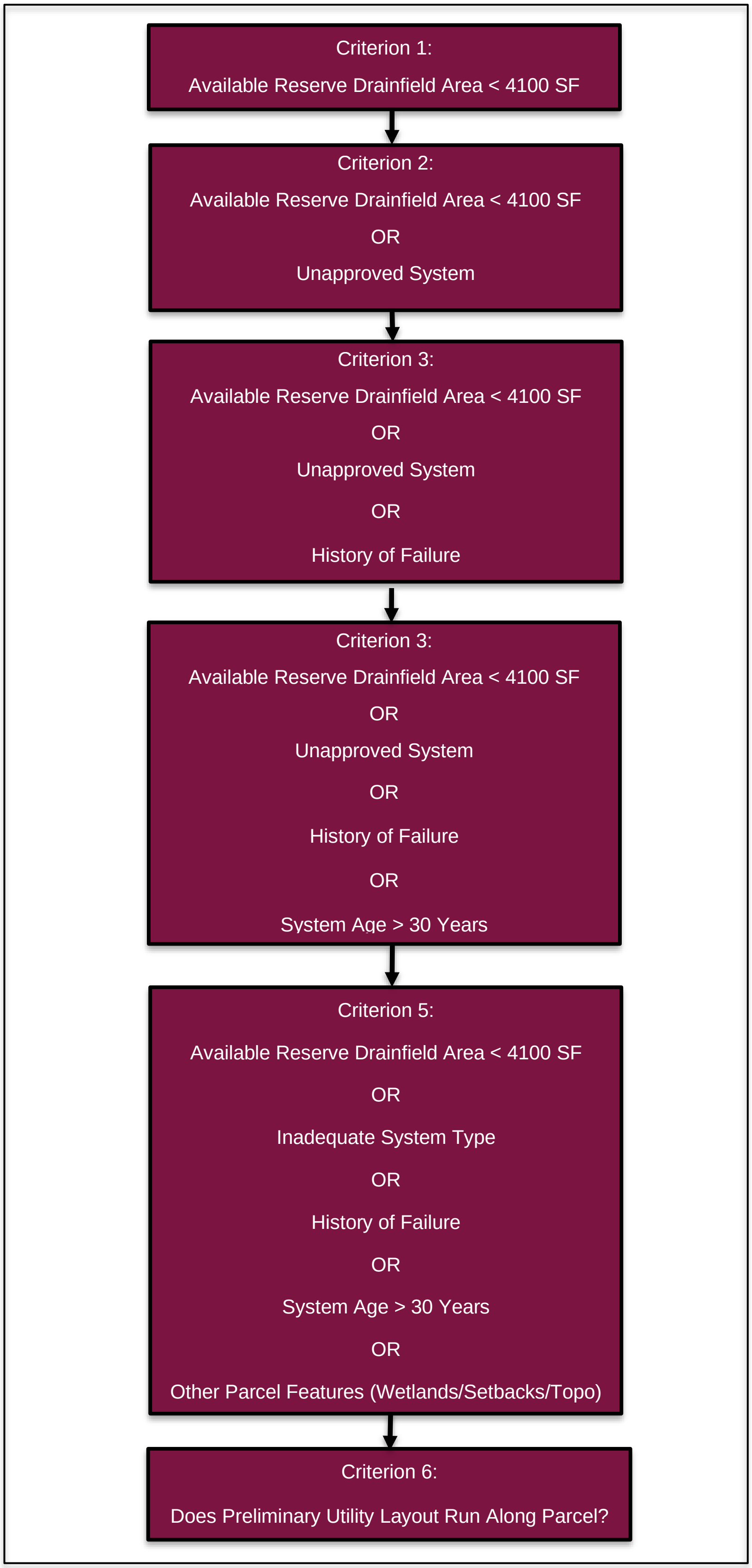

Figure 2-2 – Sewer Boundary Criteria Flowchart

ADDITIONAL CRITERIA/SETBACKS

Virginia Administrative Code (12VAC5-610-592) and Loudoun County Codified Ordinance (LCCO) standards require minimum separation and setback distances for private water and wastewater systems. For subsurface wastewater facilities, 12VAC5-610-597, Table 4.2 identifies minimum separation distances and within the LCCO, Chapter 1066 Appendix I details required minimum setback distances. For wells, LCCO Chapter 1040, Appendix II, Table 1 dictates minimum safe distances. These setbacks, shown in Table 2-1 and Table 2-2, were applied in determining available area for private onsite systems as well as determination of the adequacy of the existing systems.

Table 2-1 – Minimum Setback Distances for Subsurface Facilities

MINIMUM SETBACK DISTANCES (SUBSURFACE FACILITIES)	
STRUCTURE/ TOPOGRAPHIC FEATURE	**MINIMUM DISTANCE (FT)**
Property Lines	10[a]
Active Driveways/Parking Areas	5
Building Foundations	10
Basements	20
Drinking Water Wells (all classes)	50
[a] Distances to property lines may be reduced to 5-ft if a survey plat is provided and the applicable property lines are clearly marked in the field by a licensed surveyor both during permitting and construction.	

Table 2-2 – Minimum Setback Distances for Wells

MINIMUM SETBACK DISTANCES (SUBSURFACE FACILITIES)	
STRUCTURE/ TOPOGRAPHIC FEATURE	**MINIMUM DISTANCE (FT)**
Property Lines	10
Septic Tanks	50
Absorption Fields	50
Foundation of Solid Masonry Building	15[a]
[a] **Should any existing houses be identified as having received termite treatment;** required setback from house foundation would be 50-ft.	

Each setback was applied to individual parcels to determine the available area for onsite systems and, also, to determine if existing systems comply with these required setbacks.

2.4 Wastewater Service Area Determination

The initial boundary determined was the wastewater service area. As shown in Figure 2-2, the wastewater service area boundary screening process began with an analysis of the available reserve drainfield area for each property within the Community.

2.4.1 Iteration #1 (Wastewater Boundary): Available Reserve Drainfield Area

The LCCO requires all properties with septic systems to have sufficient available area for a reserve drainfield equal 100% of the size of the property's operational drainfield per 1066.12(c). Required drainfield area for lots varies based on several factors, therefore two key assumptions were made for this analysis: number of bedrooms and soil percolation rate.

Firstly, a three-bedroom household was conservatively assumed. Secondly, a soil percolation rate of 120 minutes/inch was assumed for all parcels. This percolation rate is the slowest, and therefore most conservative, percolation rate listed under Virginia Administrative Code 12VAC5-610-950 for Absorption

Area Design, shown in Table 2-3. Since the sewer boundary determination is only a desktop analysis and included no field work, the exact soil percolation rate throughout the Community was unknown. However, a desktop analysis was completed using USGS Web Soil Survey to identify existing soils within the Community. Using conservative percolation rates from Loudoun County WebLogis for each soil type, the resulting weighted average percolation rate within the Paeonian Springs Community was 119.16 min/in. The use of this conservative percolation rate of 120 min/in will offset any potentially overlooked or unaccounted for parcel features that may reduce available reserve drainfield area such as steep topography or disturbed areas. These conservative assumptions were utilized to estimate the approximate drainfield area required for each parcel. Virginia Administrative Code dictates that for the assumed lot conditions of a 3-bedroom home and 120 minutes/inch soil percolation rate, the required drainfield area is approximately 4100 square feet. Further soil studies and assessments may be performed by a soil scientist to determine actual percolation rates for each individual parcel.

Table 2-3 – 12VAC5-610-950 Absorption Area Design Table 5.4

12VAC5-610-950			
AREA REQUIREMENTS FOR ABSORPTION TRENCHES			
PERCOLATION RATE (MIN / IN)	AREA REQUIRED (FT^2)		
	1-BEDROOM	2-BEDROOMS	3-BEDROOMS
5	165	330	495
10	180	360	540
15	198	396	594
20	218	436	654
25	237	474	711
30	260	520	780
35	286	572	858
40	314	628	942
45	344	688	1032
50	376	752	1128
55	412	824	1236
60	452	904	1356
65	496	992	1488
70	544	1088	1632
75	596	1192	1788
80	656	1312	1968
85	718	1436	2154
90	786	1572	2358
95	862	1724	2586
100	946	1892	2838
105	1038	2076	3114
110	1138	2276	3414
115	1248	2496	3744
120	1368	2736	4104

In order to apply the space constraints for the required setbacks and conservative required area for a drainfield, existing ArcGIS data was utilized and transformed to apply the setback and drainfield requirements discussed above. Locations of existing wells, drainfields, buildings, and driveways were pulled from Loudoun County online GIS data.

To determine available area, first, setbacks were applied to each parcel: a 5-ft setback from property lines, a 50-ft setback from all wells, and a 10-ft setback from structures. The application of these setbacks for a portion of the Community is shown in Figure 2-3.

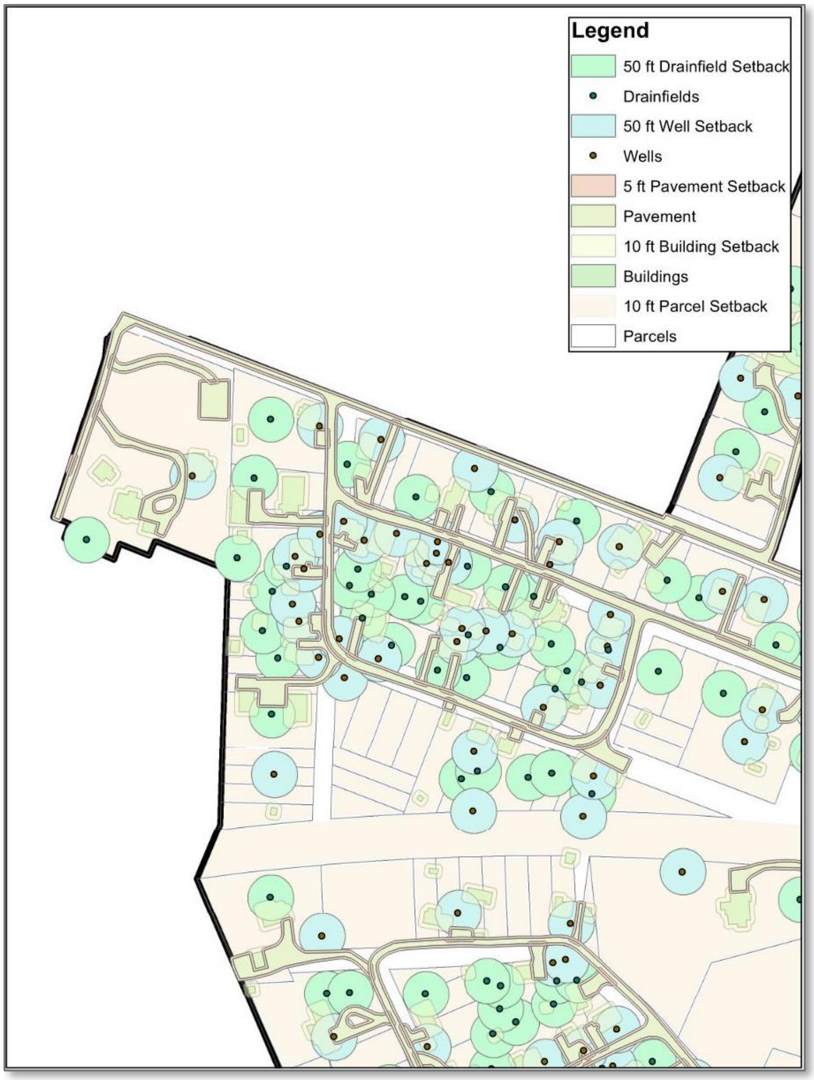

Figure 2-3 – Example Setback and Available Drainfield Area Determination

All parcels with more than 4,100 square feet of available reserve drainfield area, considering existing features and setback requirements, were considered to have sufficient room to replace their sewer system and were excluded from this iteration of the service area boundary. Those parcels that did not have sufficient area to accommodate a drainfield of this size were included within the sewer boundary. A map of the parcels determined to have insufficient area to accommodate a reserve drainfield area are shown in the Figure 2-4 below. The green parcels signify those parcels included within the service area boundary while red parcels, those with sufficient area, are those excluded from the boundary based on this iteration.

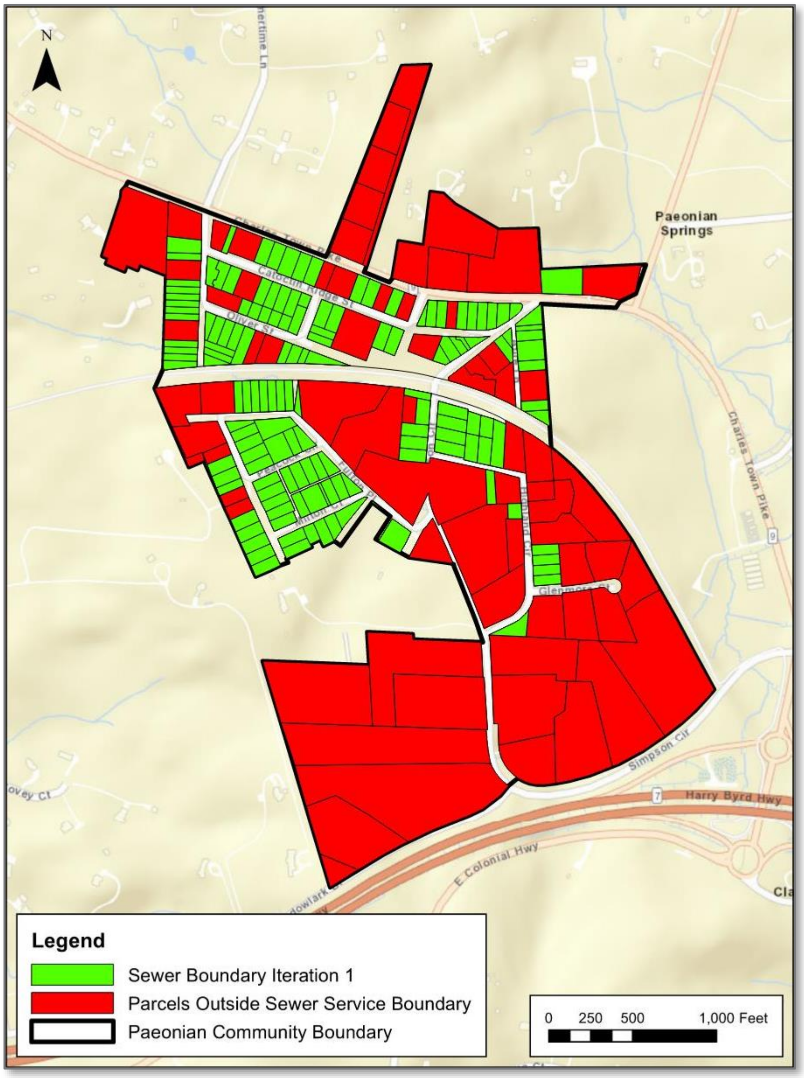

Figure 2-4 - Wastewater Service Area Boundary Iteration #1

2.4.2 Iteration #2 (Wastewater Boundary): Existing System Characteristics

The subsequent iteration for development of the boundary included review of existing Loudoun County Health Department Data to determine the existing onsite wastewater system characteristics for each parcel within the Community. The health department data was considered in conjunction with the results of iteration #1. Therefore, all properties within the Community were evaluated parcel-by-parcel, with attention to those parcels which were initially excluded from the service area boundary in iteration #1. System type was the initial criterion evaluated.

First, those properties with inadequate onsite wastewater systems, such as pump and haul, pit privy, and raised bed systems were identified and checked to ensure inclusion in the service area boundary. Any system that did not conform to approved regulatory standards was considered in need of a new system and added to the boundary, if not captured in iteration #1.

Next, systems' history of failure and likelihood of failure based on system age were evaluated. Generally, repeated history of failure was considered a clear indicator of risk of future failure, and system failures with no record of resolution were considered inadequate systems. any parcels with systems which met these criteria were included in the boundary.

The next criteria considered was system age, which was utilized as an indicator of likelihood of failure. Per LCCO 1066.12(c), soil absorption areas for onsite wastewater systems are considered to have a life expectancy of thirty years. Therefore, thirty years was used as a benchmark to determine whether an approved system without any history of failure was at an increased risk of failure in the future. All systems that were determined to have a system age of thirty years or greater, while also having inadequate area to install a new system (without reserve area as this would be replacement alternatives), were compiled and added to the boundary.

The remaining parcels were analyzed using criteria associated with various other features such as wetlands located on the parcel and adherence to well, structure, and parcel setback standards. While many of these at-risk parcels overlapped with those identified as having a health need in the drainfield area evaluation, twenty-seven parcels were added in this second iteration of the wastewater system boundary that had not been included in the previous iteration. Based on these criteria, the boundary was revised as shown in Figure 2-5. Again, green parcels are those included in the boundary and red signifies exclusion from the boundary.

