Date of the Meeting: November 19, 2024

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BOARD OF SUPERVISORS
BUSINESS MEETING
ACTION ITEM

SUBJECT: **FINANCE/GOVERNMENT OPERATIONS AND ECONOMIC DEVELOPMENT COMMITTEE REPORT: Paeonian Springs and Waterford Joint Water and Wastewater System Feasibility Study Findings**

ELECTION DISTRICT(S): Catoctin

STAFF CONTACT(S): Scott Fincham, General Services
Ernest N. Brown, General Services

PURPOSE: To provide the Board of Supervisors (Board) with the findings of the 2024 Paeonian Springs and Waterford Joint Water and Wastewater System Feasibility Study and to seek Board endorsement and further guidance regarding the continued design of the interconnected water and wastewater systems between the Villages of Paeonian Springs and Waterford.

RECOMMENDATION(S):

Finance/Government Operations and Economic Development Committee (FGOEDC): At the FGOEDC meeting on November 12, 2024, the FGOEDC recommended (4-0-1: Randall absent) the Board direct staff to create a new Capital Improvement Program (CIP) project entitled *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems* and close the existing CIP projects, the Village of Waterford Communal Water System and the Village of Paeonian Springs Wastewater Modernization and move the remaining balance of $1,289,200 from the Village of Waterford Communal Water System project to the new *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems* project.

The FGOEDC further recommended that the Board endorse the continued design of the interconnected water and wastewater systems between the Villages of Paeonian Springs and Waterford and that the Board appropriate $4,000,000 from the Water/Wastewater Program CIP Fund to the new *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems* in support of land acquisition, land use approvals, and other costs associated with upgrading the existing Waterford Wastewater Treatment Plant (WWTP) to accept Paeonian Springs flow.

Staff: Staff concurs with the recommendation of the FGOEDC.

BACKGROUND: In 2016, Loudoun County (County) began accepting applications for the newly established Water and Wastewater Program (Program). The Program is a County Board initiative designed to assist County communities experiencing issues with deficient water and/or wastewater systems. The Program is managed and administered by the Department of General Services (DGS) in partnership with Loudoun Water (LW).

In 2017, residents from the Village of Paeonian Springs (Paeonian Springs) submitted a Program application for water and wastewater assistance, and in 2019, residents from the Village of Waterford (Waterford) applied to the Program for water assistance. Feasibility Studies were completed for both villages, in partnership with LW, and in accordance with the 2015 Memorandum of Understanding between the County and LW that outlines Program responsibilities.

Village of Paeonian Springs

Paeonian Springs is an unincorporated community in the County located in the Catoctin Election District, approximately 5 miles northwest of the Town of Leesburg and 2.5 miles south of Waterford. Paeonian Springs is located in the Catoctin Creek Watershed, which is a part of the Chesapeake Bay Watershed.

Established in 1890, with its surrounding countryside, Paeonian Springs was a resort town for citizens trying to escape the city and suburban life of Washington, DC. Citizens would use the Washington & Ohio Railroad to travel to Paeonian Springs. The community was listed on the National Register of Historic Places in 2006.

Currently, Paeonian Springs has no public water distribution or sanitary sewer system. Homes and businesses in Paeonian Springs rely on private wells for potable water and individual onsite sewage disposal systems for wastewater treatment.

In 2017, residents of Paeonian Springs submitted a Program application for assistance to address concerns with the water quality of their wells and wastewater systems. The application was reviewed, and Paeonian Springs was approved to move forward with a feasibility study, the Paeonian Springs Water and Wastewater Feasibility Study (Paeonian Springs Feasibility Study). The original boundary included 216 individual improved and unimproved parcels, which has since been reduced to 201, following additional technical review conducted in 2022 as discussed further in the item.

In 2019, the initial Paeonian Springs Feasibility Study was completed, and outlined alternatives to address the water and wastewater concerns. The Paeonian Springs Feasibility Study was completed by Dewberry Engineers Inc. (Dewberry), under agreement with LW. The study was designed to evaluate the water and wastewater concerns identified by the community application and to determine the technical feasibility of potential solutions to address identified issues. The Paeonian Springs Feasibility Study reviewed the existing conditions, presented the estimated existing and future water demands, provided an analysis of the existing water supply systems, and evaluated potential options to improve or mitigate the water supply concerns. Prior to analyzing the

feasibility of solutions, an analysis of the overall community was performed to better understand the existing community characteristics such as topography, historical resources, local planning, and current zoning regulations.

Following a detailed review of the Paeonian Springs Feasibility Study with other County departments, County Administration, and LW, it was determined that additional supplemental technical work was necessary. Consequently, LW was asked to work with their consultant to produce a technical memorandum that would expand on the original Paeonian Springs Feasibility Study for the following items:

- Establish criteria and perform detailed research to identify a project boundary that properly reflects the area of public health risks;
- Re-examine and provide further details on other potential alternative solutions following recent policy or practice changes; and
- Complete further research to evaluate whether fixing the wastewater conditions only would have a significant impact on the water conditions.

The Paeonian Springs Water & Wastewater Boundary and Treatment Alternatives Technical Memorandum (Technical Memorandum) was completed in 2022 and resulted in a refined community boundary of 201 parcels, evaluation of a potential surface discharge treatment system, and updated cost estimates.

Based on the evaluation presented in the 2019 Paeonian Springs Feasibility Study and the 2022 Technical Memorandum assessment, a community water and wastewater system owned and operated by LW was the preferred solution to address the Paeonian Springs ongoing water and wastewater problems. A community system solution was initially introduced for Paeonian Springs in a 1972 Feasibility Study and most recently supported by the Loudoun County Health Department in a letter dated March 16, 2017[1]. Homeowners wanting to connect to the water and/or wastewater system, would be responsible for their connection from the house to the water distribution line and from the house to the wastewater collection line; quarterly LW usage fees would apply.

In 2022, the preliminary cost estimate for this option, which includes design, permitting, surveying, construction of the water distribution and wastewater treatment systems, road restoration, land acquisition, and site work, was approximately $31 million. This original estimate from the Paeonian Springs Feasibility Study was a high-level conceptual estimate. Since then, LW has refined the estimate by incorporating data from the joint system feasibility study proposed in this item, along with relevant cost data from other community system projects. Based on LW's analysis, the updated 2024 cost for a single community water and wastewater system in Paeonian Springs is approximately $43 million, excluding any contingency funding.

[1]The Department of Health letter can be located in (Attachment 4) of the Paeonian Springs Water and Wastewater Feasibility Study

On April 19, 2022, the Board approved (9-0) $3.5 million of American Rescue Plan Act (ARPA) funds for the initial design of modernizing water and wastewater services in Paeonian Springs, where LW is currently in the preliminary study and design phase.

Village of Waterford

Waterford is an unincorporated area of the County located within the Catoctin Election District, approximately 5 miles northwest of the Town of Leesburg and 2.5 miles north of Paeonian Springs. Waterford is located in the Catoctin Creek Watershed, which is a part of the Chesapeake Bay Watershed.

Waterford, established in 1733, with its surrounding countryside, was granted the National Historic Landmark (NHL) status in 1970. This NHL is one of only a few that encompasses an entire village. Following this NHL designation, local citizens, County and state officials, and friends of Waterford from across the nation have continued the work of preserving this historic landmark.

Currently, homes and businesses in Waterford rely on private wells for potable water and a community wastewater system for sanitary sewer. The sanitary sewer system became operational in 1978 to address inadequate and failing septic systems in the village. The community is serviced by the Waterford WWTP owned and operated by LW along Old Wheatland Road (Route 698), west of Catoctin Creek.

In 2019, residents of Waterford submitted a Program application for assistance regarding water quantity (yield) concerns. The application was reviewed, and Waterford was approved to move forward with a feasibility study. The existing sewer service area established in 1975 for Waterford was used as the feasibility study boundary which included 145 individual improved and unimproved parcels fully in the boundary with an additional 8 parcels "partially" in the study area boundary.

In 2022, the Historic Waterford Water Feasibility Study (Waterford Feasibility Study) was completed, and alternatives to address the water concerns in the village were outlined. Dewberry completed the Waterford Water Feasibility Study under an agreement with LW. The study was designed to evaluate the water concerns identified by the community application and determine the technical feasibility of potential solutions to address those issues. The Waterford Feasibility Study reviewed the existing conditions, presented the estimated existing and future water demands, analyzed the existing water supply systems, and evaluated potential options to improve or mitigate the water supply concerns. Before evaluating solution feasibility, a comprehensive community analysis was performed to better understand the existing characteristics such as topography, historical resources, local planning, and current zoning regulations.

Based on the evaluation presented in the Waterford Feasibility Study, a community water system owned and operated by LW was recommended as the preferred long-term sustainable solution to address the village's water supply issues. The recommended community system solution is not new to Waterford, as it was first mentioned in a 1966 Waterford Feasibility Study, but did not progress as the priority at that time was addressing the inadequate and failing wastewater systems.

However, the community system recommendation was reiterated in a 1987 Waterford Area Management Plan completed by the County in partnership with a Citizens' Advisory Committee, and most recently supported in 2022 by the Department of Transportation and Capital Infrastructure (DTCI) study titled "Village of Waterford Preserving the Landmark Infrastructure Improvements Master Plan Study". Homeowners wanting to connect to the water system would be responsible for connection from the house to the water distribution line. Quarterly LW usage fees would apply.

In 2022, the preliminary cost estimate for this option, which includes design, permitting, surveying, construction of the water distribution and wastewater treatment systems, road restoration, land acquisition, and site work, was approximately $12 million, which did not include contingency funding. This original estimate from the Waterford Feasibility Study was a high-level conceptual estimate. Since then, LW has refined the estimate by incorporating information gathered during the joint system feasibility study proposed in this item and relevant cost data from other projects. Based on LW's analysis, the updated 2024 cost for a single community water system for Waterford is approximately $13 million, excluding any contingency funding.

On February 21, 2023, Board endorsed (7-0-2: Randall and Buffington absent) the Waterford Water Feasibility Study, which recommended a communal water system in the Village of Waterford. As part of this approval, the Board directed $1.5 million from the existing Water/Wastewater Program CIP to be moved to the Village of Waterford Communal Water System project to conduct preliminary design work for a community water system.

Interconnected Community Systems

As discussed previously, the Paeonian Springs Technical Memorandum, completed in April 2022, suggested exploring an additional alternative to address the water and wastewater needs of the Villages of Paeonian Springs and Waterford since the communities are located only 2.5 miles apart. The initial concept was to further explore interconnected water and wastewater systems between the villages, reducing the need for four treatment facilities in the Rural Policy Area to two. This concept requires the new construction of only one water treatment facility and expansion of the existing Waterford WWTP and provides significant reductions in long-term operation and maintenance responsibilities and costs.

The policies of the *Loudoun County 2019 General Plan* (2019 GP) encourages public water and wastewater facilities to provide services to the existing Rural Historic Villages (Ref: 2019 GP, Chapter 2, Rural Historic Villages, Design Guidelines). However, before proposing interconnected systems be explored, staff requested an analysis from Department of Planning and Zoning (DPZ), to assure the concept was in accordance with the 2019 GP and the *Revised 1993 Loudoun County Zoning Ordinance*.

Based on the analysis[2], DPZ felt that an interconnected communal system for the purpose of providing solutions to address public health issues was consistent with the 2019 GP. With the

[2] The Department of Planning and Zoning analysis can be located in Board Item #9g (Attachment 3) of the February 21, 2023 Business Meeting.

adoption of the 2023 Loudoun County Zoning Ordinance, provisions governing community systems will apply but will not impact the original analysis.

As mentioned previously, on February 21, 2023, the Board endorsed (7-0-2: Randall and Buffington absent) the FGOEDC recommendation for a communal water system in the Village of Waterford and directed staff to continue evaluation of potential interconnected communal systems to address water and wastewater needs for the Villages of Waterford and Paeonian Springs.

Feasibility Study

The Joint Water and Wastewater System Feasibility Study (Feasibility Study) was completed by Dewberry, under agreement with LW on October 17, 2024 (Attachment 1).

The purpose of the Feasibility Study was to evaluate the technical feasibility of constructing a proposed interconnected water and wastewater systems to serve both the Villages of Paeonian Springs and Waterford and to identify any challenges that could potentially prevent a project from moving forward.

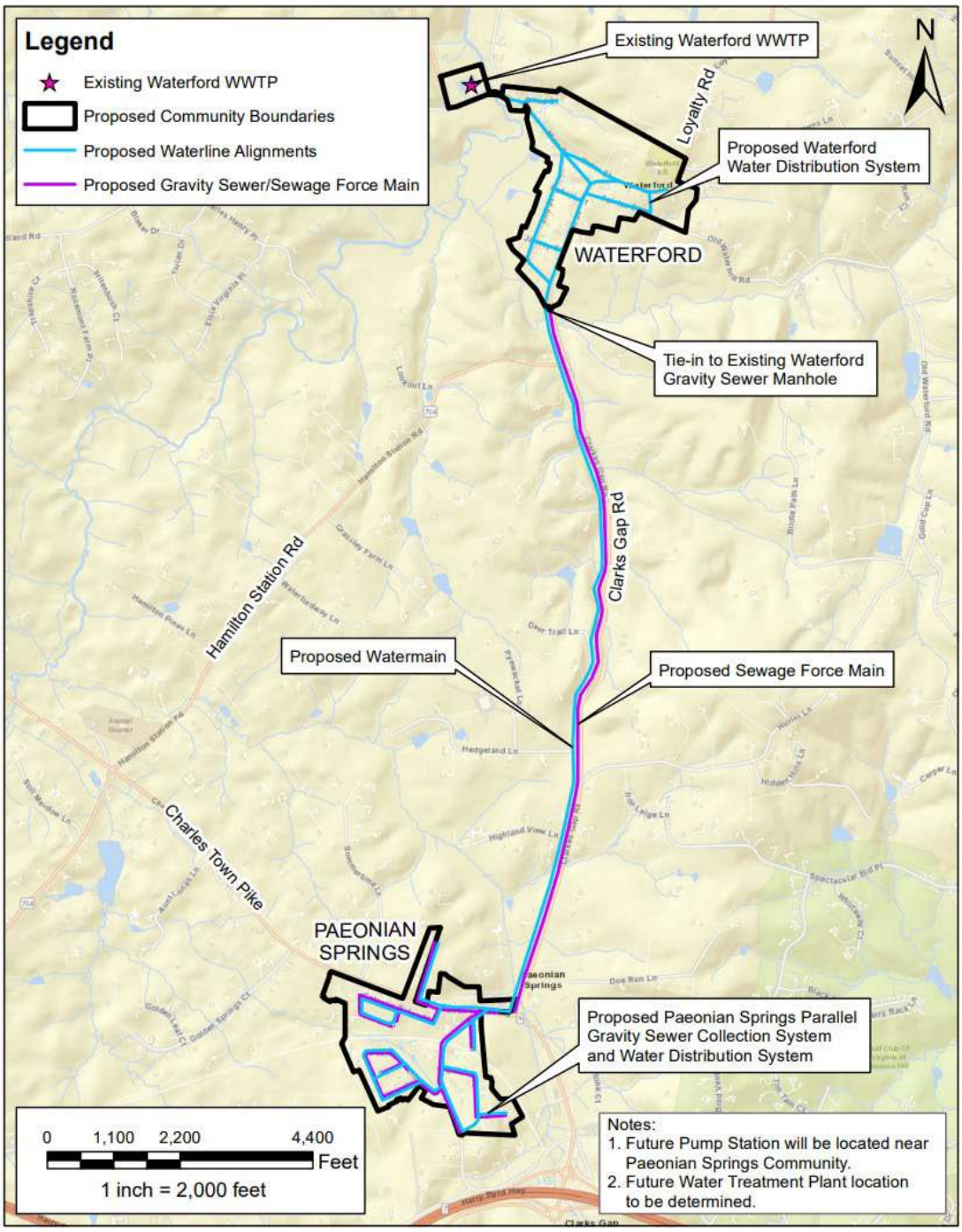
Feasibility Study Tasks

A conceptual layout of what an interconnected water and wastewater systems project may look like is represented in Exhibit 1.

The Feasibility Study scope included:

- Evaluation of the technical feasibility of an interconnected wastewater system solution, including a sewage collection system, pumping station, and force main for Paeonian Springs, as well as upgrades to the existing Waterford WWTP site required to accept flow from Paeonian Springs.
- Evaluation of the technical feasibility of an interconnected water system solution, including distribution systems for both communities and a groundwater well, treatment, storage, and booster pumping system located in the Clarkes Gap Road corridor between Paeonian Springs and Waterford that serves both communities.
- Identification of potential constructability challenges associated with the proposed project and an outline preliminary coordination required with outside stakeholders such as Virginia Department of Transportation (VDOT).
- Summarization of the technical feasibility of the interconnected water and wastewater systems solution.
- Opinion of Probable Construction Costs (OPCC) for the most feasible solution.

Exhibit 1: Conceptual Layout of Interconnected Water and Wastewater Systems



Feasibility Study Summary

Assuming easements for groundwater wells are acquired, and the wells could be located along Clarkes Gap Road corridor with sufficient yield, the Feasibility Study confirmed it is technically

feasible to design, permit, and construct all components of an interconnected water system and wastewater system.

System Design

Wastewater System Project - Paeonian Springs:

Based on LW's wastewater flow computation standards for community systems, 112 currently occupied parcels in Paeonian Springs would result in a design flow of 45,000 gallons per day (gpd). Although unlikely, if all 201 parcels within the Paeonian Springs service boundary currently being considered were built upon, the design flow could rise to 75,000 gpd.

Wastewater system components would include:

- Sanitary sewer collection system serving all connections in the Paeonian Springs service area boundary
- Sewage Pumping Station
- Sewage Force Main to convey flows from Paeonian Springs to Waterford sanitary sewer collection system
- Upgrades at the Waterford WWTP to meet additional flows from Paeonian Springs

Water System Project – Paeonian Springs and Waterford:

Based on LW's water demand computation standards for community systems, the target yield for the groundwater wells to serve built-out scenario (total of 345 parcels within the two communities' service area boundary) for both villages is approximately 414 gallons per minute (gpm). The preliminary groundwater investigation indicates that up to 5 wells could be required. Treatment and storage systems would also be designed to meet the demand.

- Groundwater Well, Treatment, Storage and Pumping Facility sited in the 2.5-mile corridor between Paeonian Springs and Waterford along Clarkes Gap Road
- Watermain conveying treated potable water from the Well and Treatment facility to Paeonian Springs and Waterford
- Water distribution system within Paeonian Springs and Waterford to serve all connections within the respective service areas

Construction Challenges

The Feasibility Study identified constructability challenges to consider when implementing the proposed Paeonian Springs and Waterford interconnected water and wastewater systems.

Due to the historic nature of both communities and the proximity of Paeonian Springs to the Washington and Old Dominion Trail (W&OD), the potential impact of this project on archeological and cultural resources must be considered. In addition, construction impacts to residents and traffic along the proposed gravity sewer, sewage force main, and waterline alignments were also identified for planning purposes.

- Roadway Impacts and VDOT Coordination:
  The water distribution and sewer collection systems in both Paeonian Springs and Waterford are proposed to be installed mostly in the paved roads within each community. Most of the roads in both communities along the proposed alignments are maintained by VDOT. In Paeonian Springs, however, there are two private roads that will require coordination with Homeowner Associations/private road owners for construction activities to occur in these rights-of-ways (ROW). During the design phase, deed research will be conducted to identify if the roadways have fee-simple ROW or are on prescriptive easements. Temporary lane closures will be required during construction of roads within Paeonian Springs and Waterford. A detailed traffic control plan for all impacted roads will be developed during the design phase. Following discussions with VDOT, currently no new utilities can be constructed in the paved portion of the Clarkes Gap Road ROW. As a result, both the sewage force main and water distribution main along the Clarkes Gap Road corridor will need to be routed outside of the pavement. While construction will take place outside the pavement, this will cause traffic impacts along Clarkes Gap Road that will need to be managed during the duration of the construction. Coordination with VDOT will be required throughout the design and construction phase of the project to ensure optimum traffic flow through this corridor, which is anticipated to take approximately 8 months for installation of the force main and watermain.

- Washington & Old Dominion Trail Crossing:
  The proposed water and sewer system layouts within Paeonian Springs include crossings of the W&OD Trail. The W&OD Trail is owned by the Northern Virginia Regional Park Authority (NVRPA) and is considered a Historic District by the Virginia Department of Historic Resources (DHR). Therefore, utilities crossing the W&OD Trail need to be installed using a trenchless method under the trail to minimize impacts to the historic district. Coordination with NVRPA will also be required during design and construction.

- Archaeological and Cultural Resources Impact:
  Paeonian Springs and Waterford are designated on the National Register of Historic Districts (NRHP) by the DHR. The Waterford Historic District (DHR ID 401- 0123) is also a listed resource in the NRHP, Virginia Landmarks Register (VLR), and the NHLs Register and encompasses the entirety of the Waterford community as well as portions of the surrounding area. Virginia Cultural Resources Information System (VCRIS) listed 58 established DHR easements within or adjacent to the Waterford community. The Paeonian Springs Historic District (DHR ID 053-5072), a listed resource in the NRHP and VLR, encompasses most of the eastern half of the community. The area also includes the Catoctin Creek Scenic River (DHR ID 053-0059) and the W&OD Railroad Historic District (DHR ID 053-0276), both considered eligible for NRHP listing by DHR. Numerous additional known architectural and archaeological resources are located within the project area, with some potentially eligible for the NRHP. Although the historic designations of the areas do not affect the project's feasibility, extensive coordination with Local, State, and Federal agencies is expected.

- Easement and Property Acquisition:
  Acquisition of land for siting of the sewage pumping station and some segments of linear utilities within Paeonian Springs, drinking water wells, and the treatment and pumping facility in the Clarkes Gap Road corridor between the villages is a significant driver in determining the success of this project. As previously noted, the force main and water main alignment running parallel along Clarkes Gap Road will be installed within the ROW outside the pavement to the extent practicable. However, the ROW is narrow, and corridor has existing overhead powerlines. Therefore, additional easement acquisition would be required along the 2.5-mile alignment section between the villages, depending on the existing ROW and easements. An approximation of the land acquisition required for the entire project is estimated at 20 acres for overall system components.

Table 1: Interconnected Systems Easement / Land Acquisition Estimate

SYSTEM COMPONENT	NUMBER	AREA/UNIT	TOTAL LAND (SF)	TOTAL LAND (ACRES)
Groundwater Wells	4 Wells	200' Ø Circle	125,664	2.88
Water Treatment	1 Facility	1 Acre	43,560	1.00
Groundwater Well Raw Water Piping	10,000 LF	20' Width	200,000	4.59
Sewage Pumping Station	1 Facility	0.5 Acre	21,780	0.50
Wastewater Collection/Water Distribution Systems	11,500 LF	ROW	N/A	N/A
Sewage Force Main	12,500 LF	10' Width Outside ROW	125,000	2.87
Water Transmission Main	12,500 LF	10' Width Outside ROW	125,000	2.87
		SUBTOTAL	641,004	14.72
Contingency 1: Remote Well Locations	5,000 LF	20' Width	100,000	2.30
Contingency 2: Unknown Easements & Property	5% of subtotal		32,050	0.74
		SUBTOTAL	773,054	17.75
Temporary Construction Easement	10% of subtotal		77,305	1.78
		SUBTOTAL	**850,360**	**19.53**

Advantages of Interconnected Systems

Interconnected system solution provides several distinct advantages:

- Utilizing the Waterford WWTP site eliminates the need to acquire land for a new wastewater treatment facility.
- The existing Waterford WWTP discharge permit can be modified to accommodate the Paeonian Springs flows without needing additional nutrient credits.
- The Waterford WWTP discharges into the Catoctin Creek and is currently under its own discharge permit. Maintaining proper treatment and meeting effluent permit requirements at one facility instead of two significantly reduces the risk of environmental impacts and permit violations.
- The joint system uses a single WWTP and a single water treatment plant (WTP), which avoids the visual impacts on existing viewsheds and minimizes any interaction with

existing historical designation within rural communities and surrounding areas that an additional facility would create.

- Water availability along Clarke's Gap Road allows a solution that could serve both Waterford and Paeonian Springs as previous studies have found limited potential water in and around the communities and the Clarke's Gap corridor significantly increases the number of potential sites for the water system.
- Consolidating systems reduces overall operation and maintenance costs and facility lifecycle costs while also reducing the risk of failure or non-compliance.

ISSUES: Staff has identified the following items to elevate to the Board's attention.

Cost Effectiveness: Based on a limited-purpose 50-year life cycle cost analysis, which factors in the capital cost, land acquisition cost, and operation and maintenance cost, LW estimates a 20 to 30 percent cost savings if interconnected water and wastewater systems are installed over individual community systems. The analysis was conducted utilizing planning-level capital cost estimates and LW's experience owning and operating similar facilities.

The interconnected project proposes adding only one new treatment plant in western Loudoun, compared to three additional plants if the projects are not interconnected. In addition to the minimized impact in western Loudoun, significant savings are associated with operating and maintaining (O&M) only one new water plant and the existing wastewater plant. In addition to the annual O&M savings, the interconnected system approach is expected to result in an 8 to 10 percent capital cost savings, which translates to approximately $6 to $8 million based on 2024 planning-level estimates.

It is important to also address that an interconnected wastewater system, where Paeonian Springs wastewater is pumped to the Waterford WWTP, will have a more accurate cost estimate than for a new Paeonian Springs WWTP. The cost estimate is more accurate because the Waterford WWTP already exists, needing only a facility expansion rather than acquiring new land for a new WWTP, which is already accounted for. Additionally, the project timeline allows the County to work alongside LW during their upcoming required WWTP upgrade project. In contrast, building a new WWTP solely for Paeonian Springs would increase costs, and permitting would be much more involved, costly, and challenging, as several unknowns exist when establishing a new WWTP.

Project Timing: Due to the complexity of the project, it is imperative that the interconnected water and wastewater systems project progresses in alignment with two additional projects occurring in or around the Waterford area: the DTCI Village of Waterford Preserving the Landmark Infrastructure Improvements Master Plan Study project and the LW Waterford WWTP Upgrade project.

- Loudoun Water Waterford WWTP Upgrade:
  LW owns and operates the existing Waterford WWTP, currently in the design phase of a state-mandated upgrade to comply with new ammonia regulations. The timing of this upgrade in relation to the design of the interconnected water and wastewater systems is

very advantageous to the project. The County can work with LW to design and install some components that would handle additional future load requirements from Paeonian Springs. Although additional construction work would be necessary following the upgrade to accept Paeonian Springs wastewater flow, these forward-thinking actions would create savings, reduce construction waste and unnecessary component replacements, save construction time and resources, and ultimately allow for a smoother and smaller construction project in the future. The County and LW staff have discussed this overall concept and the steps necessary to initiate this work.

- Village of Waterford Preserving the Landmark Infrastructure Improvements Master Plan:
  During the July 19, 2022, Board Business Meeting, County staff from DTCI presented the Village of Waterford Preserving the Landmark Infrastructure Improvements Master Plan Study.

  The Board forwarded the request to fund the Village of Waterford improvements outlined in the Master Plan Study to the FY 2024 budget process for consideration and prioritization (8-0-1: Saines absent). Funding for $7.5 million was approved for preliminary programming and planning measures. The improvements being evaluated include traffic calming measures, improving mobility, and expanding pedestrian connectivity by enhancing roads and sidewalks, undergrounding utilities, correcting drainage and managing stormwater, and coordinating with the village's potable water system.

  Due to the complexity of both projects, DGS and DTCI staff must collaborate to coordinate the Water project and Infrastructure Improvement projects to minimize disturbance to roadways and related infrastructure and reduce impacts to the overall Waterford community. Since DTCI has already started its preliminary planning efforts, it is imperative that DGS and LW's design work occur in parallel. One option currently being discussed is for the DTCI project to design and construct the water distribution system within the limits of Waterford along with their infrastructure project.

- ARPA:
  On April 19, 2022, the Board approved $3.5 million of ARPA funds to be applied toward the design of modernizing water and wastewater services in Paeonian Springs, in which LW is currently in the preliminary study and design phase. $500,000 of the ARPA funds were reallocated in October 2024 because of the Department of Treasury's fund obligation deadline requirement. The remaining $3 million for design has already been encumbered but must be expended by December 31, 2026. Any delay in progressing the design forward could jeopardize these funds and make them unable to be reallocated to other county projects.

Fire Flow: While not required for the existing villages under the Loudoun County Facilities Standard Manual, Loudoun County Fire and Rescue routinely recommends that an approved water supply sized to provide a community with fire protection services be considered when community water projects are proposed.

Fire flow is typically not considered for projects under the Water and Wastewater Program, as it can be challenging to include with smaller community water projects. Challenges include increased project costs, extended design and construction timelines, and difficulty locating a sufficient water supply within close proximity to the community it would be serving. If the interconnected system is pursued, the project scope and increased project area necessary to locate a sufficient water supply for both villages would potentially allow for both potable water and fire flow to be considered.

Residents have expressed an interest in better fire suppression infrastructure to DGS and DTCI, and a letter from the Hamilton Volunteer Fire Department (VFD) was included as part of the 2019 Waterford Water and Wastewater Program application requesting fire flow be considered. Current fire suppression is handled through dry hydrants. Concerns expressed include a fear that dry hydrants and underground tanks currently in place cannot provide water quickly or consistently for fire suppression and that dry hydrants are not located in optimal locations for fire suppression needs. The Hamilton VFD letter stated, "from our limited firefighting perspective, a consistent, under pressure, wet hydrant system would be superior to the current dry hydrant and tank system.".