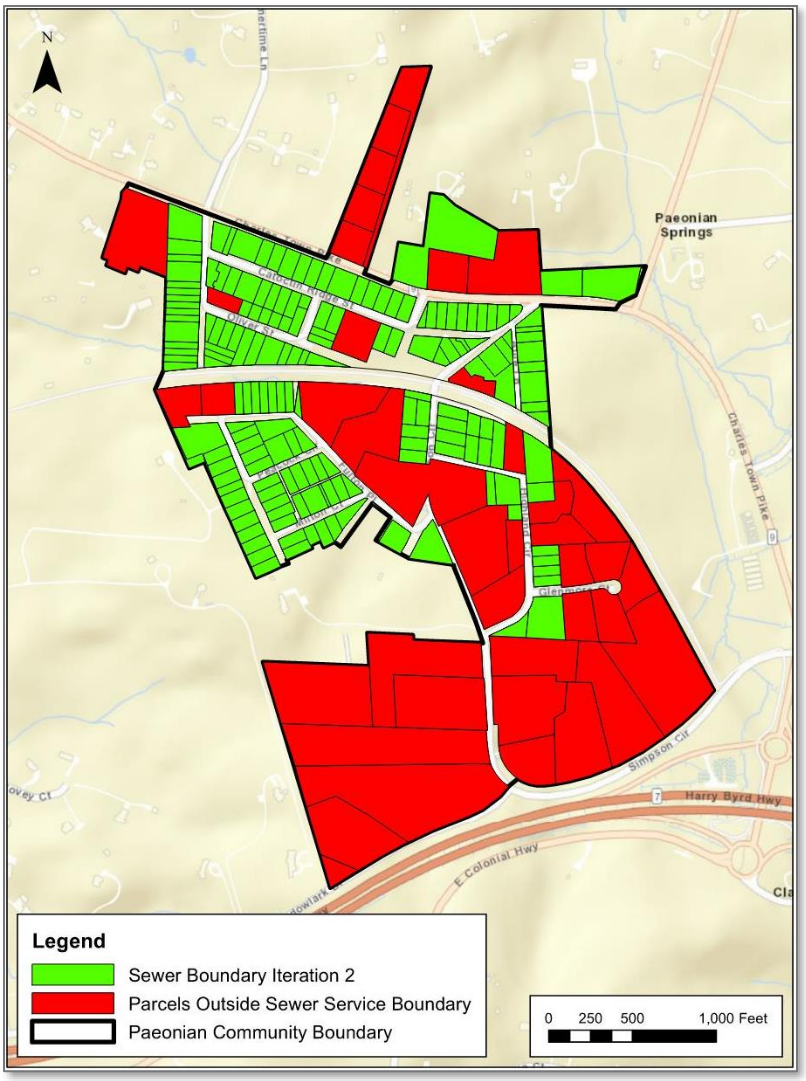

Figure 2-5 - Wastewater Service Area Boundary Iteration #2

2.4.3 Iteration #3 (Wastewater Boundary): Parcel Soil Conditions

In addition to review of the existing available parcel area and the existing system data, a brief review of existing soil types within the Community was conducted in order to select parcels for a site soil survey.

Based on discussions with Loudoun Water and Loudoun County, as well as a Dewberry conducted review of soil types from Loudoun County GIS data, multiple parcels were selected to undergo a site soil survey by Marsh & Legge. The parcels selected for the survey were based on review of several criteria:

- Parcels determined to have sufficient area for drainfields, but poor soil types
- Soil type and potential for use for drainage areas based on soil type
- Parcels with water features or soil drains running through
- Parcels where utilities would not otherwise be installed

Figure 2-6 shows the drainage potential of the various soils throughout the Community, which range from very poor to good.

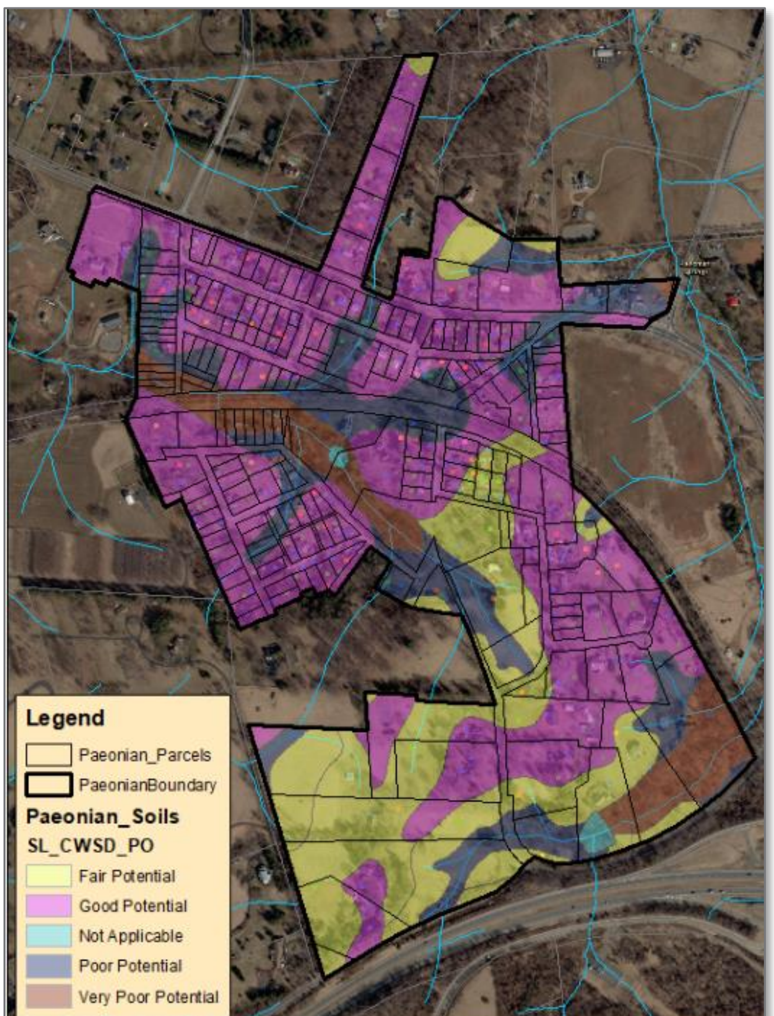

Figure 2-6 – Soil Map

Based on our initial assessment, the parcels for further study were identified along Hill Haven Lane. These parcels are on the north side of Route 9 and represent lots with potential challenges not identified through desktop soil review. Figure 2-7 shows the parcels included in the soil survey.

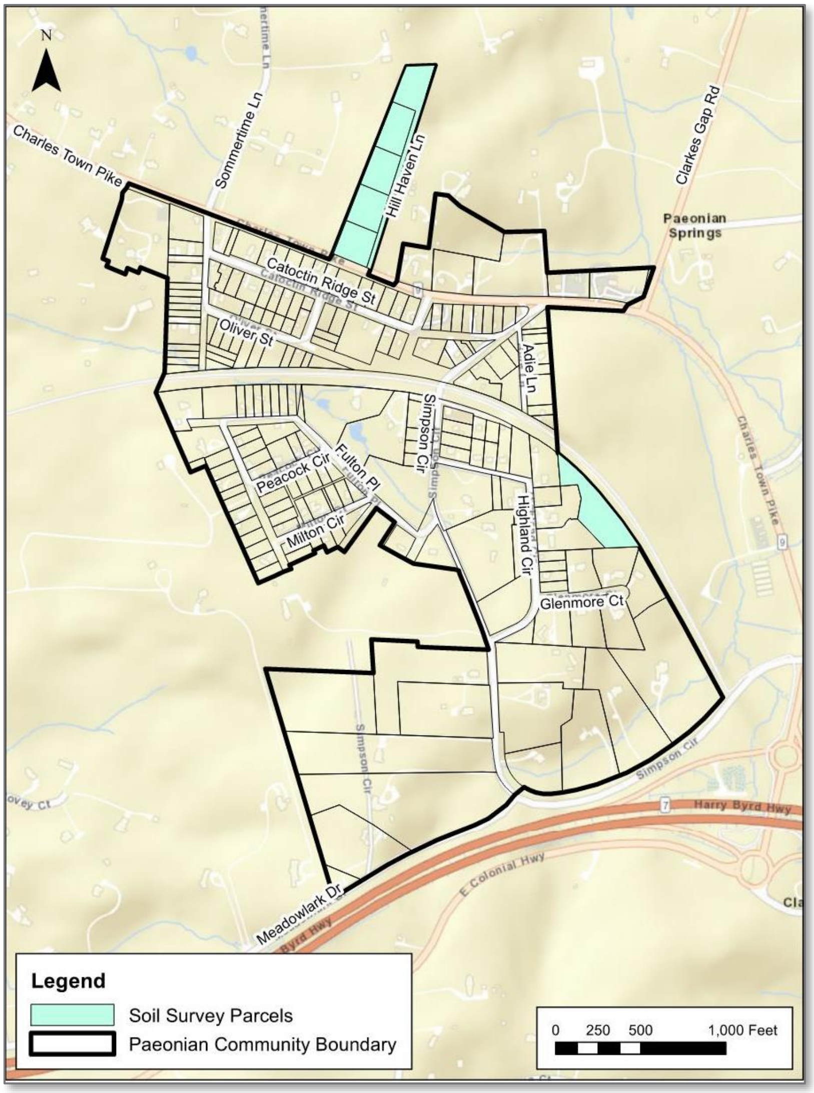

Figure 2-7 – Map of Soil Survey Parcels

DESKTOP SOIL SURVEY

In April 2022, Marsh and Legge conducted a soil survey of the above-mentioned parcels. The goal of the survey was to determine the practicality of installing a brand new drainfield on each parcel evaluated. As part of the survey, Marsh and Legge analyzed VDH well and septic records as well as key data points such as soil type, slope, setback distances, and lot size to evaluate each parcels' sufficiency for a new drainfield. The results of the evaluation, shown in Table 2-4, were used to formulate Iteration #3 of the wastewater service boundary. Figure 2-8 shows the third iteration of the boundary. The complete desktop analysis is attached as Appendix A.

Table 2-4 – Soil Survey Results Summary

Parcel ID	Practicality
345402442000	*Practical for TL-2 alternative system
345403162000	Not practical for new system
345403882000	Not practical for new system
344104606000	Not practical for new system
344105523000	*Practical for TL-2 alternative system
307256980000	Approved reserve drainfield area
*Limited available area	

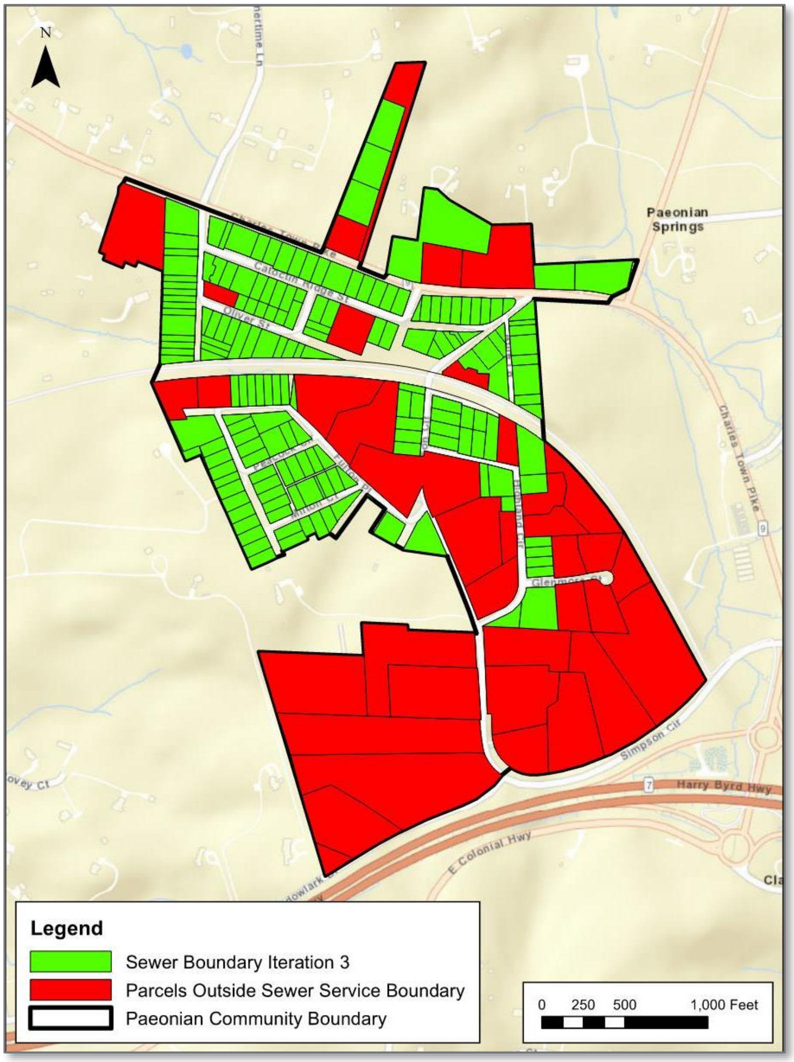

Figure 2-8 – Wastewater Service Area Boundary Iteration #3

2.4.4 Iteration #4 (Wastewater Boundary): Adjacent Parcel Inclusion

The location of parcels in relation to the proposed sewer line alignment was the final criteria used to determine the boundary. Since a communal solution to the Community's wastewater needs would involve running a sewer line throughout the Community to meet the parcels in need, several parcels which were not included in the boundary through the previous criteria evaluations are located adjacent to the utility layout necessary to reach all the Community's parcels in need. Due to the proximity of the sewer line to their location, these parcels were included in the final iteration of the sewer service boundary, shown in Figure 2-9.

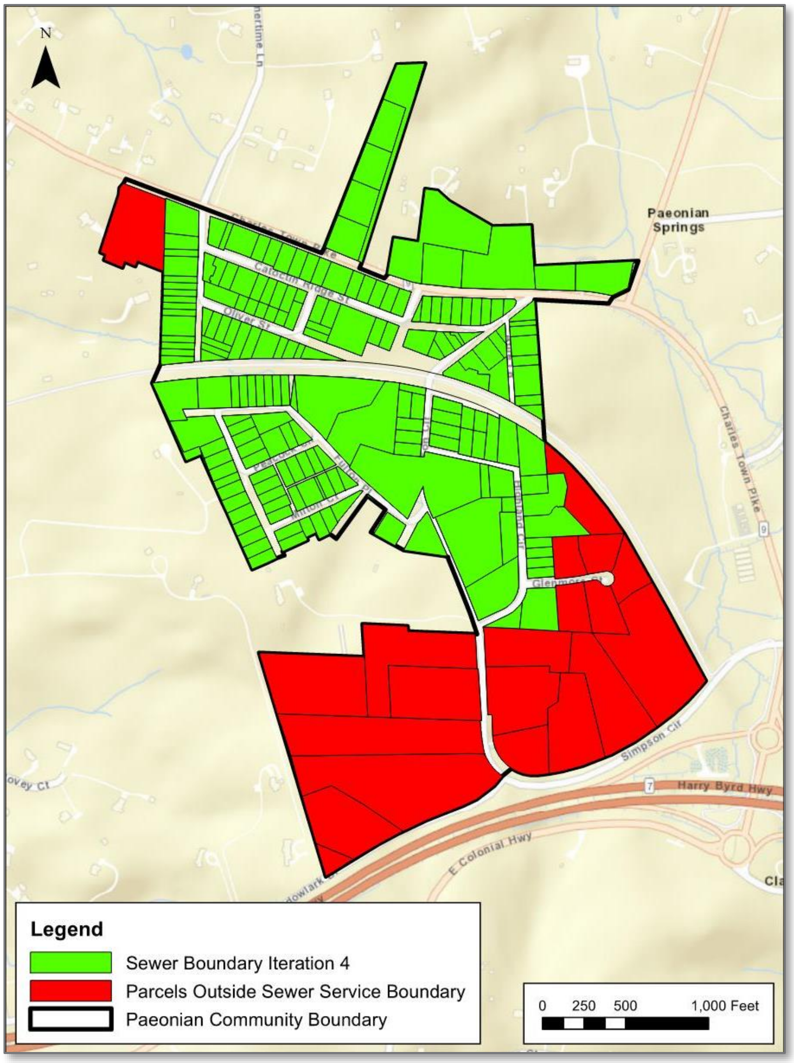

Figure 2-9 – Wastewater Service Area Boundary Iteration #4 (Final)

2.5 Water Service Area Boundary Determination

Following determination of the preliminary wastewater service area boundary, a similar screening process was utilized in determination of a water service area boundary. The general steps followed in this analysis were as follows:

1. Review of Existing Wells, History of Failure, System Type and System Age
2. Determination of sufficient area for Additional Well with setbacks
3. Review of Loudoun County provided Well Tests (Limited Information)

Again, the parcel screening process was performed as a parcel-by-parcel evaluation. Figure 2-10 show a flowchart for the steps of the analysis for the water service area boundary.

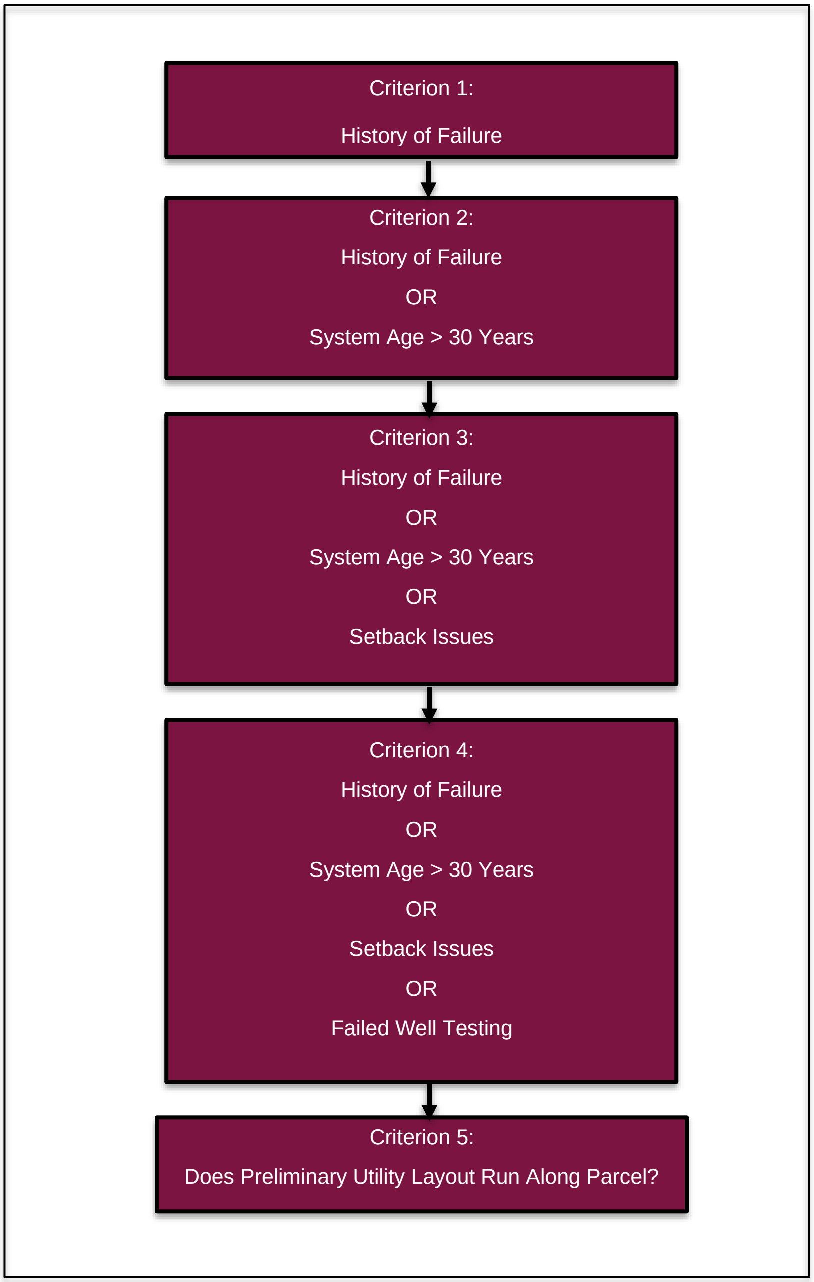

Figure 2-10 – Water Boundary Criteria Flowchart

2.5.1 Iteration #1 (Water Boundary): Existing System Characteristics - History of Failure

The first criteria considered for the development of the water service boundary was an evaluation of the history of failure, or inadequacy, of the Community's existing individual drinking water wells. This evaluation was conducted by reviewing available Loudoun County Health Department Data to determine which wells within the Community have a history of failure. As was determined with the septic systems, history of failure was considered to be an indicator of high risk of future failure in wells. Therefore, all parcels containing a well that had a history of failure were included in the first iteration of the water boundary. A map showing this iteration of the boundary is shown in Figure 2-11. As with the wastewater boundary, the green parcels meet the criteria for inclusion and the red do not meet the criteria.

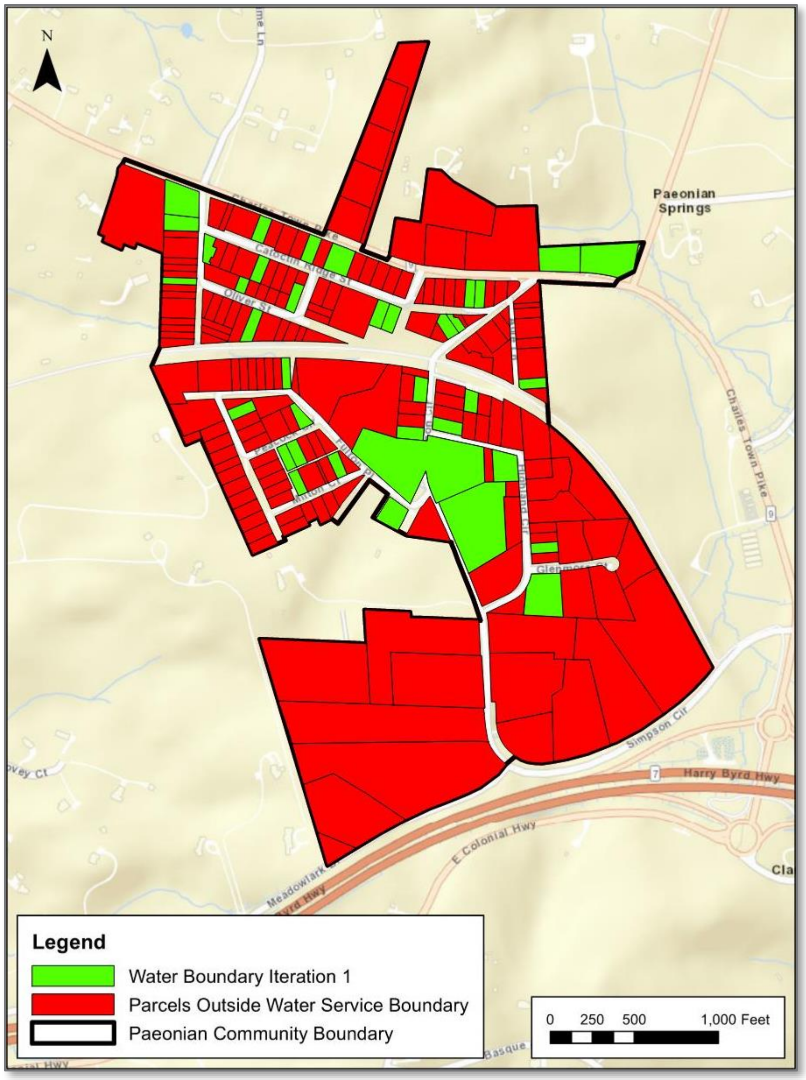

Figure 2-11 – Water Service Boundary Iteration #1

2.5.2 Iteration #2 (Water Boundary): Existing System Characteristics – System Age

The next water boundary consideration was system age. Loudoun County Health Department Data was analyzed to determine the year in which each well within the Community was built. The USGS states that the average lifespan of a private water well is 30-50 years. Per discussions with LCHD and Loudoun Water, it was determined that 30 years should be used as a benchmark to determine whether a well is old enough to be determined at risk of future failure. Because of this, any existing well aged 30 years or older was included in this iteration of the water boundary, shown in Figure 2-12.

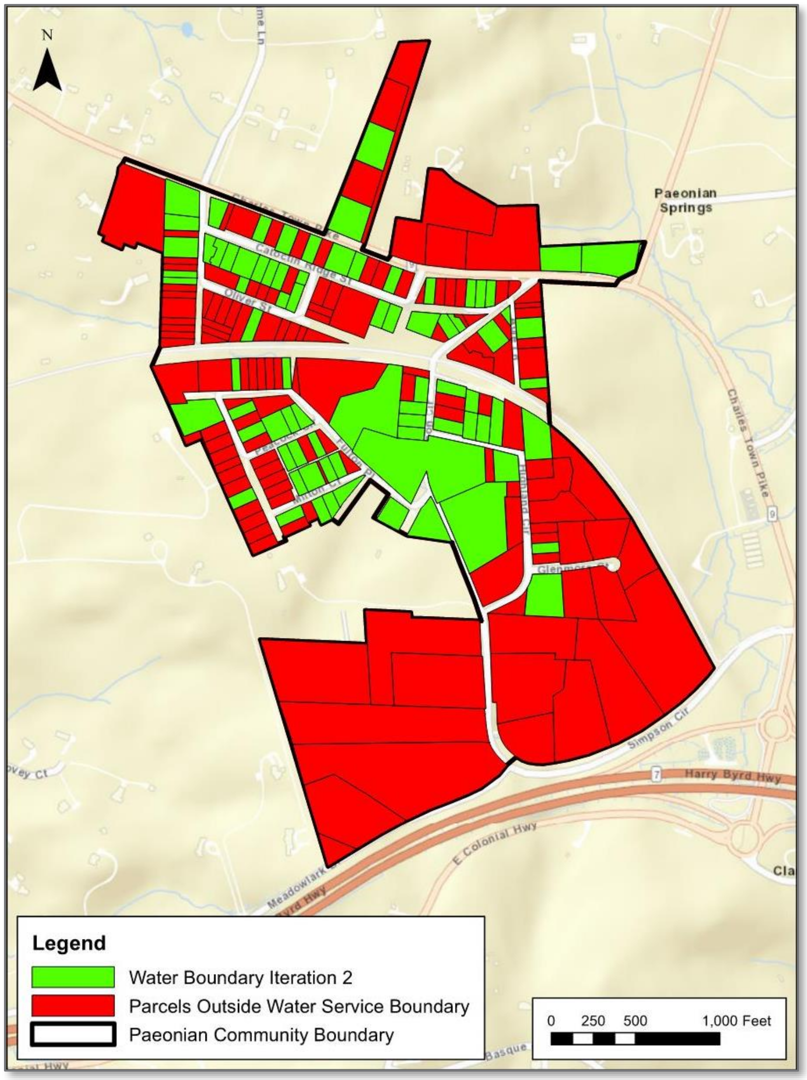

Figure 2-12 – Water Service Boundary Iteration #2

2.5.3 Iteration #3 (Water Boundary): Review of Setback Compliance

The third iteration of the water boundary was formulated by evaluating setback requirements for drinking water wells outlined in LCCO Chapter 1066. As summarized above in Table 2.1 and Table 2.2, minimum setback distances from property lines, building foundations, paved areas, and septic tanks are regulated for water wells. These requirements were used as a basis for determining the compliance of existing wells within the Community as well as available area for installation of a new well for certain parcels. Any parcel that contained a well that was did not comply with any of the County's setback requirements was added in this iteration of the boundary. Additionally, any parcel that did not include a well but was determined to be too small to accommodate a new well while meeting setback requirements was also added to the boundary. This iteration of the boundary is shown in Figure 2-13 below.

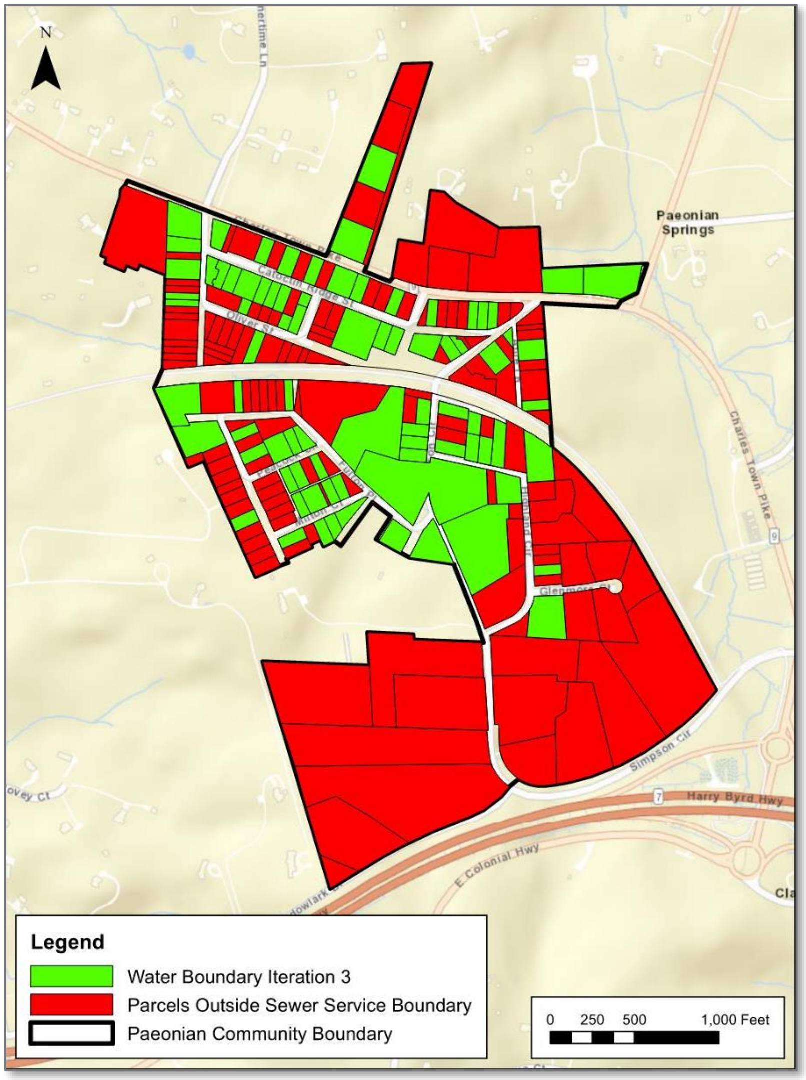

Figure 2-13 – Water Service Boundary Iteration #3

2.5.4 Iteration #4 (Water Boundary): Loudoun County Well Testing Results

In addition to the Health Department data, in August of 2021, Loudoun County performed testing of multiple wells throughout the Community on a volunteer basis and provided the results to Dewberry for incorporation into this memo. The purpose of the testing was to identify if certain existing wells in the Community have issues meeting current well drinking water standards.

The County's well testing included Total Coliform, E. coli, Nitrate and Nitrite, and Chloride in the drinking water of 30 volunteers. A presence-absence test was conducted for both Total Coliform and E. coli. Of the 30 wells tested, E. coli was identified as present in 3 wells, and total coliform was identified as present in 11 wells. The Nitrate/Nitrite levels ranged from 1.2 mg/l to 9.4 mg/l. The Environmental Protection Agency (EPA) has set an enforceable standard called a maximum contaminant level (MCL) in water for nitrates at 10 mg/L. All wells tested were below the MCL for nitrate. Chloride concentrations ranged from 14.2 mg/L to 242 mg/L. EPA Secondary Drinking Water Standards set an MCL in drinking water for chloride at 250 mg/L. All tested wells were below the MCL.

The presence of bacteria within the water presents public health risk, particularly with the presence of E. coli, which in addition to being a health risk could also be an indication of improperly functioning nearby sewage systems, sewage overflow, or polluted stormwater runoff entering the groundwater. Because the presence of E. coli or Total Coliform in drinking water poses a public health risk, all parcels with Total Coliform or E. coli present during well testing were considered in need of a new communal system and were subsequently added to the service boundary, shown in Figure 2-14.