Preliminary discussions with LW and their consultant have identified if the target well water yield of 414 gpm for the potable water supply system is met, fire flow demands in accordance with LW's Engineering Design Manual requirements could be considered. Assuming a proper water supply is found and based on limited hydraulic modeling and design activities to date, the design team believes only minor design upgrades would be needed to provide fire flow services. Necessary changes would include distribution system hydrants, an adequately sized pump to provide for the increased flow, and a water storage tank which likely can be located inside the water treatment facility fence. This needs to be further evaluated, taking into consideration the well locations, available yield, and potential fire flow demands. Further discussion with Loudoun County Fire and Rescue would also be required.

As both villages have high-density sections with structures in close proximity of one another, staff believe fire flow for protection of life and property should be evaluated and considered as part of an approved water and wastewater project.

Adaptive Reuse: A community water system also has the potential of allowing adaptive reuse, or repurposing of historic buildings to better preserve their historical and architectural significance.

In the 2019 GP under the Rural Historic Villages, Policies, Strategies and Actions section Strategy 1.2 it states, "Preserve the character of the villages and their historic structures and sites through the rehabilitation and adaptive reuse of existing buildings.".

As the owner of 13 properties in Waterford, the Waterford Foundation, Inc. (WFI) has identified 11 foundation properties that lack water, preventing their use and income potential necessary for long-term sustainability. The WFI believes that the combined system does not present a new or

more significant threat to the NHL and believes a community water system will improve their ability to care for their historic properties (Attachment 2).

FISCAL IMPACT: The feasibility study developed an OPCC. The anticipated cost to construct the proposed interconnected systems to serve the Villages of Paeonian Springs and Waterford in 2024 is approximately $51.7 million, which includes 20 percent contingency and construction management costs, as shown in Table 2. This funding is not currently planned for in the FY 2025 – FY 2030 CIP.

At this time, staff is requesting authorization from the Board to move $4 million from the Water/Wastewater Program to a newly established CIP project entitled *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems.*

If the funding request of $4 million is authorized, funds will be used to complete an interconnected systems project's infrastructure planning and design phase. The funds are also necessary for the land use approval process, land acquisition required for design, and to support design and component integration measures into LW's Waterford WWTP upgrade project, allowing for the acceptance of future Paeonian Springs wastewater flow. The Water/Wastewater Program has adequate funding to support these measures. However, authorization to use the program outside the parameters outlined in the 2015 Water and Wastewater Funding Policy (Funding Policy) requires Board authorization, as the communities have not been able to verify the 51 percent low to moderate household income levels currently established by the Funding Policy. However, the policy does not limit the powers of the Board to waive the Funding Policy restrictions to address public health or safety issues.

To advance this complex project to construction, the design must be finalized, environmental studies and permitting approvals must be received, additional public engagement performed, and funding must be secured. Upon completion of an acceptable level of project design, a more detailed cost estimate will be developed based on more accurate project development information. The funding request will be submitted to the Office of Management and Budget to be incorporated into a future CIP budget development process for consideration and prioritization by the Board.

Staff will also seek federal and state grant opportunities to help fund this project; however, it is important to note that grant availability may be limited. In 2024, staff sought the services of AECOM Technical Services, Inc. (AECOM) to research and locate potential federal and state grants the County may want to pursue for the Paeonian Springs project. At the time of AECOM's review and based on the project description and grant eligibility for rural, economic, and income requirements, only two potential federal grant opportunities were identified. Staff will continue to work with the County Grants Coordinator to evaluate the two identified grants and monitor additional upcoming opportunities at the state and federal levels during the continued planning and design phase.

Table 2: 2024 Estimate for Total Capital Costs for Interconnected Systems

Design and Indirect Costs	Current Project Phase
Design, Permitting, Surveying[1]	$ 4,500,000
Land Acquisition, Land Use Approval, Contracted Services[2]	$ 2,700,000
Waterford WWTP Upgrades[3]	$ 1,300,000
Total Costs	**$ 8,500,000**
Construction Costs	Future Project Phase
Joint Wastewater System Construction Costs	$ 19,700,000
Joint Water System Construction Costs	$ 19,200,000
Contingency for Construction Costs (20%)	$ 8,000,000
Construction Management[4]	$ 4,800,000
Total Costs[5]	**$ 51,700,000**
Total Capital Costs	**$ 60,200,000**

[1] This cost has already been allocated through ARPA (3M) and the W/WW CIP Fund (1.5M)
[2] This (2.7M) in conjunction with the (1.3M) for the Waterford WWTP Upgrade make up the (4M) requested in the Item
[3] These are costs associated with capitalizing on the current LW project to upgrade the Waterford WWTP by incorporating provisions to facilitate the expansion to accept Paeonian Springs flow. The (1.3M) is included with the Joint Wastewater System Construction Costs in the Feasibility Study
[4] Construction Management cost is estimated to be approximately 10% of the construction cost
[5] The industry standard range for construction cost estimates developed for the current level of project definition is - 20% to +30%. For this project, the construction cost is expected to fall between $38,000,000 and $63,000,000

ALTERNATIVES:

1. The Board may direct staff to create a new project entitled *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems* and close the Village of Waterford Communal Water System and the Village of Paeonian Springs Wastewater Modernization projects and move the remaining balance of $1,289,200 from the Village of Waterford Communal Water System project to the new interconnected project.

   The Board may further endorse the continued design of interconnected water and wastewater systems, including fire flow, between the Villages of Paeonian Springs and Waterford and appropriate $4,000,000 from the Water/Wastewater Program to further support land acquisition, land use approvals, and costs associated with upgrading the existing WWTP to accept Paeonian Springs wastewater flow.

2. The Board may endorse that the existing Village of Waterford Water and Paeonian Springs Water and Wastewater Capital Improvement projects remain separated, and the previous Board approved community system design work continue. *(This action could result in the construction of two additional treatment facilities in the Rural Policy Area, increased project construction costs, additional permitting needs, and difficulties locating water resources adjacent to the villages for potable water and fire flow needs.)*

3. The Board may recommend an alternative option for future planning and implementation of a Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems project. *(This action could require reallocation of ARPA funds due to a Department of Treasury obligation deadline of December 31, 2024, and in turn require County funds to continue the design work for the Paeonian Springs project.)*

DRAFT MOTIONS:

1. I move the recommendation of the Finance/Government Operations and Economic Development Committee that the Board of Supervisors direct staff to create a new project entitled *Villages of Paeonian Springs and Waterford Interconnected Community Water and Wastewater Systems* and close the Village of Waterford Communal Water System and the Village of Paeonian Springs Wastewater Modernization projects, and move the remaining balance of $1,289,200 from the Village of Waterford Communal Water System project to the new interconnected project.

   I further move the recommendation of the Finance/Government Operations and Economic Development Committee that the Board of Supervisors endorse the continued design of interconnected water and wastewater systems, including fire flow, between the Villages of Paeonian Springs and Waterford and appropriate $4,000,000 from the Water/Wastewater Program to further support land acquisition, land use approvals, and costs associated with upgrading the existing Waterford Wastewater Treatment Plant to accept Paeonian Springs wastewater flow.

OR

2. I move an alternate motion.

ATTACHMENT(S):

1. October 17, 2024, Village of Paeonian Springs and Waterford Joint Water and Wastewater Systems Feasibility Study
2. October 15, 2024, Waterford Foundation, Inc. Letter

ATTACHMENT 1

REFERENCE NO. 50146469

PAEONIAN SPRINGS AND WATERFORD

Joint Water and Wastewater System Feasibility Study

OCTOBER 17, 2024

Dewberry

SUBMITTED BY
Dewberry Engineers Inc.
8401 Arlington Boulevard
Fairfax, Virginia 22031-4666

SUBMITTED TO
Loudoun Water
44865 Loudoun Water Way
Ashburn, Virginia 20146

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1. Project Background

The Village of Paeonian Springs (Paeonian Springs) is an unincorporated residential community in Loudoun County, Virginia located at the intersection of Charles Town Pike and Harry Byrd Highway. The Village currently has no public water distribution or sewage collection systems. Individual parcels within Paeonian Springs are currently served by private drinking water wells and individual on-site wastewater systems.

In 2017, Paeonian Springs applied to the Loudoun County Water and Wastewater Community Needs Assessment Program (Program) because of aging and failing systems. To support the Program, Loudoun Water (LW) tasked Dewberry Engineers Inc. (Dewberry) with the development of the 'Paeonian Springs Water and Wastewater Feasibility Study' (June 2019 Paeonian Springs Study) which analyzed the technical feasibility of potential communal solutions to Paeonian Springs' water and wastewater issues. In 2022, Dewberry developed a follow-up study, the 'Paeonian Springs Water and Wastewater Boundary and Treatment Alternatives Technical Memorandum' (April 2022 Paeonian Springs TM) which outlined the existing Paeonian Springs water and sewer systems and proposed a utility service area boundary for the Community. The April 2022 Paeonian Springs TM proposed a service boundary which includes two hundred one (201) parcels, shown in **Figure 1-1**, and determined that formal public water distribution and wastewater collection systems were needed to address public health concerns within Paeonian Springs.

The Village of Waterford (Waterford) is an unincorporated village in the Catoctin Valley of Loudoun County, Virginia located approximately 2.5 miles northeast of Paeonian Springs. Waterford has an existing community wastewater collection system and wastewater treatment plant (WWTP) but has no public drinking water system. Waterford applied to the Program to evaluate the feasibility of providing a public water distribution system to serve the Village.

As part of the Program, Dewberry developed the 'Historic Waterford Water Feasibility Study' (Waterford Feasibility Study) for LW in March 2022. The study evaluated the feasibility of providing a public water system to a Water Service Area boundary for Waterford, which consists of one hundred twenty-two (122) developed parcels and one hundred forty-four (144) total parcels. The Waterford Feasibility Study determined that a formal public water distribution system is necessary for the sustainability of the Village.

Loudoun County's (County) 2019 Comprehensive Plan allows for communities within the Rural Policy Area to connect to nearby municipalities' water and wastewater systems. This opened the possibility of connecting Paeonian Springs and Waterford as a joint system solution which would provide potential benefits to both communities. In October 2022, Dewberry submitted a memorandum summarizing benefits and preliminary costs based on limited information for the proposed joint community water and wastewater system for Waterford and Paeonian Springs. The Loudoun County Board of Supervisors has since expressed willingness to further explore this concept. In February 2023, the Loudoun County Department of Planning and Zoning (DPZ) conducted an analysis of potential conflicts within the 2019 Comprehensive Plan and the Loudoun County Zoning Ordinance in relation to the development of an interconnected water and wastewater system between the Village of Waterford and the Village of Paeonian Springs. The analysis indicated that an interconnected communal system for meeting a public health need is generally consistent with the 2019 Comprehensive Plan and that a commission permit will be necessary to confirm plan compliance. Therefore, LW has tasked Dewberry with the development of a Feasibility Study to evaluate the technical feasibility of developing a joint system solution to meet the needs of both communities.

1.1 Feasibility Study Purpose

This Report has been developed to evaluate the technical feasibility of constructing the proposed joint water and wastewater systems to serve Waterford and Paeonian Springs and to identify any roadblocks that could potentially prevent this project from moving forward. The purpose of this Feasibility Study includes the following:

- Evaluate the technical feasibility of a joint wastewater system solution including a sewage collection system, pumping station and force main for Paeonian Springs, as well as upgrades to the existing Waterford WWTP site required to accept flow from Paeonian Springs.

- Evaluate the technical feasibility of a joint water system solution including distribution systems for both communities, as well as a groundwater well, treatment, storage, and booster pumping system located in the Clarkes Gap Road corridor between Paeonian Springs and Waterford that serves both communities.

- Identify potential constructability challenges associated with the proposed project and outline preliminary coordination required with outside stakeholders such as Virginia Department of Transportation (VDOT).

- Summarize the technical feasibility of the water and wastewater systems solution.

- Develop an opinion of probable construction costs (OPCC) for the most feasible solution.

1.2 Assumptions

Per discussions with LW and the County, Dewberry made several assumptions for the purposes of the feasibility study. The assumptions are as follows.

- Wells will be found in the area between the two communities with safe groundwater yield sufficient to serve both communities.

- The County will be able to obtain easements necessary for the successful completion of the project.

- The project will be able to obtain Commission Permits and Special Exception (SPEX) for both water and wastewater systems.

1.3 Projected Flows and Demand

Determining technical feasibility and developing preliminary design requires an understanding of current flows/demand, future flows/demand and the schedule of development/connections into the systems. The program consists of three (3) major components.

- Paeonian Springs Wastewater System

- Paeonian Springs Water System

- Waterford Water System

A Flow Analysis Memo (attached as **Appendix A**) was developed to summarize the anticipated flows for the Paeonian Springs Service Area, as it does not have a current water or wastewater system. The flow memorandum analyzes several potential scenarios for both water demand and wastewater flow for Paeonian Springs Community. For the purpose of this Feasibility Study, the resulting phased flows, shown in **Table 1-1** below, were assumed to be the basis for designing the joint system. Phase I flows assume connections for the current buildout of the Community. Phase II flows include connections associated with the maximum future buildout of the Community assuming one connection per existing parcel regardless of the size.

Table 1-1 Paeonian Springs Water and Wastewater Phased Flows

PHASE	No. OF CONNECTIONS	ESTIMATED WATER DEMAND (PEAK HOUR) [GPD]	ESTIMATED WASTEWATER FLOW (AVERAGE DAY) [GPD]
Phase I (Current Buildout)	112	157,000	45,000
Phase II (Potential Future Buildout)	201	281,500	75,000

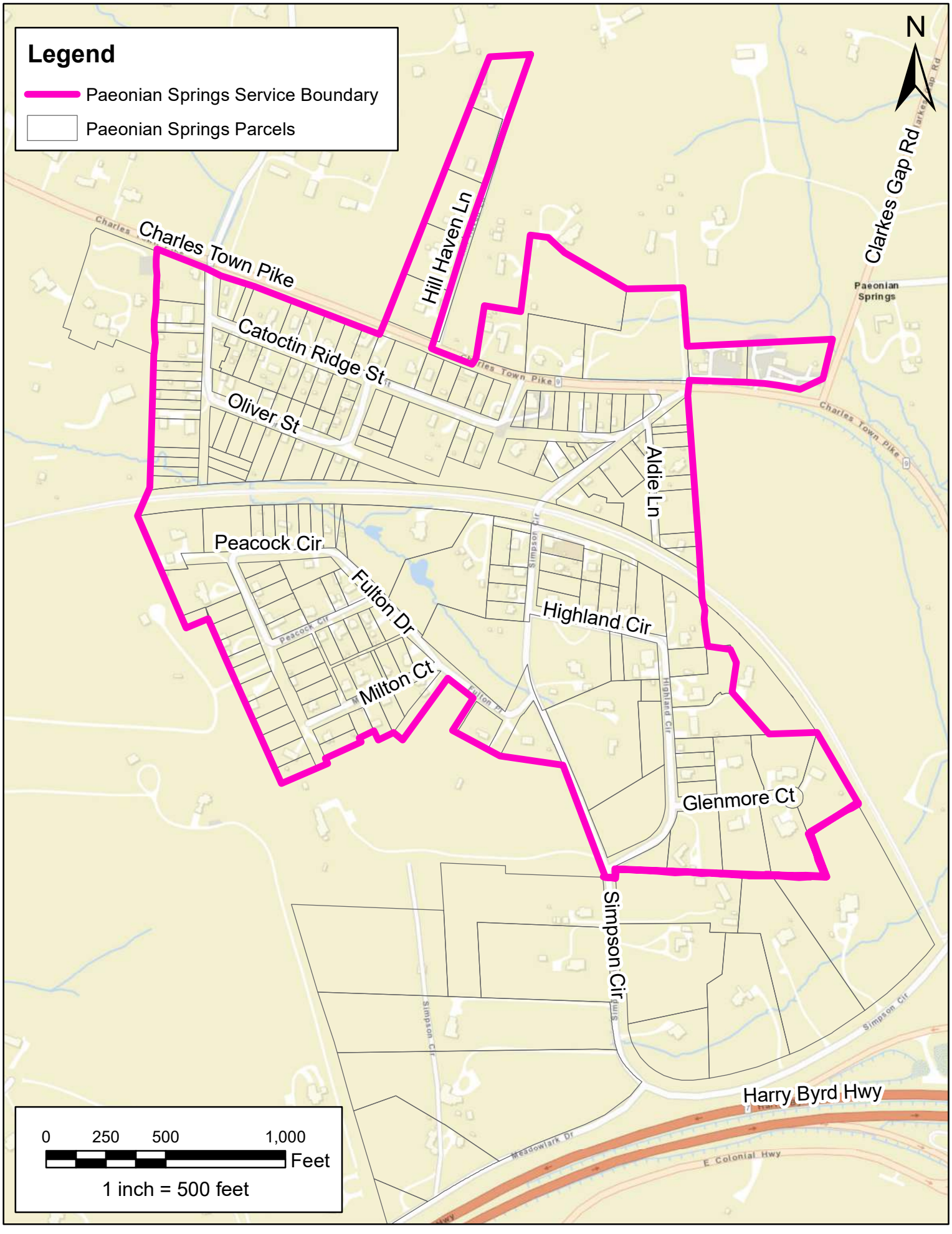
For Waterford, a new water system will need to serve the existing sewer service area. As part of the Waterford Water System Feasibility Study, a demand analysis for the community was prepared. The water demand for Waterford included current buildout of 122 connections with a future scenario of 144 connections as summarized in **Table 1-2**.

Table 1-2 Waterford Water and Wastewater Phased Flows

PHASE	No. OF CONNECTIONS	ESTIMATED WATER DEMAND (PEAK HOUR) [GPD]	ESTIMATED WASTEWATER FLOW (AVERAGE DAY)
Phase I (Current Buildout)	122	171,000	n/a
Phase II (Potential Future Buildout)	144	202,000	n/a

It should be noted that peak hour demand is used to size water distribution systems and will be used to determine pumping and storage requirements, if necessary. Well yield and treatment system design will be based on the number of connections in accordance with Loudoun Water regulations. The well yield and treatment requirements are further discussed in Section 3.2.1.

Figure 1-1: Paeonian Springs Water and Wastewater Service Area Boundary



2. Paeonian Springs Wastewater System

The existing Paeonian Springs Wastewater System consists of individual on-site wastewater treatment facilities including septic systems, alternative on-site sewage, pump and haul and pit privy systems. As part of the proposed joint community wastewater system solution between Paeonian Springs and Waterford, a new public wastewater collection system is proposed to be constructed within Paeonian Springs to meet the Community's anticipated wastewater flows. This new system will include the following components:

- Sanitary Sewer Collection System
- Sewage Pump Station (SPS)
- Sewage Force Main to convey flows from the Paeonian Springs SPS to the existing Waterford sanitary sewer system

In addition to these new facilities, the existing Waterford WWTP and collection system will need to be upgraded to meet the capacity required to accept the new flows from Paeonian Springs.

Developing a sewer collection system layout starts at the terminal connection point of the system, which is typically the low point of the site. For Paeonian Springs, an SPS will be required to convey sewage to the existing Waterford Collection System. Therefore, the first decision required to design the collection system is the location of the pumping station. This location will determine approximately ground elevation, sewer depth and pump station hydraulic conditions.

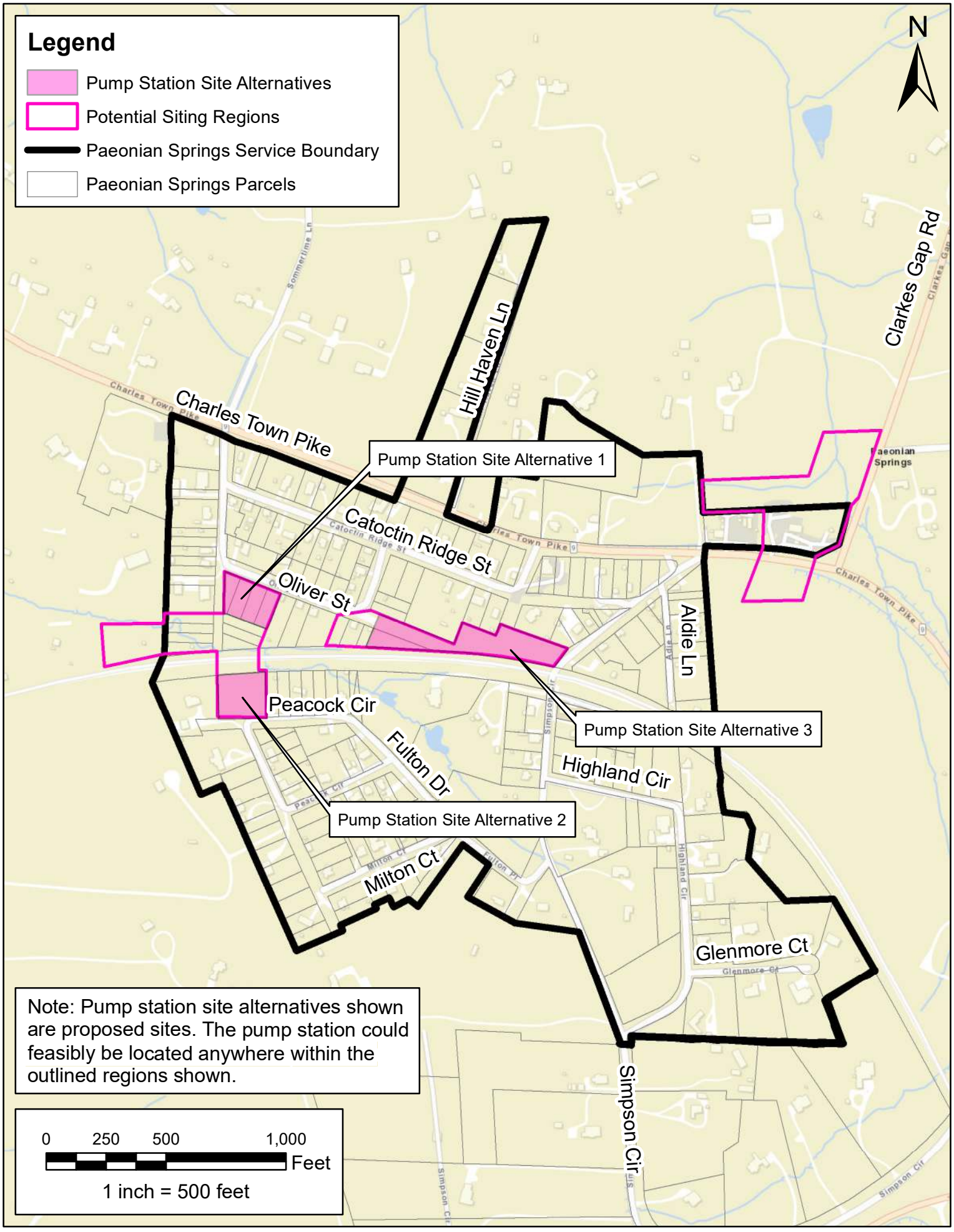
2.1 Sewage Pump Station

The proposed joint wastewater system includes a sewage pump station located in the vicinity of the Paeonian Springs Community that will act as a central collection point and pump wastewater from Paeonian Springs to the existing Waterford gravity sewer system which will convey the wastewater to the Waterford WWTP. An aerial topographic survey of the community was completed in 2023 to provide elevation information for the entirety of the community. Using this information, a preliminary siting study was developed to locate potential SPS locations. The evaluation was based on identification of various parcel features and potential environmental/community impacts including the following:

- Feasible gravity sewer routing through high points and low points based on existing topography within the Community
- Available buildable acreage (LW Engineering Design Manual (EDM) specifies a minimum of 0.5 acres for SPS siting)
- Proximity to wetlands and FEMA designated flood zones
- Parcel vacancy (i.e. are there existing buildings, wells or drainfield on the parcel?)
- Ease of access to the parcel
- Parcel ownership
- Potential impact to the W&OD Trail and other historic and architectural resources

The evaluation, detailed in a Preliminary Sewer Layout Memo attached as **Appendix B**, resulted in the identification of three potential pump station site alternatives as shown in **Figure 2-1**. All of the potential sites located and studied are technically feasible to design and construct a new SPS.

Figure 2-1: Sewage Pump Station Alternatives



2.1.1 Pump Station Site Alternative 1

The first alternative proposed for pump station siting is a cluster of parcels located on the west end of the Community. The four (4) vacant parcels (PINs 345394193, 345394690, 345395188, and 345395786) located on the north side of the W&OD Trail all have the same owner. This site has 0.76 acres of buildable area and sits at a general low point at elevation 520'. The site is outside the minor floodplain (per County GIS) which makes it a preferred location. Based on the preliminary sewer layout evaluation, an estimated 5 LPS connections will be required to serve the entire Community with the pump station in this location. Approximately 1,000 LF of deep sewer will be required to route the system to this pump station site. The sewer layout associated with this pump station site is shown in **Figure 2-2**.

2.1.2 Pump Station Site Alternative 2

The next alternative identified for potential pump station siting is a parcel (PIN 345393747) located just south of the Washington and Old Dominion Trail (W&OD Trail) on the west side of the Community. The site has 0.87 acres of buildable area and the lowest point of the parcel is at elevation 520'.

As with Alternative 1, an estimated 5 LPS connections will be required to serve the entire Community with this alternative. Approximately 1,000 LF of deep sewer will be required to route the system to pump station site alternative 2. There are no wetland or floodplain impacts resulting from building the pump station on this parcel, however, locating the pump station on the south side of the W&OD Trail will require two Jack & Bore crossings of the trail (once for the influent gravity line and once for sewage force main) as shown in **Figure 2-3**.

2.1.3 Pump Station Site Alternative 3

The final location identified for potential pump station siting is a parcel (PIN 345300871 and adjacent easement) located just north of the Washington and Old Dominion Trail (W&OD Trail) in the center of the Community. The proposed site is owned by the Northern Virginia Regional Park Authority and is inside the Paeonian Springs Historic District designated by the Virginia Department of Historic Resources (DHR). Siting of the SPS here would require coordination with both the Park Authority and DHR. The site has 1.81 acres of buildable area and is located at elevation 535'.

Based on the preliminary sewer layout evaluation, routing the proposed sanitary sewer lines to this site requires approximately 5 LPS connections. In addition to this, approximately 950 LF of deep sewer will be required to route the gravity sewer to a pump station in this region. The sewer layout associated with pump station site alternative 3 is shown in **Figure 2-4**.

2.2 Sewage Collection System Layout

As part of the joint system feasibility study, Dewberry developed preliminary layouts of the sewage collection system based on existing topography. Based on the existing topographic features of the Paeonian Springs Community, it is not feasible to serve the entire community with gravity sewer. In areas where existing topography does not allow for gravity sewers, low pressure systems (LPS) will be required. In addition to this, some of the evaluated preliminary layouts require sections of deep sewer to convey wastewater through the Community and to the proposed SPS site. For the purpose of this Feasibility Study, deep sewers are defined as any sewer deeper than 20'. LW specified that a depth of 25' should be considered as the maximum allowable depth for gravity sewer lines. As detailed in Section 2.1, three preliminary SPS site alternatives were evaluated. Each of these sites requires a unique sewer collection system layout. All of these layouts are technically feasible.

The proposed preliminary sewer layouts are shown in **Figures 2-2, 2-3,** and **2-4**.