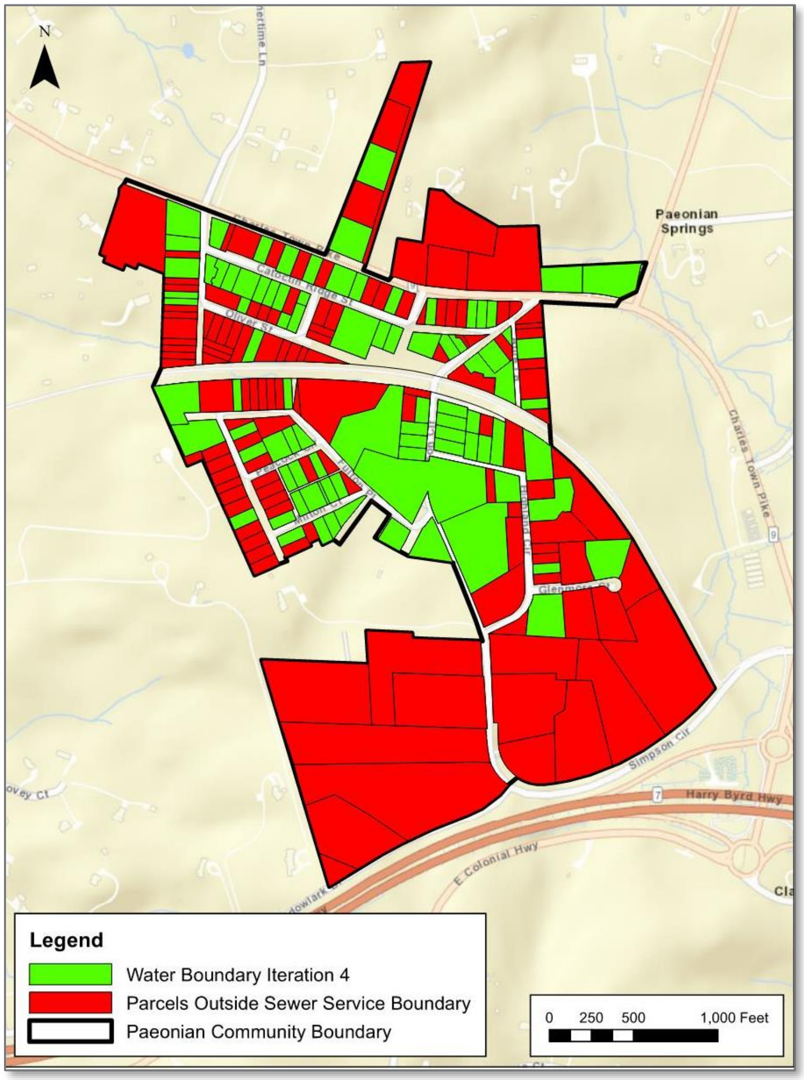

Figure 2-14 – Water Service Boundary Iteration #4

2.5.5 Iteration #5 (Water Boundary): Adjacent Parcel Inclusion

The final water boundary consideration was parcel location in relation to the proposed infrastructure layout. As described in the Sewer Service Area Boundary Determination section of this TM, the utility layout necessary for including all parcels in need of a communal solution runs along multiple parcels which were not included in the boundary via the previous criteria. Because they are located adjacent to the proposed waterline layout, these parcels were included in the final iteration of the water boundary, as shown in Figure 2-15.

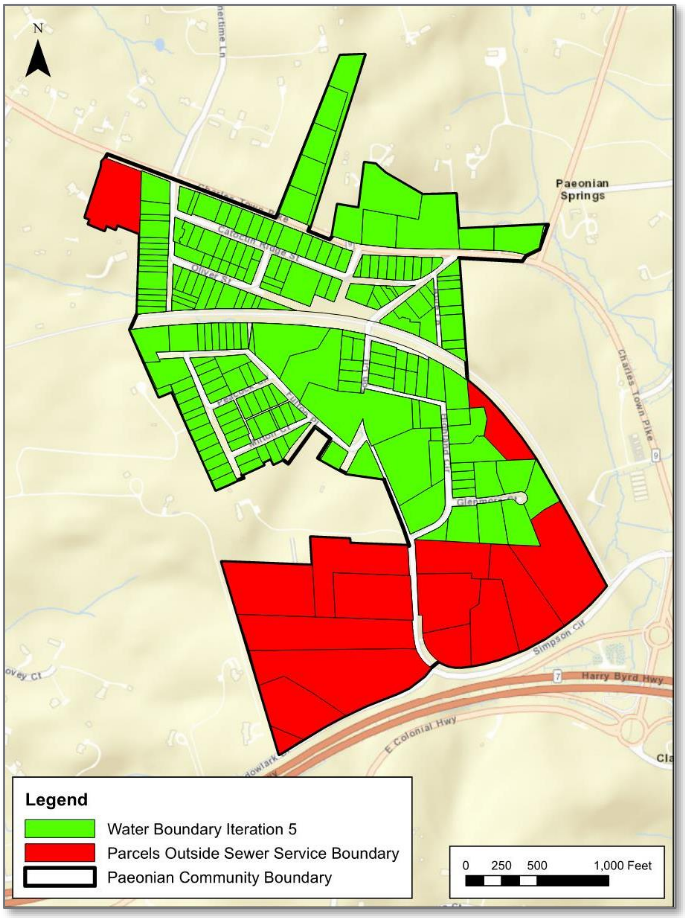

Figure 2-15 – Water Service Boundary Iteration #5 (Final)

2.6 Recommended Boundaries

After developing separate boundaries for the water and wastewater systems, a final, combined service area boundary was created for both water and wastewater systems. The combined service area would be planned to serve all parcels within the proposed boundary with both water and sewer. This boundary represents parcels based on public health need, proximity to proposed utility lines, and soil conditions.

Addressing failures associated with septic systems is more challenging than water systems due to the large size of the systems and space available on existing parcels. Therefore, a wastewater-only alternative was considered. Providing a wastewater-only system will result in septic system elimination and may allow homeowners to address groundwater issues by installing new wells within areas previously utilized as buffers to meet required septic system setbacks. However, this may not address well yield issues and studies have shown that elimination of septic systems could further compound well yield issues as a result of long-term aquifer depletion due to elimination of effluent dispersal. Therefore, it is recommended that the boundary be combined to provide both water and wastewater solutions for the Community. The final overall Paeonian Springs Community service boundary is shown in Figure 2-16.

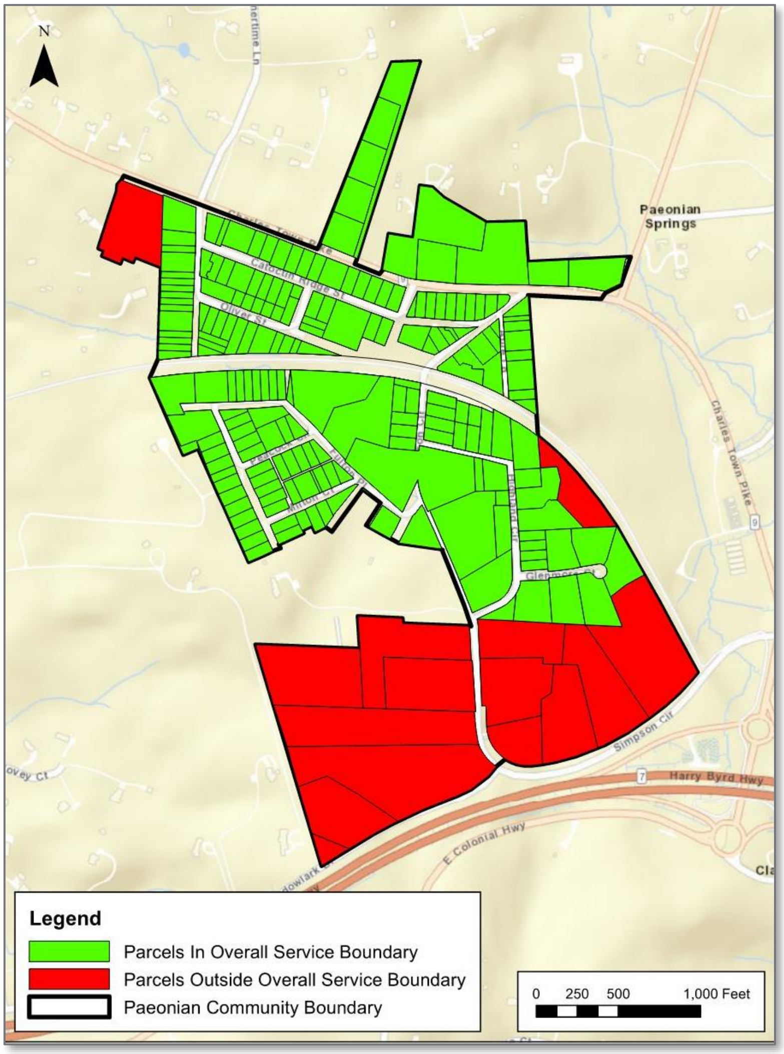

Figure 2-16 – Final Overall Paeonian Springs Service Boundary

2.7 Preliminary Utility Layout: Community Water Distribution & Sewage Collection

Based on the boundaries determined above, a preliminary layout was developed for both the proposed water and sewer lines to reach all parcels within the boundary. The water and wastewater layouts assume that there are limited existing utilities within the roadway throughout the Community, and are available for water and sewer main construction. During design, utility designation will be required to identify potential conflicts for placement of the water and sewer layouts. Additionally, because the water and sewer layouts are being proposed to run parallel to one another, a minimum separation distance of 10-feet will be required per 12VAC5-590-1150.

The 2019 Feasibility Study included a preliminary layout for a communal utility system for the entire Community. The preliminary layout was used as a basis for developing the new layout for the updated service area boundary. The new proposed system layout assumed a low-pressure sewer system, as was recommended in the original Feasibility Study. A low-pressure sewer system provides ultimate flexibility for discharge locations for the sewer system to site a pump station, if necessary.

The proposed layouts follow the Community streets to serve all parcels within the boundary. The water distribution system layout is shown in Figure 2-17. Figure 2-18 shows the wastewater collection system layout.

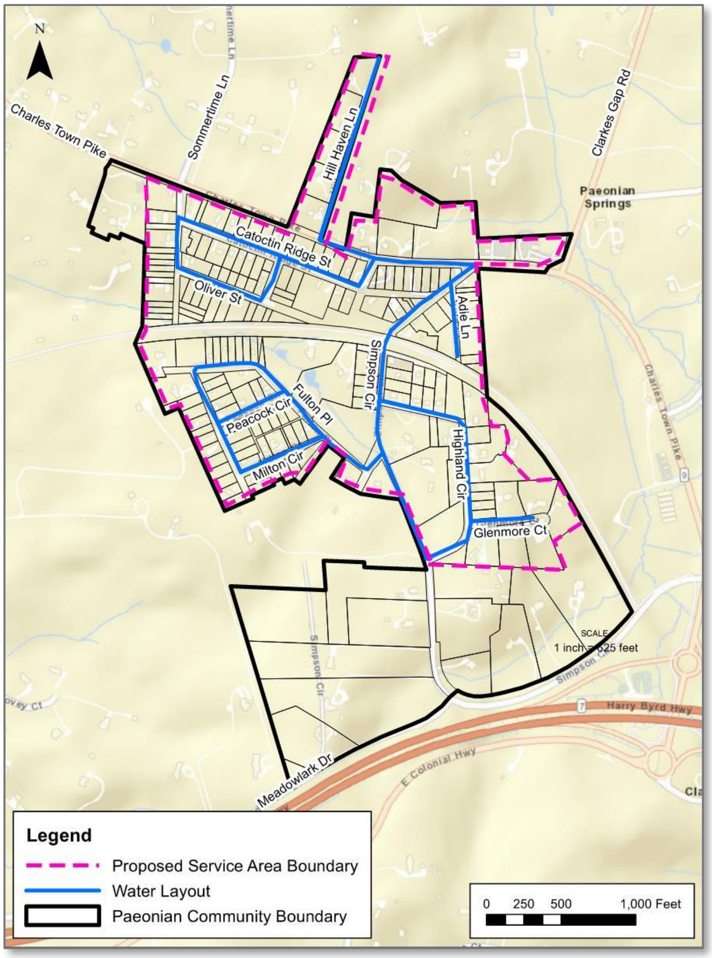

Figure 2-17 – Preliminary Water Layout

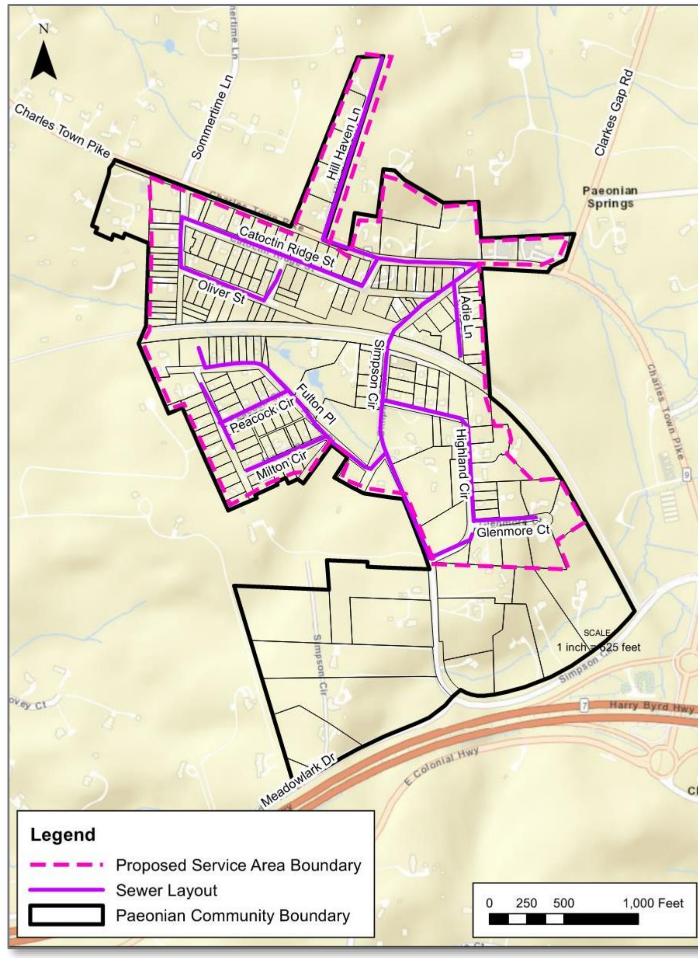

Figure 2-18 – Preliminary Sewer Layout

These preliminary layouts consider water distribution and wastewater collection only. The water system connection to a water source and the wastewater system connection to a discharge/treatment location are considered in subsequent sections. Treatment and supply potential alternatives for the water and wastewater systems include:

- Connection to a Nearby Municipality (Town of Purcellville or Town of Hamilton)
- Wastewater Treatment Surface Discharge

Prior to consideration of the nearby connections, a preliminary flow analysis was performed to determine water demand and sewer flow based on the two approaches considered: parcel-by-parcel versus property (single address).

2.8 Water & Wastewater Demand for Parcel vs Property Boundary Determination

As discussed in Section 2.2, two methods were considered for the process of service area boundary determination. To avoid future issues associated with multi-parcel properties being divided and sold separately, the decision was made to use a parcel-by-parcel approach.

The use of a parcel-by-parcel approach has the potential to lead to overly conservative design parameters related to water demand and sewage flows which could lead to an oversized system. A preliminary analysis of these design parameters was performed to demonstrate and compare the flows for each the two methods considered.

2.8.1 Demand Comparison

The 2019 Feasibility Study used requirements from Loudoun Water, Loudoun County, Virginia Administrative Code 12VAC5-590-690 and Virginia Water Works Regulations to estimate current and potential future flows for the Community's water and sewer systems. The estimations in the Feasibility Study were developed VAC-under the assumption that the entire Community would be included in the service boundary. Using the new boundary defined in this TM, water and sewage demand flow calculations were updated. Virginia Department of Health (VDH) capacity of waterworks regulations for daily water consumption rates and SCAT regulations for sewage flow estimates for residential, gas/service stations, restaurants, and commercial/office spaces were used as a basis for calculating the new demand flows. The demand flows were generated for the results of each boundary determination approach.

For the parcel-by-parcel method, a conservative approach was taken to assume that all parcels would be fully developed. Under the 2019 Feasibility Study, water demand estimates were based on Virginia Administrative Code 12VAC5-590-690, which has since been repealed. The updated water demand performed under this task utilizes the Loudoun Water EDM Requirements. Table 2-5 shows the Loudoun Water EDM water demand loading rates.

Table 2-5 – Loudoun Water EDM Water Demand Loading Rates

Facility	Units	Demand (gpd)
Residential	Per Dwelling Unit	300
Commercial/Industrial	Per Employee	100
School	Per Staff/Student	20

In addition to these loading rates, the following additional requirements from Loudoun Water, Loudoun County, and Virginia Water Works had to be considered:

- Loudoun Water: 1.2 gpm/connection (1,728 gpd/connection)
- Loudoun County: 1.0 gpm/connection (1,440 gpd/connection)
- Virginia Water Works Regulations: 0.5 gpm/connection (720 gpd/connection)

In the 2019 Feasibility Study, 300 gpd was used for the residential water demand loading rate based on historic flows. For consistency and an accurate comparison, 300 gpd was again used to estimate residential water demand for residential parcels within the Community. It should be noted that fire flow demand is not accounted for in these estimates and is not required in the rural policy area. Fire protective devices such as dry hydrants and storage facilities can be installed to provide added protection. Ultimately, however, the Loudoun Water connection demand requirement of 1.2 gpm/connection controlled the water demand results. SCAT regulations, summarized in Table 2-6 below, dictated the sewer demand calculations.