Figure 2-2: Paeonian Springs Preliminary Sewer Layout Alternative 1

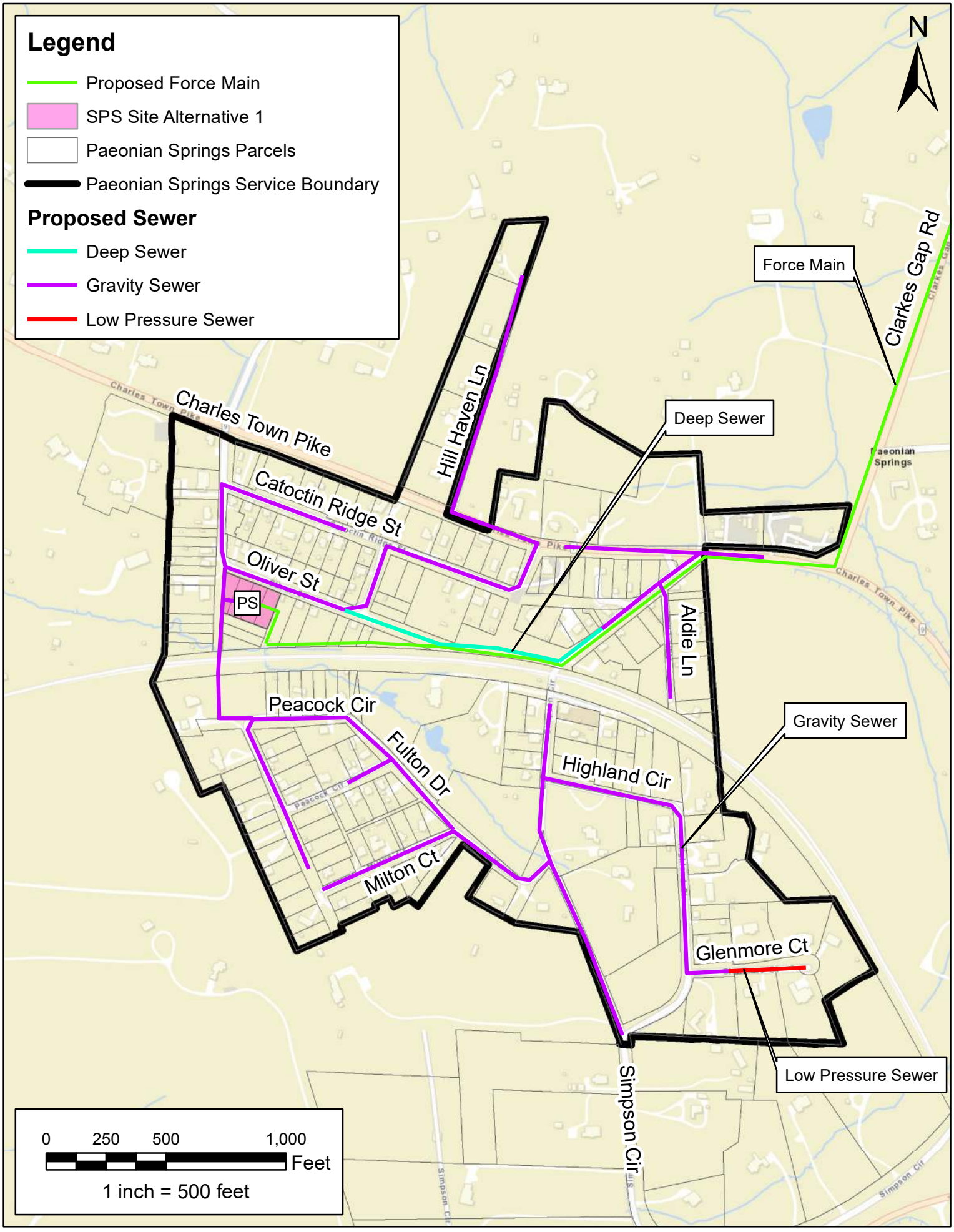


Figure 2-3: Paeonian Springs Preliminary Sewer Layout Alternative 2

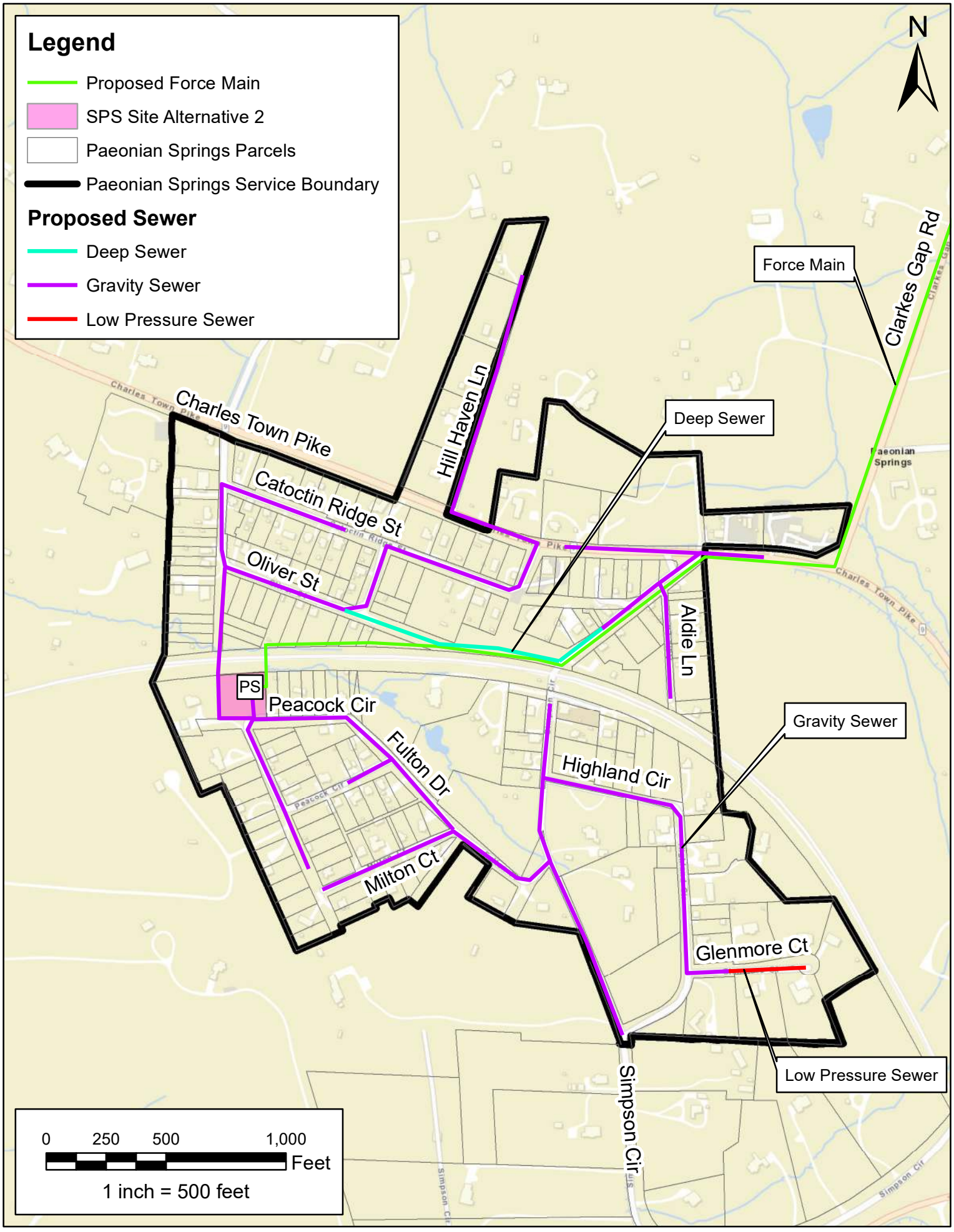
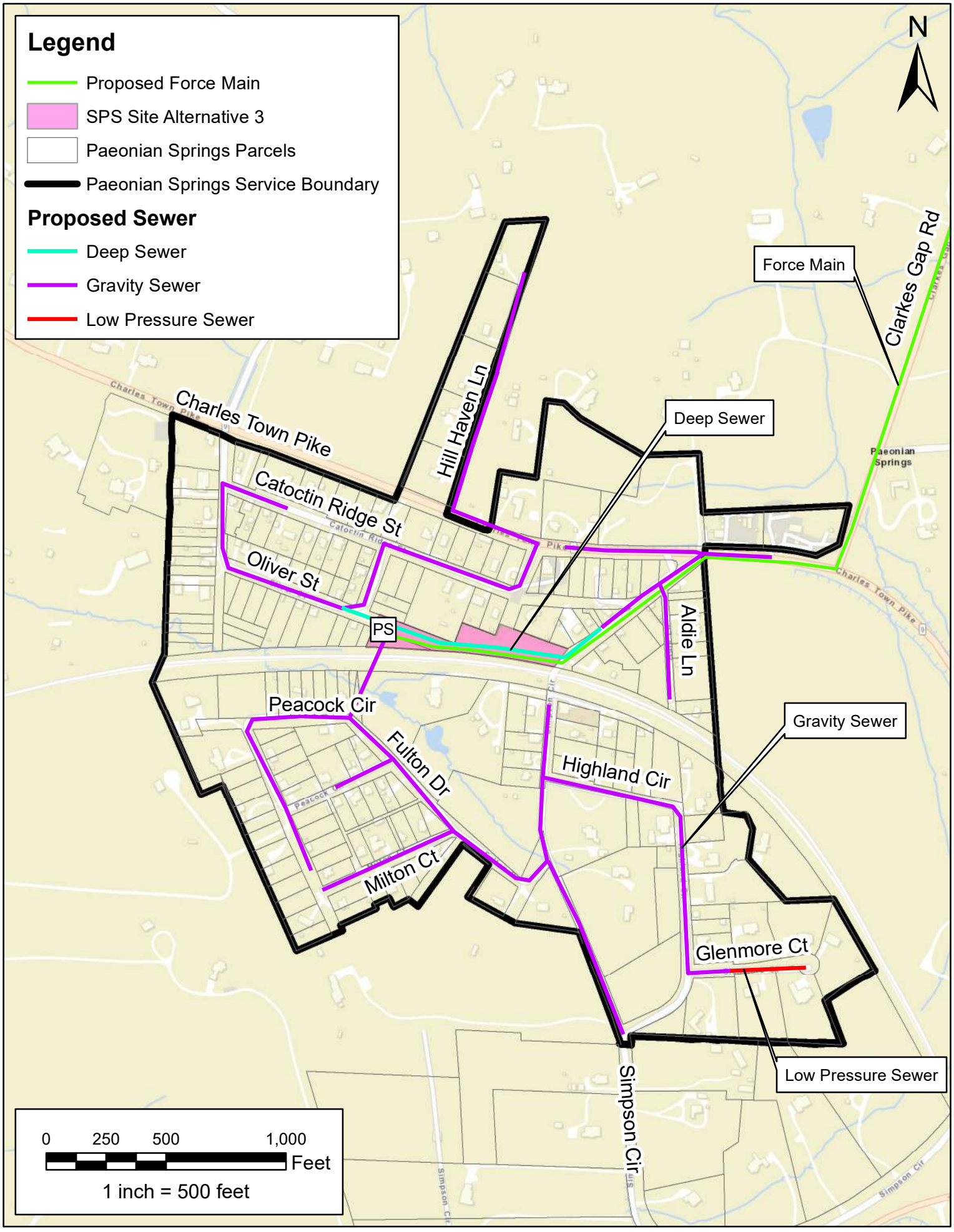


Figure 2-4: Paeonian Springs Preliminary Sewer Layout Alternative 3



2.3 Force Main Alignment

The force main alignment within the Paeonian Springs community will ultimately be dependent upon the location of the SPS. The general alignment of the force main once it exits the Paeonian Springs community will run north along Clarkes Gap Road for approximately 2.5 miles and outfall into Waterford's existing sanitary sewer system.

Per discussions with Virginia Department of Transportation (VDOT), utilities cannot be installed under the paved road within the Clarkes Gap Road right-of-way (ROW). However, VDOT expressed that installation of utility lines within ROW that are outside of the paved road is allowable through this corridor. Therefore, routing the force main along Clarkes Gap Road is feasible. However, easement acquisition may be required for the force main depending on existing ROW and existing easements along the 2.5-mile corridor. Further coordination with VDOT will be required as this project moves into the detailed design phase. This is discussed further in Section 4 of this Feasibility Study.

Based on the three SPS siting alternatives outlined in Section 2.1, preliminary horizontal alignments were developed for the force main within the Paeonian Springs community shown in **Figures 2-2, 2-3** and **2-4**. For each alignment alternative, the force main was routed through the Community and along the W&OD Trail to minimize installation of utilities in the Charles Town Pike ROW per LW preference. This alignment will require additional land acquisition. If land acquisition along this route becomes infeasible, potential exists for an alternative force main route along Charles Town Pike.

The force main profile will be determined by existing topography and existing utilities along the force main alignment and will be developed during the design phase. A surface profile of the Clarkes Gap Road corridor between the communities, is included as **Appendix D**.

2.4 Preliminary System Sizing

Based on the above-outlined sewer system, Dewberry developed hydraulic calculations to determine preliminary design points for the pumps and size the force main for each proposed SPS site alternative. The results of the calculations are summarized in **Table 2-1** below.

Table 2-1 Paeonian Springs Preliminary Wastewater System Sizing

PHASE	SEWAGE PUMP STATION					SEWAGE FORCE MAIN	
	FLOW (GPM)	PUMP OFF LEVEL (FT)	CONTROL ELEVATION (FT)	STATIC HEAD (FT)	TDH (FT)	DIAMETER (IN)	VELOCITY (FT/S)
Pump Station Site Alternative 1 & 2							
Phase I	80	497.0	543.5	46.5	77	4	2.04
					51	6	0.91
Phase II	134				127	4	3.42
					58	6	1.52
Pump Station Site Alternative 3							
Phase I	80	512.0	543.5	31.5	59	4	2.04
					35	6	0.91
Phase II	134				103	4	3.42
					41	6	1.52

Based on these calculations, for both flow phases, a 4-inch force main will allow for velocities that meet the required 2.0 ft/s for scouring the line. However, for Phase II, use of a 4-inch force main results in high head conditions. Therefore, to avoid these conditions, a 6-inch force main may be necessary. Since a 6-inch force main will cause velocities to drop below 2.0 ft/s, provisions will need to be made for adding odor control, as well as routine flushing, pigging, and cleaning of the line.

Alternatively, two parallel 4-inch force mains could be initially installed, with one in operation during Phase I, and the second being brought online for Phase II. This would help avoid issues related to scouring velocities, as well as eliminate the cost impact associated with upsizing the force main between Phases I and II. The ultimate pump selection and force main sizing and configuration will be determined during the basis of design phase based on the results of the hydraulic model.

It should be noted that based on the elevation profile across the potential force main alignment, the controlling high point of the system will not be the discharge. Several control valves may be required on the force main, including both surge protection devices (i.e. air relief valves) and pressure control valves (i.e. pressure reducing valves). A hydraulic model of the system will determine the final valve requirements. In addition, there may be opportunity to transition the system to gravity prior to discharging to Waterford, which would reduce system head and pump horsepower. The final configuration of the pump station and force main will be determined through the hydraulic modeling efforts. However, the pump station and force main solution is feasible.

2.5 Waterford Wastewater Treatment Plant Upgrades

Loudoun Water initiated the Waterford WWTP upgrade project to comply with DEQ's new ammonia removal requirements by December 2025. Waterford is one of the three plants that will be upgraded to meet the new regulatory requirements. Loudoun Water selected a progressive design-build (PDB) contract mechanism to advance the upgrade project and awarded the PDB contract in September 2023. The PDB team has adopted an aggressive schedule to meet the regulatory compliance requirements. The project team has already initiated coordination with permitting agencies and has plans to begin procurement of long lead time equipment in Q4 of 2024, begin heavy civil construction in Q4 of 2025, and complete construction by Q3 of 2026.

The current PDB contract is based on achieving regulatory compliance for the Waterford WWTP under the current permitted capacity. The PDB project does not account for capacity expansion to incorporate additional flow from areas outside the existing Waterford wastewater service area.

Treating flows from Paeonian Springs would require the capability to treat up to an additional 75,000 GPD of wastewater flow at the existing site. This additional flow would require more treatment equipment, process tankage and other improvements. There are several critical components that are required to confirm technical feasibility.

(1) **Land Area:** The Waterford WWTP sits on 8.83 acres of land owned by Loudoun Water. Based on a preliminary review of the PDB project site plans, sufficient area will be available to construct structures necessary to handle Paeonian Springs flow at the site.
(2) **Discharge Permit:** The existing discharge permit for Waterford WWTP will remain in place after the plant upgrade. Discharge permits focus on two main components: flow (quantity) and loading (quality). These components determine effluent limits and treatment targets for the facility.
    a. Loading is mainly a function of nutrient removal capability of the treatment system. The new treatment technology installed with the PDB contract will significantly reduce nutrients and effluent loading compared to the existing lagoon-based treatment system. Therefore, an expanded system treating to similar standards could accommodate Paeonian Springs flows on a discharge loading basis.
    b. From a flow perspective, Paeonian Springs would more than double the discharge flow into the receiving stream. Per Loudoun Water's conversations with DEQ, while there are steps required to increase the flow tier at Waterford to account for Paeonian Springs, a flow tier increase can be obtained from DEQ without the need to obtain additional credits for nutrient discharge limits.

(3) **Approach:** Based on the status of the existing PDB project, it is anticipated that Paeonian Springs wastewater flows will be treated on site through the construction of a separate expansion after all agreements between Loudoun County, Loudoun Water and the communities are in place that meet the requirements of Chapter 2 of Loudoun Water's Engineering Design Manual (EDM). Loudoun Water's PDB contract will incorporate reasonable provisions to facilitate future expansion of the Waterford WWTP to accommodate Paeonian Springs flows that will help reduce overall project cost.

In summary, Dewberry finds it technically feasible to treat and discharge Paeonian Springs wastewater at the Waterford WWTP site. Community outreach is required through permitting processes and legislative approvals.

3. Paeonian Springs and Waterford Water System

As discussed in Section 1, both Paeonian Springs and Waterford currently use individual private on-site drinking water systems. Dewberry evaluated the feasibility of a combined water system between the two communities as part of the joint system approach. The drinking water system would include the following components:

- Groundwater well, treatment, storage and pumping facility located in the 2.5-mile Clarkes Gap Road corridor between Paeonian Springs and Waterford
- Water distribution lines to pump water north and south from the facility to both communities along Clarkes Gap Road
- Water distribution systems within Paeonian Springs and Waterford

It is important to note that the evaluation of the joint drinking water system in this Feasibility Study does not include provision for fire flow. Loudoun County Facility Standards Manual (FSM) Chapter 1042 requires that new water systems and extensions of existing water systems provide fire flow. However, per FSM 2.330.A, appurtenances such as tanks for fire flow may be required. Fire protection in the rural policy area is outlined in Loudoun County's facilities standards manual (Section 2.300) and requires a combination of day tanks, dry hydrants and connection locations to serve the communities. Easements for this equipment will be required by Loudoun County for fire protection.

If future well investigation results show sufficient water yield, fire flow can be incorporated into the water system through well yield. If well yields are insufficient to support fire flow, other measures are available such as water storage tanks and dry hydrants.

3.1 Waterworks Regulations

The design of the proposed joint drinking water system will be conducted in accordance with requirements from Chapter 7 of the Loudoun Water EDM as well as Virginia Department of Health (VDH) waterworks regulations (12VAC5-590) to ensure that the water distributed to the communities is safe for drinking. These standards specify necessary groundwater monitoring, quality, storage, and pumping requirements, as well as acceptable treatment techniques. The standards used for each component of the proposed water system are as follows:

- **Groundwater Well –** Loudoun Water EDM Chapter 7-J & 7-P and 12VAC5-590-840
- **Facility Siting** – Loudoun Water EDM Chapter 7-K
- **Water Treatment** – Loudoun Water EDM Chapter 7-Q & 7-R and 12VAC5-590-680
- **Water Storage** – Loudoun Water EDM Chapter 7-W
- **Water Pumping Stations** – Loudoun Water EDM Chapter 7-U and 12VAC5-590-1040

Using these standards as a basis, the feasibility of a joint drinking water system was evaluated and is summarized in the following sections.

3.2 Groundwater Well

As outlined above, locating groundwater wells within the Clarkes Gap Road corridor with sufficient yield to serve both communities is essential to the feasibility of the joint water system approach. Therefore, a groundwater investigation is required to determine if groundwater sources exist with enough yield to meet the project requirements. Once a sufficient yield to serve both communities is located, acquisition of land for the groundwater source will be required. This land will be the location of a drinking water well, treatment

and storage facility which will be designed in accordance with the above-mentioned regulatory requirements.

3.2.1 Groundwater Well Yield Requirements

Loudoun Water EDM regulations were used to approximate the required well yield for the joint water system. Loudoun Water EDM Chapter 7-J dictates that groundwater systems serving more than fifty connections must provide a number of wells capable of continuously pumping at least 1.2 gpm (1,728 gpd) per connection, with each well producing a minimum of 0.6 gpm (2,304 gpd) per connection. The EDM requires a hydrogeologic study prior to well testing.

The well yield should serve the future buildout of the communities and ultimate phase of development. The potential well yield scenarios are summarized in Table 3.1 below:

Table 3-1 Well Yield Scenarios

	No. OF CONNECTIONS	LW EDM REQUIREMENT	
Paeonian Springs	201	1.2	241
Waterford	144	1.2	173
Total	345	414 gpm	

Therefore, the target yield for the groundwater wells is approximately 414 gpm. Treatment and storage systems would also be designed to meet this demand requirement. If sufficient well yield to meet the 414-gpm demand is not found, a combination of expansion of groundwater investigation area, design modifications and coordination with LW and VDH would be required to meet the needs of the system.

3.2.2 Groundwater Well Siting

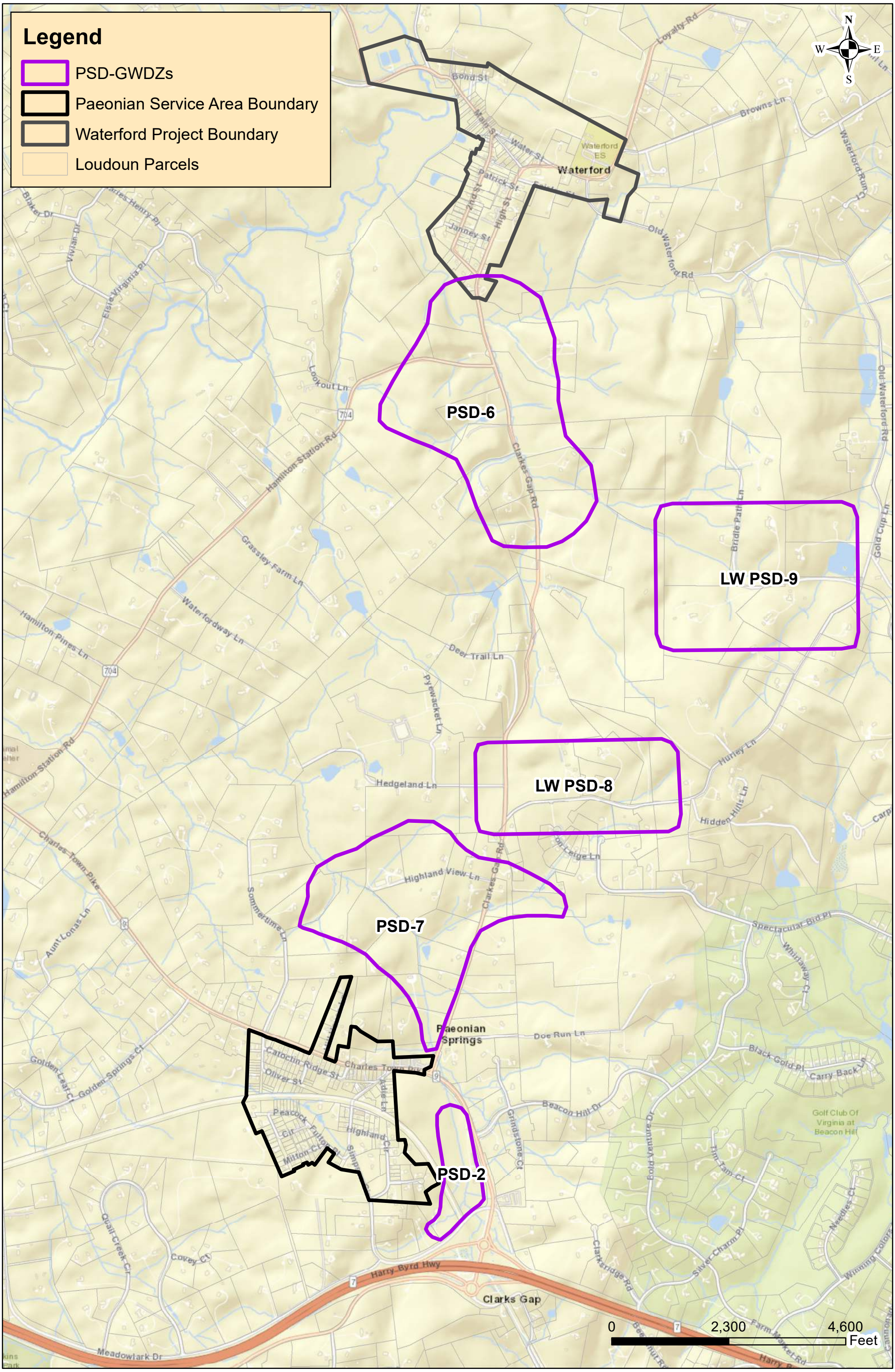
In May 2023, as part of the feasibility study, Emery & Garrett Groundwater Investigations (EGGI) developed a preliminary hydrogeologic site assessment of the Paeonian Springs expanded study area. The EGGI study, attached as **Appendix C**, included assessment of the local bedrock geology, groundwater recharge analysis, and a review of potential contaminant threats to groundwater quality. The study resulted in identification of three potential groundwater development zones (GDZs) as having high-yield potential. In addition to these GDZs, Loudoun County requested that two additional zones be included in the Phase II groundwater investigation. The GDZs are shown in **Figure 3-1**.

The Phase II investigation will include geophysical survey to specify siting of exploratory test wells on land within the GDZs. These exploratory test wells will be drilled and tested as part of Phase III of the well identification and development process and will be performed in accordance with 12VAC5-590-840 and Loudoun Water EDM. The tests will provide key information on groundwater well yield and water quality within the identified GDZs which will ultimately determine the feasibility of the joint drinking water system.

The well facility, which will include the groundwater well and control building with treatment train, storage tank and booster pumps will be located on the site of one of the groundwater wells. Siting of the groundwater well facility will be based on specifications from both Loudoun Water EDM and VDH waterworks regulations. Siting can be limited by several factors, outlined below:

- Site must have available area to meet a 100-foot radial or a square, 200 feet by 200 feet, well lot required as a minimum for each well (Loudoun Water EDM Chapter 7-P)
- Wells cannot be located within any major 100-year flood plain (Loudoun Water EDM Chapter 7-P)
- Well location must meet required setbacks (12VAC5-610-592)

Figure 3-1: Proposed Geophysical Study Areas



  - Property lines: Minimum 10 ft setback
  - Existing Drainfields: Minimum 50 ft setback
  - Foundation of Solid Masonry Building: Minimum 15 ft setback

- Wells cannot be located inside existing conservation easements that limit such construction.
- Accessibility of waterlines from well site to Clarkes Gap Road ROW
- Groundwater yield must be adequate for serving both Paeonian Springs and Waterford with safe drinking water.
- Quality of groundwater must meet minimum standard to make treatment both feasible and cost-effective for the County.
- Willingness of the property owner to work with the County and allow acquisition of land for the well and treatment facility.

These requirements will all be considered when determining the optimum locations for well testing. Dewberry also conducted deed research for any parcels with conservation easements that fall within the identified GDZs to determine if construction of a well and treatment facility is allowed on these parcels based on the language of the easement deeds.

As mentioned in Section 3.2, the feasibility of any parcel for siting of the facility will ultimately be driven by the quality and quantity of groundwater in the area, as well as the willingness of the landowner to sell their land to the County for siting of the facility.

3.2.3 Groundwater Treatment

The well will pump the groundwater to the associated treatment facility which will be designed to treat the raw groundwater to meet the minimum drinking water requirements prior to distribution to Paeonian Springs and Waterford. The water treatment technologies required will ultimately depend upon the water quality of the well. Based on the results of well testing, any contaminants found in the groundwater will need to be treated to the Environmental Protection Agency's (EPA) maximum contaminant level (MCL) using conventional technology as outlined in Chapter 7 of the Loudoun Water EDM. Examples of conventional treatment technology include the following:

- **Greensand Filters** – Uses manganese oxide filter media for removal of iron, manganese, and radium from the groundwater.
- **Membrane Filtration** – Uses semi-permeable membrane filters for removal of bacteria from the groundwater.
- **Activated Carbon Filters** – Uses porous absorption media for removal of gaseous volatile organic compounds (VOCs) as well as heavy metals such as copper and lead from the groundwater.
- **Chlorination** – Injection of sodium hypochlorite for disinfection of the groundwater.
- **VDH-Approved Corrosion Inhibitors** – Injection of chemicals such as orthophosphate for corrosion protection.

As mentioned above, the extent of required treatment will be determined by the quality of the groundwater discovered in the well testing during EGGI's Phase II and III groundwater survey.

3.2.4 Water Booster Station and Storage

Once the groundwater has been adequately treated to meet the drinking water requirements, the treated water can be pumped into the distribution system. The groundwater well and treatment facility will include water booster pumps and all associated electrical gear for pumping the treated water to Paeonian Springs and Waterford. In addition to this, depending upon the groundwater yield discovered in the Phase II and III groundwater survey, additional storage may be required at the facility.

The configuration of the water booster station will be dependent upon the location of the groundwater facility site. The existing topography between Paeonian Springs and Waterford generally slopes upward to a highpoint about 0.75 miles north of Paeonian Springs and then downward moving north between the high point and Waterford along Clarkes Gap Rd. The elevation difference between the communities is approximately 110 ft. Therefore, due to this elevation difference, the design of the drinking water facility will depend upon the elevation of the station site relative to both communities. If the site is located closer to Waterford, booster pumps will be required to pump the treated water to Paeonian Springs. However, if the site is located on higher ground closer to Paeonian Springs, water can be stored using a hydropneumatic tank system and conveyed downhill to Waterford potentially without the need of booster pumps. The components required for the facility will be dependent upon system flows and pressures which will be confirmed by the hydraulic model.

The groundwater well and treatment facility will be designed in accordance with LW EDM Chapter 7-U and may include the following components:

- Concrete Masonry Unit (CMU) Building with Asphalt Roof
- Two (2) booster pumps designed to meet peak water demand with the largest pump offline
- Flanged ductile iron (DI) process piping, valves, fittings and appurtenances
- HVAC equipment including exhaust fan and air conditioning unit
- All electrical gear including emergency backup generator with automatic transfer switch capable of powering the closest water supply well, any booster pumps and air compressors to meet the peak demand.
- Hydropneumatic Tank system with lead/lag air compressor in accordance with Loudoun Water EDM Chapter 7-W
    - The storage requirements will be dependent on the ultimate well yield and treatment capacity and the peak hour demand on the water system. Assuming the well serves the full buildout of the communities (345 connections), the storage requirement would be approximately 60,000 gallons.

In summary, assuming sufficient space is available and well yield is found within the study area, this solution is technically feasible.