Table 2-6 – SCAT Regulation Sewer Demand Loading Rates

Facility	Units	Demand (gpd)
Residential	Per Dwelling Unit	300
Restaurant/Market	Per Seat	50
Commercial	Per Square Foot	0.16
Gas Station	Per Vehicle	10

Table 2-7 below summarizes water demand and sewage flows associated with each approach.

Table 2-7 – Average Daily Water Demand and Sewage Flows

Method	No. of Connections	Water Demand (gpd)	Sewage Flow (gpd)
2019 Feasibility Study	216	373,000	70,365
1. Parcel-By-Parcel	201	350,000	65,841
2. By Property	109	190,000	38,241

As shown in the table, the use of the parcel-by-parcel approach significantly increases the average daily water demand and sewage flows. A system designed to handle flows for a full build-out (all parcels being developed) has the potential for long-term operation and maintenance issues associated with low flows and demand if development potential is not realized. In order to prevent these future O&M issues, it is essential that a specific number of connections be established at the start of operation and remain unchanged throughout the service life of the system. The actual number of connections and estimated demand and flow projections will be finalized to mitigate risk of long-term O&M during the preliminary design and through the commission permit process.

Further investigation into potential development will be required to effectively design and size both the water and wastewater systems.

It should be noted that both methods decrease the number of connections and flow from the original study due to the new boundary. However, the decrease in connections and corresponding demand and flow using Method 1 is minor.

3.0 NEARBY MUNICIPAL CONNECTIONS

3.1 Overview of Nearby Municipalities

As mentioned above, the 2019 Comprehensive Plan allows utility connections from Rural Policy Areas to municipalities, subject to restrictions. Two Community connections were considered to address the water and wastewater needs of the Paeonian Springs Community. The nearby municipalities considered for potential water and wastewater connection points include the Town of Hamilton and the Town of Purcellville, which are shown in Figure 3-1. This section will present preliminary connection alignments, identify associated challenges, and present the feasibility of each alternative.

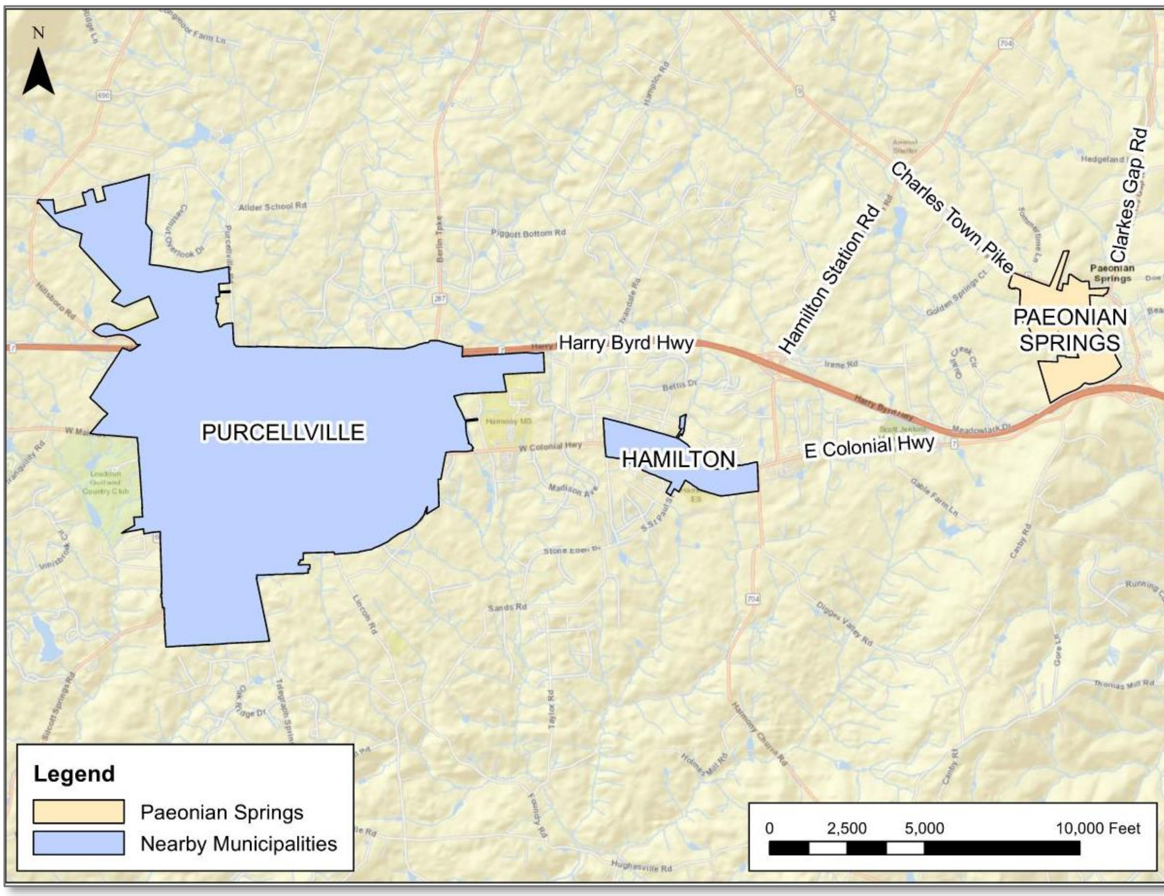

Figure 3-1 – Map of Paeonian Springs, Hamilton, and Purcellville

3.1.1 Town of Hamilton

The Town of Hamilton (Hamilton) is located approximately 2 miles southwest of Paeonian Springs, south of Harry Byrd Hwy on Colonial Hwy. Hamilton is served by a municipal water and wastewater system.

HAMILTON WASTEWATER SYSTEM

Hamilton's wastewater system consists of force mains and gravity lines, ranging in size from 8 to 12-inches, and three pump stations which carry wastewater to the Town of Hamilton Sewage Treatment Plant. The wastewater treatment plant is located at 104 N Rogers Street., Hamilton, VA 20158. The wastewater system is operated and maintained by the Town of Hamilton through a contract with Inboden Environmental Services, Inc. The majority of the system was installed in 1965.

The Town of Hamilton Sewage Treatment Plant utilizes a conventional activated sludge process for treatment, before discharging the treated water into an unnamed tributary of the South Fork of Catoctin Creek. The sewer system currently serves residents within the Town Boundary as well as customers located in the immediate vicinity of the Town within the Joint Land Management Area (JLMA).

The current wastewater treatment plant has a design capacity of 0.16 million gallons per day (MGD) and the current average daily flow is approximately 0.11 MGD. The sewer system has significant issues with inflow and infiltration (I/I), which has caused the design capacity of the wastewater treatment plant to be exceeded during significant wet weather events.

Due to the existing capacity constraints related to I/I, a sewer connection moratorium has been in place since 2015 and was most recently reconsidered in January 2020 by the Town Council, but not lifted.

Based on the current system capacity constraints, it is not likely that the Town of Hamilton will be capable of accepting the additional flow from Paeonian Springs. Connection would require approval from the Town Council and additional investigation into capacity availability. Should it be determined to be feasible to connect to the wastewater system, a pump station would be constructed in Paeonian Springs to convey the wastewater to the Town of Hamilton.

It should be noted that the Town of Hamilton has had discussions with the Town of Purcellville to provide a connection for a combined system in the past. Those discussions did not proceed to an actual project, however, with the proposed modifications to the comprehensive plan, this option may be revisited. Should this connection occur, available capacity may be realized. However, the timing of such connection is unknown and cannot be relied upon for making a recommendation.

HAMILTON WATER SYSTEM

Hamilton's water system is served by groundwater from five wells located throughout the Town. Four of the wells serve as the primary water sources and the fifth is an "emergency" use well and is not operated on a regular basis.

The water system currently produces sufficient water to serve the Town of Hamilton connections with average daily demand of 0.09 MGD.

Additional analysis will be required to determine the total yields for the five wells that serve the Town of Hamilton to determine if the system has capacity and storage necessary to serve the Paeonian Springs Community. Furthermore, any improvements necessary (i.e. Pump Station, water storage tank, etc.) would require town approval.

3.1.2 Town of Purcellville

The Town of Purcellville (Purcellville) is located approximately 4 miles west of Paeonian Springs and approximately 3 miles west of Hamilton along Route 7. Purcellville is served by wastewater and water system.

PURCELLVILLE WASTEWATER SYSTEM

Purcellville owns and operates their wastewater collection and treatment system. Purcellville's existing wastewater system consists of 35 miles of sewer lines including 2.5 miles of force main, four public town-run pump stations and four private pump stations. Purcellville's wastewater is treated at the Basham Simms Wastewater Facility, located at 1001 S 20th St, Purcellville, VA. The wastewater treatment facility has a capacity of 1.5 MGD and currently treats an average daily flow of 575,000 gallons per day. So, at average daily flow, the wastewater treatment plant utilizes less than half of its rated capacity.

Similar to the connection to the Town of Hamilton, a pump station and associated force main would be required to carry the wastewater flows from Paeonian Springs to Purcellville, where it would be discharged into the existing Purcellville system.

Paeonian Springs would likely be required to pay a connection fee to the Town of Purcellville to establish a connection and purchase capacity in the system.

PURCELLVILLE WATER SYSTEM

Purcellville's water system obtains water from both surface water and groundwater sources. The system consists of a surface water reservoir, five groundwater wells, two water storage tanks, 47 miles of waterline and a water treatment plant.

Similar to the wastewater system, the Town of Purcellville would need to accept the connection and verify that their water system has adequate capacity to provide the additional water demand. Paeonian Springs would likely be required to pay a connection fee to the Town of Purcellville to establish a connection and purchase capacity in the system. Furthermore, an additional pump station will likely be required to convey water from the Town of Purcellville to Paeonian Springs. Water modeling would be required to determine the system functionality.

3.2 Alignment Alternatives

As part of the municipal connection analysis, alignment alternatives for connection to both of the considered nearby towns were developed. The proposed alignments were developed using the proposed utility layout detailed in Section 2.0 of this TM as a basis for determining points where the utility lines might exit the Community. Proposed alignments shown below begin at the southernmost point at which the water and sewer lines exited the Paeonian Springs Community from the intersection of Simpson Circle and Meadowlark Drive. This alignment can feasibly be applied for the water system, but the wastewater system would require a pump station located in the vicinity of the Community to act as a central collection point and pump the wastewater via a force main to the nearby municipalities. The potential location for the pump station, identified in the original feasibility study based on an analysis of the Community topography, may be the most feasible location. Should the County wish to identify additional potential locations, further analysis would need to be conducted. Depending on the type of system installed, there may be flexibility with the pump station location.

Alignment alternatives were developed for the municipal connections. The proposed alignments connect the municipalities to the proposed Paeonian Springs Community utility layout shown in the Service Area Determination section. Proposed alignments connect on the south side of the Community and follow Meadowlark Drive. The Community wastewater system will require a pump station to act as a central collection point and pump the wastewater via a force main to the nearby municipalities. Water could potentially be pumped directly into the Community distribution system.

For both alignment alternatives, it was assumed that no existing utilities were present in the proposed alignment locations. During design, utility designation will be required to determine the locations of any existing utilities.

The proposed alignment for the connection between Paeonian Springs and the Town of Hamilton begins at the intersection of Simpson Circle and Meadowlark Drive on the south side of the Community. The proposed water and sewer lines run south, crossing beneath Harry Byrd Hwy and then turn west along E Colonial Hwy. The proposed lines follow E Colonial Hwy west for approximately 11,000 LF before reaching the boundary of the Town of Hamilton. Here the proposed sewer connection will tie into the existing manhole at the corner of E Colonial Hwy and Harmony Church Road. The preliminary utility alignment for the connection between Paeonian Springs and the Town of Hamilton is shown in Figure 3-2 below.

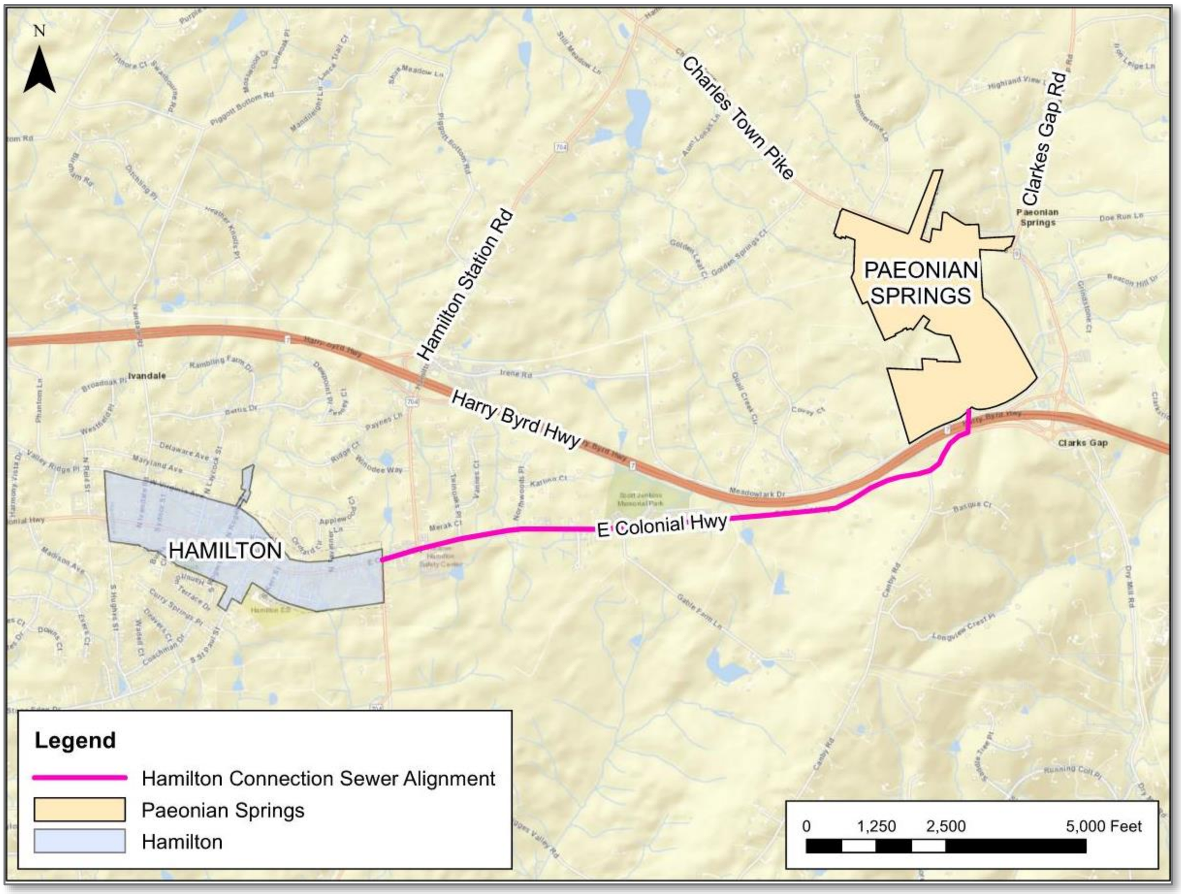

Figure 3-2 – Preliminary Hamilton Connection Alignment

The proposed alignment for the connection between Paeonian Springs and the Town of Purcellville begins at the intersection of Simpson Circle and Meadowlark Drive on the south side of the Community. The proposed lines run south, crossing beneath Harry Byrd Hwy and then turn west along E Colonial Hwy. The proposed lines follow E Colonial Hwy west for approximately 23,000 LF before reaching the proposed a connection point to the Town. The proposed sewer connection ties into an existing manhole just west of the intersection of E Colonial Hwy and Berlin Turnpike. The preliminary alignment for the sewer connection to the Town of Purcellville is shown in Figure 3-3.

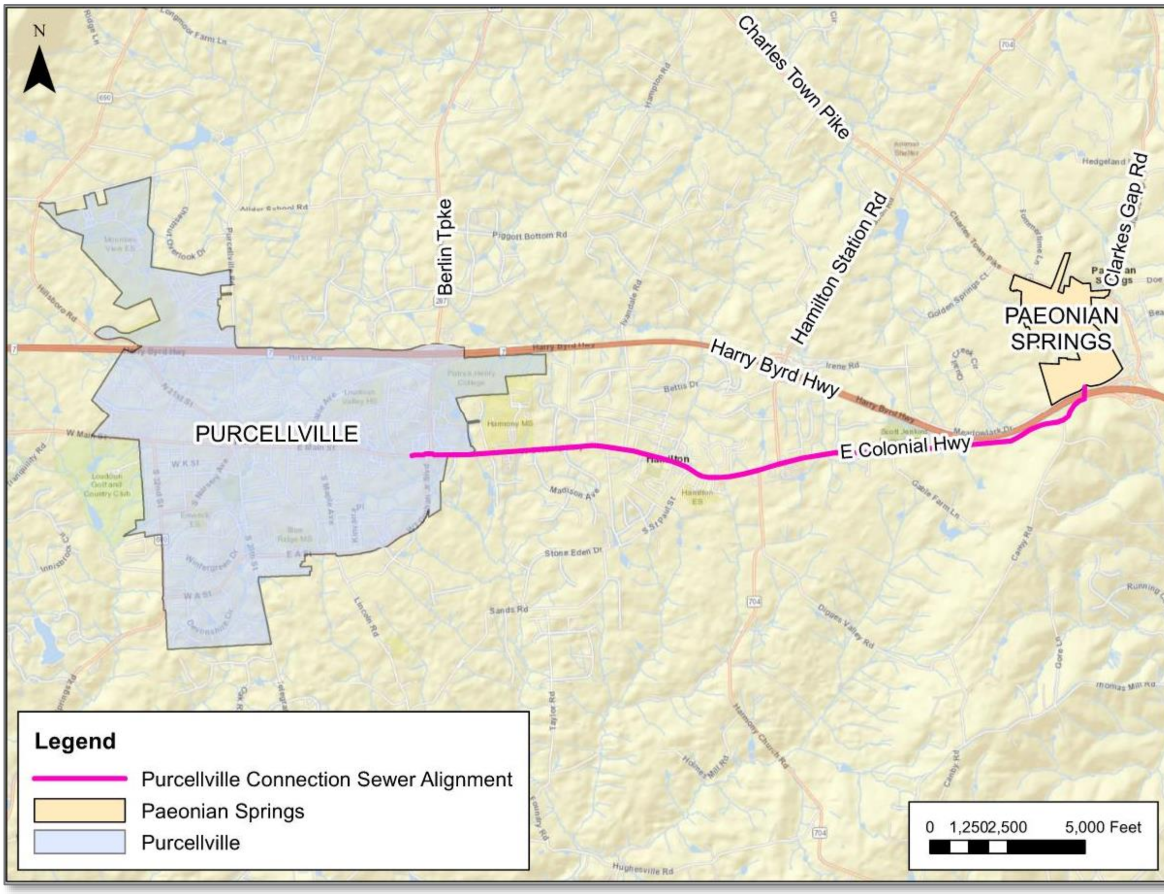

Figure 3-3 – Preliminary Purcellville Connection Alignment

The tie-in points for the wastewater discharge assumes that the existing municipal sewer systems have sufficient capacity to accept the additional flows from Paeonian Springs. Additional analysis in conjunction with the nearby municipalities would be required to determine the capacity of the systems.

3.3 Preliminary Profile

Preliminary pipe profiles were developed for each connection alternative. The anticipated vertical alignment for the Town of Hamilton connection is shown in Figure 3-4. The alignment starts at the intersection of Simpson Circle and Meadowlark Drive where the new proposed system exits the Paeonian Springs Community to the existing manhole at the Town of Hamilton's boundary. The preliminary profile for the Town of Purcellville connection alternative, as shown in Figure 3-5, depicts the vertical alignment of the proposed connection from the Paeonian Springs Community to the connection point near the Town's eastern boundary.

Generally, the topography decreases in elevation for both profiles with several high points. As shown in the profiles, the highest topographical feature is located near the Paeonian Springs Community. This high point is caused by the elevated Harry Byrd Highway, and will not be a significant high point for the systems as implied by the profiles. Based on the profile, a connection with a pump station and force main is technically feasible from a hydraulics perspective. Due to the elevation change, water systems may require a booster system to increase system pressures. A booster pumping station is not included in the cost estimate, which could increase project costs by approximately $1.5 million.

Figure 3-4 – Preliminary Paeonian Springs Connection to Hamilton Ground Elevations

Figure 3-5 – Preliminary Paeonian Springs Connection to Purcellville Ground Elevations

3.4 Constructability Challenges

Although technically feasible, constructing a water main and/or a sewage force main within roadways between municipalities will present constructability challenges. The Washington & Old Dominion Trail runs through the Paeonian Springs Community, dividing the service boundary. Because the service boundary includes parcels on both sides of the trail, the proposed water and sewer lines will be required to cross beneath the trail to service all the parcels in need. Coordination with Washington and Old Dominion Railroad Regional Park and Northern Virginia Regional Park Authority will be required during design and construction. All roads within the Community are owned by VDOT except for Adie Lane and Hill Haven Lane. For construction of the proposed water and sewer lines on these roads, coordination with the owner will be required. In addition to this, easement acquisition will be required to construct and maintain the water and sewer lines along these roads.

In addition to this, connection to either Hamilton or Purcellville requires extensive construction along and within major roadways with limited travel lanes. Colonial Highway has only two travel lanes until it reaches Purcellville. Extensive traffic control, detours, and local coordination will be required. Because the proposed connections require running water and sewer lines along and across E Colonial Hwy and Harry Byrd Hwy, traffic impacts will be experienced on these major roadways. Temporary lane closures may be required during construction of these sections. The proposed preliminary Purcellville connection requires extension of utilities through the Town of Hamilton which will result in temporary road closures and close coordination with the Town of Hamilton. Construction at the connection point of both town alternatives will also create roadway and traffic impacts that will require further coordination with the towns.

The proposed pipeline may also cross environmentally sensitive areas. Further research into potential environmental impacts will need to be conducted as part of the design phase of this project to determine if any mitigation will be required. In addition to this, numerous Community impacts will be created throughout the entire duration of the project. The Paeonian Springs Community's compact layout creates installation challenges as construction within the Community will have significant impact on residential traffic. During installation, daily temporary road closure operations throughout the Community are anticipated. Extensive coordination with community members in advance will be required.

3.5 Additional Connection Alternative

Another potential solution to the Paeonian Springs Community's water and/or sewer needs could involve a connection with the nearby village of Waterford. Waterford is an unincorporated village with National Historic Landmark designation located approximately 3 miles north of the Paeonian Springs Community. Analysis of this alternative was considered outside the scope of this report and a detailed feasibility analysis of this potential alternative has not been conducted. Should the County choose to pursue this alternative, additional technical evaluation would be required.

Based on preliminary desktop analysis, a connection between these systems is technically feasible. Waterford has an existing wastewater treatment facility that is scheduled for improvements and integrating additional flow could provide overall program cost savings. Conveying and treating sewage at a single location is anticipated to be the most cost-effective long-term solution. Challenges associated with permitting, policy and capacity would require further investigation.

Currently, Waterford does not have a formal community water system. However, it is currently under study to provide a communal solution. A joint communal approach to providing water for both communities could provide further cost savings by constructing one (1) well system and water treatment facility that would convey treated water to both areas. Further analysis of groundwater resources and siting would need to occur to determine a technically feasible approach. Policy and permitting questions would also require investigation.

4.0 SURFACE WATER DISCHARGE

4.1 Overview

An alternative for wastewater treatment and disposal for the Paeonian Springs Community is utilization of a wastewater treatment plant with surface water discharge. To determine the feasibility of siting a surface water discharging wastewater treatment plant near the Community involved the following tasks:

- Virtual Meeting with Virginia Department of Environmental Quality (VDEQ) to discuss the nutrient credit program
- Development of preliminary alternatives for siting a surface discharge treatment facility

Surface water discharge refers to direct discharge of treated effluent to surface water. The nearest surface water to the Community is South Fork Catoctin Creek. It is located northwest of the Community.

4.1.1 Discharge and Treatment Locations

DISCHARGE LOCATION & PERMITTING

South Fork Catoctin Creek is located to the northwest of Paeonian Springs. Several tributaries of South Fork Catoctin Creek are located near the Community. All three preliminary alternatives propose discharging the treated effluent into these tributaries. Because Catoctin Creek is a tributary of the Potomac River, treated effluent discharged into the tributary is subject to requirements of the Chesapeake Bay drainage area. Catoctin Creek is classified as a “Water of the United States (WOTUS).” According to the Clean Water Act, surface water discharge to a WOTUS requires a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permits control water pollution by regulating the discharge to surface water. The permit defines requirements for each discharger.

Virginia Department of Environmental Quality (VDEQ) requires special authorization to discharge into the tributary, including acquisition of nutrient credits, as well as adherence to strict discharge standards and permitting. VDEQ administers the NPDES program as the Virginia Pollutant Discharge Elimination System (VPDES). The permits are obtained through one of seven regional DEQ offices. VPDES permits are required for all point source discharges to surface water to limit pollutants entering streams, rivers, and bays as well as to establish load allocations to each individual point source.

The VPDES permits include stringent nutrient limits for dischargers in the Chesapeake Bay drainage area, which the South Fork Catoctin Creek falls into. Several discharge locations are presented in this section.

Stream modeling will be required to determine actual discharge location. The tributaries of the Catoctin Creek closest to the Community consist of perennial and seasonal streams. While there is no clear restriction of discharging into a seasonal stream, the technical feasibility of meeting effluent permit requirements is very low. However, it is recommended that the discharge location be in a perennial stream with constant base flow.

4.1.2 Nutrient Credits

In compliance with the Environmental Protection Agency’s (EPA) mandate to regulate nutrient discharge into the Chesapeake Bay, VDEQ created a nutrient credit trading program that offers credits for discharge of nitrogen and phosphorus into the Chesapeake Bay watershed. Virginia municipalities use these credits to limit discharge of effluent into the Bay and its tributaries to prevent excess nutrient loading. The treatment system will need to be designed to treat the wastewater to the limits of available technology. In addition to this, acquisition or utilization of credits for nitrogen and phosphorus discharge may be required to meet the advanced effluent discharge standards.

Based on discussions with VDEQ, nutrient credits within the Potomac River basin are nearly all allocated and purchasing or transferring credits would need to be obtained from existing dischargers with excess nutrient credits. The availability of these credits from these dischargers is unknown and will require outreach. Nutrient credits would need to be purchased to allow for surface discharge for the Community's wastewater treatment and disposal system.

Based on discussions with DEQ, nitrogen credits can be exchanged, or obtained, through the permitting process by accounting for the elimination of septic systems throughout the Community. Credit tradeoff is not one-for-one, meaning that the community will not meet the nitrogen credit requirements solely through the elimination of septic systems. Therefore, credits would need to be purchased for total nitrogen being discharged. However, phosphorous credits cannot be obtained through the elimination of septic systems. Therefore, phosphorous credits would need to be purchased through the credit exchange program. In either case, it is likely that nutrient credits will be required for both TN and TP to fully meet required effluent limits.

4.1.3 Standards & Permitting

As described above, the utilization of a wastewater treatment surface discharge facility will require strict compliance with various codes, standards, and regulations relating to surface discharge. Sewage Collection and Treatment (SCAT) regulations govern the design, construction, and operation of sewage systems and treatment works serving more than one residential or non-residential sewage source. Within the commonwealth of Virginia, SCAT regulations are administered by VDEQ and are found in Virginia Administrative code 9VAC25-790. These standards will govern design and operation of the proposed treatment facility.

In addition to SCAT regulations, VDEQ administers various permits that are required for all surface water discharge facilities. VDEQ oversees the Virginia Pollutant Discharge Eliminations System (VPDES) program in accordance with the Clean Water Act's aims to prevent pollutants from getting into streams, rivers, and bays. VDEQ requires any potential developer of a new sanitary sewer system and treatment facility to obtain a VPDES permit prior to construction. In addition to this, the developer must obtain a VDEQ "Certificate to Construct" permit (CTC). Upon completion of construction and as a condition for substantial completion, the developer must also obtain a "Certificate to Operate" permit (CTO) issued by VDEQ.

4.1.4 Discharge Location Alternatives

Three preliminary alternatives for the location of the surface discharge treatment facility were developed. The basis for the development of the alternatives consisted of identification of streams and tributaries available for discharge with perennial flow. All tributaries selected have flow year-round based on VDEQ online GIS data. Multiple tributaries near the Community are seasonal and were therefore not selected as potential discharge locations.

The discharge alternatives do not identify specific land parcels for construction of the treatment facility, but instead, general areas which provide a feasible point of discharge. For each alternative, the preliminary treatment facility can be sited within the identified area adjacent to the associated stream or tributary. (or potentially farther away and pumped?) Stream modeling will be required to determine feasibility of discharge locations prior to land acquisition. In addition, stream modeling may identify preferred discharge locations based on stream water quality and base stream flow.

4.2 Discharge Location Alternative #1

The first discharge alternative identified was at the south end of a tributary of the South Fork Catoctin Creek located just north of the Paeonian Springs Community. The tributary runs through several residential parcels located just outside the Community. The preliminary connection from the Community would approach the discharge facility by turning north off Charles Town Pike and following Sommertime Lane to the proposed location. The total pipe required to make this connection is approximately 3,500 LF. The potential alignment for this infrastructure may require easements through privately owned roadways. The general location identified for the discharge treatment facility for Alternative #1 is shown in Figure 4-1.

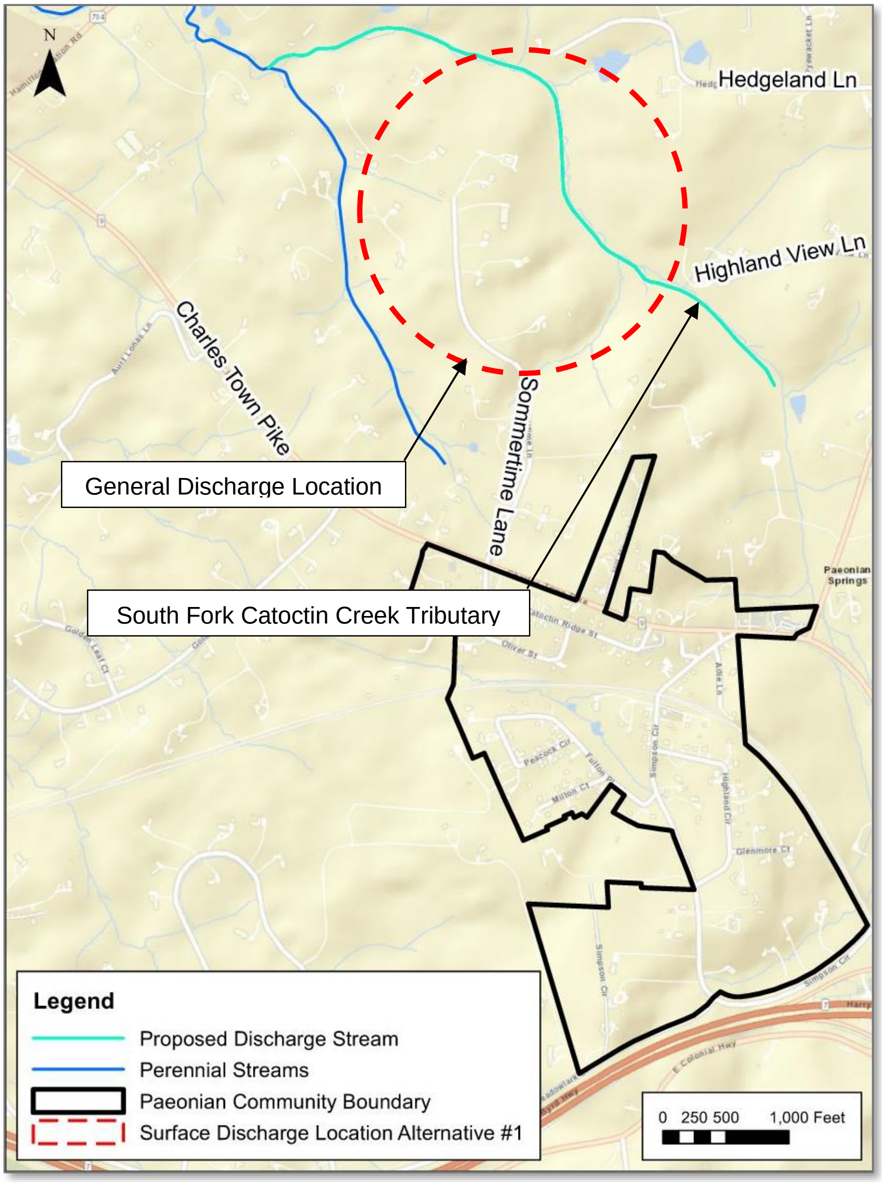

Figure 4-1 – Discharge Treatment Facility Location Alternative #1

4.3 Discharge Location Alternative #2

A second discharge location alternative that was identified is a tributary of the South Fork of Catoctin Creek located northwest of Paeonian Springs approximately 3,000 LF down Charles Town Pike. The tributary stream begins just north of Kalnasy Pond and runs northwest before discharging into Catoctin Creek. The general proposed location of the treatment facility for this alternative includes several large land parcels near the intersection of Charles Town Pike and Hamilton Station Road.