3.3 Water Distribution System

Because the site of the Groundwater Wells and Treatment Facility are currently undetermined, the exact length of the watermain is unknown. The booster pumps at the groundwater well and treatment facility will pump the treated water from the facility site to a watermain located in Clarkes Gap Road. From here, the watermain would have a total length along Clarkes Gap Road of approximately 12,500 LF north and south to convey the necessary flows to both Paeonian Springs and Waterford.

As previously mentioned, the watermain along Clarkes Gap Road will run parallel to the Paeonian Springs SPS force main in the unpaved ROW. Parallel sewer and water pipes will be designed with a minimum horizontal separation of 10 feet and a minimum vertical separation of 1.5 feet per Loudoun Water EDM.

Once the watermain reaches Paeonian Springs and Waterford, the water distribution piping will be installed in the paved ROW parallel to the sanitary sewer lines and offset as required in the Loudoun Water EDM. The proposed Paeonian Springs water distribution system, shown in **Figure 3-2**, consists of approximately 11,500 LF of MJ DI pipe. The proposed Waterford water distribution system, shown in **Figure 3-3**, consists of approximately 13,350 LF of MJ DI pipe. The parallel watermain and sewage force main along Clarkes Gap Road is shown in **Figure 3-4**.

Figure 3-2: Paeonian Springs Preliminary Water Layout

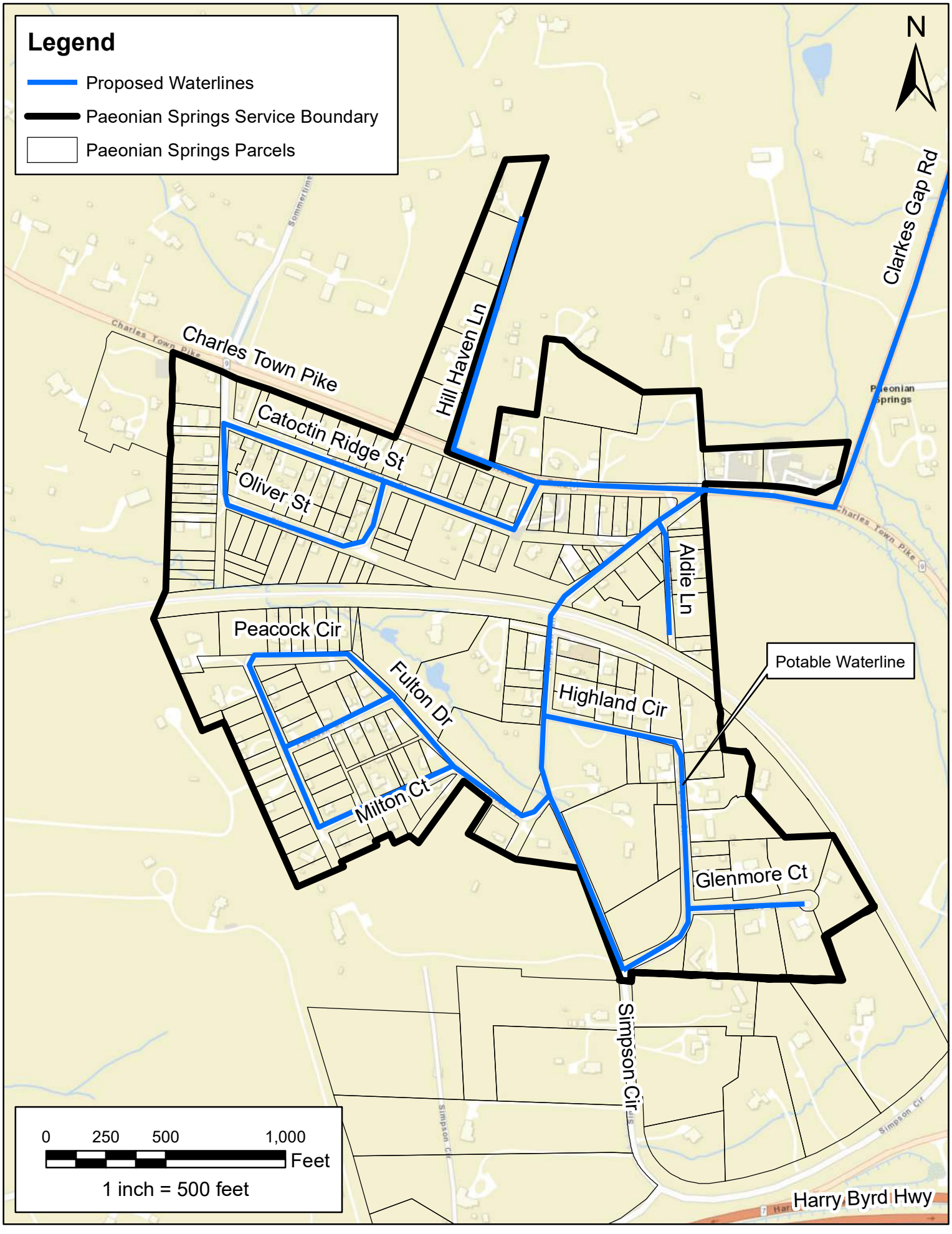


Figure 3-3: Waterford Preliminary Water Layout

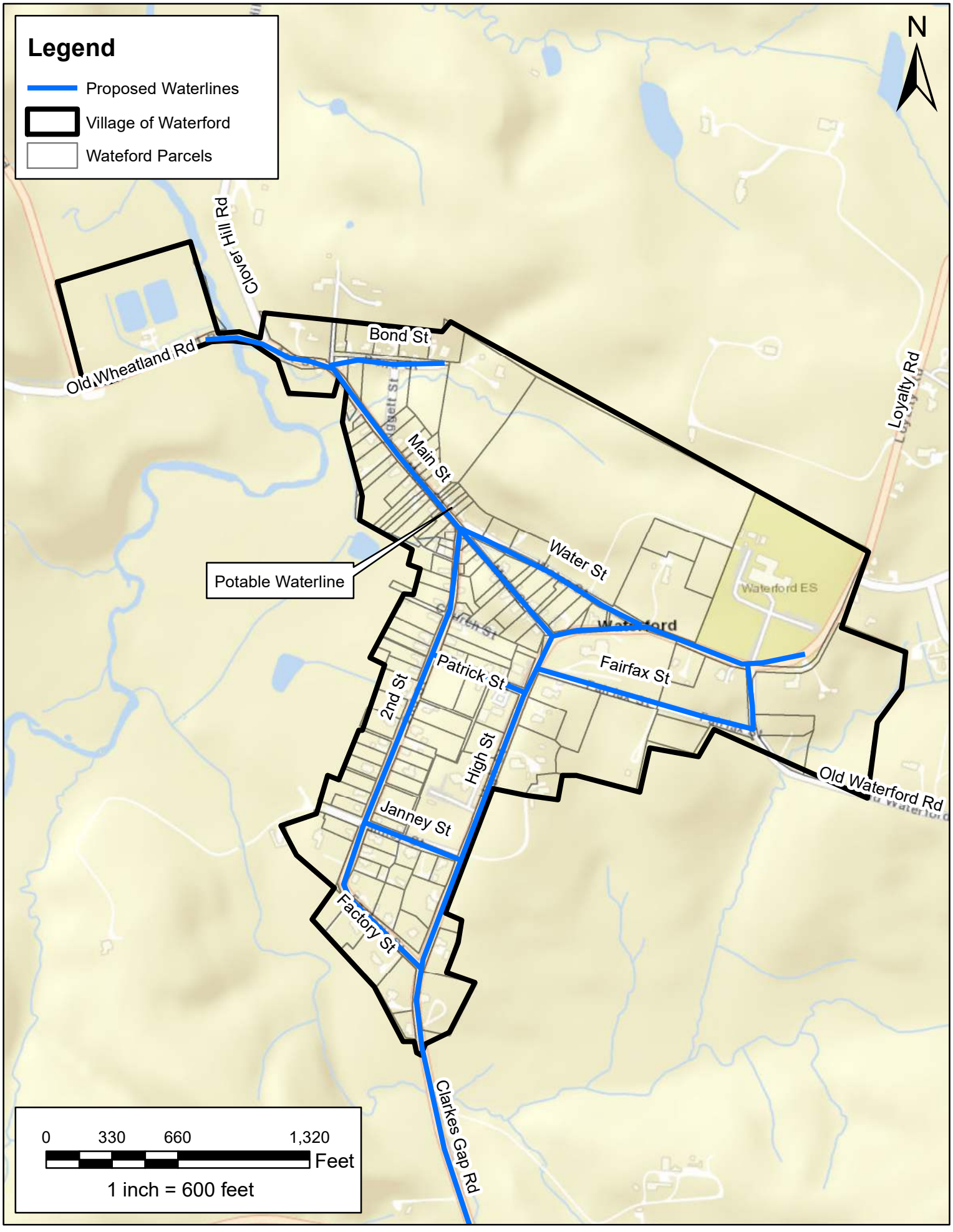
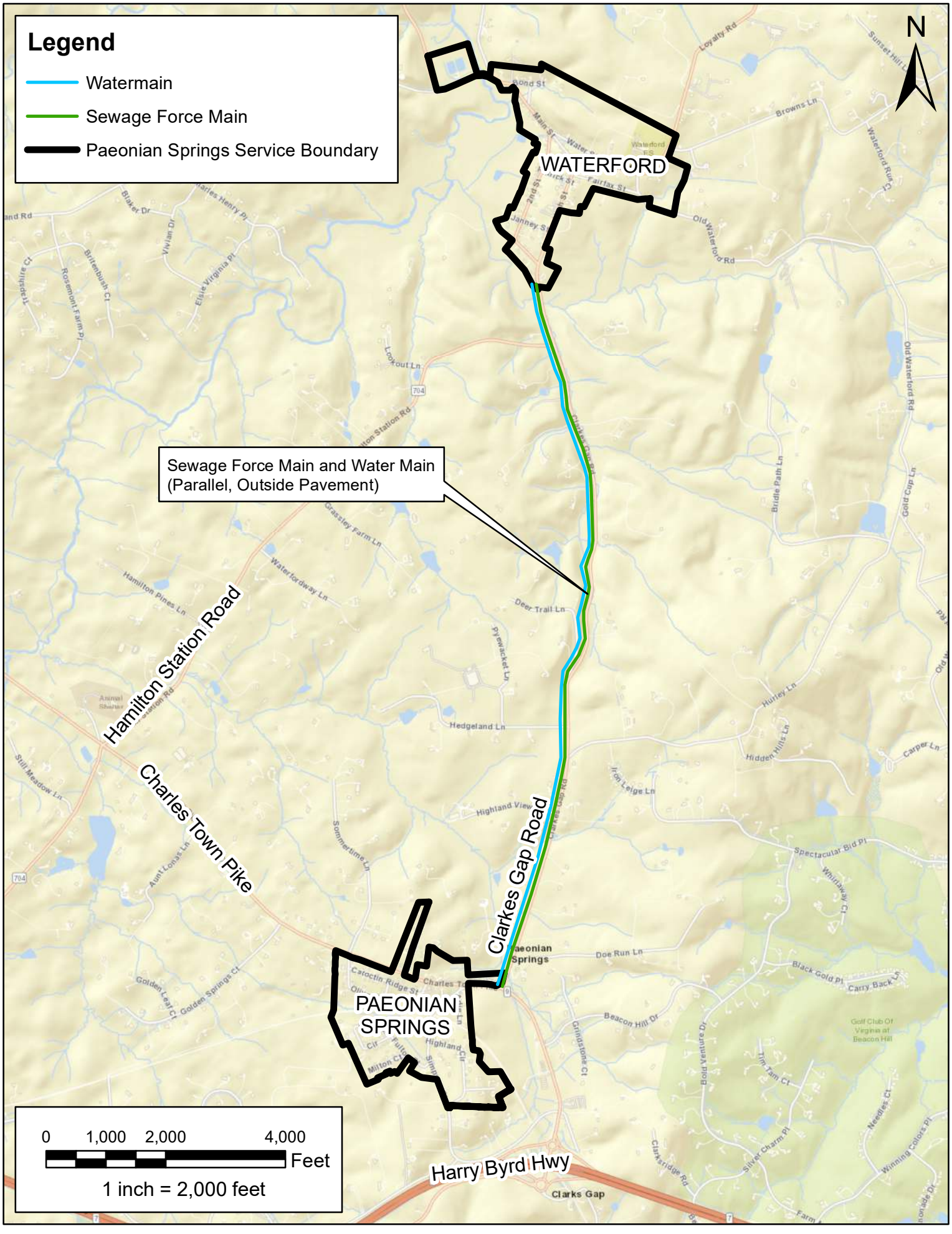


Figure 3-4: Clarkes Gap Road Corridor Alignment



4. Constructability Challenges

As part of the feasibility study, Dewberry identified several constructability challenges associated with the implementation of the proposed Paeonian Springs and Waterford joint water and wastewater system. Due to the historic nature of both communities and the proximity of Paeonian Springs to the W&OD Trail, the potential impact of this project on archeological and cultural resources must be considered. In addition to this, construction impacts to residents and traffic along the proposed gravity sewer, sewage force main and waterline alignments were identified.

4.1 Roadway Impacts and VDOT Coordination

As shown in Section 2.2 and Section 3.3, the water distribution and sewer collection systems in both Paeonian Springs and Waterford are proposed to be installed in the paved roads within each community. Most of the roads in both communities along the proposed alignments are maintained by VDOT. In Paeonian Springs, both Adie Ln and Hill Haven Ln are private roads. Coordination with VDOT and HOA/private road owners will be required prior to construction in these ROWs. During the design phase, deed research will be conducted to identify if the roadways have fee-simple ROW or are on prescriptive easements. Temporary lane closures will be required during construction in roads within Paeonian Springs and Waterford. A detailed traffic control plan for all impacted roads will be developed during the design phase.

As discussed in Section 2.3, VDOT specified that no new utilities can be constructed in the paved portion of the Clarkes Gap Road ROW. As a result, both the sewage force main and water distribution main along the Clarkes Gap Road corridor will need to be routed outside of the pavement. While construction will take place outside the pavement, this will cause traffic impacts along Clarkes Gap Road for the entire duration of the construction. Coordination with VDOT will be required throughout the design and construction phase of the project to ensure optimum traffic flow through this corridor during the approximately 8 months required for installation of the force main and watermain.

4.2 Easement and Property Acquisition

As outlined in Sections 2.1 and 3.2, a driving factor in the feasibility of the joint system approach, is the acquisition of land for siting of the SPS within Paeonian Springs, drinking water wells, and the treatment and pumping facility in the Clarkes Gap Road corridor between the communities. Dewberry understands the County will lead coordination with the property owners for land acquisition. An approximation of the land acquisition required for the entire project is outlined in **Table 4-1** below.

Table 4-1 Joint System Easement/Land Acquisition Estimate

SYSTEM COMPONENT	NUMBER	AREA/UNIT	TOTAL LAND (SF)	TOTAL LAND (ACRES)
Groundwater Wells	4 Wells	200' Ø Circle	125,664	2.88
Water Treatment	1 Facility	1 Acre	43,560	1.00
Groundwater Well Raw Water Piping	10,000 LF	20' Width	200,000	4.59
Sewage Pumping Station	1 Facility	0.5 Acre	21,780	0.50
Wastewater Collection/Water Distribution Systems	11,500 LF	ROW	N/A	N/A
Sewage Force Main	12,500 LF	10' Width Outside ROW	125,000	2.87
Water Transmission Main	12,500 LF	10' Width Outside ROW	125,000	2.87
		SUBTOTAL	641,004	14.72
Contingency 1: Remote Well Locations	5,000 LF	20' Width	100,000	2.30
Contingency 2: Unknown Easements & Property	5% of subtotal		32,050	0.74
		SUBTOTAL	773,054	17.75
Temporary Construction Easement	10% of subtotal		77,305	1.78
		SUBTOTAL	**850,360**	**19.53**

As mentioned in Section 4.1, the force main and watermain alignment running parallel along Clarkes Gap Road will be installed in the ROW outside the pavement. Therefore, easement acquisition may be required depending on existing ROW and easements along the alignment between Paeonian Springs and Waterford. Dewberry conducted deed research of the parcels along the 2.5-mile segment of Clarkes Gap Road between Paeonian Springs and Waterford to determine the number of parcels on which the proposed alignments run and the extent of required easement acquisition. As previously stated, the land acquisition process and current owners' willingness to sell to the County will be a major driver in determining the ultimate location of the water and sewer facilities outlined in this Feasibility Study.

4.3 Washington & Old Dominion Trail Crossing

The proposed water and sewer system layouts within Paeonian Springs include crossings of the W&OD Trail as shown in **Figures 2-1**, **2-2** and **2-3**. The W&OD Trail is owned by the Northern Virginia Regional Park Authority and is considered a Historic District by the Virginia Department of Historic Resources. Therefore, utilities crossing the W&OD Trail will be installed using jack and bore to minimize impacts to the historic district. Coordination with the Park Authority will be required during design and construction.

4.4 Archaeological and Cultural Resources Impact

In addition to the W&OD Trail, both Paeonian Springs and Waterford are designated on the National Register of Historic Districts by the Virginia Department of Historic Resources. There are several known architectural and archaeological resources located within the project area.

A review of the Virginia Department of Historic Resources (DHR) Virginia Cultural Resources Information System (VCRIS) database identified 4 archaeological resources within or immediately adjacent to the Waterford community. None of the archaeological resources have been evaluated for eligibility for the National Register of Historic Places (NRHP). VCRIS also listed 144 architectural resources within or immediately adjacent to the Waterford community. Of those resources, 15 architectural resources are considered Individual Historic District properties that are not individually eligible for NRHP listing but are considered eligible as part of the Waterford Historic District. The Waterford Historic District (DHR ID 401-0123), which is a listed resource in the NRHP, Virginia Landmarks Register (VLR) and the National Historic Landmarks register, encompasses the entirety of the Waterford community as well as portions of the surrounding area. Other than the Catoctin Creek Scenic River (DHR ID 053-0059), which is considered eligible for NRHP listing by the DHR board, the remainder of the architectural resources have not been evaluated for NRHP eligibility. Lastly, VCRIS listed 58 established DHR easements within or adjacent to the Waterford community.

A review of the DHR VCRIS database identified 1 archaeological resource within the Paeonian Springs community. This archaeological resource has not been evaluated for eligibility for the NRHP. VCRIS also listed 47 architectural resources immediately adjacent to the Paeonian Springs community. Of those resources, 31 architectural resources are considered Individual Historic District properties that are not individually eligible for NRHP listing but are considered eligible as part of the Paeonian Springs Historic District. The Paeonian Springs Historic District (DHR ID 053-5072), which is a listed resource in the NRHP and VLR, encompasses the majority of the eastern half of the community. The W&OD Railroad Historic District (DHR ID 053-0276), which is considered eligible for NRHP listing by DHR, passes through the community as well. The remainder of architectural resources that are not listed as Individual Historic District properties have been determined not eligible for NRHP listing by DHR.

Maps showing the existing resources in both Paeonian Springs and Waterford are included below as **Figures 4-1** and **4-2**.

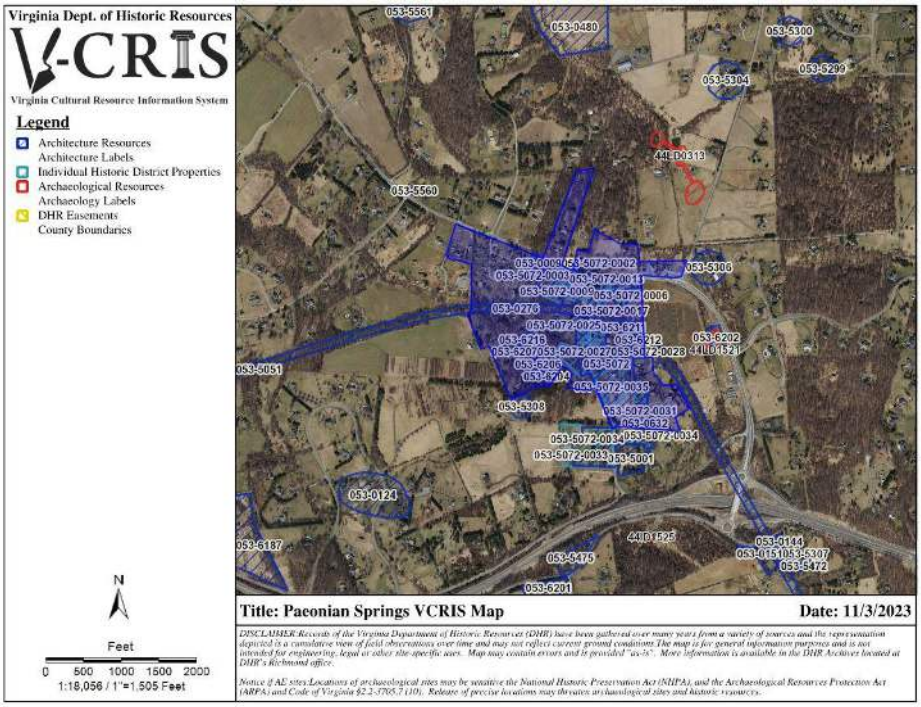


Figure 4-1: Paeonian Springs Architectural and Archaeological Sites

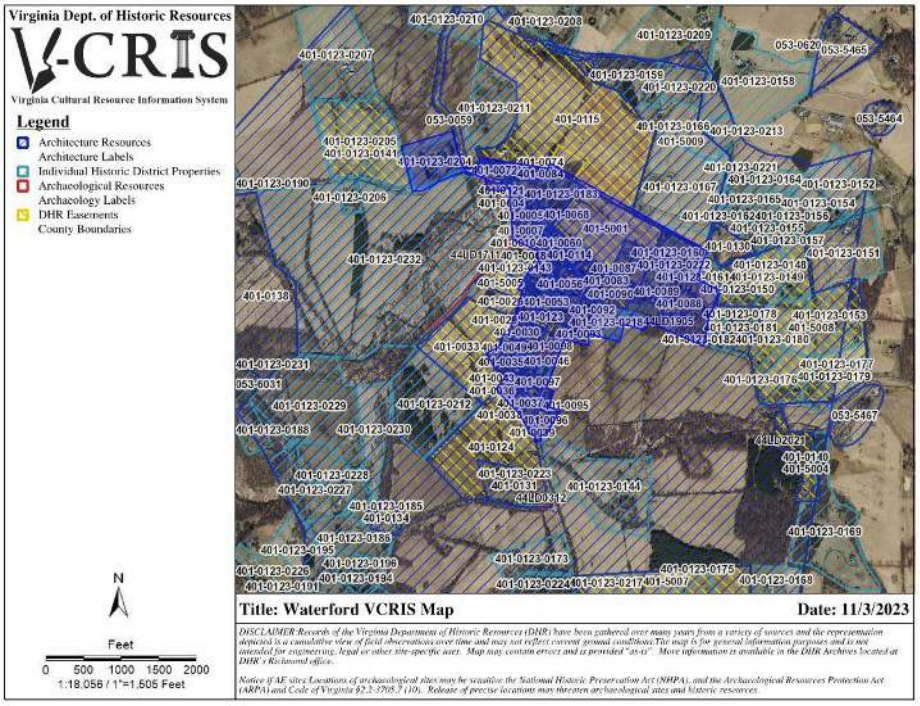


Figure 4-2: Waterford Architectural and Archaeological Sites

The designation of Paeonian Springs and Waterford as National Register of Historic Districts may require additional permitting and coordination with federal agencies or specific design modifications and installation criteria. The historic designations of the areas do not affect the feasibility of the project.

5. Opinion of Probable Construction Costs

An opinion of probable construction costs (OPCC) was developed for the joint system based on the system components outlined in this memo. At this time, numerous uncertainties still exist relating to the project that could significantly impact the project's overall cost, including the following:

- Final siting of the sewage pumping station and groundwater well facility
- Availability and quality of source groundwater to serve the potable water needs of both communities
- Approach ultimately chosen for the Waterford WWTP upgrade

In addition to these uncertainties, a number of considerations associated with the current state of the market including supply chain issues and inflation contribute to high volatility in material costs. The OPCC developed in this Feasibility Study takes the current state of the market into account but based on volatility of pricing for certain items, potential exists for long-term effects to construction costs that may affect the final project costs. Therefore, the OPCC included in this Feasibility Study is an AACE Class 4 cost estimate with an accuracy range of -20% to +30%. High and low range estimates are included in the OPCC to capture the wide range of accuracy at this stage of the project. **Table 5-1** below summarizes the high-level OPCC for the Paeonian Springs and Waterford joint water and wastewater system outlined in this Feasibility Study.

Table 5-1 Opinion of Probable Construction Costs

OPINION OF PROBABLE CONSTRUCTION COSTS (2024 COST)				
WASTEWATER SYSTEM				
Item	**Units**	**Quantity**	**Unit Price**	**Total**
Paeonian Springs Sewage Collection System	LF	11,500	$ 364	$ 4,186,000
Paeonian Springs Sewage Pump Station	LS	1	$ 2,600,000	$ 2,600,000
Paeonian Springs Sewage Force Main	LF	12,500	$ 260	$ 3,250,000
Road Restoration & Site Work*	LS	1	$ 2,775,760	$ 2,776,000
Waterford WWTP Upgrades	LS	1	$ 8,164,000	$ 8,164,000
Joint Wastewater System Capital Costs Subtotal				$ 20,976,000
JOINT WATER SYSTEM				
Item	**Units**	**Quantity**	**Unit Price**	**Total**
Paeonian Springs Water Distribution System	LF	11,500	$ 312	$ 3,588,000
Waterford Water Distribution System	LF	13,350	$ 312	$ 4,165,200
Water Meter and Service Installation	LS	1	$ 1,166,880	$ 1,167,000
Water Well & Treatment Facility				
Groundwater Wells	LS	1	$ 1,040,000	$ 1,040,000
Pump & Storage Facility	LS	1	$ 3,120,000	$ 3,120,000
Water Treatment System	LS	1	$ 1,300,000	$ 1,300,000
Furnish & Install 6" DIP Water Main	LF	12,500	$ 312	$ 3,900,000
Road Restoration & Site Work*	LS	1	$ 874,640	$ 875,000
Joint Water System Capital Costs Subtotal				$ 19,156,000
COMBINED SYSTEM				
TOTAL CONSTRUCTION COSTS (2024 COST)				**$ 40,132,000**
CONTINGENCY (20%)				$ 8,027,000
TOTAL CONSTRUCTION COSTS W/ CONTINGENCY				**$ 48,159,000**
LOW RANGE ESTIMATE (-20%)				$ 38,527,000
HIGH RANGE ESTIMATE (+30%)				$ 62,607,000
DESIGN, PERMITTING, & SURVEYING**				$ 4,500,000
CONSTRUCTION ADMINISTRATION (10% OF 2024 COST)				$ 4,820,000
LAND ACQUISTION (HIGH LEVEL ESTIMATE)				$ 2,000,000
TOTAL CAPITAL COSTS				**$ 59,479,000**

*Road Restoration & Site Work costs assume that waterlines and sewer lines are installed simultaneously where they are proposed to run parallel to each other. "JOINT WASTEWATER SYSTEM" Road restoration & Site Work line item covers restoration in areas where parallel water and sewer lines are proposed. "JOINT WATER SYSTEM" Road restoration & Site Work line item covers restoration in areas where only installation of waterlines is proposed.

** Already approved by the Board of Supervisors.

There are several key assumptions that are included in this OPCC that may impact costs. Those key assumptions include:

- The OPCC is for ultimate buildout of the project and all phases of construction.
- Land acquisition areas required will be close to the approximated values outlined in **Table 4-1**. Land acquisition costs will be refined as the design process progresses.
- The Waterford WWTP expansion would be constructed within existing WWTP site, eliminating the need for land acquisition.
- The gravity sewer in Waterford does not need to be upsized or replaced
- Sufficient groundwater yield is available in three (3) to four (4) wells located in close proximity. Additional wells and associated piping, land acquisition and site improvements could increase cost.
- The OPCC presented does not account for cost associated with fire flow. If future well investigation results show sufficient water yield, fire flow can be incorporated into the system with minimal additional costs. If well yields are insufficient to support fire flow, other measures are available, such as water storage tanks and dry hydrants. This will be accounted for in future design and associated cost estimates if fire flow is included.
- The groundwater system is located close to Clarkes Gap Road and piping is mainly installed within the Clarkes Gap Road corridor.
- The water and wastewater systems are designed and installed concurrently (within Clarkes Gap and Paeonian). This combines site restoration, roadway work and engineering/permitting work rather than doubling effort.
- Costs associated with installation of grinder pumps for the 5 currently developed parcels on Glenmore Ct that will need to be served by a low-pressure system are included in the cost estimate. Private individual homeowner costs for connecting to the system (well and septic system abandonment, and installation of service laterals) were not included in the OPCC.
- A packaged water treatment facility is included in this estimate. The facility was assumed to include greensand filtration for iron removal as well as chlorine injection for disinfection. Should water quality prove that no treatment other than disinfection is required, the cost would be reduced.

6. Overall Summary

To address the communities' water and wastewater challenges and the public health need identified in previous studies conducted for Paeonian Springs and Waterford, a joint water and wastewater system was proposed. The proposed system consists of the following components:

- Wastewater System
    - Paeonian Springs
        - Sanitary sewer collection system serving all connections in the Paeonian Springs service area boundary
        - Sewage Pumping Station
        - Sewage Force Main to convey flows from Paeonian Springs to Waterford sanitary sewer collection system
    - Waterford
        - Upgrades at the Waterford WWTP to meet additional flows from Paeonian Springs
- Water System
    - Paeonian Springs and Waterford
        - Groundwater Well, Treatment, Storage and Pumping Facility sited in the 2.5-mile corridor between Paeonian Springs and Waterford along Clarkes Gap Road
        - Watermain conveying treated potable water from the Well and Treatment facility to Paeonian Springs and Waterford
        - Water distribution system within Paeonian Springs and Waterford to serve all connections within the respective service areas.

Based on the OPCC developed as part of the feasibility study, the total anticipated construction cost for the proposed system is approximately $40 million in 2024 dollars (not including contingency). Assuming land acquisition is completed, and groundwater wells are developed with sufficient yield, every component of the system is technically feasible to design, permit and construct. The joint system solution provides several distinct advantages over other alternatives.

- Utilizing the existing Waterford WWTP site eliminates the need to acquire land for a new wastewater treatment facility. In addition, working alongside LW with an already planned upgrade provides an opportunity to coordinate future work, develop a more reliable cost estimate, and mitigates unknowns and hurdles inherent to a new WWTP.
- The existing Waterford WWTP discharge permit can be modified to accommodate the Paeonian Springs flows without the need to obtain additional nutrient credits.
- The existing Waterford WWTP discharges into the Catoctin Creek and is currently under its own discharge permit. Maintaining proper treatment and meeting effluent permit requirements at one facility instead of two significantly reduces the risk of environmental impacts, permit violations and mitigates required upgrades due to regulation changes.

- The use of a single WWTP through the joint system avoids the visual impacts to existing viewsheds, as well as minimizes any interaction with existing historical designation within rural communities and surrounding areas that an additional treatment facility may create. This would also hold true for a single water treatment plant to serve the two communities.

- Water availability along Clarke's Gap Road allows a solution that could serve both Waterford and Paeonian Springs as previous studies have found limited potential water in and around the communities and the Clarke's Gap corridor significantly increases the number of potential sites for the water system.

- Consolidating systems reduces overall operation and maintenance costs and reduces the lifecycle costs of facilities while also reducing risk of failure or non-compliance. Based on Loudoun Water analysis, there is potential for a cost savings over a 50-year life cycle in the range of 20 to 30% for a joint system approach over an independent systems approach.

Appendix A
Paeonian Springs Flow Analysis Memo

Dewberry

MEMORANDUM

DATE: October 27, 2023 (Updated April 3, 2024)

TO: Amulya Poudel, PE, Loudoun Water

FROM: Paul Longo, PE, Dewberry

SUBJECT: **Paeonian Springs Flow Scenarios and Design Flow Estimate**

1 Project Background and Purpose

Paeonian Springs is an unincorporated, rural historic community in Loudoun County, Virginia. Located near the intersection of Route 9 (Charles Town Pike) and Route 7 (Harry Bird Highway), Paeonian Springs is bisected by the Washington and Old Dominion (W&OD) Trail. The community presently has no public water distribution or wastewater collection system and is served by private wells and on-site sewage treatment.

Paeonian Springs was accepted as part of Loudoun County's Water and Wastewater Needs Assessment Program (Program). As part of the program, an assessment of the existing water and wastewater systems was performed and several feasibility studies and reports were prepared. It was determined that portions of the Paeonian Springs Community have a public health need for water and wastewater systems. The "Paeonian Springs Water and Wastewater Feasibility Study" (dated October 2019) evaluated the feasibility of public water and wastewater systems to serve the community. In April 2022, Dewberry completed a technical memorandum that defined a water and wastewater service area boundary for the community (report titled "Paeonian Springs Water & Wastewater Boundary and Treatment Alternatives") based on the public health needs of the community. The proposed Paeonian Springs Water and Wastewater Service Area (Service Area) consists of 201 parcels and is shown in **Figure 1.1**.

The purpose of this technical memorandum is to evaluate water demand and wastewater flows for the proposed Paeonian Springs Water and Wastewater Service Area Boundary. The aforementioned reports were utilized as a basis for the flow analysis. Three (3) flow scenarios are presented for both water and wastewater as follows:

- Existing Buildout
- Potential Buildout (All Properties Developed)
- Full Buildout (All Parcels Developed)

In the analysis of the scenarios, unique features of the Paeonian Springs Service Area were first considered as discussed in Section 2.

FIGURE 1.1 PAEONIAN SPRINGS PARCELS AND BOUNDARY

N

LEGEND

Paeonian Service Area

Dewberry

0 250 500 1,000

US Feet

2 Service Area Development & Zoning

2.1 Parcels, Properties & Address Points

Parcels & Properties: The proposed service area includes 201 individual parcels. Typically, in flow analyses, each individual parcel would be considered a singular potential connection for water and wastewater. However, it should be noted that the current development of the Paeonian Springs community has a unique characteristic due to its historic nature. Throughout the service area, groups of parcels comprise a single property, defined as adjacent parcels with one identified owner and a single address point. That is, multiple parcels were transferred under a single sale. In these instances, 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, or structures that overlap parcel lines, as well as private water and wastewater systems. As currently developed, the community has a total of 121 properties. 112 of these properties are developed. For the purposes of this memorandum, "Property" refers to one of the following:

(1) A parcel with a single parcel sale history
(2) A parcel with no sale history
(3) Multi-parcels sale for which the County real estate database provides info as one property

Figure 2.1 – Example Property
(PINs 307254158000, 307254152000, 307254146000, 307254240000)

Address Points: In addition to a single property being made up of multiple parcels, another unique development characteristic within the community is the location of multiple address points on a single parcel. For example, PIN 37045226000 is a single parcel with two structures, and each has an individual address point as shown in **Figure 2.2**. There are three (3) residential parcels that meet this case. In addition to PIN 307452226000, PINs 345494745000 and 345302723000 have two separate addresses on each parcel. Two (2) commercial properties have multiple address points. PIN 307455027000 has three (3) address points, each corresponding to a separate business. PIN 345308641000 has two address points with one being the post office and the second address appears to be a residential home based on Loudoun County property data. So, PIN 345308641000 is treated as a residential connection for the flow estimates.

Figure 2.2 – Example Parcel w/Multiple Address Points
(PIN 307452226000, 40562 Charles Town Pike, 40550 Charles Town Pike)

The occupancy of the multiple address points is unknown, but as connections are determined for the service area, these special cases will need to be considered. In general, Loudoun Water standard allows a single connection to public utilities for individual parcels. In line with this, the flows considered for these special cases in this memo assume a single connection for each of these parcels.

The scenarios presented within this memo generally consider existing properties in current demand and future demands account for the number of connections with individual sales and additional development on parcels. The assumptions utilized for each flow scenario are detailed as they are discussed throughout the memo.

2.2 Loudoun County Zoning

In addition to considering existing properties and parcels, the flow analysis also considers the current zoning within the service area. As shown in **Figure 2.3** below, the service area includes three zoning districts:

- Countryside Residential-1 (CR1)
- Countryside Residential-2 (CR2)
- Rural Commercial (RC)

Per the Loudoun County Zoning Ordinance, minimum lot sizes for these zones are dictated by availability -of water and wastewater service. Depending on if the water and wastewater service in the area is public or private, the minimum lot size differs. Private water and wastewater service generally requires a larger minimum lot size for development than in the case of publicly available water and wastewater. **Table 2.1** below summarizes the minimum required lot sizes.

Table 2-1: Minimum Lot Area by Zoning District, from Loudoun County Zoning Ordinance

	Minimum Lot Size (Sq ft)*	
DISTRICT	PUBLIC WATER/WASTEWATER SERVICE	PRIVATE WATER/WASTEWATER SERVICE
CR1	20,000	40,000
CR2	20,000	40,000
RC	10,000	10,000

*LCZO sections 2-505(A), 2-506(A), 2-605(A), 2-606(A), 2-905(A)

The zoning within the Service Area and minimum lot sizes are considered in applicable flow scenarios.

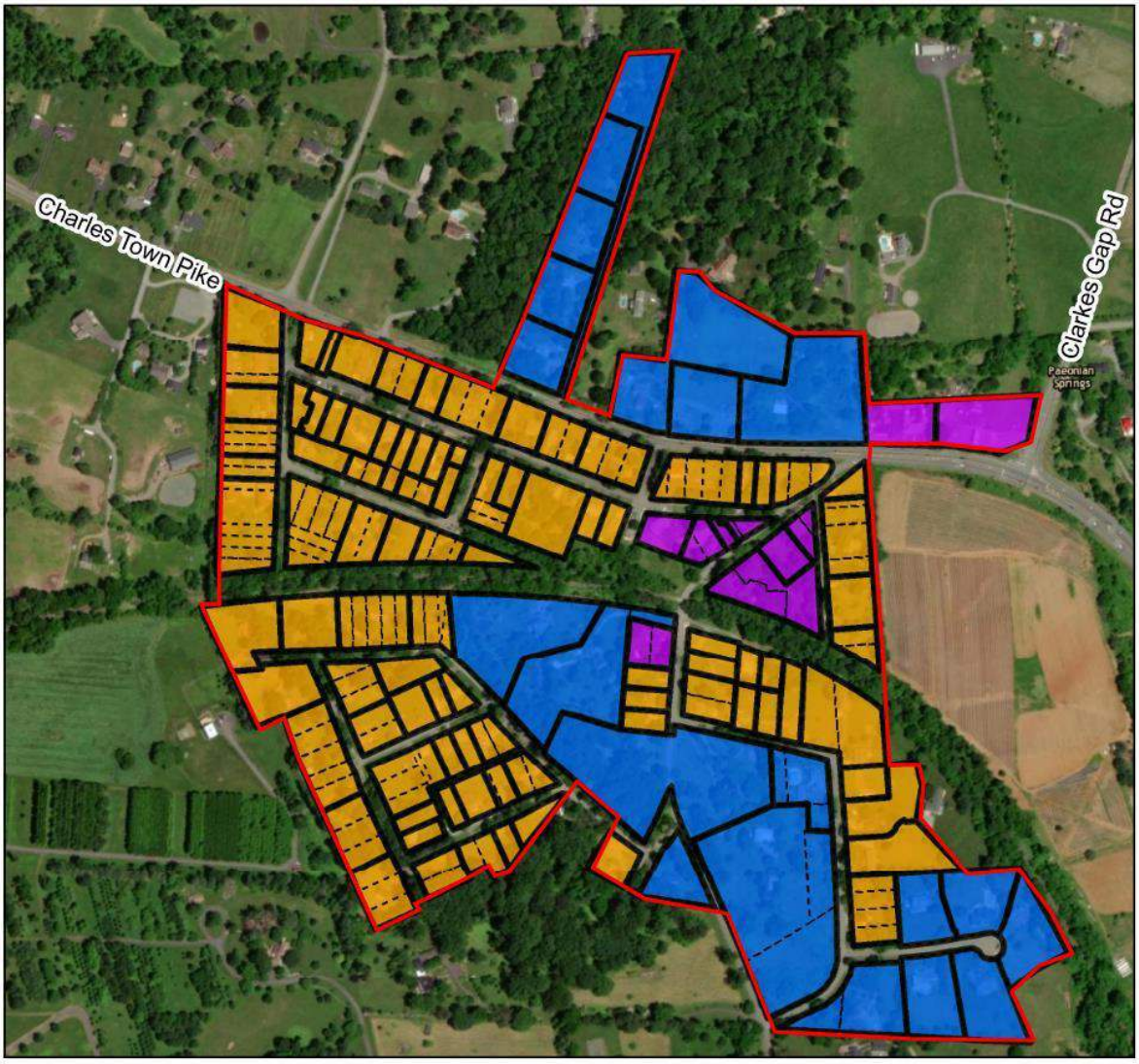


FIGURE 2.3 PAEONIAN SPRINGS PROPERTIES AND ZONING

N

LEGEND

Loudoun County Zoning

- A3
- CR1
- CR2
- RC

- Paeonian Service Area

Properties

- CR1
- CR2
- RC
- Parcels

Dewberry

0 250 500 1,000 US Feet

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2.3 Community Development

Due to the unique characteristics of Paeonian Springs, a substantial increase in density is not expected but is potentially feasible. The demand scenarios presented within this memo account for existing development, but also consider future development to determine the potential flows and system capacity required to serve the community with public water and wastewater systems.

The proposed water and wastewater systems, service area, and future subdivision will require approval through the Loudoun County Board of Supervisors. During legislative approval processes, specifically the commission permit, the total number of anticipated connections will be further defined and incorporated into the approval. The demand flows presented within the memo are intended for planning and design purposes.

Lastly, the rate of development and connections is a key consideration when determining ultimate design flows. The scenarios presented below capture three (3) reasonable alternatives that span from the existing buildout that would address the current public health need to a full buildout scenario that would require significant construction of existing parcels within the community. Future zoning modifications, intensification, subdivision or growth is not considered with these scenarios. The following section summarizes the development scenarios considered.

2.4 Development Scenarios

Three (3) different development scenarios have been considered in this assessment to determine design approach and inform future decision making. The flow scenarios for the Paeonian Springs Service Area are as follows:

- **Scenario #1 – Existing Buildout**: Includes connections for all developed properties as of September 2023
- **Scenario #2 – Potential Buildout**: Includes connections for all developed and undeveloped properties as of September 2023
- **Scenario #3 – Full Buildout**: Includes connections for all 201 parcels within the community boundary.

There is potential for several parcels within the community to be subdivided as-of-right that could expand the number of connections beyond the full buildout scenario. However, there are also several parcels within the community that are not buildable based on parcel size, setback requirements and other property restrictions such as wetlands or easements. Considering both as-of-right subdivision (flow increase) and unbuildable parcels (flow decrease), the full buildout scenario of 201 parcels balances both potential conditions and provides a reasonable target for ultimate design demand and flow.

These scenarios result in the number of connections summarized in Table 2-2.

Table 2-2: No. of Connections for Flow Scenarios

SCENARIO NO.	SCENARIO	NO. OF CONNECTIONS/SERVICES
#1	Existing Buildout	112
#2	Potential Buildout (All Properties Developed)	121
#3	Full Buildout (All Parcels Developed)	201

3 Regulatory Requirements

To determine applicable water demand and wastewater flows for this analysis, Dewberry reviewed engineering standards to determine flow requirements. Due to the historic nature of the community and uncertainty in the number of connections to the future system, flows were estimated for each scenario outlined in Section 2.4.

3.1 Water Demand Regulatory Requirements

The relevant standards for water demand are the Loudoun County Facility Standards Manual (FSM), and the Loudoun Water Engineering Design Manual (EDM).

The Loudoun County FSM states that applications of rural water services for communal water systems will be guided by Loudoun Water standards. Per 7.2-J-1 of the Loudoun Water EDM, community water systems shall be designed to meet a maximum daily demand of 900 gallons (.625 gpm) per connection.

For water demand, 0.625 gpm (900 gpd) per Loudoun Water EDM requirements was used in the analysis for each scenario. Loudoun County FSM 1042 requires that new water systems and extensions of existing water systems provide fire flow. However, in the 2.330.A, the FSM mentions that appurtenances (tanks) for fire flow may be required. Therefore, for the purposes of this memo, fire flow was not included in the flow analysis.

It is also important to note that while this memo includes the flow analysis for Paeonian Springs only, Waterford demand will contribute to the final yield required at the well site. Flow analysis calculations for Waterford will be presented in a separate memo.

3.2 Wastewater Flow Regulatory Requirements

Similar to water demand, Dewberry evaluated established engineering standards to determine applicable wastewater flows. The relevant standards for wastewater flow for the Service Area are the Loudoun County FSM, the Loudoun Water EDM, and the Virginia Sewage Collection and Treatment Regulations.

The Loudoun County FSM requires sewer be built in compliance with the Loudoun Water EDM and offers no additional regulatory requirement for wastewater flow estimates. The Loudoun Water EDM requires sewer systems be built with the capacity to serve the user population with an average design flow of no less than 100 gpd per person. Furthermore, Table 5.1 in the Loudoun Water EDM provides unit loading rates for commercial/office space and single-family dwellings (SFDs). The Virginia Sewage Collection and Treatment Regulations (9VAC25-970) also specifies a minimum wastewater design flow of 100 gpd per person.

The Loudon Water EDM design wastewater flow per residential property is 350 gpd. At 100 gpd per person, this suggests a mean household size of 3.50 persons per household. In accordance with Loudoun Water EDM, the wastewater flow analysis utilizes 350 gpd for residential connections.

The majority of the Paeonian Springs Service Area is residential with a limited number of commercial/non-residential properties. For the commercial wastewater flows, a combination of Loudoun Water EDM and VA SCAT regulations are used.

- Restaurant: 50 gpd/seat (LW EDM)
- Commercial/Office Space: 0.16 gpd/ sq ft (LW EDM)
- Gas Station: 10 gpd/vehicle (VA SCAT)

In addition to average demand, a peaking factor of 2.5 was applied to the average estimated flows. The 2.5 peaking factor is given by the LW EDM in 9.5-C.1.

The following section details the flow analyses for the defined scenarios.

4 Water Demand & Wastewater Flow Analysis

As discussed above, the water demand and wastewater flow analysis is based on four scenarios:

- Scenario #1 – Existing Buildout
- Scenario #2 – Potential Buildout (All Properties Developed)
- Scenario #3 – Full Buildout (All Parcels Developed)

This section details the estimated flow based on the defined scenarios.

4.1 Scenario #1 – Existing Buildout

This scenario includes water demand and wastewater flow to serve the Paeonian Springs Service Area as currently developed with 112 total connections. The water demand (Table 4-1) for the existing buildout is 100,800 gpd (70 gpm). The average wastewater demand is 46,242 gpd with peak flows of 115,606 gpd as shown in Table 4-2. The wastewater demand is broken down into number of residential connections and applicable units for the commercial connections. Commercial facilities were determined by Loudoun County GIS commercial property data. Demand for commercial facilities uses gpd/square foot using gross floor area from Loudoun County GIS. Demand for any businesses associated with a residential structure was assumed to be the more conservative demand for Commercial or Residential designations.

Table 4-1: Existing Buildout Water Demand Estimate

Water Demand			
Scenario #1	**No. of Connections**	**Unit (GPD/Connection)**	**Estimated Demand (GPD)**
Existing Buildout	112	900	100,800

Table 4-2: Existing Buildout Wastewater Flow Estimate

Wastewater Demand			
Scenario	**Quantity**	**Unit (GPD/Connection)**	**Estimated Flow (GPD)**
Residential Connections	110	350	38,500
Commercial	10,890	0.16 gpd/sq ft	1,742
Restaurant/Market	20	50 gpd/seat	1,000
Gas Station	500	10 gpd/vehicle	5,000
		Total Estimated Flow	46,242
		Peaking Factor	2.5
		Peak Flow	115,606

4.2 Scenario #2 – Potential Buildout (All Properties Developed)

Scenario #2 includes full buildout of Paeonian Springs with all properties within the service area being developed. This includes sixteen (16) additional connections for a total of 121 connections. The water demand for this scenario is 108,900 gpd (75.6 gpm) as shown in . The estimated wastewater flow (Table 4-4) is 49,392 gpd with peak flow of 123,480 gpd.

Table 4-3: Potential Buildout Water Flow Estimate

Water Demand			
Scenario #2	**No. of Connections**	**Unit (GPD/Connection)**	**Estimated Demand (GPD)**
Existing Buildout	121	900	108,900

Table 4-4: Potential Buildout Wastewater Flow Estimate

Wastewater Demand			
Scenario	**Quantity**	**Unit (GPD/Connection)**	**Estimated Flow (GPD)**
Residential Connections	119	350	41,650
Commercial	10,890	0.16 gpd/sq ft	1,742
Restaurant/Market	20	50 gpd/seat	1,000
Gas Station	500	10 gpd/vehicle	5,000
		Total Estimated Flow	49,392
		Peaking Factor	2.5
		Peak Flow	123,480

4.3 Scenario #3 – Full Buildout (All Parcels Developed)

Scenario #3 includes connections for all parcels within the community of 201 connections. This scenario assumes the County ordinance allows for the sale and development of individual parcels regardless of parcel size since all existing parcels would be grandfathered from current zoning requirements.

The water demand (Table 4-5) for this scenario is 180,900 gpd (125.6 gpm). The estimated average wastewater flow are 77,392 gpd with a peak flow rate of 193,480 gpd as summarized in Table 4-6.

Table 4-5: Future Buildout Water Demand Estimate

Water Demand			
Scenario #3	**No. of Connections**	**Unit (GPD/Connection)**	**Estimated Demand (GPD)**
Existing Buildout	201	900	180,900

Table 4-6: Future Buildout Wastewater Flow Estimate

Wastewater Demand			
Scenario	**Quantity**	**Unit (GPD/Connection)**	**Estimated Flow (GPD)**
Residential Connections	199	350	69,650
Commercial	10,890	0.16 gpd/sq ft	1,742
Restaurant/Market	20	50 gpd/seat	1,000
Gas Station	500	10 gpd/vehicle	5,000
		Total Estimated Flow	77,392
		Peaking Factor	2.5
		Peak Flow	193,480

These flow scenarios considered are based on Dewberry's understanding of a range of by right developments that can occur within the Paeonian Springs Service Area. The actual development and number of connections will be dictated by several factors including legislative approvals, zoning ordinance modifications, program connection fee requirements, Loudoun County and Loudoun Water agreements, and cost per parcel. The scenarios are summarized and a recommendation for sizing the water and wastewater systems in the subsequent section.

5 Design Flow

It is understood that the Program does not require connections to the utility after installation. This poses challenges associated with operating oversized systems that may have significantly less flow than designed.

On the wastewater side, this may result in an oversized force main with velocities that do not meet 2.0 ft/s, the velocity required for scouring the line. Table 5-1 below outlines number of connections required to maintain scouring velocities for various force main diameters.

Table 5-1: Connections required for Scouring Velocity

Scouring Velocity Calculations			
Force Main Size	**Pipe Cross Sectional Area (in^2)**	**Flow (gpd) required for Velocity = 2 ft/s**	**No. of Connections required for Velocity = 2 ft/s**
4" Force Main	12.56	112,739	129
6" Force Main	28.26	253,662	290

Based on the length of the force main, it was determined that the head loss resulting from a 3" force main would be too great to feasibly pump the sewage from Paeonian Springs to Waterford. Therefore, for the purposes of this analysis, 4" is the minimum force main size evaluated. Ultimately, the hydraulic model will confirm required force main sizing, however based on the preliminary analysis, provisions will need to be made for adding odor control, flushing, pigging, and cleaning the line when the system includes less than 129 connections.

The most significant impacts due to the unknown number of connections are realized in the water system. For groundwater systems, chlorine disinfection is required. Virginia Department of Health (VDH) specifies chlorine residual requirements that are driven by groundwater quality, chlorine dosing rates, storage, and number of connections. The ultimate system requirements will be driven by the location of the wells, storage, and treatment facility, as well as modelling of the system to determine appropriate pipe sizing. However, for the purpose of demonstrating the potential impact of overdesigning the water system, the following components were assumed:

- 7-day maximum water age
- Approximately 6,000 LF from well and treatment facility to Paeonian Springs Community
- Approximately 4,000 LF from Clarkes Gap Road to the furthest connection
- 10" diameter distribution pipe between the groundwater well facility and Paeonian Springs

Based on these assumptions, Dewberry conducted high-level water age calculations assuming 6", 8" and 10" distribution pipe within Paeonian Springs. The results, shown in Table 5-2, demonstrate that for all evaluated pipe sizes, the system will require significant provisions for routine flushing, pigging, and cleaning of the line in order to maintain water age of less than 7 days. This will create higher initial operations and maintenance costs to Loudoun Water.

Table 5-2: Water Age Calculations

Water Age Calculations						
Scenario	**Cross Sectional Area (ft^2)**	**Length (LF)**	**Capacity (Gal)**	**Total Capacity (Gal)**	**ADF Flow Rate (GPD)**	**No. of Connections required**
6" Community Water Distribution Piping						
10" Distribution Piping	0.55	6,000	24,480	30,338	350	13
6" Distribution Piping	0.20	4,000	5,872			
8" Community Water Distribution Piping						
10" Distribution Piping	0.55	6,000	24,480	34,905	350	15
6" Distribution Piping	0.35	4,000	10,439			
10" Community Water Distribution Piping						
10" Distribution Piping	0.55	10,000	40,776	40,776	350	17

It is important to note that while the well yield and treatment flow calculations included in this memo are based on peak flows, the water age calculations used average daily flows. Ultimately the number of connections required will be determined through the hydraulic model, the location of the well and treatment site, groundwater quality, water storage, and chlorine dosage rates. In addition, the hydraulic model will provide the information necessary to determine the maximum number of connections for the system above the design.

6 Summary & Conclusion

As discussed above, due to the unique characteristics of the zoning of Paeonian Springs and historic nature of the community, a substantial increase in density is not anticipated.

Table 6-1 summarizes the flow ranges for each of the scenarios for both water and wastewater.

Table 6-1: Water and Wastewater Scenarios Summary

Estimated Water Demand & Wastewater Flows			
Scenario	**No. of Connections**	**Estimated Water Demand (GPD)**	**Estimated Average Wastewater Flow [Peak Flow] (GPD)**
Scenario #1 - Existing Development	112	100,800	46,242 [115,606]
Scenario #2 – Potential Buildout	121	108,900	49,392 [123,480]
Scenario #3 - Full Buildout	201	180,900	77,392 [193,480]

Of the scenarios considered, Scenarios #1 and #2 may be realized short term. There is potential that Scenario #3 (full buildout) may be realized as property sales occur and redevelopment of existing parcels and properties is completed over a longer time period.

The projected demand outlook is key to infrastructure planning and design. Since there are uncertainties regarding future development and flows in Paeonian Springs, for the purpose of design, it is recommended that a phased flow/demand approach be used for sizing both water and wastewater

system components. With this approach, the water and wastewater systems will be developed in phases, considering several factors, including system efficiency, operational impacts, and cost effectiveness of phased expansion. The initial phase would be intended to meet the near-term and more likely demand scenario, and a subsequent phase can address expansion of the system to handle future additional connections.

Some advantages of the phased approach are:

- **Operability** – Oversizing water and wastewater system components can have long term impacts on system operability and significantly increase maintenance requirements. Due to the number and significance of the unknowns (i.e. number of connections, timing of connections, redevelopment, etc.…) designing the system to more realistic flows will allow time to better understand the flow characteristics for long term operation and maintenance.
- **Capital Cost** – A phased approach will balance risk with capital cost to install system components that serve the current communities without installing oversized systems that would increase program costs and increase system O&M. Over time, as flow characteristics are further defined the system can be expanded or upgraded to serve the full buildout of the community. As outlined in Table 5-2, there are systems that should be installed to serve the ultimate phase that do not significantly increase current capital cost while accounting for long term expansion without the need for additional O&M or significantly higher future capital cost. It should be noted that the funding mechanism for future phase expansions is subject to Loudoun Water and Loudoun County agreements, and, therefore, discussion regarding it is beyond the scope of this memo.

As outlined in Section 5, the unknowns associated with number of connections that will be brought online immediately after installation pose challenges associated with operating oversized systems that may have significantly less flow than designed, which is compounded further when designing and installing infrastructure for future potential flow scenarios. However, several components of water and wastewater systems can be sized for full development with limited impact to long term operation. In general, the preferred phasing approach would be to size the buried linear utilities for the ultimate anticipated flows (Phase II) and major above ground mechanical components to be sized for the current buildout (Phase I).

Table 6-2 summarizes the recommended design approach for the infrastructure associated with the project.

Table 6-2: Recommended Improvements & Phasing

Recommended Improvements	
Component	**Recommended Design Approach/System Capacity**
Wastewater Collection System	Phase II
Wastewater Pumping Station	Phase I (Expandable to Phase II)
Wastewater Force Main	Phase II (Provisions for cleaning/flushing during Phase I)
Waterford WWTP	Phase II (TBD during subsequent memos)
Groundwater Wells[1]	Phase II
Groundwater Treatment System[1]	Phase I (Expandable to Phase II)
Finished Water Piping	Phase II (Provisions for flushing during Phase I)
Water Distribution System	Phase II (Provisions for flushing during Phase I)

1 – the groundwater system will also include the demand from the Waterford community.

The recommended phases with flows are summarized in Table 6-3 below. It should be noted that due to the variability of these estimates, the numbers have been rounded to the nearest five thousand GPD.

Table 6-3: Recommended Water and Wastewater Flow Scenarios

Estimated Water Demand & Wastewater Flows			
Phase	**No. of Connections**	**Estimated Water Demand (GPD) [GPM]**	**Estimated Average Wastewater Flow [Peak Flow] (GPD)**
Phase I (Scenario #1 – Low Range)	112	100,000 [69 gpm]	45,000 [112,500]
Phase II (Scenario #3 – High Range)	201	180,000 [125 gpm]	75,000 [187,500]

Upon review of this memo by Loudoun Water and Loudoun County and subsequent discussions to finalize the design approach, Dewberry will prepare a Preliminary Engineering Report (PER) which will provide the Basis of Design (BOD) for Paeonian Springs Water and Wastewater systems. Subsequent tasks will develop hydraulic models for both water and wastewater systems to further define the design impacts to each system component.

Appendix B
Paeonian Springs Sewer Layout Memo

Dewberry

MEMORANDUM

DATE: October 26, 2023 (Revised 11.07.2024)

TO: Amulya Poudel, Loudoun Water

FROM: Paul Longo, Dewberry Engineers Inc.

SUBJECT: **Paeonian Springs Preliminary Pump Station Locations and Sewer System Layouts**

1 Purpose

The purpose of this memorandum is to present preliminary layouts for a potential sewer collection system for the Paeonian Springs community to site a new sewer pumping station and force main to convey raw sewage from the Paeonian Springs Community to the Waterford Wastewater Treatment Plant (WWTP). The goal is to prioritize parcels for land acquisition by Loudoun County.