Connection from the Community's system to this discharge location would involve running the sanitary sewer line northwest along Charles Town Pike for approximately 3,000 LF before turning southwest onto the potential discharge facility site. The discharge treatment facility location for Alternative #2 is shown in Figure 4-2.

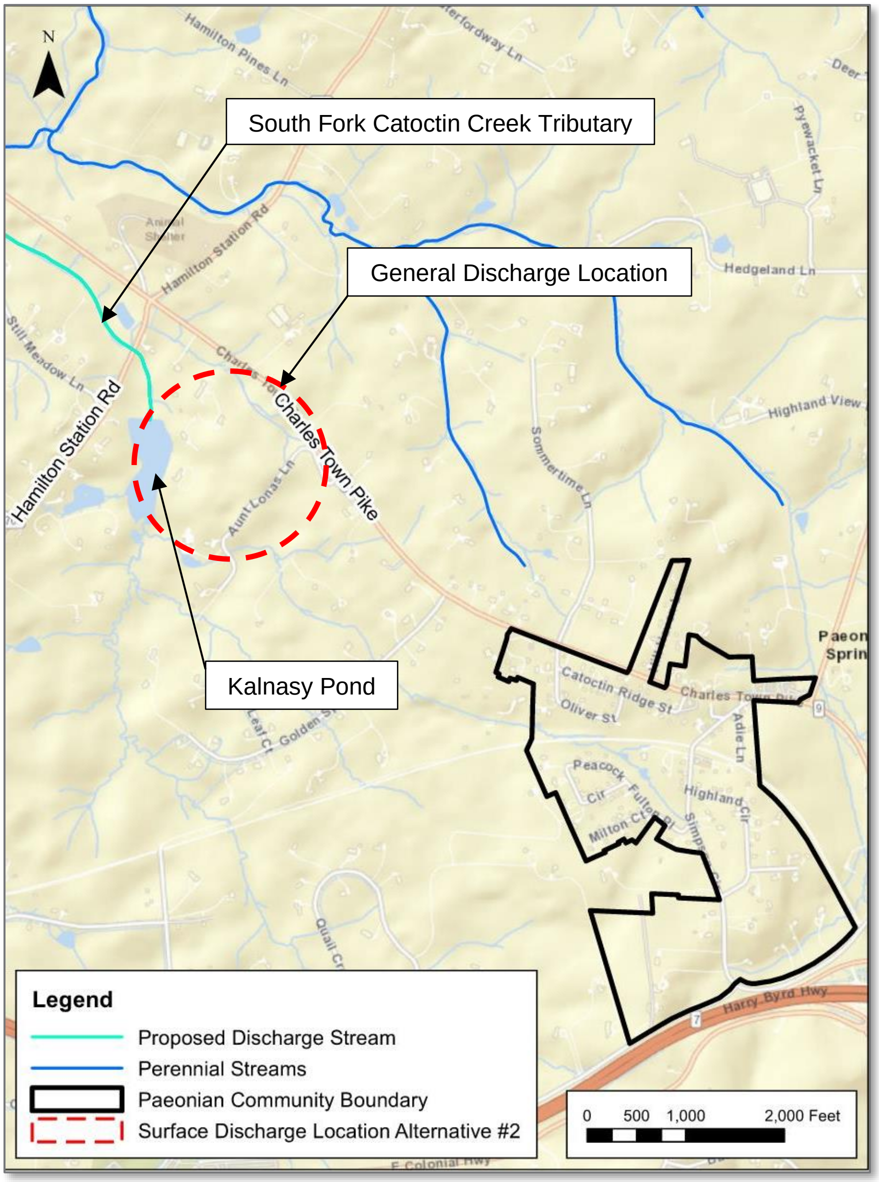

Figure 4-2 – Discharge Treatment Facility Location Alternative #2

4.4 Discharge Location Alternative #3

The third discharge location alternative that was identified is a tributary of the South Fork of Catoctin Creek located northwest of Paeonian Springs approximately 7,500 LF down Charles Town Pike. The tributary is located on the north side of Charles Town Pike. The general proposed location of the treatment facility for this alternative includes several land parcels on the north side of Charles Town Pike approximately 2,200 LF beyond the intersection of Charles Town Pike and Hamilton Station Road.

While the site is further away from the Community than the sites of Alternatives #1 or #2 and may, as a result, incur a slightly greater cost of construction, it is still reasonably close to Paeonian Springs. Connection from the Community's system to this discharge location would involve running the sanitary sewer line northwest along Charles Town Pike for approximately 7,500 LF before turning northeast onto the potential discharge facility site. The discharge treatment facility location for Alternative #3 is shown in Figure 4-3.

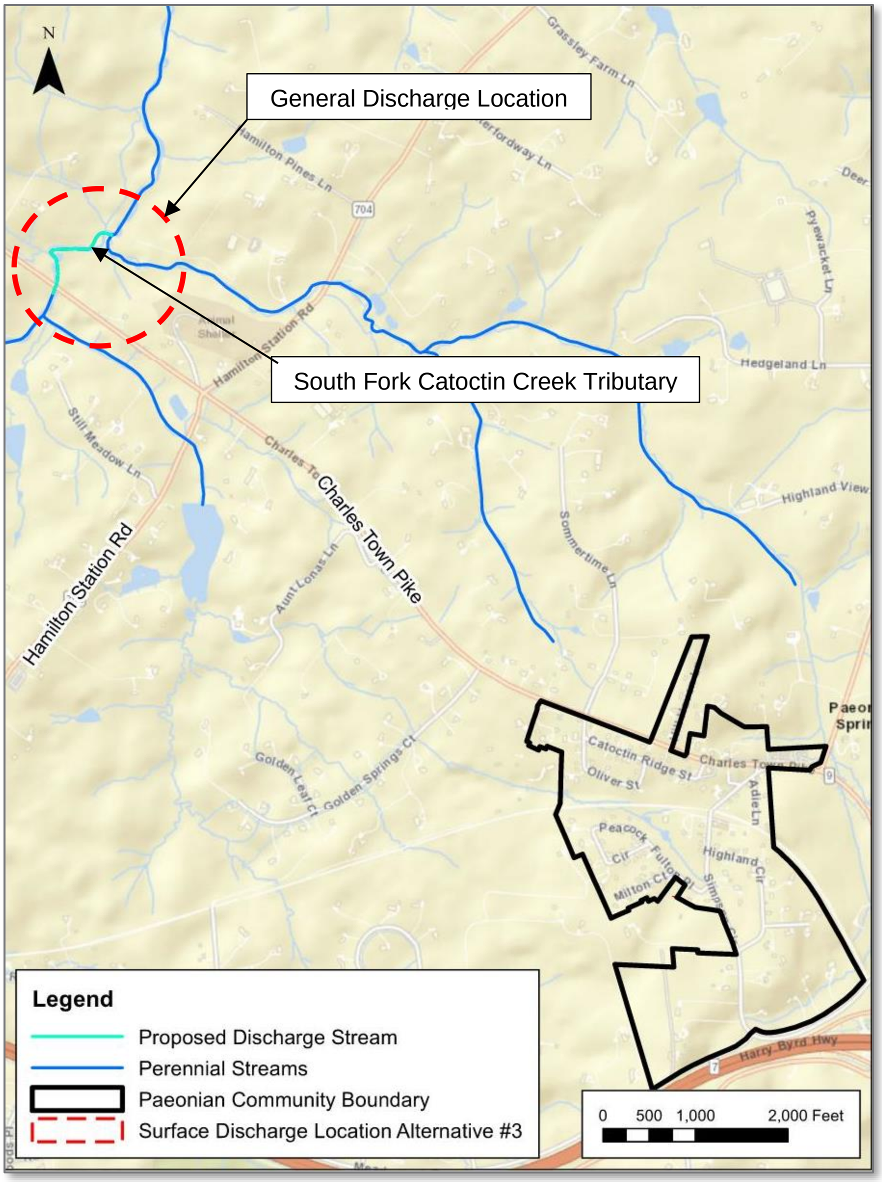

Figure 4-3 – Discharge Treatment Facility Location Alternative #3

It should be noted that since recommendations were not included in the scope of this TM, these preliminary discharge locations were developed for the purpose of providing potential alternatives for the County's consideration and should not be interpreted as formal recommendations. Land acquisition, parcel research and easement determination were not included in this preliminary work. Therefore, land availability will require additional investigation. Ultimately, the feasibility of any of the potential site locations is dependent upon land availability and will be driven by cost of acquisition.

Although technically feasible based on preliminary analysis, these discharge locations and their viability will depend on a number of additional factors with the most important being the effluent water quality. This will be dependent on the characteristics of the Community's wastewater and the nutrient levels being treated to based on the wastewater treatment selected. Additionally, as noted, surface discharge requires that nutrient credits be purchased.

4.5 Nutrient Removal Technologies

Because the proposed treatment alternatives discharge into surface waters that will end up in the Chesapeake Bay, the treatment facility will need to perform at levels meeting strict standards from the EPA and VDEQ. Due to these strict regulations regarding nutrient loading, optimum design of the facility includes development of a treatment process that minimizes levels of nitrogen and phosphorus in the effluent.

Nitrogen can be biologically removed through the nitrogen cycle as nitrogen gas and not discharged through the effluent, whereas phosphorous is mainly removed physically through sludge. Therefore, the more significant challenge is phosphorous removal. However, as previously mentioned, no current treatment process eliminates 100% of either nitrogen or phosphorous. Therefore, nutrient credits will need to be acquired for both nitrogen and phosphorous. The number of credits required will be dependent on the nutrient levels in the effluent after treatment.

As part of the surface water discharge analysis, Dewberry was tasked with developing a list of available treatment alternatives for effective phosphorus removal. The analysis included a review of publicly available literature and studies from federal, state, and local environmental agencies relating to surface water discharge treatment processes and technologies. The goal of this review was to compile a list of treatment technologies to serve as a basis for identifying feasible treatment methods to meet the Paeonian Springs Community's wastewater treatment needs. Based on our analysis, and availability of systems at this scale, the following summarizes our findings macroscopically. It should be noted that these groups of systems are high level and intended to focus on alternatives with the most effective phosphorous removal:

1. **Conventional treatment** (i.e. extended aeration, sequencing batch reactors, etc…) – conventional treatment technologies are often used to meet secondary treatment effluent limits as defined by DEQ. Conventional treatment is typically a biological process suitable for relatively high nitrogen effluent limits that removes total suspended solids and total nitrogen. These systems are very cost effective to construct and operate. However, these treatment alternatives may not meet effluent requirements, specifically for phosphorous and are not recommended for further consideration.

2. **Bioreactors** (i.e. fixed film bioreactors, moving bed biofilm reactors, etc…) – bioreactor systems use media to intensify biological activity in tanks to meet more stringent total nitrogen effluent limits. These systems are capable of meeting very low nitrogen limits, however, due to the nature of the media systems, do not provide levels of phosphorous removal necessary for a surface effluent facility in the Chesapeake Bay. Bioreactors are not recommended for further consideration.

3. **Advanced Filtration Systems** (i.e. membrane treatment systems, ultrafiltration systems, etc…) – advanced filtration systems use biological treatment systems followed by pressure filters to treat wastewater and meet stringent effluent limits. They are capable of meeting State-of-the-art (SOA) effluent limits or better and are considered to be best available technologies for systems of this scale. The micro and ultrafiltration systems provide best in class nitrogen and phosphorous reduction. The initial capital cost and long-term operating costs of these systems are the highest due to the complexity of these systems.

As outlined above, there is no available treatment system that will eliminate phosphorous from the effluent or capable of treating nitrogen to eliminate the need for credits, which will be the critical factor in siting and obtaining a discharge permit, meaning both nitrogen phosphorous credits will be required. However, advanced filtration systems will provide the most advanced level of phosphorous removal and are the basis of our recommendation moving forward.

5.0 SUMMARY, CONCLUSIONS, & BUDGETARY ESTIMATES

5.1 Project Overview and Previous Study

This updated memo for the Paeonian Springs Community's water and wastewater systems included the following:

- An in-depth study of the existing individual systems to aid in determination of a proposed service area boundary
- Evaluation of the feasibility of alternatives involving connection to nearby municipal systems
- An analysis of preliminary siting alternatives of a potential surface discharge wastewater treatment facility

An opinion of probable construction cost (OPCC) for each alternative discussed in this TM was developed. It should be noted the COVID-19 pandemic, supply chain issues, and inflation have contributed to volatility in construction costs. The budgetary estimates were developed using the most up to date industry standards and cost approximations based on a regional history. The estimates take the state of the current market into account but based on the volatility of pricing for certain items, there is potential for long-term effects to construction costs that may affect the project cost.

The 2019 Feasibility Study included an assessment of various alternatives for providing water and wastewater Community systems for the whole of the Paeonian Springs Community. The result of that report recommended the following:

- Communal well and treatment system located north of the Community
- Water distribution system serving 216 parcels
- Wastewater collection system serving 216 parcels
- Wastewater pumping station within the Community to convey sewage to remote treatment and drainfield area
- Communal conventional wastewater treatment facility with drainfield and dilution area.

A significant challenge identified through that report was the necessary land area for siting the treatment and drainfield areas to provide a sewage collection system to serve the whole of the Paeonian Springs Community. Depending on treatment level, effluent quality, and location, fifty-five (55) acres of land was preliminarily identified for siting water and wastewater facilities. The estimated total project cost from the 2019 study is summarized in Table 5-1 below, including design, permitting, surveying, collection systems, treatment and disposal systems as well as individual parcel improvements, road restoration, site work, and a line item for land acquisition costs.

Table 5-1 – Original 2019 Feasibility Study Cost Summary

2019 FEASIBILITY STUDY CAPITAL COST SUMMARY	
PAEONIAN SPRINGS WATER/WASTEWATER OPINION OF PROBABLE COST	
LINE ITEM	**ITEM COST**
Wastewater System (Serving 216 Parcels)	$12,226,000
Water System (Serving 216 Parcels)	$10,580,000
WATER/WASTEWATER CAPITAL COSTS	**$22,800,000**
LOW RANGE ESTIMATE (-20%)	$18,200,000
HIGH RANGE ESTIMATE (+30%)	$29,600,000
LAND ACQUISITION (55 acres)	$1,650,000
PROJECT TOTAL	**$24,450,000**

The OPCC developed with the 2019 study was prepared prior to the COVID-19 pandemic and the industry impacts associated with the supply chain, raw materials, and labor market. In order to compare current costs, the previous OPCC has been adjusted to reflect current market conditions. As noted above, the 2019 study assumed 216 parcels and fifty-five (55) acres of land necessary for drainfield and dilution areas. The reduction in number of parcels for the new boundary has reduced both water and sewer demand and reduces the land area required for the system to approximately fifty-two (52) acres. Furthermore, the utilization of advanced treatment discussed in this TM may result in further reduction of necessary land acquisition.

Table 5-2 below, represents an adjusted OPCC that reflects both updated market conditions and a smaller land area requirement for water and wastewater systems to serve only the parcels within the boundary as determined in this TM. This OPCC is used for comparative purposes to the newest alternatives and is approximately a 25% increase in total cost over 2019.

Table 5-2 – Adjusted 2019 Study Cost Summary

ADJUSTED 2019 FEASIBILITY STUDY CAPITAL COST SUMMARY[1]	
PAEONIAN SPRINGS WATER/WASTEWATER OPINION OF PROBABLE COST	
LINE ITEM	ITEM COST
Wastewater System (Serving 201 Parcels)	$17,897,000
Water System (Serving 201 Parcels)	$11,539,000
WATER/WASTEWATER CAPITAL COSTS	**$29,436,000**
LOW RANGE ESTIMATE (-20%)	$23,549,000
HIGH RANGE ESTIMATE (+30%)	$38,267,000
LAND ACQUISITION (52 acres)	$1,560,000
PROJECT TOTAL	**$30,996,000**

5.2 Project Alternatives

This technical memorandum further assessed parcels within the original boundary to redefine a service area based on public health need. The new service area reduced the total number of parcels from 216 to 201 and subsequently reduced demand and flow requirements for water and sewer systems. This evaluation included the following components:

- Wastewater Collection System
- Water Distribution System
- Connection to Hamilton
- Connection to Purcellville
- Surface Water Discharging Wastewater Treatment Facility

5.3 Wastewater Collection System OPCC

Cost estimates for the wastewater collection and water distribution & treatment systems are shown in Table 5-2**,** Table 5-3 and Table 5-4 , respectively.

Table 5-2 includes costs for only the wastewater collection system within the service area boundary defined within this TM. This cost estimate assumes a low-pressure sewer system, and interim pump station.

Table 5-2 – Community Wastewater Collection System OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
WASTEWATER COLLECTION SYSTEM INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
1.25-in thru 4-in Low Pressure System w/ valves, fittings, & connections	LF	11,500	$250	$2,875,000
Sewage Pump Station	EA	1	$1,500,000	$1,500,000
Individual Parcel Improvements	EA	201	$16,000	$3,216,000
Road Restoration & Site Work	SF	57,500	$17.50	$1,006,000
Mill & Overlay	SF	207,000	$3.50	$725,000
WASTEWATER COLLECTION SYSTEM TOTAL				***$9,322,000***
LOW RANGE ESTIMATE (-20%)				**$7,458,000**
HIGH RANGE ESTIMATE (+30%)				**$12,119,000**
[1] Land Acquisition costs and individual connection fees are not included in this estimate.				

5.4 Water Treatment and Distribution System OPCC

As outlined in the 2019 Feasibility Study, cost estimates for an alternative involving a potential communal groundwater well and treatment system were formulated. This alternative assumed the Community system would be connected with a groundwater well located just north of the Community and is outlined in the Feasibility Study. The new service area boundary did not change the high-level estimates for this alternative from the 2019 study other than adjusting for current market conditions and number of parcels being served.

Table 5-3 includes the costs for the water distribution system within the service area boundary and Table 5-4 includes costs for construction of a well, water treatment system, and water main to carry flows to the service area.

Table 5-3 – Community Water Distribution System OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
WATER DISTRIBUTION SYSTEM INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
6-in Ductile Iron or PVC Water Main System w/ ARVs, BOVs	LF	11,500	$300	$3,450,000
Water Meter and Service Installation	EA	201	$3,250	$653,000
Road Restoration & Site Work	SF	57,500	$17.50	$1,006,000
Mill & Overlay	SF	207,000	$3.50	$725,000
Individual Parcel Improvements	EA	201	$1,500.00	$301,500
WATER DISTRIBUTION SYSTEM TOTAL				***$6,136,000***
LOW RANGE ESTIMATE (-20%)				**$4,909,000**
HIGH RANGE ESTIMATE (+30%)				**$7,977,000**
[1] Land Acquisition costs and individual connection fees are not included in this estimate.				

Table 5-4 – Water System Well/Treatment OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
WATER SYSTEM WELL/TREATMENT INSTALLATION				
LINE ITEM	UNITS	QUANTITY	UNIT PRICE	ITEM COST
Furnish and Install 6" DIP Watermain	LF	2,800	$300	$840,000
Groundwater Well (250 VF of 8" Well and Casing)	LF	750	$85	$64,000
Water Treatment System (greensand filtration, disinfection, pressurization, SCADA, etc…)	EA	1	$2,750,000	$2,750,000
Road Restoration & Site Work	SF	7,920	$17.50	$139,000
Mill & Overlay	SF	28,512	$3.50	$100,000
			WATER CONNECTION TOTAL	***$3,893,000***
			LOW RANGE ESTIMATE (-20%)	**$3,114,000**
			HIGH RANGE ESTIMATE (+30%)	**$5,061,000**
[1] Land Acquisition costs and connection fees are not included in this estimate.				

5.5 Municipal Connections OPCC

OPCC for the nearby municipal connections considered (Hamilton & Purcellville) were also developed. It should be noted that the costs for these alternatives are not affected by the boundary determination approach. These costs include only the work associated with conveyance of wastewater and water to and from the nearby municipal connections.

Costs associated with connection to the Town of Hamilton are shown in Table 5-5 and Table 5-6. Costs associated with connection of the water and sewer system to Purcellville are shown in Table 5-7 and Table 5-8. These costs do not account for upgrades or improvements, which may be required for either municipal plant to accommodate flows from Paeonian.

Table 5-5 – Hamilton Wastewater Connection Alternative OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
HAMILTON WASTEWATER CONNECTION INSTALLATION				
LINE ITEM	UNITS	QUANTITY	UNIT PRICE	ITEM COST
4-in Sewage Force Main	LF	13,000	$250	$3,250,000
Road Restoration & Site Work	SF	65,000	$17.50	$1,137,500
Mill & Overlay	SF	312,000	$3.50	$1,092,000
			WASTEWATER CONNECTION TOTAL	***$5,480,000***
			LOW RANGE ESTIMATE (-20%)	**$4,384,000**
			HIGH RANGE ESTIMATE (+30%)	**$7,124,000**
[1] This estimate does not include land acquisition costs, connection fees, or costs associated with upgrades or improvements, which may be required, to Hamilton's wastewater system to accommodate additional flows.				

Table 5-6 – Hamilton Water Connection Alternative OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
HAMILTON WATER CONNECTION INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
6-in Ductile Iron or PVC Water Main System w/ ARVs, BOVs	LF	13,000	$300	$3,900,00
Road Restoration & Site Work	SF	65,000	$17.50	$1,138,000
Mill & Overlay	SF	312,000	$3.50	$1,092,000
			WATER CONNECTION TOTAL	***$6,130,000***
			LOW RANGE ESTIMATE (-20%)	**$4,904,000**
			HIGH RANGE ESTIMATE (+30%)	**$7,969,000**
[1] This estimate does not include land acquisition costs, connection fees, or costs associated with upgrades or improvements, which may be required, to Hamilton's water system to accommodate additional flows.				

Table 5-7 – Purcellville Wastewater Connection Alternative OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
PURCELLVILLE WASTEWATER CONNECTION INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
4-in Sewage Force Main	LF	22,000	$250	$5,500,000
Road Restoration & Site Work	SF	110,000	$17.50	$1,925,000
Mill & Overlay	SF	528,000	$3.50	$1,848,000
			WASTEWATER CONNECTION TOTAL	***$9,273,000***
			LOW RANGE ESTIMATE (-20%)	**$7,418,000**
			HIGH RANGE ESTIMATE (+30%)	**$12,055,000**
[1] This estimate does not include land acquisition costs, connection fees, or costs associated with upgrades or improvements, which may be required, to Purcellville's wastewater system to accommodate additional flows.				

Table 5-8 – Purcellville Water Connection Alternative OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
PURCELLVILLE WATER CONNECTION INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
6-in Ductile Iron or PVC Water Main System w/ ARVs, BOVs	LF	22,000	$300	$6,600,000
Road Restoration & Site Work	SF	110,000	$17.50	$1,925,000
Mill & Overlay	SF	528,000	$3.50	$1,848,000
			WATER CONNECTION TOTAL	***$10,373,000***
			LOW RANGE ESTIMATE (-20%)	**$8,298,000**
			HIGH RANGE ESTIMATE (+30%)	**$13,485,000**
[1] This estimate does not include land acquisition costs, connection fees, or costs associated with upgrades or improvements, which may be required, to Purcellville's water system to accommodate additional flows.				

5.6 Surface Discharge WWTP OPCC

Cost estimates for the treatment facility and conveyance system were developed for both surface discharge site alternatives. As outlined above, there are three (3) different discharge locations have been shown. Due to the preliminary nature of this analysis, individual properties and force main alignment have not been finalized. The major cost differentiator for these alternatives is the length of the potential sewer force main. Table 5-9, Table 5-10, and Table 5-11 show the cost estimates for each of the three discharge locations. Because the discharge location has not been finalized, an average of these costs will be used for comparison of alternatives.

Table 5-9 – Surface Discharge Facility & Conveyance System Alternative #1 OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
SURFACE DISCHARGE FACILITY ALTERNATIVE #1 INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
4-in Sewage Force Main	LF	3,500	$250	$875,000
Advanced Treatment System	EA	1	$3,250,000	$3,250,000
Road Restoration & Site Work	SF	17,500	$17.50	$306,250
Mill & Overlay	SF	84,000	$3.50	$294,000
			WATER CONNECTION TOTAL	***$4,725,000***
			LOW RANGE ESTIMATE (-20%)	**$3,780,000**
			HIGH RANGE ESTIMATE (+30%)	**$6,143,000**
[1] Land Acquisition costs are not included in this estimate.				

Table 5-10 – Surface Discharge Facility & Conveyance System Alternative #2 OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
SURFACE DISCHARGE FACILITY ALTERNATIVE #2 INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
4-in Sewage Force Main	LF	3,000	$250	$750,000
Advanced Treatment System	EA	1	$3,250,000	$3,250,000
Road Restoration & Site Work	SF	15,000	$17.50	$262,500
Mill & Overlay	SF	72,000	$3.50	$252,000
			WATER CONNECTION TOTAL	***$4,515,000***
			LOW RANGE ESTIMATE (-20%)	**$3,612,000**
			HIGH RANGE ESTIMATE (+30%)	**$5,870,000**
[1] Land Acquisition costs are not included in this estimate.				

Table 5-11 – Surface Discharge Facility & Conveyance System Alternative #3 OPCC

OPINION OF PROBABLE CONSTRUCTION COST[1]				
SURFACE DISCHARGE FACILITY ALTERNATIVE #3 INSTALLATION				
LINE ITEM	**UNITS**	**QUANTITY**	**UNIT PRICE**	**ITEM COST**
4-in Sewage Force Main	LF	7,500	$250.00	$1,875,000
Advanced Treatment System	EA	1	$3,250,000	$3,250,000
Road Restoration & Site Work	SF	37,500	$17.50	$656,250
Mill & Overlay	SF	180,000	$3.50	$630,000
			WATER CONNECTION TOTAL	***$6,411,000***
			LOW RANGE ESTIMATE (-20%)	**$5,129,000**
			HIGH RANGE ESTIMATE (+30%)	**$8,334,000**
[1] Land Acquisition costs are not included in this estimate.				

5.7 Feasibility Study OPCC Update (Based on New Service Area Boundary)

The 2019 Feasibility Study estimated costs for creating communal solutions for the entire Paeonian Springs Community. The purpose of this TM was to update the design and budgetary information based on the newly determined service boundary. The tables below compare the estimated costs from the 2019 Feasibility Study (updated for 2022) with the estimated costs of each proposed alternative discussed in this TM. Table 5-12 compares the costs associated with the Community wastewater system, Table 5-13 compares costs associated with the Community water system, and Table 5-14 summarizes the results of Tables 5-12 and 5-13 for an overall system cost comparison. For estimates associated with surface discharge, the average pipe connection length of the three location alternatives was used.

Table 5-12 – Wastewater System Alternative Cost Comparison

PROJECT COST COMPARISON [1]				
PAEONIAN SPRINGS WASTEWATER SYSTEM				
LINE ITEM	**ORIGINAL STUDY (2022 COST) [2]**	**HAMILTON CONNECTION**	**PURCELLVILLE CONNECTION**	**SURFACE DISCHARGE**
Design, Permitting, & Surveying	$2,332,000	$2,220,000	$2,789,000	$2,181,000
Treatment and Disposal System	$4,350,000	-	-	$3,250,000
Collection System[3]	$5,450,000	$7,625,000	$9,875,000	$5,542,000
Low Pressure Collection System	*$2,875,000*	*$2,875,000*	*$2,875,000*	*$2,875,000*
Interim Pump Station	*$1,500,000*	*$1,500,000*	*$1,500,000*	*$1,500,000*
Force Main	*$1,075,000*	*$3,250,000*	*$5,500,000*	*$1,167,000*
Individual Parcel Improvements	$3,216,000	$3,216,000	$3,216,000	$3,216,000
Road Restoration & Site Work	$2,531,000	$3,960,500	$5,504,000	$2,531,000
TOTAL CAPITAL COSTS	$17,879,000	$17,022,000	$21,384,000	$16,720,000
LOW RANGE ESTIMATE (-20%)	$14,303,000	$13,618,000	$17,107,000	$13,376,000
HIGH RANGE ESTIMATE (+30%)	$23,243,000	$22,129,000	$27,799,000	$21,736,000

[1] Connection fees are not included in this estimate.
[2] Original Study estimates have been adjusted to reflect 2022 costs and updated boundary as outlined in this TM.
[3] Cumulative Line Item for collection system components.

Table 5-13 – Water System Alternative Cost Comparison

PROJECT COST COMPARISON[1]				
PAEONIAN SPRINGS WATER SYSTEM				
LINE ITEM	**ORIGINAL STUDY (2022 COST)[2]**	**HAMILTON CONNECTION**	**PURCELLVILLE CONNECTION**	**COMMUNAL WELL/TREATMENT**
Design, Permitting, & Surveying	$1,504,000	$1,840,000	$2,476,000	$1,504,000
Groundwater Well	$64,000	-	-	$64,000
Water Treatment System	$2,750,000	-	-	$2,750,000
Water Distribution System[3]	$4,943,000	$8,003,000	$10,703,000	$4,943,000
Transmission Main (Water Source to Community)	$840,000	$3,900,000	$6,600,000	$840,000
Distribution Main (within Community)	$3,450,000	$3,450,000	$3,450,000	$3,450,000
Water Meter & Service Installation	$653,000	$653,000	$653,000	$653,000
Individual Parcel Improvements	$301,500	$301,500	$301,500	$301,500
Road Restoration & Site Work	$1,970,000	$3,961,000	$5,504,000	$1,970,000
TOTAL CAPITAL COSTS	$11,533,000	$14,106,000	$18,985,000	$11,533,000
LOW RANGE ESTIMATE (-20%)	$9,226,000	$11,285,000	$15,188,000	$9,226,000
HIGH RANGE ESTIMATE (+30%)	$14,993,000	$18,338,000	$24,681,000	$14,993,000

[1] Connection fees are not included in this estimate.
[2] Original Study estimates have been updated to reflect 2022 costs and updated boundary as outlined in this TM.
[3] Cumulative Line Item for distribution system components.

Table 5-14 – Overall System Alternative Cost Comparison

PROJECT COST COMPARISON				
PAEONIAN SPRINGS OVERALL SYSTEM				
LINE ITEM	**ORIGINAL STUDY (2022 COST)[2]**	**HAMILTON CONNECTION[1]**	**PURCELLVILLE CONNECTION[1]**	**WELL & SURFACE DISCHARGE**
Wastewater System	$17,879,000	$17,022,000	$21,384,000	$16,720,000
Water System	$11,533,000	$14,106,000	$18,985,000	$11,533,000
TOTAL CAPITAL COSTS	$29,412,000	$31,128,000	$40,369,000	$28,253,000
LOW RANGE ESTIMATE (-20%)	$23,530,000	$24,902,000	$32,295,000	$22,602,000
HIGH RANGE ESTIMATE (+30%)	$38,236,000	$40,466,000	$52,480,000	$36,729,000
Land Acquisition ($30,000/acre)[3]	$1,560,000	-	-	$165,000[4]
PROJECT TOTAL	$30,972,000	$31,128,000	$40,369,000	$28,418,00

[1] Connection fees are not included in this estimate.
[2] Original Study estimates have been updated to reflect 2022 costs and updated boundary as outlined in this TM.
[3] Land acquisition costs for municipal connection alternatives are not included for this estimate.
[4] Assumes 3 acres for well facility and 2.5 acres of land required for the surface discharge wastewater treatment facility and outfall.

It should be noted that estimates for connections with both Hamilton and Purcellville do not include land acquisition costs or connection fees due to uncertainties associated with the need for various components of both municipal connection alternatives (i.e. water booster station, utility easement in public/private ROWs, etc.). These fees will greatly increase the costs of both alternatives. Because of this, these may not be economical solutions. In addition to this, these alternatives will be dependent on the Towns' willingness to allow Paeonian Springs to connect. Lastly, based on preliminary assessment of topography, and depending on the water systems for each town, water booster stations and other ancillary improvements such as water storage tank upgrades/additions may be required which would further increase project costs.

The new boundary slightly reduces the water and wastewater demands from the original TM, however, cost escalations over the past three years makes the solution from the original study more expensive than at that time. The surface discharge alternative is a technically feasible solution with similar overall costs to the subsurface discharge alternative outlined in the original study.

In summary, both the subsurface discharge alternative outlined in the original study and the surface discharge alternative analyzed in this memorandum are feasible alternatives with similar construction costs. The main challenge, and cost variable associated with subsurface discharge will be land acquisition to meet the requirements of a drainfield and dilution area. The most significant challenge associated with the surface discharge alternative will be discharge permit compliance, nutrient credits and land acquisition for treatment facility siting.

APPENDIX A
DESKTOP SOIL ANALYSIS