2 Preliminary Layouts

Preliminary sewer layouts have been developed using topographic information obtained by Quantum Spatial under a separate task order. This data has been used to generate the preliminary layouts presented in this memorandum. In addition, parcel information, floodplain information and other features have been utilized from Loudoun County GIS for pump station siting and preliminary constraints.

2.1 Pump Station Site

Pump station configuration and sizing has not been confirmed but based on anticipated flows it is assumed that a submersible pumping station will be utilized. The pump station site will include a precast concrete wet well, valve vaults, a control building housing the pumps and emergency standby generator, odor control system and room for access and turn around as required by Loudoun Water.

The pump station site location will significantly impact numerous components of the system. The location will impact the required configuration, depth and type of the sanitary sewer collection system, the discharge force main alignment, and pump station wet well depth. All of these components should be carefully evaluated to minimize potential operations and maintenance issues for Loudoun Water in the future. Therefore, it is critical that optimum siting be identified to design the system appropriately and reduce initial capital costs as well as operations and maintenance costs.

Based on discussions with Loudoun Water, pump stations are typically required to have 0.5 acre parcels or deeded easements. However, Loudoun Water expressed willingness to be flexible on the requirement of 0.5 acres if it significantly limits feasible options for pump station siting. Therefore, some of the parcels considered in the alternatives evaluation are smaller than 0.5 acres but are included in this memo due to other parcel features that make them feasible options. However, these smaller parcels were lowered in priority during the alternatives evaluation, outlined later in this memo. In addition, setbacks and property restrictions will need to be considered. To meet County buffer requirements, a 25’ setback from property lines has been used to identify feasible siting locations.

2.2 Collection System Approach

The preferred alternative for wastewater collection is through the use of gravity sewers. However, based on topography, the entire community cannot be served solely by gravity sewer. Therefore, low pressure sewers (LPS) will be required to collect and convey sewage from portions of the community to the proposed pump station. In addition to LPS systems, deep sewers will be required to convey sewage to the proposed

pumping station. For the purpose of this memorandum, deep sewers are identified as any sewer deeper than 20'. Sewer lines will be located in the ROW, the maximum allowable sewer depth is based on the width of the ROW along the alignment. For the purposes of the preliminary layouts, 25' was used as the maximum allowable depth. The preliminary layouts do not include any sewer deeper than 24'. Preliminary layouts for each evaluated alternative are included in this memo as figures A, B, and C.

Also, it should be noted that this memo focuses on the layouts for the sewer system. Once the wastewater system layout is finalized, the water lines for the proposed distribution system will run parallel to the proposed sewer lines with required horizontal and vertifcal offsets per Loudoun Water EDM. Therefore, for clarity, the conceptual figures outlining the sewer layout do not show the proposed waterlines.

The prioritization of the pump station locations focuses on eliminating or reducing LPS and deep sewer installations.

2.3 Floodplain Impacts

The Paeonian Springs community and surrounding areas has several floodplain areas. All of the floodplain throughout the siting locations are identified as 'minor floodplain' areas as defined by Loudoun County. Construction in these areas is limited based on County zoning ordinance as outlined in Section 4-1500. In any case, pump stations need to be constructed to a minimum of 1.5' above the 100-year floodplain elevation. Therefore, for any site with a minor floodplain, significant regrading may be necessary to construct features above floodplain elevations.

While pump stations can be constructed in these minor floodplains, additional work will be required to obtain approval with the permanent structures and regrading. This will require the completion of an initial floodplain studies of the parcel followed by the completion of floodplain alteration studies that quantify impacts. Lastly, coordination with FEMA and map revisions may be required to validate floodplain impacts and memorialize changes. A few sites that were identified as potentially feasible do exist within the minor floodplain and are shown in this memo. However, Loudoun Water has expressed that these are not preferred for pump station siting, and therefore this memo prioritizes potential sites outside of the 100-year floodplain.

2.4 Community Impacts

Currently, the community does not have any wastewater utilities. Sewage pumping stations are sources of noise and odor. In addition, proximity to nearby residents and businesses can impact the ability to obtain property and build a pump station.

One of the alternatives presented in this memorandum is on a developed parcel with a residential property primarily due to the suitability of the location based on engineering considerations. We have prioritized siting the pump station on undeveloped land and further away from existing residents and businesses to minimize community impact.

In addition to this, odor impacts to the community increase from using LPS rather than gravity sewer. Therefore, as referenced in Section 2.2, gravity sewer was the preferred alternative over LPS during the development of the sewer system layout.

3 Summary

Based on the considerations above, we have developed our preliminary layouts as shown in the attached figures. Our initial assessment divided the community and pump station site into regions, focusing on low lying areas. The regions are shown in the attached Figure 1 and identified as A, B and C. Within these regions, individual sites have been identified where pump stations could be constructed to serve the community as shown in Figures 2, 3 and 4.

Table 2 includes a pump station site selection priority ranking. The ranking scores a site higher in the following order:

1. Fewer LPS connections
2. Overall System Depth
3. Pump Station Wet Well Depth (low lying areas score higher)
4. Flood Plain
5. Proximity to Building/Residents
6. Parcel Size

It should be noted that this priority ranking is strictly based on technical considerations only and does not consider the land acquisition aspect. Dewberry understands this will be the next step of the process to select the pump station sites for further evaluations.

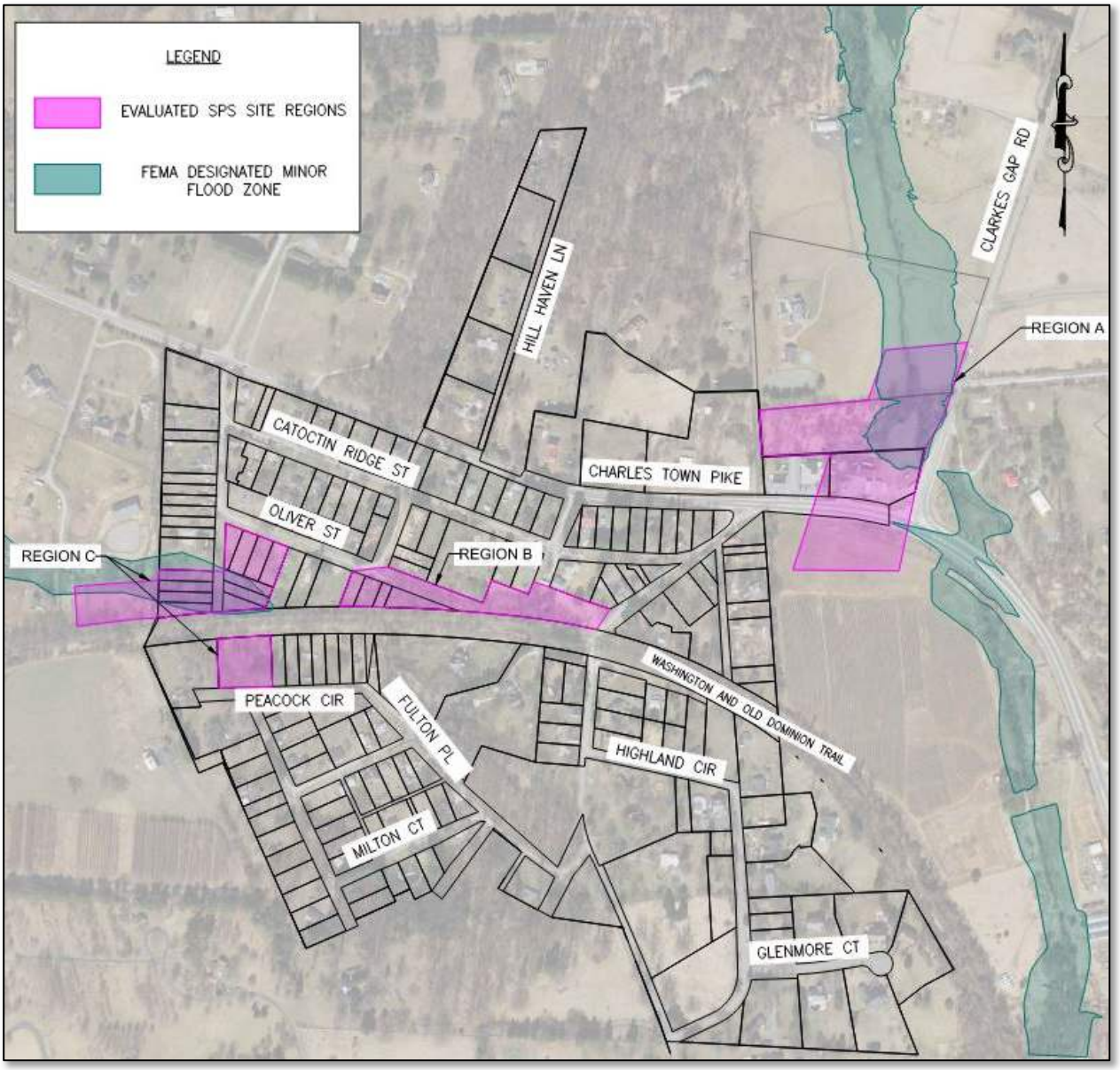


Figure 1 – Paeonian Springs Potential Pump Station Site Regions Map

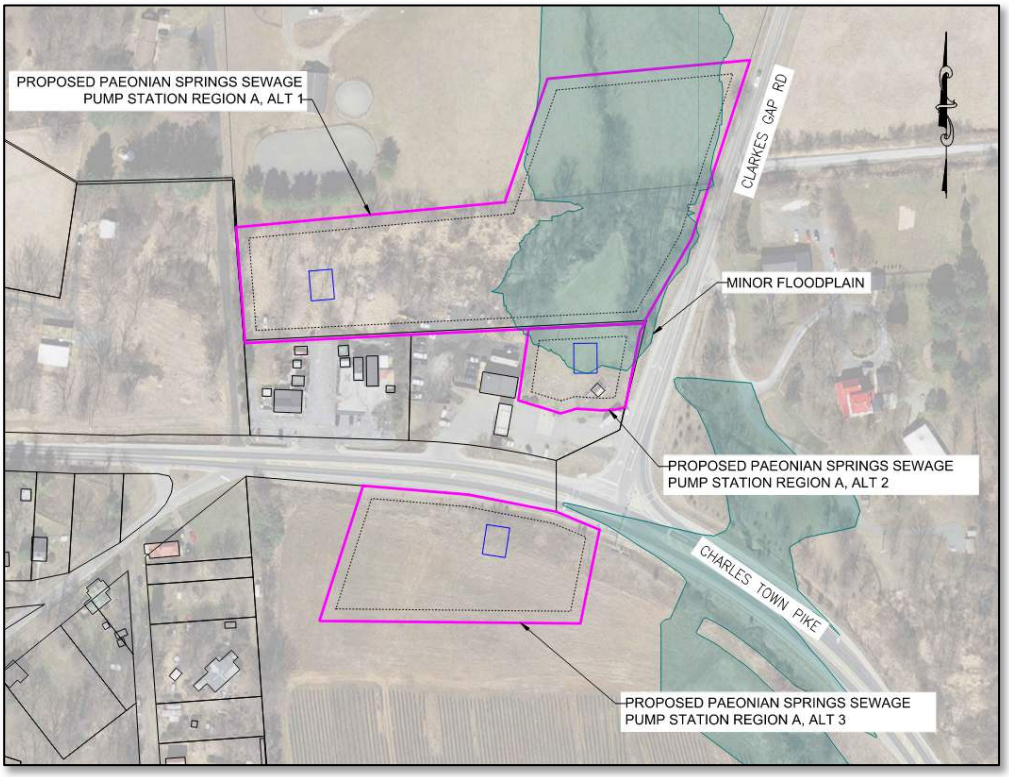


Figure 2 – Paeonian Springs Potential Pump Station Site Region A

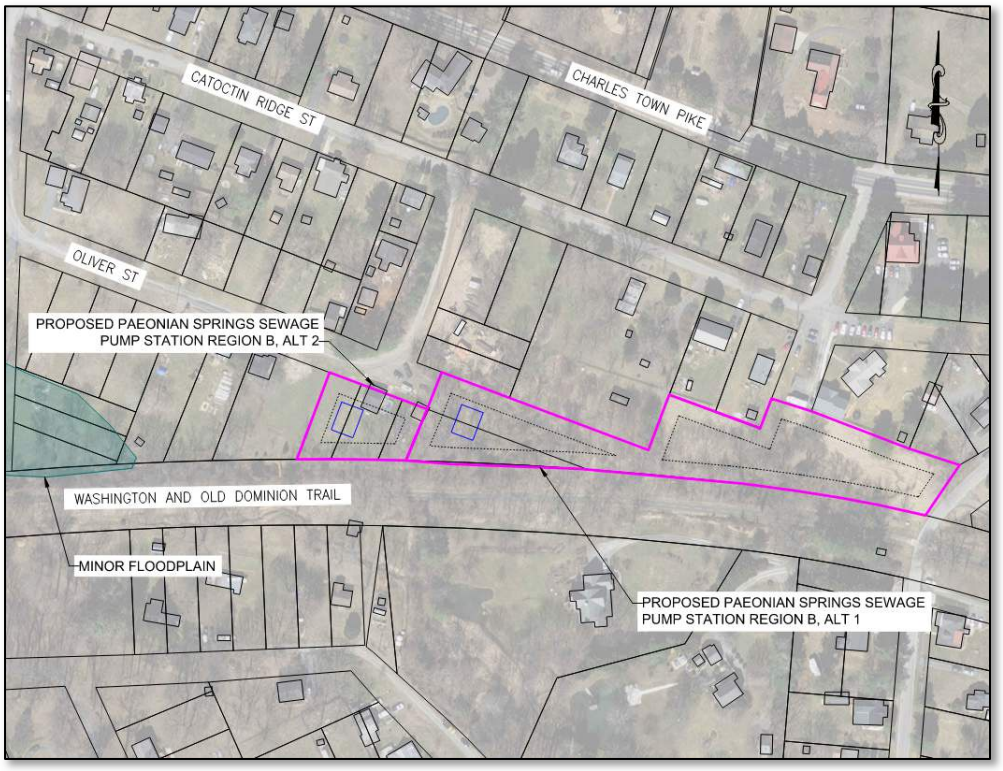


Figure 3 – Paeonian Springs Potential Pump Station Site Region B

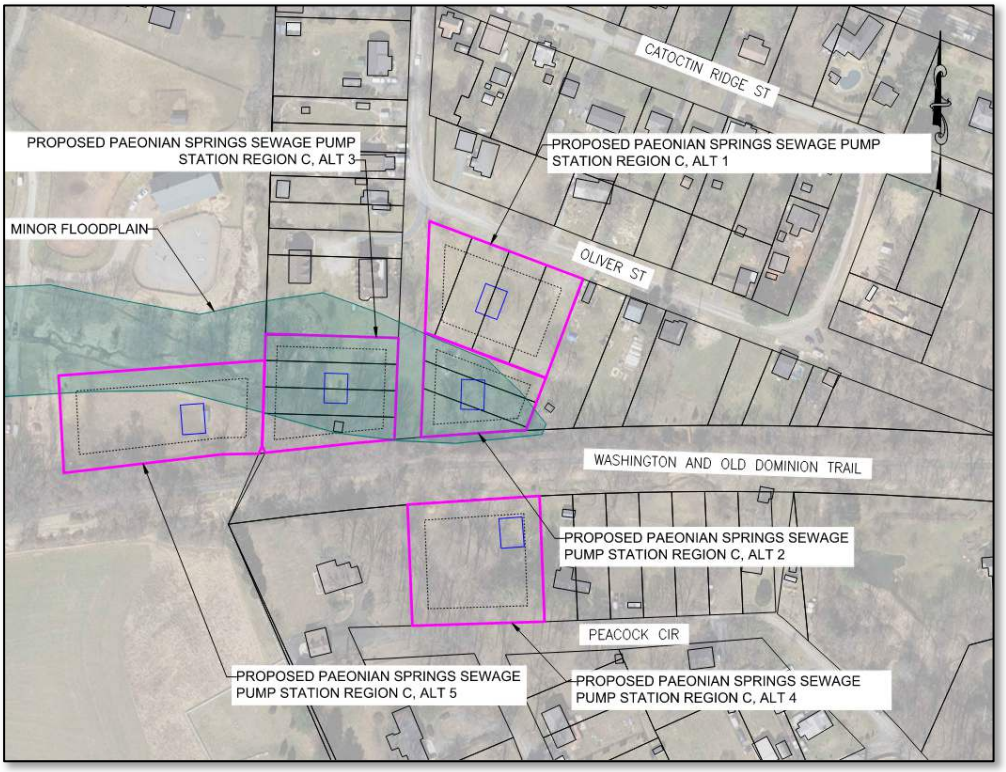


Figure 4 – Paeonian Springs Potential Pump Station Site Region C

We have evaluated each of these sites using the general criteria outlined above and have identified individual lots and parcels for potential purchase or easement acquisition. This is summarized in Table 1 below:

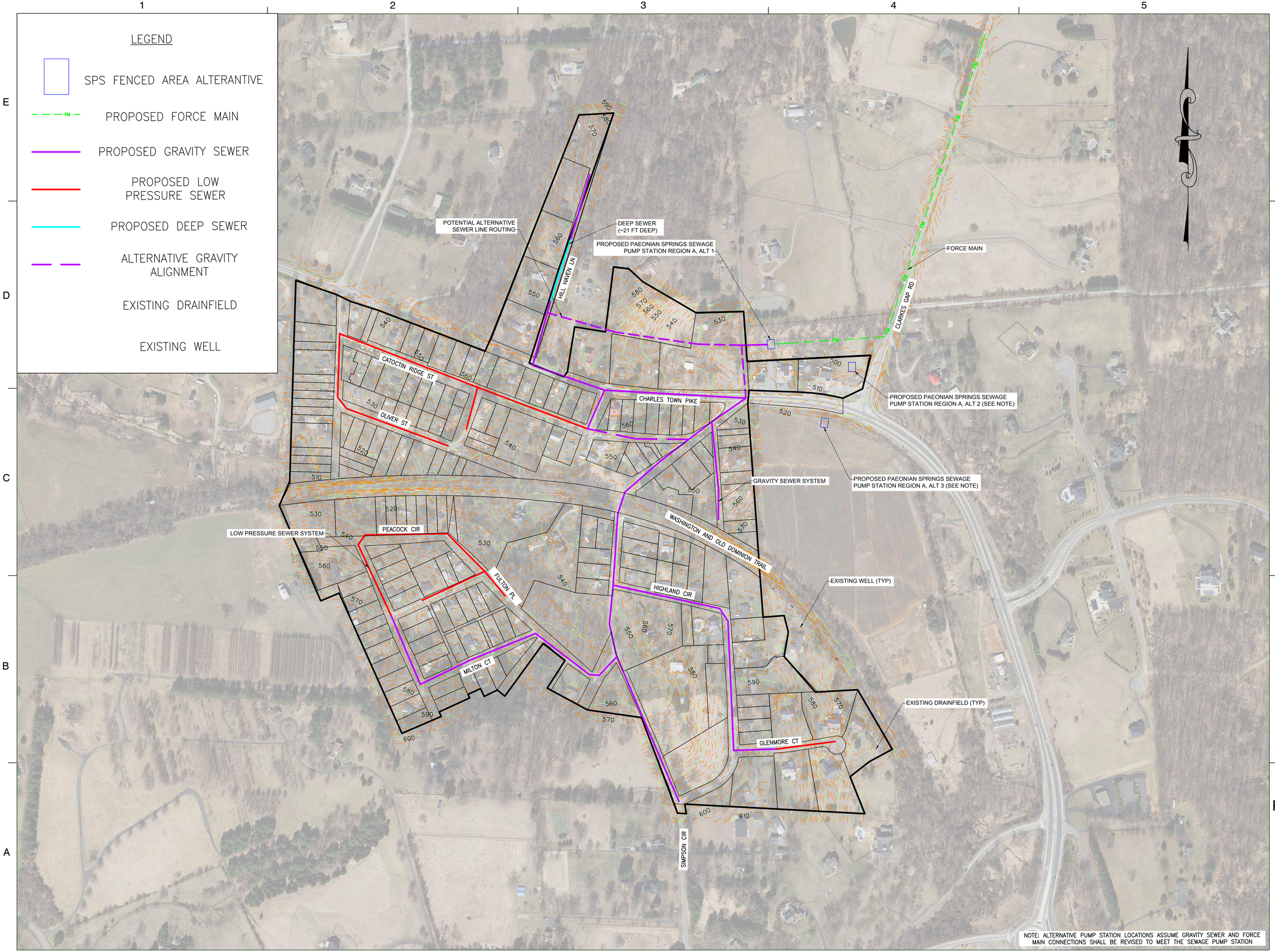
Table 1 – Pump Station Site Alternatives Summary

Alternatives		Property Info	Impacts/Restrictions		
Region	Alt.	PIN(s)	Layout	Environmental	Other
A	1	307458438, 307457774	LPS Connections: 91 Deep Sewer: 0 LF	Minor floodplain, stream and wetlands anticipated	Challenging access from roadway, Distance to nearest building: 75 ft
	2	307458116		Minor floodplain, stream and wetlands anticipated	Existing buildings on parcel, existing drainfield on vacant portion of parcel
	3	307361404		No Floodplain	Requires subdivision or easement, Distance to nearest building: 140 ft
B	1	345300871	LPS Connections: 5 Deep Sewer: Approx. 1,100 LF between 20-24 ft deep	No Floodplain	NOVA parks owned property with additional unrecognized landowner parcels, Distance to nearest building: 115 ft
	2	345399075, 345398477, 345399674		No Floodplain	Existing buildings and occupied residence
C	1	345394193, 345394690, 345395188, 345395786	LPS Connections: 5 Deep Sewer: Approx. 1,100 LF between 20-24 ft deep	Minor floodplain, stream and wetlands near parcels (not located on parcel)	Closer to residents, Distance to nearest building: 135 ft
	2	345394379, 345394375, 345394371		Minor floodplain, stream and wetlands anticipated	Further from residents but in floodplain, distance to nearest building: 170 ft
	3	345392383, 345392379, 345392375, 345392370		Minor floodplain, stream and wetlands	Further from residents but in floodplain, distance to nearest building: 115 ft
	4	345393747		No Floodplain	Close to residents, force main will need to cross W&OD Trail (2 total crossings required), distance to nearest building: 60 ft
	5	345382698		Minor floodplain, stream and wetlands	Located outside of Community, distance to nearest building: 125 ft

It should be noted that further field due diligence is required prior to final land acquisition. Each of the identified Pump Station site locations are technically feasible, however because of existing parcel features, some of the identified locations will be easier to work with than others. Based on the impacts outlined above, Dewberry has prioritized the potential sites as shown in Table 2.

Table 2 – Pump Station Site Alternatives Priority List

	Region/Alt.	Factors/Impacts/Restrictions
1	C-1	• Vacant parcels • Buildable Area: 0.43 acres • Minor floodplain, streams and wetlands adjacent to parcel (floodplain study may still be required) • Least required LPS connections • Approx. 1,100 LF of deep sewer
2	C-4	• Vacant parcel • Buildable Area: 0.47 acres • No floodplain impact • Least required LPS connections • Approx. 1,100 LF of deep sewer • Jack and Bore under W&OD Trail required twice
3	B-1	• Vacant parcel • Buildable Area: 0.76 acres • No floodplain impacts • NOVA parks coordination required, use of additional unrecognized landowner parcels • Located in Paeonian Springs Historic District • Less LPS connections • Approx. 1,100 LF of deep sewer required
4	C-2	• Vacant parcels • Buildable Area: 0.26 acres • Minor floodplain, stream and wetlands on parcel • Least required LPS connections • No deep sewer required
5	C-3	• Vacant parcels • Buildable Area: 0.49 acres • Minor floodplain, stream and wetlands on parcel • Least required LPS connections • Approx. 1,100 LF of deep sewer
6	C-5	• Existing buildings on parcel • Buildable Area: 0.54 acres • Minor floodplain, stream and wetlands on parcel • Least required LPS connections • Approx. 1,100 LF of deep sewer • Parcel located outside Paeonian Springs community
7	A-3	• Agricultural use, proposed portion is vacant • Buildable Area: 1.17 acres • No floodplain impact • Most required LPS connections • No deep sewer required
8	A-1	• Vacant parcel • Buildable Area: 3.31 acres • Minor floodplain, stream and wetlands anticipated on portion of parcel • Most required LPS connections • No deep sewer required
9	A-2	• Gas station and convenience store on parcel • Buildable area: 0.26 acres • Minor floodplain, stream, wetlands on parcel, existing drainfield on vacant portion of parcel • Most required LPS connections • No deep sewer required
10	B-2	• Existing buildings on parcel • Buildable area: 0.15 acres • Existing drainfield on vacant portion of parcel • No floodplain impacts • Less required LPS connections • Approx. 1,100 LF of deep sewer required



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PAEONIAN SPRINGS AND WATERFORD WATER & SEWER

LOUDOUN WATER

LOUDOUN COUNTY, VIRGINIA

SEAL

KEY PLAN

SCALE

0' 250' 500'
HORIZONTAL GRAPHIC SCALE
SCALE: 1" = 250'

No.	DATE	BY	Description

REVISIONS

DRAWN BY	AMJ
APPROVED BY	PJL
CHECKED BY	SAA
DATE	NOVEMBER 2023

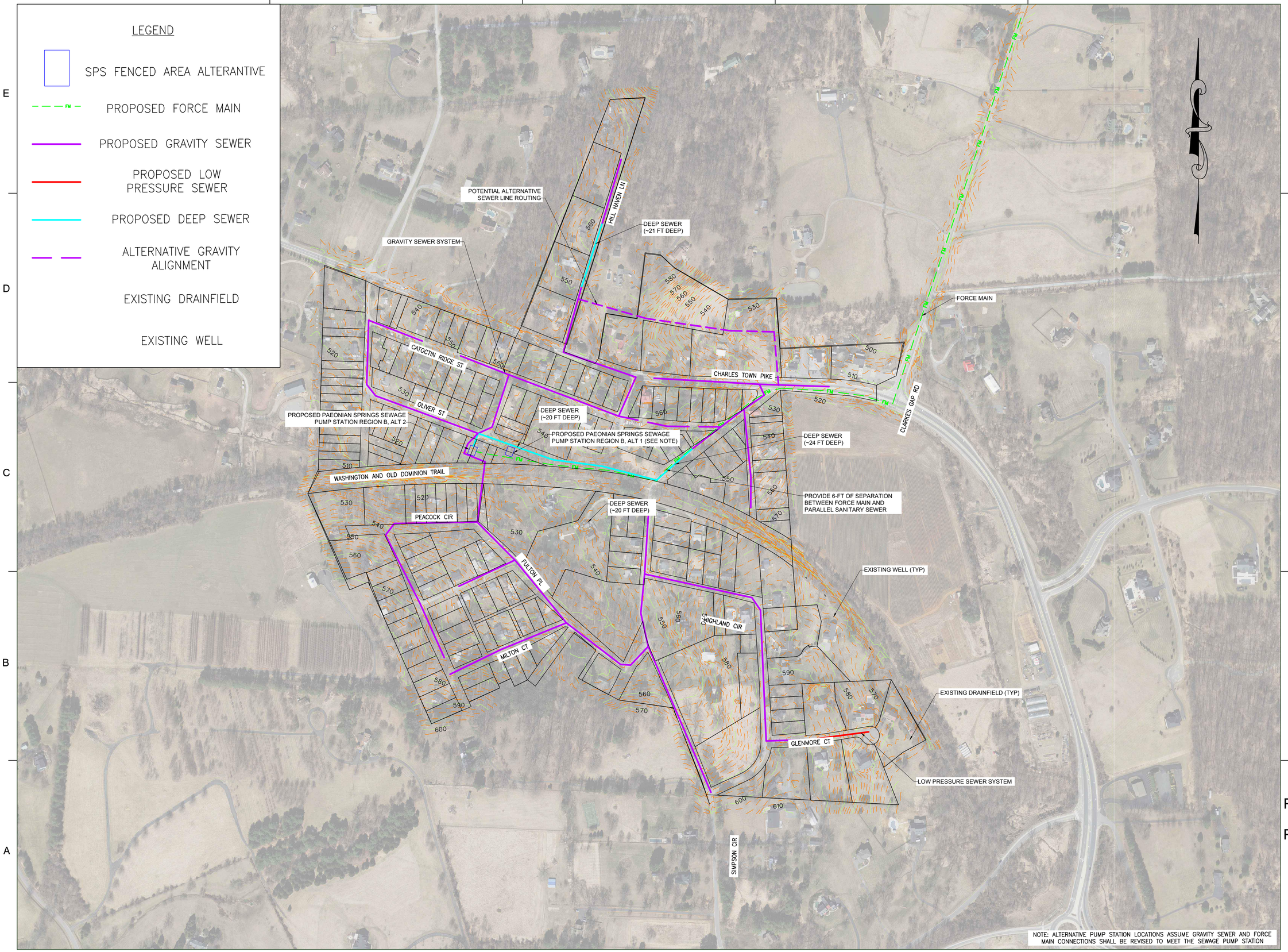
TITLE

PAEONIAN SPRINGS GRAVITY SEWER PRELIMINARY LAYOUT

PROJECT NO. 50146469

A

SHEET NO.



Dewberry

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PAEONIAN SPRINGS AND WATERFORD WATER & SEWER

LOUDOUN WATER

LOUDOUN COUNTY, VIRGINIA

SEAL

KEY PLAN

SCALE

0' 250' 500'

HORIZONTAL GRAPHIC SCALE
SCALE: 1" = 250'

No.	DATE	BY	Description

REVISIONS

DRAWN BY	AMJ
APPROVED BY	PJL
CHECKED BY	SAA
DATE	NOVEMBER 2023

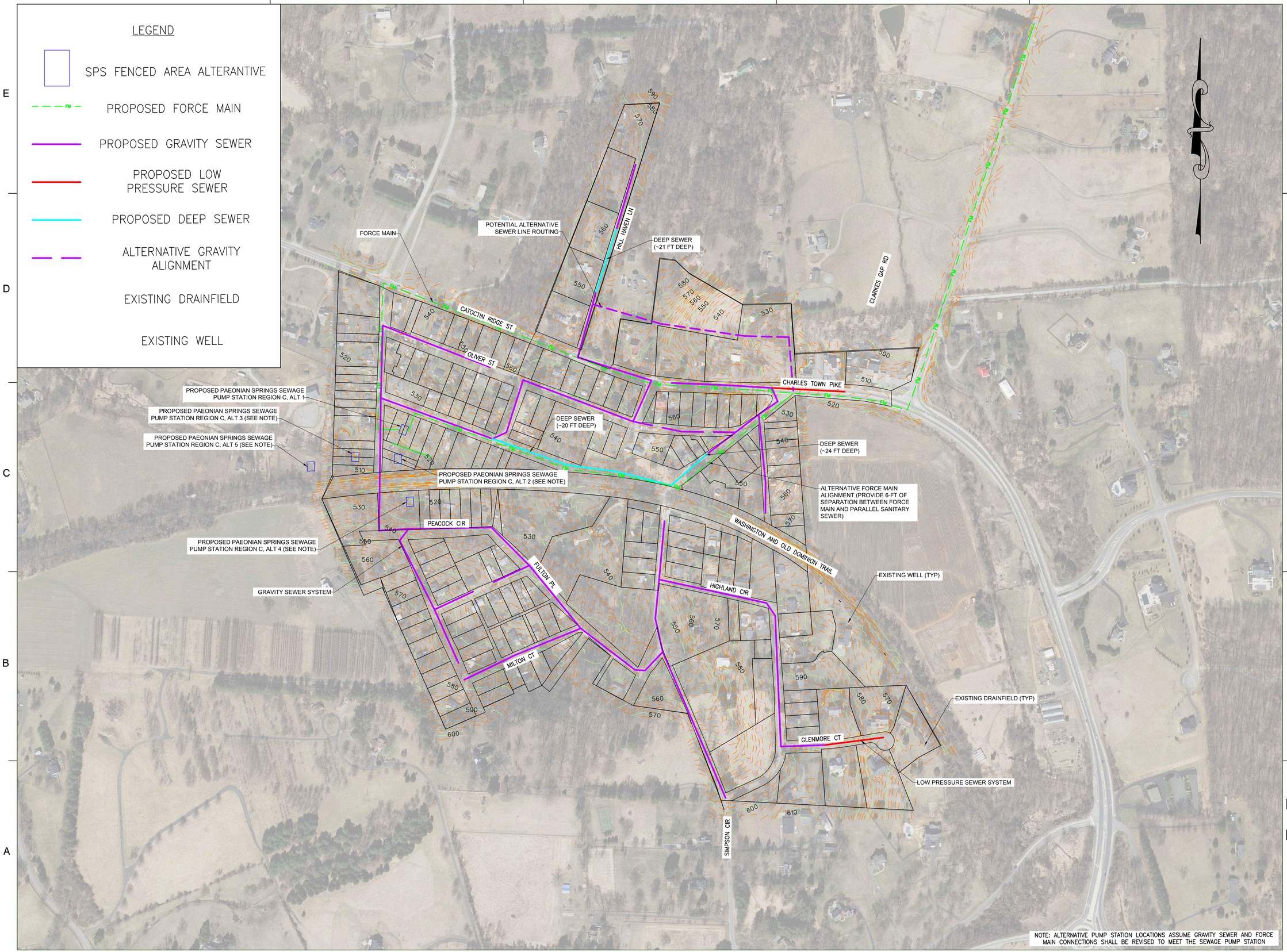
TITLE

PAEONIAN SPRINGS PRELIMINARY PUMP STATION SITE REGION B

PROJECT NO. 50146469

B

SHEET NO.



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SEAL

KEY PLAN

SCALE

0' 250' 500'

HORIZONTAL GRAPHIC SCALE
SCALE: 1" = 250'

No.	DATE	BY	Description

REVISIONS

DRAWN BY	AMJ
APPROVED BY	PJL
CHECKED BY	SAA
DATE	NOVEMBER 2023

TITLE

PAEONIAN SPRINGS PRELIMINARY PUMP STATION SITE REGION C

PROJECT NO. 50146469

C

SHEET NO.

Appendix C
Hydrogeologic Site Assessment Memo

Dewberry

DATE: December 4, 2023

TO: Amulya Poudel, PE

FROM: Paul Longo, PE

SUBJECT: Paeonian Springs & Waterford Groundwater Hydrology – Phase I Investigation

Background/Purpose

The Paeonian Springs Water and Wastewater Service Area Boundary consists of two hundred one (201) parcels. Paeonian Springs residents are currently served by private, onsite water and wastewater systems. The Waterford Wastewater Service Area Boundary consists of one hundred and forty-four (144) parcels. The Waterford residents are currently served by private, onsite water systems and a community wastewater system. In collaboration with Loudoun County Government and supported through separate Task Orders with Dewberry, it was determined that providing formal water distribution and sewage collection is required to support the sustainability of the community and to address public health concerns.

To construct a community water system to serve the Paeonian Springs and Waterford Communities, a water source (i.e. well) must be identified and developed. Well identification and development requires a number of phases to determine hydrogeologically favorable areas and eventual drilling and testing of wells. The process is generally broken down as follows:

- Phase I – Hydrogeologic Review of Available Groundwater Resources and Assessment of Hydrogeologic Setting of the Selected Study Area
- Phase II – Specific Siting of Exploratory Test Wells within the Study Area – Conduct Geophysical Surveys
- Phase III – Exploratory Test Well Drilling and Testing
- Phase IV – Production Well Drilling
- Phase V – Long-Term Pumping Tests
- Phase VI – Final Hydrogeological Report & Submission to Virginia Department of Health

In May 2023, Emery & Garrett Groundwater Investigations (EGGI) conducted a Phase I groundwater exploration within a study area between Paeonian Springs and Waterford, along a 2.5-mile corridor of Clarkes Gap Road with a 2,000-ft buffer. This investigation assessed the potential to develop groundwater resources in the area along Clarkes Gap Road, a 2.5-mile corridor connecting the Waterford and Paeonian Springs communities. A 2,000-foot buffer was included along both sides of the road, creating a study area of approximately 1,225 acres **(Figure 1)**. As detailed in the Phase I report (**Attachment A**), three (3) groundwater development zones (GWDZ's) were identified within the study area and were selected based on data analysis and evaluations of the following items:

- A remote sensing analysis of high and low altitude photography and imagery;
- An assessment of the local bedrock geology through the compilation of existing geologic maps and on-site geologic mapping;
- A groundwater recharge analysis;
- A review of potential contaminant threats to groundwater quality; and
- A compilation of available existing well data.

It should also be noted that EGGI previously completed a separate Phase I investigation in October 2018 for a 1000-ft buffer surrounding a Paeonian Springs Community Boundary as part of the Paeonian Springs Water and Wastewater Feasibility Study (October 2019).

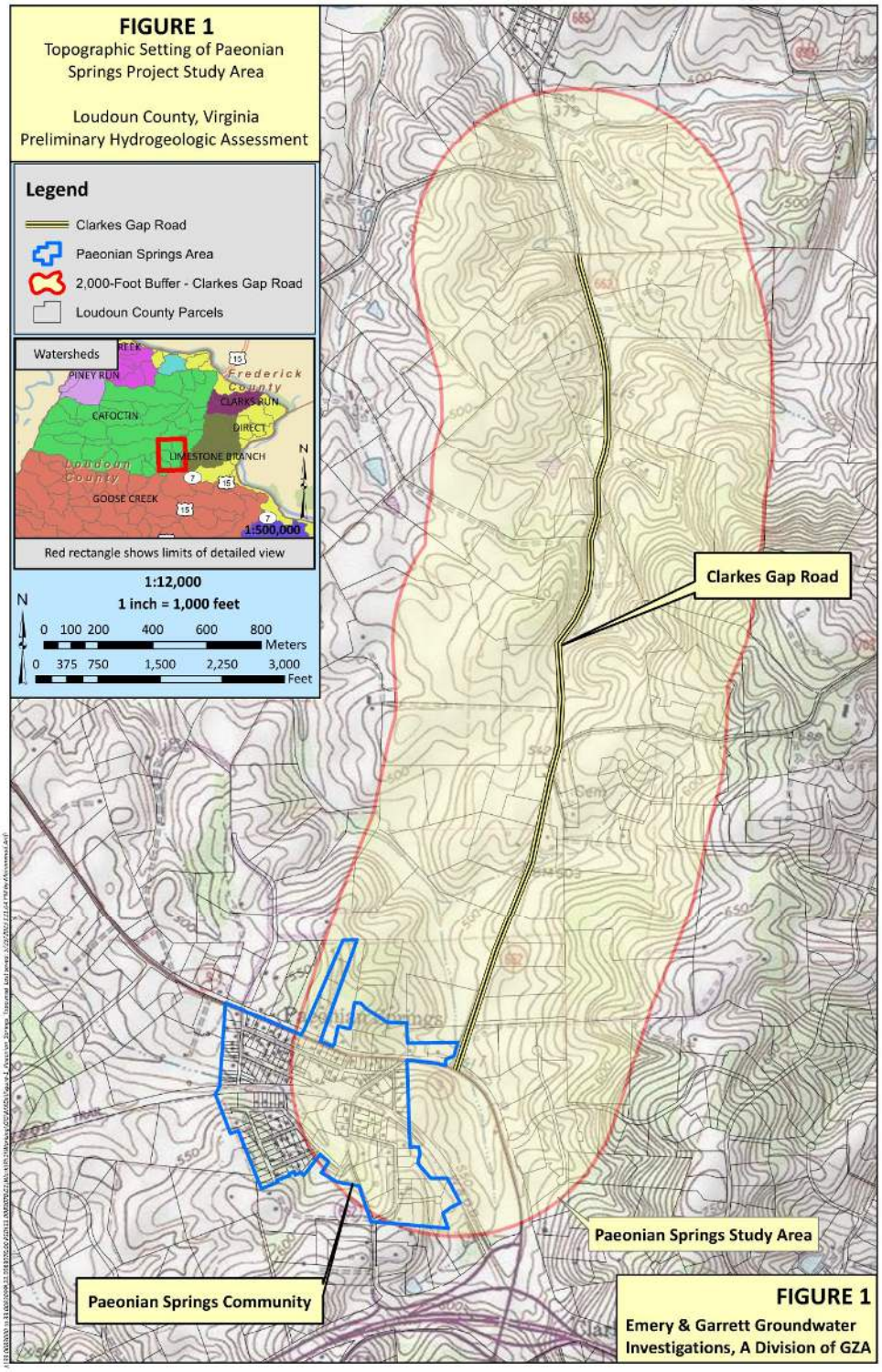

Figure 1: Paeonian Springs Study Area (Figure from EGGI)

Phase I Hydrogeologic Review Summary

The Paeonian Springs Water Service Area Boundary includes approximately 201 parcels. For this initial assessment, EGGI notes that Loudoun Water guidelines require 1.2 gallons per minute (gpm) per residential connection, or approximately 241 gpm total to serve this area. And the Waterford Water Service Area Boundary includes approximately 144 parcels, requiring approximately 173 gpm. To serve both Paeonian Springs and Waterford, a total of approximately 414 gpm will be required. Dewberry is currently working with Loudoun Water to finalize a wastewater flow and water demand memo that will determine the final required well yield for the subsequent phases of the groundwater study.

Remote Sensing Analysis of Study Area

EGGI identified surface expressions, known as lineaments, that correspond with potential water-bearing subsurface features, such as fracture zones, bedrock discontinuities, faults, and geologic contacts. A total of 1,848 lineaments were identified in the study area with 115 coincident lineaments (**Attachment A, Plate 1, View A**). And EGGI states that 52 of these coincident lineaments are considered to be bedrock fracture supported. As EGGI notes, discontinuities in bedrock that has enhanced water-bearing properties often lay beneath coincident lineaments, these lineaments helped EGGI to identify locations where geophysical surveys should be performed.

Bedrock Geology

Groundwater resources from fractured bedrock aquifers are directly affected by the bedrock's chemical and physical characteristics. According to EGGI's evaluation, existing geologic maps of the Paeonian Springs area indicate that the bedrock is primarily made up of three (3) rock units: Proterozoic metagranite, the Catoctin Formation (composed of greenstone), and the Swift Run Formation (primarily consists of fine-grained phyllite). Each rock type has different intrinsic properties that affect its ability to store and transmit groundwater. EGGI considers the greenstone and metagranite to be favorable rocks for the development of groundwater resources in this area.

Preliminary Recharge Assessment

EGGI also considered watershed recharge ability within the study area, which is located within the Catoctin Creek watershed. Based on historical estimates of groundwater recharge in the Study Area, EGGI assumed a conservative recharge value of 10 inches per year, or 477,000 gallons per day (gpd) per square mile. Given a study area of approximately 1.9 square miles acres, this assumption yields an estimated recharge value of 906,702 gpd. Actual groundwater recharge of the local bedrock aquifer will be determined through future pumping tests of potential production wells.

Existing Wells

Most properties surrounding and within the Paeonian Springs study area are served by individual domestic wells. EGGI compiled well records utilizing Loudoun County GIS data (Attachment A, Plate 2, View B). Based on 191 well records, the average well yield for this area is 16 gpm, with an average depth of 388 feet. Of these wells, only 15.7% reported a yield of 20 gpm or more, and only 2.6% exceeded a yield of 50 gpm. This suggests that bedrock wells in the Study Area are highly variable, but generally of moderate to low yield. EGGI notes that while the development of moderate to high yielding wells in this area may be possible, it will be challenging.

Preliminary Contaminant Threat

Lastly, EGGI reviewed potential sources of groundwater contamination in a survey area extending 2,000 feet beyond the Study Area to identify the presence of potential contaminant threats to groundwater quality. Virginia Department of Environmental Quality databases, including Petroleum Release Sites, Registered Petroleum Tank Facilities Releases, Pollution Response Program, and Federal Facilities, were queried. Based on this data, EGGI considers the areas within the selected Potential Groundwater Development Zones to be relatively free of land uses that might degrade the quality of groundwater resources. However, it is important to note that this review of potential contaminate threats is not exhaustive. Groundwater quality will be determined following exploratory test well drilling and water sampling.

EGGI Summary

Based on review of all data summarized above and detailed in **Attachment A**, EGGI identified three (3) Potential Groundwater Development Zones, identified as PSD-2, PSD-6, and PSD-7 (**Figures 2**). These areas identified by EGGI are considered the best candidate areas for developing potable groundwater resources within the study area.

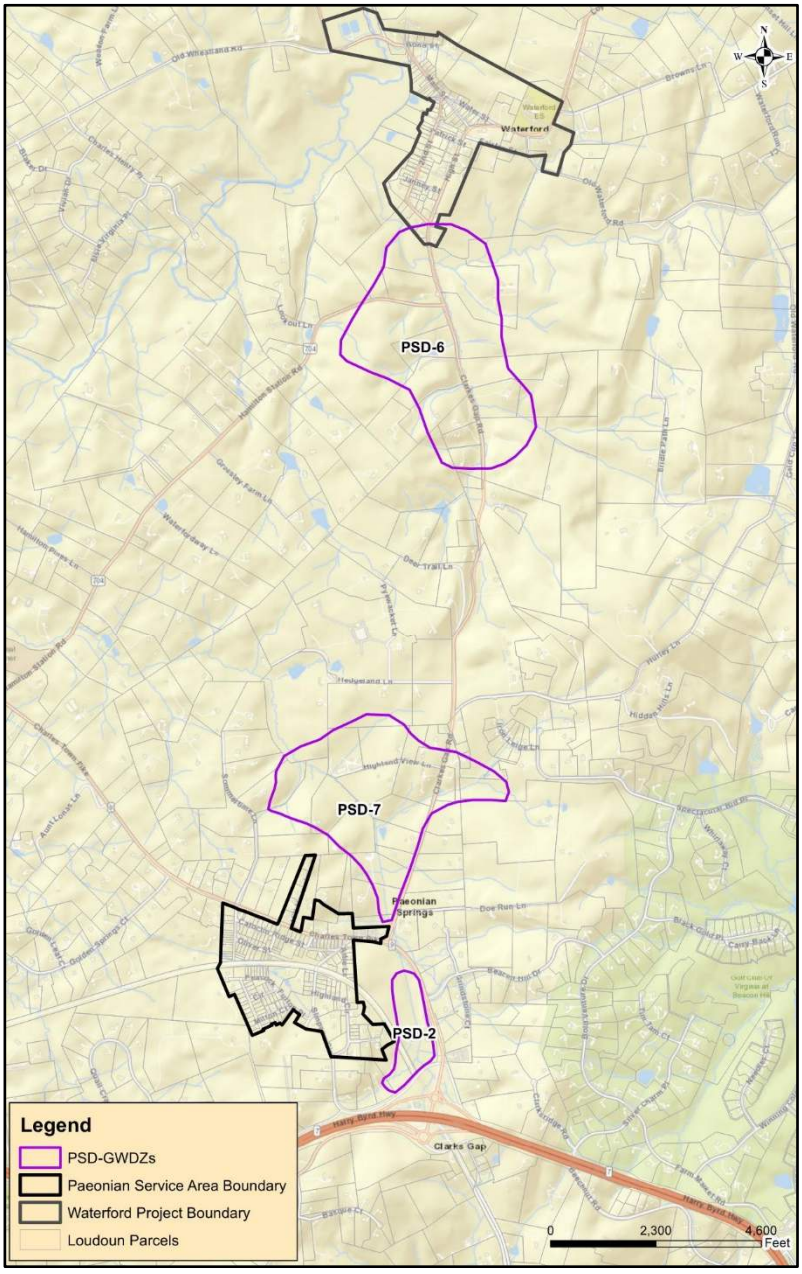

Figure 2: Groundwater Development Zones

Loudoun County/Loudoun Water Review

Loudoun County provided additional investigation areas based on review of the Phase I investigation, and review of well yield data in the vicinity of the communities.

Proposed investigation areas selected by Loudoun Water are referenced as:

- LW PSD-8
- LW PSD-9

Figure 3 below shows the groundwater development zones selected by EGGI as well as the additional areas selected by Loudoun County.

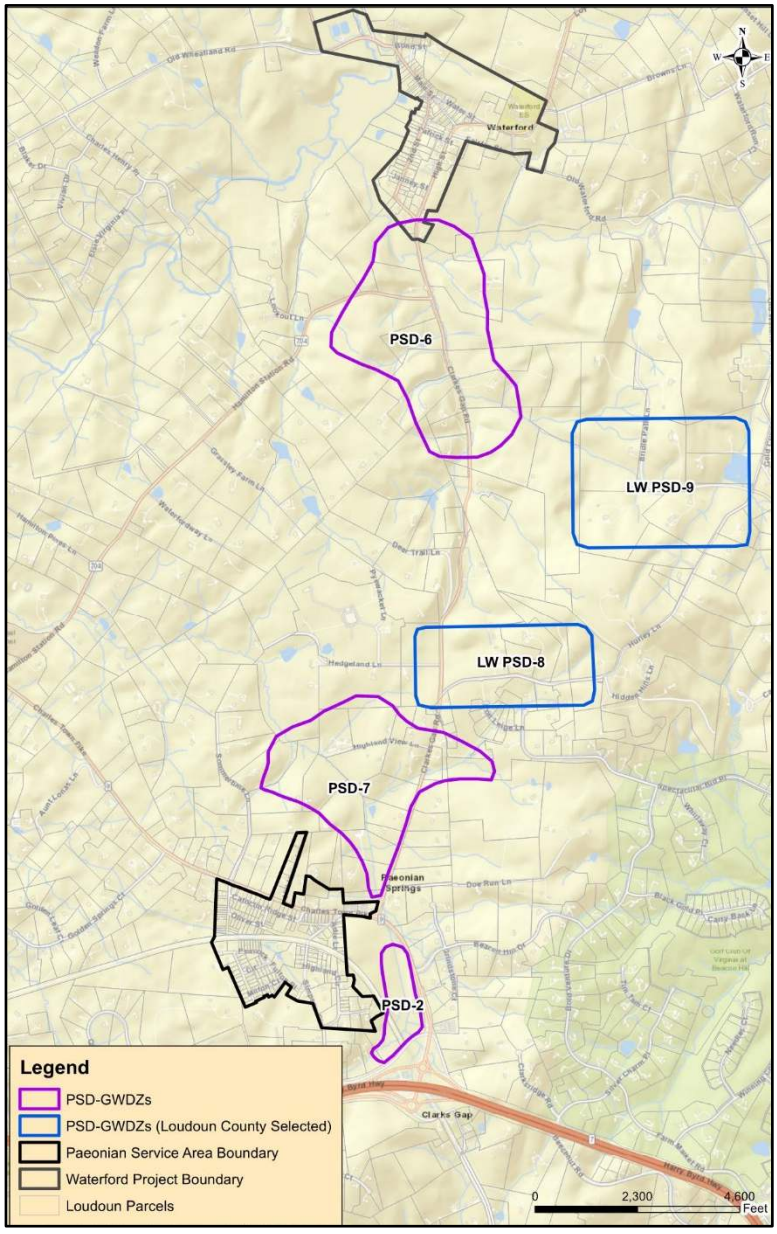

Figure 3: Groundwater Development Zones & Additional Investigation Areas

Recommendations & Next Steps

In accordance with EGGI recommendations, Dewberry recommends that Loudoun Water proceed with Phase II investigation to conduct geophysical surveys.

Table 1 below identifies all parcels within the potential groundwater development zones as well as the total parcel area and approximate parcel area located within the GWDZ. Per Virginia Department of Health Regulations, well lots require a minimum distance of 50-ft from the well to all property lines (12VAC5-590-840 D). To meet this regulation, the well lot size will be required to have minimum dimensions of 100-ft x 100-ft, or 10,000 sq. ft. (~.23 acres).

Dewberry recommends that Loudoun Water initiate contact via property notification letters to parcels owners to request permission for property access to conduct geophysical surveys with primary focus on the larger parcels. Although, at this early stage of the investigation, it is not recommended to exclude any parcels. Property access letters should be sent to all property owners within the EGGI GWDZ's as well as the additional areas identified by Loudoun County.

Table 1: Parcels Included within Potential Groundwater Development Zones

Potential Development Zone	Parcels Included	Total Parcel Area (Acres)	Approx. Parcel Area Within GWDZ (Acres)
PSD-2	307361404000	33.54	17.41
	307254234000	6.53	3.61
	307162165000	4.15	0.45
PSD-6	304463314000	0.98	0.10
	304464304000	0.85	0.76
	304364880000	0.21	0.21
	304366999000	1.41	1.45
	304466318000	0.57	0.12
	304473640000	42.07	5.81
	304373811000	27.56	19.86
	304283694000*	140.12	30.95
	304179374000	14.56	8.73
	304179721000	10.83	10.83
	304185133000	14.63	2.63
	305383098000	31.23	12.81
	305472217000	5.37	4.08
	305471450000	4.42	4.42
	305470782000	4.82	4.82
	305364576000	29.94	2.72
	304167814000	11.95	7.42
	304167361000	12.89	10.24
	304266508000	10.18	10.18
	304155367000	64.31	31.63
	304363012000	10.03	9.46
	342309085000	18.62	0.15
PSD-7	344303992000	39.98	4.13
	344295789000	10.01	0.18
	344200266000	12.45	6.39
	344201819000	16.78	9.39
	344103163000	10	0.03
	306251331000	11.07	9.99
	306153074000	11.94	10.04
	306357092000	24.2	3.41
	306351828000	10	9.12
	306357439000	11.06	10.29

Potential Development Zone	Parcels Included	Total Parcel Area (Acres)	Approx. Parcel Area Within GWDZ (Acres)
PSD-7 (Con't)	306255770000	10.78	10.78
	306364741000	3.93	2.32
	306365243000	3	0.19
	306366614000	3	3
	306264188000	10	10
	306261028000	10	10
	306161270000	7	7
	306160946000	3	3
	306158023000	10	7.61
	307457774000	10.05	3.84
	307458438000	2.8	0.51
	307452680000	3.14	0.02
	306371932000	0.83	0.03
	306370501000	3	2.27
	306372406000	1	0.85
	306269666000	3.47	3.47
	306268905000	6.91	0.8
	306375234000	19.04	2.21
	306277784000	1.59	0.64
	306279464000	14.56	6.15
	306279916000	38.65	0.2

*Parcel 304283694000 is noncontiguous

Attachments

1. **Attachment A:** Technical Memorandum Preliminary Hydrogeologic Site Assessment Paeonian Springs and Waterford Community Water

Dewberry

Attachment A

Technical Memorandum
Preliminary Hydrogeologic Site Assessment
Paeonian Springs

Emery&
Garrett
GROUNDWATER
INVESTIGATIONS
A Division of GZA

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
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TECHNICAL MEMORANDUM
PRELIMINARY HYDROGEOLOGIC SITE ASSESSMENT
PAEONIAN SPRINGS

LOUDOUN COUNTY, VIRGINIA

May 23, 2023
33.0083070.01

PREPARED FOR:
Paul Longo, P.E.
Stephanie Acosta, EIT
Dewberry

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May 23, 2023
Project No. 33.0083070.01

Mr. Paul Longo, P.E.
Ms. Stephanie Acosta, EIT
Dewberry
Water and Wastewater Services
8401 Arlington Boulevard
Fairfax, Virginia 22031

Re: Technical Memorandum of Preliminary Hydrogeologic Site Assessment of Paeonian Springs (Clarkes Gap Road Study Area)

Dear Paul and Stephanie:

Emery & Garrett Groundwater Investigations, (EGGI) A Division of GZA is pleased to present this technical memorandum as a summary of the Phase I groundwater exploration and development program within the Paeonian Springs Expanded Study Area (**Figure 1**). This Phase I investigation focused on assessing the potential to develop groundwater resources in the area along Clarkes Gap Road, a 2.5-mile corridor from Waterford to Paeonian Springs. The Study Area includes a 2,000-foot buffer on both sides of the road which is equivalent to approximately 1,225 acres (**Figures 1** and **2**). Our Phase I investigation resulted in the identification of three potential Groundwater Development Zones (GDZs). One of these GDZs (PSD-2) was identified by EGGI in a previous investigation conducted in 2018[1]. This report is subject to the Limitations in **Appendix A**.

The Paeonian Springs Community encompasses approximately 116 acres (**Figure 1**). Paeonian Springs consists of 216 residential lots that range in size from approximately 0.10 acres to 8 acres and average 0.8 acres. In accordance with current Loudoun Water guidelines, it is necessary to develop 1.2 gallons per minute (gpm) per residential connection or approximately 260 gallons per minute. However, the Virginia Water Works Regulations require that only 0.5 gpm per residential connection (108 gpm) be developed when constructing a community water system. The final amount of water to be developed for this project will need to be resolved during the next several phases if groundwater study.

The results of the work conducted to date are summarized below and are presented on the accompanying Figures and Plates. The data analyzed and evaluations performed included:

- A remote sensing analysis of high and low altitude photography and imagery;
- An assessment of the local bedrock geology through the compilation of existing geologic maps and on-site geologic mapping;

[1] A previous hydrogeologic investigation conducted by EGGI in 2018 identified five potential Groundwater Development Zones for Paeonian Springs Subdivision. These zones were presented in a letter report entitled, **"Groundwater Supply Development Program, Preliminary Hydrogeologic Assessment-Phase I, Paeonian Springs, Loudoun County, Virginia"**.

- A groundwater recharge analysis;
- A review of potential contaminant threats to groundwater quality; and
- A compilation of available existing well data.

Remote Sensing Analysis of Study Area

Potential water-bearing subsurface features, such as fracture zones, bedrock discontinuities, faults, and geologic contacts, often have ground surface expressions that can be detected through an analysis of topographic maps and computer-enhanced images. These surface expressions, known as lineaments, typically appear on the ground surface as topographic depressions, vegetation changes, and/or tonal anomalies. A lineament can be loosely defined as a mappable linear feature, as seen on the terrain surface, whose parts are aligned in a rectilinear or curvilinear manner.

A total of 1,848 lineaments were identified in this investigation. Lineaments in the Study Area were defined on four scales of platforms (Table on Plate 1). Each lineament was described by its length, azimuth (trend in degrees east of north), and location.

A synoptic rose diagram[2] was created as part of this analysis, which shows the prominent trends of lineaments observed within 2.3 kilometers of the Paeonian Springs study area (**Plate 1**). The most common trends identified by the rose diagram are, in decreasing order of prominence, 48°, 114°, 134°, 22°, 174°, 74°, and 88°. Note, however, that lineaments trending at orientations other than those shown on the rose diagram do occur locally, as shown on the map (**Plate 1, View A**).

From the original 1,848 lineaments, 115 coincident lineaments[3] were identified. A total of 52 of these coincident lineaments are considered to be bedrock fracture-supported[4] (**Plate 1, View A**). Since discontinuities in the bedrock that possess enhanced water-bearing properties often underlie coincident lineaments, the lineaments helped EGGI identify locations where geophysical surveys should be performed. (These geophysical data will ultimately determine where the best locations exist for drilling exploratory wells.)

Bedrock Geology

Groundwater resources available within the Study Area must be derived from underlying fractured bedrock aquifers. Groundwater resources extracted from such fractured bedrock aquifers are directly influenced by the bedrock's inherent chemical and physical characteristics.

[2] A rose diagram is illustrated on **Plate 1** and shows the orientations of lineament data. The trend of each rose petal represents lineament orientations posted in degrees east of north. Petal width is a measure of lineament data scatter and petal length is a measure of relative numbers of data in each lineament family.

[3] Lineaments observed on images at different scales that have a similar trend (±5°) and similar location (±2 mm at the scale of the image) are referred to as coincident lineaments (**Mabee, and others, 1994**). The use of such coincident lineaments helps to remove the inherent subjectivity of lineament analysis (**Wise, 1982**) and facilitates the confident use of lineament mapping as a groundwater exploration tool.

[4] Reduction of raw lineament data to coincident lineaments and fracture-supported coincident lineaments follows the method described in **Mabee and others (1994)**. Those coincident lineaments that are sub-parallel with nearby bedrock fracture family orientations, bedding orientations, or lithologic contacts are highlighted in magenta as "fracture-supported" coincident lineaments.

Existing geologic maps (**Southworth and others, 1999**), indicate that the bedrock beneath the Paeonian Springs Study Area is made up of three different rock units: Proterozoic metagranite (Ybg, Yg, Ymb, Yn, and Yp) the Catoctin Formation (Zc, Zcp, Zcs, and Zmd), and the Swift Run Formation (Zsm, Zsp, and Zss), (**Plate 1, View B**). All rocks were poorly exposed within the Paeonian Springs Study Area.

The Catoctin Formation is comprised of greenstone (metamorphosed basalt) and localized intercalated meta-sediments that underlie the eastern portion the Study Area. The Swift Run Formation primarily consists of fine-grained phyllite that transects in the central of the Study Area. Local layers of marble are interbedded within the phyllite north of Paeonian Springs Subdivision (**Plate 1, View B**).[5] Metagranitic rocks are located on the northwestern edge of the study area and are locally intruded by metadiabase dikes (Zmd). The foliation[6] and compositional layering in all these rocks all trend to the north-northeast and dip to the southeast at moderate angles.

Each of these rock types has different intrinsic properties that affect its ability to store and transmit groundwater. In general terms, EGGI considers the greenstone and metagranite to be more favorable rocks for the development of groundwater resources within the Paeonian Springs Study Area. The phyllites are generally much less favorable for developing high yielding bedrock wells unless solution cavities within a local layer of marble can be intercepted during drilling.

Preliminary Recharge Assessment

The Study Area lies entirely within the Catoctin Creek watershed (**inset Figure 1**). In the Piedmont of Virginia, estimates of groundwater recharge have ranged from 8.4 inches per year (**Pavich, 1986**), to 10.5 inches per year (**Richardson, 1980**), to 11.3 inches per year (**Nutter and Otton, 1969**). For the purposes of this study, EGGI applied a conservative recharge value of ten inches per year over the study area to estimate available recharge.

Since groundwater recharge to bedrock aquifers is not restricted to study areas, and nearby drainage ways will contribute groundwater recharge to the underlying bedrock aquifer(s), the actual amount of groundwater recharge received by the local bedrock aquifer underlying the study area can only be estimated. A recharge value of 10 inches per year is equivalent to approximately 477,000 gallons per day per square mile. The Paeonian Springs study area of approximately 1.9 square miles acres (**Figure 1**), providing an overall potential of about 906,702 gpd (629 gpm) of groundwater recharge to the Study Area.[7]

The actual amount of groundwater recharge received by the local bedrock aquifer and the extent of pumping impacts will need to be determined through the hydrologic testing (pumping tests) of potential production wells.

Existing Wells

Many homes proximal to and within the Paeonian Springs study area are served by groundwater from individual domestic wells. Well records compiled from the Loudoun County GIS database are shown on **Plate 2, View B**. Based upon 191 well records, reported airlift yields range from 1 to 100 gpm and the well depths range from 63 to 1,200 feet (**Table on Plate 2**). The average yield of the wells is 16 gpm and their average depth is 388 feet.

[5] EGGI plans on targeting the marble unit in Zone PSD-7 as a future drilling target pending Phase II investigation results.

[6] Foliation is the parallel alignment of minerals developed during the metamorphism and deformation of the rocks.

[7] This is considered a rough estimate only, as topography, vegetation, soil type, slope, and geomorphology of the landscape all impact recharge rates. It is to be understood that wells drilled on site will not be able to access all available recharge, but rather only a portion of this amount.

Thirty of the 191 wells reported yielding 20 gpm or more (or 15.7%) with only 5 wells exceeding 50 gpm (or only 2.6%).

Overall, these data show that yields of bedrock wells in the local area are highly variable but generally of moderate to low yield, which suggests that although possible to develop moderate- to high-yielding Production Wells in the study area, it will be certainly challenging. Detailed geophysical surveys will be required to specifically select the best drilling targets in the study area.

Preliminary Contaminant Threat Review

The quality of groundwater resources can be adversely affected by land uses involving groundwater contaminants that could potentially migrate into underlying bedrock aquifers. Therefore, one element of this groundwater resource investigation was to review the presence of potential contaminant threats to groundwater quality. This survey was carried out to a distance of 2,000 feet from the Study Area (**Plate 2, View A**).

Databases maintained by the Virginia Department of Environmental Quality were queried to investigate potential threats to groundwater quality. Queried databases include Petroleum Release Sites, Registered Petroleum Tank Facilities Releases, Pollution Response Program, and Federal Facilities.

Based on the data collected and reviewed to date, EGGI considers the areas within the selected Potential Groundwater Development Zones to be relatively free of land uses that might degrade the quality of groundwater resources (such as leaking underground storage tanks, etc.) (**Plate 2, View A**). However, it should be noted that this review of potential contaminate threats is not exhaustive and only after exploratory test wells have been drilled and representative samples of the groundwater have been chemically analyzed will the quality of the available groundwater resources be fully known.

Conclusions and Recommendations

The Phase I hydrogeologic investigation of the Paeonian Springs Study Area has served to identify three potential Groundwater Development Zones and are identified as PSD-2, PSD-6 and PSD-7. These Zones supplement the five zones (PSD-1, PSD-2, PSD-3, PSD-4, and PSD-5) previous selected in the 2018 study and are considered the best candidate areas for developing potable groundwater resources within the Expanded Study Area.

Based upon the hydrogeologic data collected to date, EGGI recommends that this groundwater exploration program proceed to Phase II (geophysics). The hydrogeologic conditions revealed by Phase I investigations suggest that potentially high yielding wells can be developed within the designated Groundwater Development Zones, but the development of high yielding wells (50 gpm or more) will be challenging. It will require that detailed geophysical surveys be conducted in the selected Groundwater Development Zones in order to most accurately identify the best opportunities for drilling successful exploratory wells.

EGGI recommends gaining access to those larger properties identified in each potential Groundwater Development Zone (**Figures 2-4**) so that geophysical surveys can be conducted to identify site specific locations for drilling. EGGI can provide example private property permission letters (upon request) that can be used to gain access to selected lots to conduct geophysical surveys.

We hope you find this letter responsive to your needs. If you have any questions regarding the information presented herein, please do not hesitate to contact us.

Very truly yours,

EMERY & GARRETT GROUNDWATER INVESTIGATIONS, A DIVISION OF GZA

Mark B. Wingsted, P.G.
Senior Project Manager

James M. Emery, P.G.
Principal/District Office Manager
Senior Hydrogeologist

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Enclosures:

Figure 1	Topographic Setting of Paeonian Springs Study Area
Figure 2	Potential Groundwater Development Zone PSD-2
Figure 3	Potential Groundwater Development Zone PSD-6
Figure 4	Potential Groundwater Development Zone PSD-7
Appendix A	Limitations
Plate 1	Lineaments and Bedrock Geology
Plate 2	Existing Wells and Potential Threats to Groundwater Quality

References:

Emery & Garrett Groundwater Investigations, A Division of GZA, 2018, Groundwater Supply Development Program, Preliminary Hydrogeologic Assessment-Phase I, Paeonian Springs, Loudoun County, Virginia.

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Emery & Garrett
GROUNDWATER INVESTIGATIONS
A Division of GZA

Figures

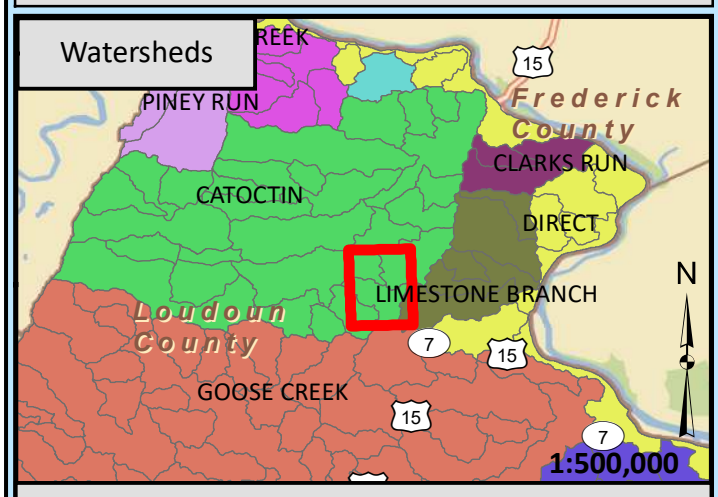
FIGURE 1

Topographic Setting of Paeonian Springs Project Study Area

Loudoun County, Virginia
Preliminary Hydrogeologic Assessment

Legend

- Clarkes Gap Road
- Paeonian Springs Area
- 2,000-Foot Buffer - Clarkes Gap Road
- Loudoun County Parcels



Red rectangle shows limits of detailed view

1:12,000

1 inch = 1,000 feet

N

0 100 200 400 600 800 Meters

0 375 750 1,500 2,250 3,000 Feet

Clarkes Gap Road

Paeonian Springs Study Area

Paeonian Springs Community

FIGURE 1

Emery & Garrett Groundwater Investigations, A Division of GZA

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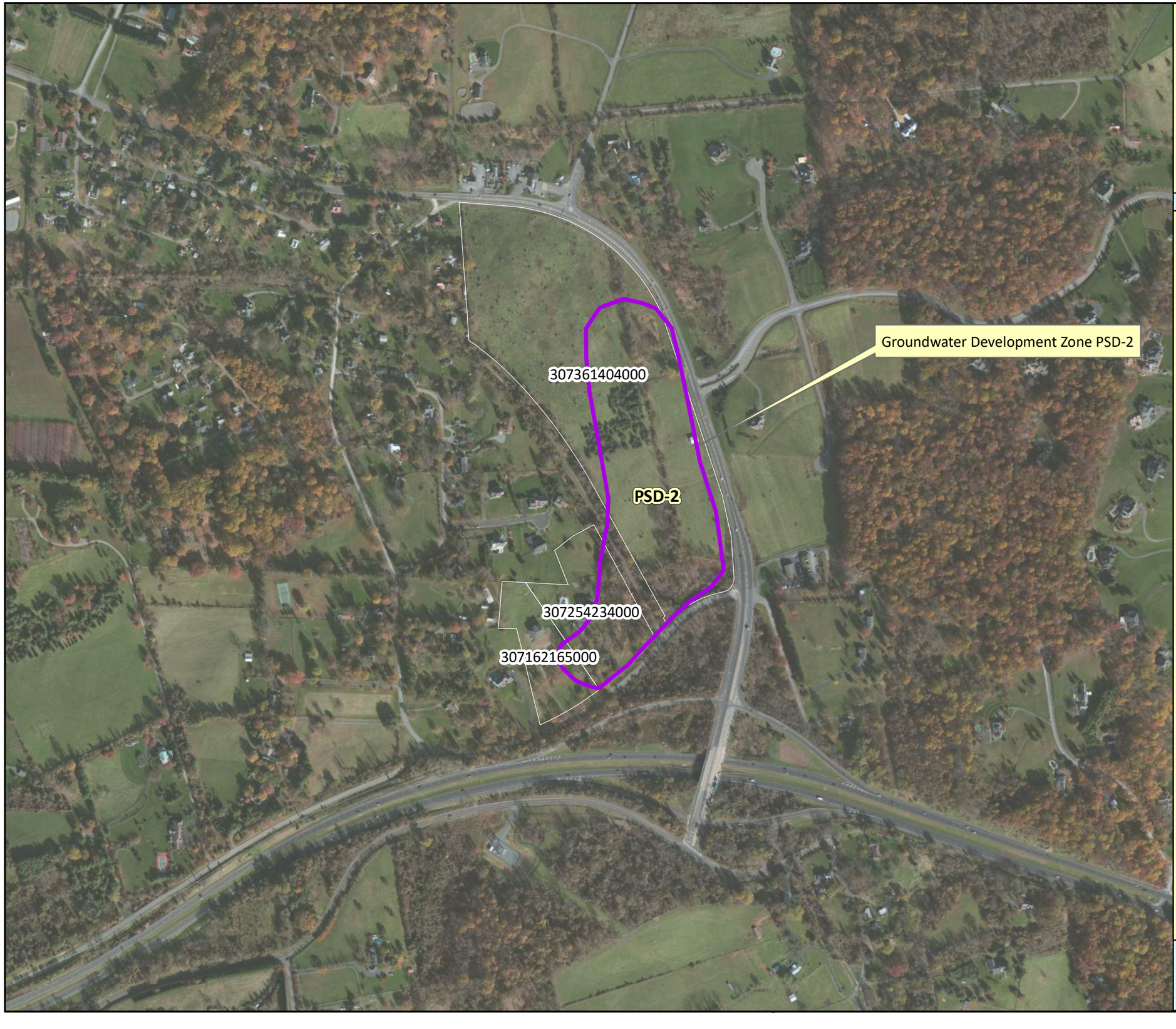
FIGURE 2

Potential Groundwater Development Zone
PSD-2
Paeonian Springs Project Study Area
Loudoun County, Virginia

Preliminary Hydrogeologic Assessment



Legend

Potential Groundwater Development Zones

Status

Primary

Loudoun County Parcels

N

Scale is 1:6,000
1 inch = 500 feet

0 62.5 125 250 Meters

0 255 510 1,020 Feet

FIGURE 2

Emery & Garrett Groundwater Investigations, A Division of GZA

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FIGURE 3

Potential Groundwater Development Zone
PSD-6
Paeonian Springs Project Study Area
Loudoun County, Virginia

Preliminary Hydrogeologic Assessment

Legend

Potential Groundwater Development Zones

Status

Primary

Loudoun County Parcels

N

Scale is 1:6,000
1 inch = 500 feet

0 62.5 125 250 Meters

0 255 510 1,020 Feet

FIGURE 3

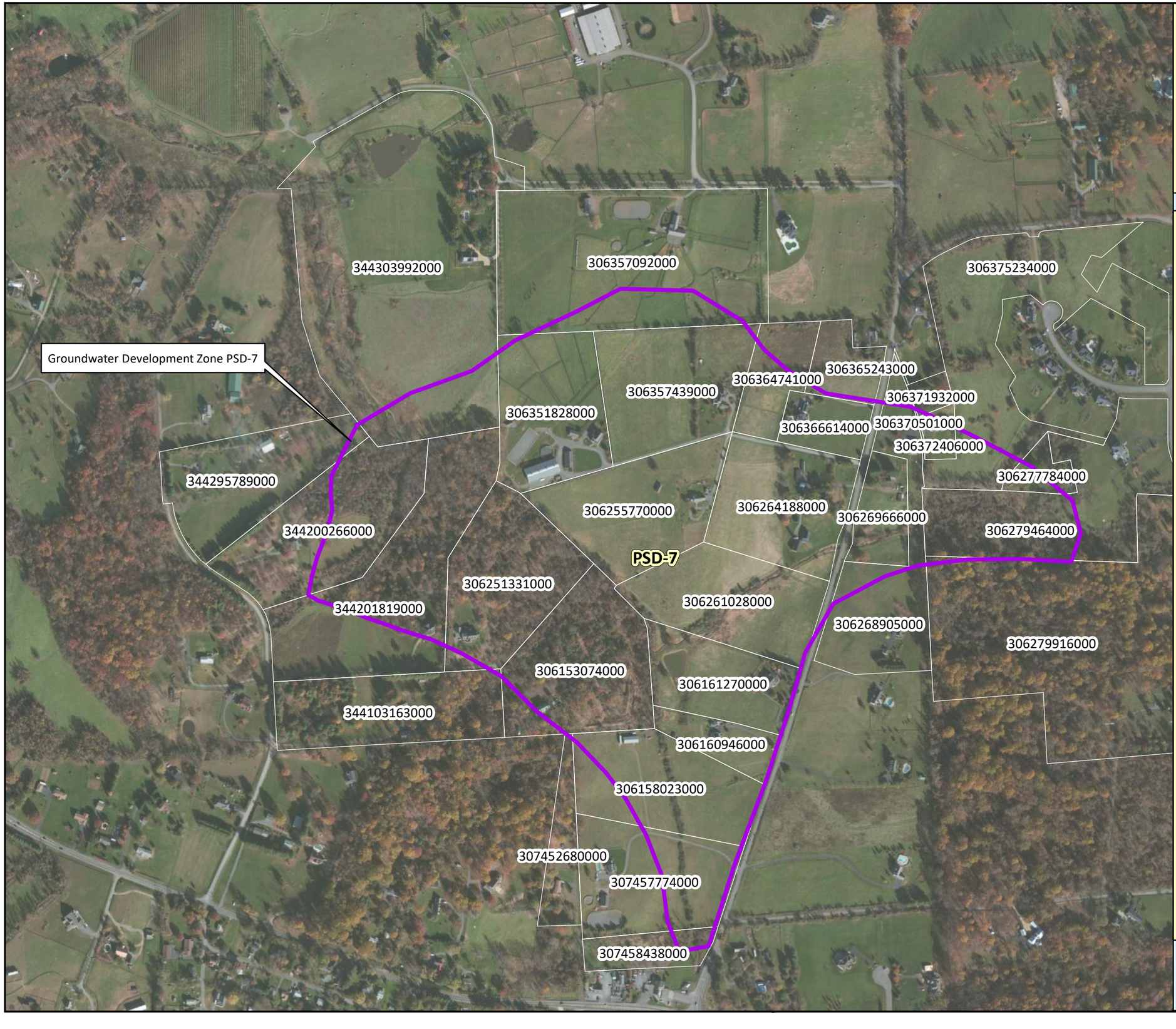
Emery & Garrett Groundwater Investigations, A Division of GZA

J:\33.0083000 to 33.0083099\33.0083070.00 PSD\33.0083070.01\Work\Ph1\Working\GIS\MXDs\PSD-Figure 3.mxd Last saved: 5/23/2023 1:24:05 PM by Mohammad.Arifi

FIGURE 4

Potential Groundwater Development Zone
PSD-7
Paeonian Springs Project Study Area
Loudoun County, Virginia

Preliminary Hydrogeologic Assessment



Legend

Potential Groundwater Development Zones

Status

Primary

Loudoun County Parcels

N

Scale is 1:6,000
1 inch = 500 feet

0 62.5 125 250 Meters

0 255 510 1,020 Feet

FIGURE 4

Emery & Garrett Groundwater Investigations, A Division of GZA

J:\33.0083000 to 33.0083099\33.0083070.00 PSD\33.0083070.01\Work\Ph1\Working\GIS\MXDs\PSD-Figure 4.mxd Last saved: 5/23/2023 1:47:54 PM by Mark.Wingsted

Appendix A - Limitations

USE OF REPORT

1. Emery & Garrett Groundwater Investigations (EGGI), a Division of GZA GeoEnvironmental, Inc. (GZA) (hereafter referenced as GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during its study. Additionally, GZA makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state or federal agency.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

5. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

INTERPRETATION OF DATA

6. Our opinions are based on available information as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support the opinions provided in the Report.

ADDITIONAL INFORMATION

7. In the event that the Client or others authorized to use this report obtain additional information on environmental or hazardous waste issues in the Study Area that are not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

Emery & Garrett
GROUNDWATER INVESTIGATIONS
A Division of GZA

Plates

PLATE 1 — RESULTS of the HYDROGEOLOGIC INVESTIGATION FOR PAEONIAN SPRINGS PROJECT SITE, LOUDOUN COUNTY, VIRGINIA

A) Coincident Lineaments

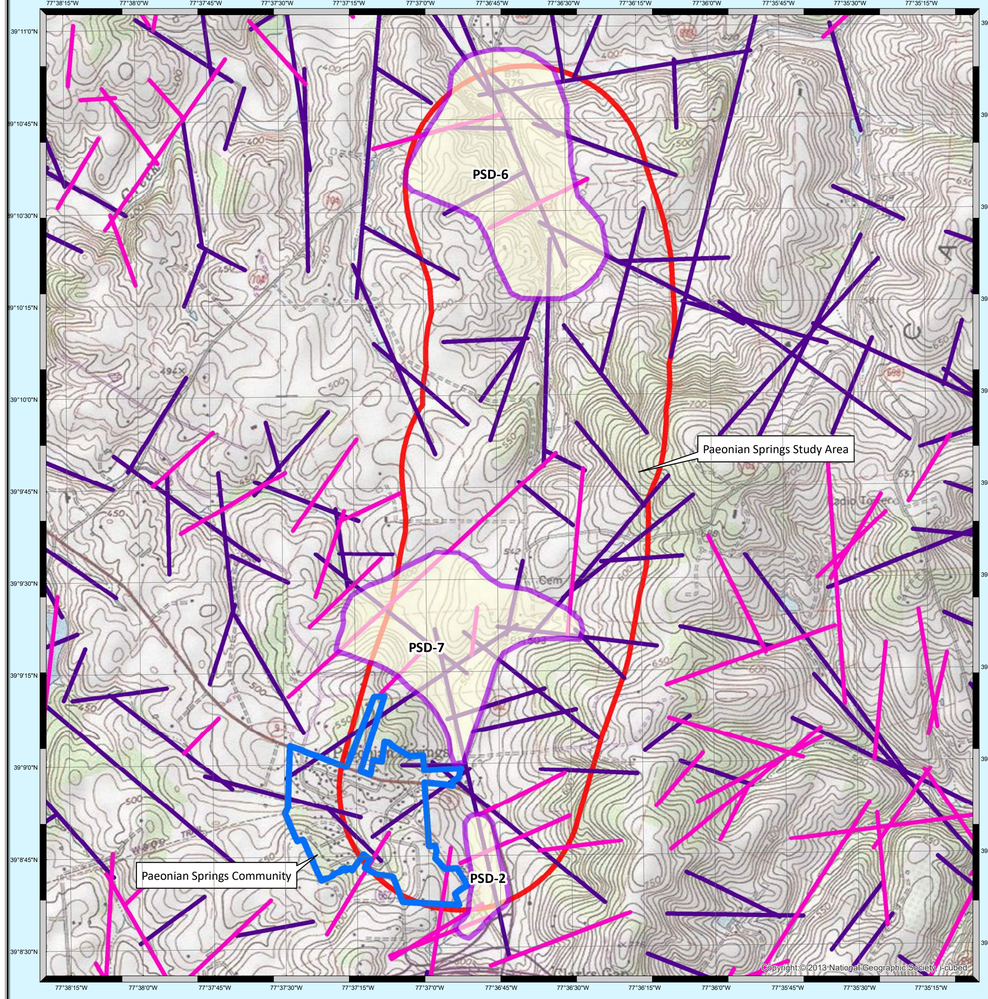


Photo 1: Loose Block of Catoctin Formation.

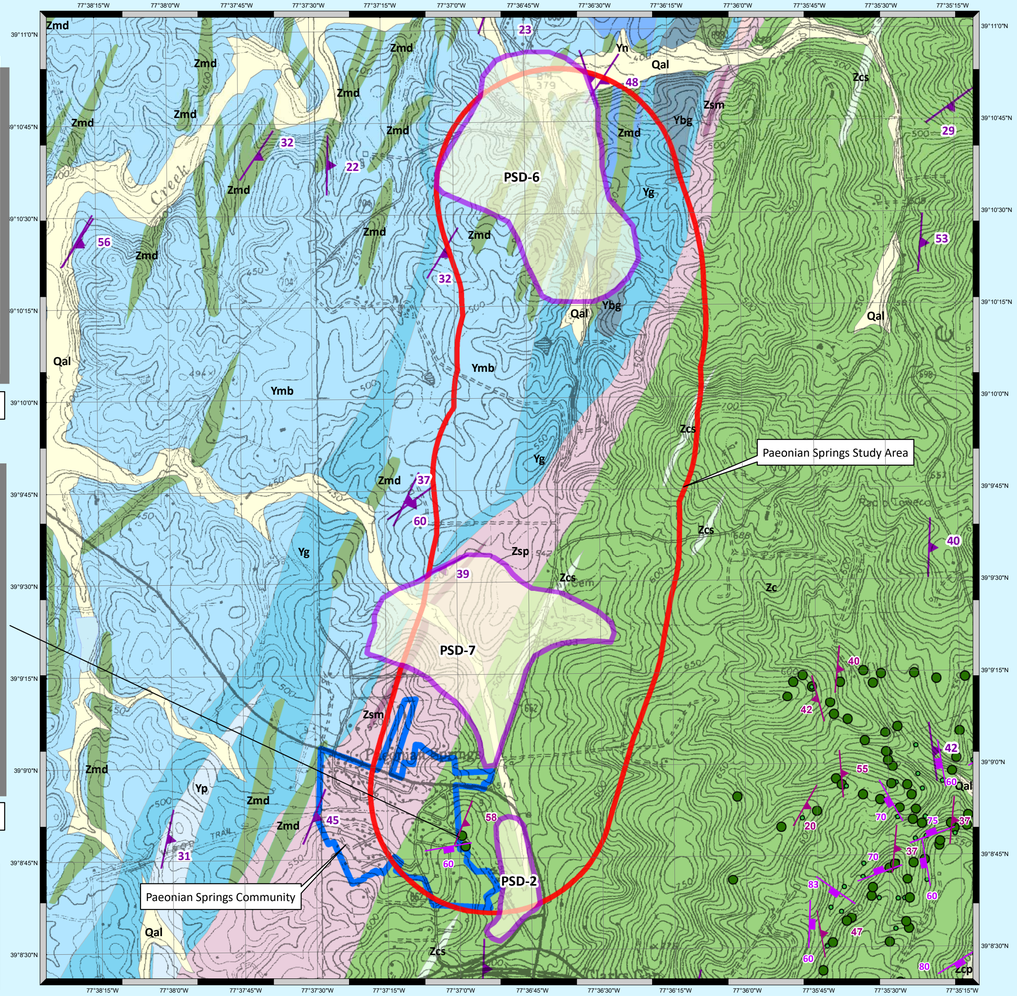
Photo 2: Bedrock exposure of Catoctin Formation along W&OD rail trail.

0 1,250 2,500 5,000 Feet

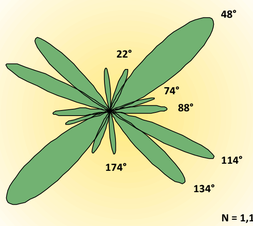
1:15,000

1 inch = 1,250 feet

B) Bedrock Geology



Lineament Rose Diagram



ROSE DIAGRAM NOTATION - Rose petals represent trends of lineaments derived by fitting gaussian curves to azimuth frequency histograms. The trend of each peak is posted in degrees east of north. Petal width is a measure of data scatter and petal length a measure of relative numbers of data in each lineament family.

LINEAMENT PLATFORMS EVALUATED

Scale	Image Id (Name / Roll / Frame)	Image Type	Number of Observational Trials	Total Number of Lineaments Observed
1:10,000	Color Infrared Aerial Photograph	Photograph	2	331
1:12,000	Topographic Wetness Index	Digital Elevation Model Computer Images	2	278
1:18,000	USGS Topographic Map	Topographic Map	2	243
1:24,000	3m Digital Elevation Model	Digital Elevation Model Computer Images	4	996
		TOTALS:	10	1848

Legend

90 — *Observed on more than three scales of imagery AND co-parallels nearby fracture family or bedding trends.*

90 — *Observed on more than three scales of imagery. (trend is posted in degrees east of north)*

Legend

Potential Groundwater Development Zones

- Primary
- 2,000 Foot Buffer - Clarkes Gap Road
- Paeonian Springs Project Site

Legend

(after Southworth, 1999)

Proterozoic Basement Rocks

- Ybg — Biotite gneiss and amphibolite
- Yg — Leucocratic metagranite
- Ymb — Biotite Marshall metagranite
- Yn — Metanorite
- Yp — Paragneiss

Outcrop Identified by EGGI

- greenstone

Bedrock Structures

- Bedrock Fracture
- Foliation — *Strike and Dip of Foliation*

Catoctin Formation

- Zc — Metabasalt
- Zcp — Laminated Phyllite
- Zcs — Phyllite, metasiltstone and metasandstone
- Zmd — Metadiabase dike

Swift Run Formation

- Zsm — Marble
- Zsp — Phyllite

PLATE 1

RESULTS of the HYDROGEOLOGIC INVESTIGATION for Paeonian Springs Project Site, Loudoun County, Virginia

LINEAMENTS and BEDROCK GEOLOGY

Emery & Garrett Groundwater Investigations, A Division of GZA

Groundwater Exploration, Development, and Protection

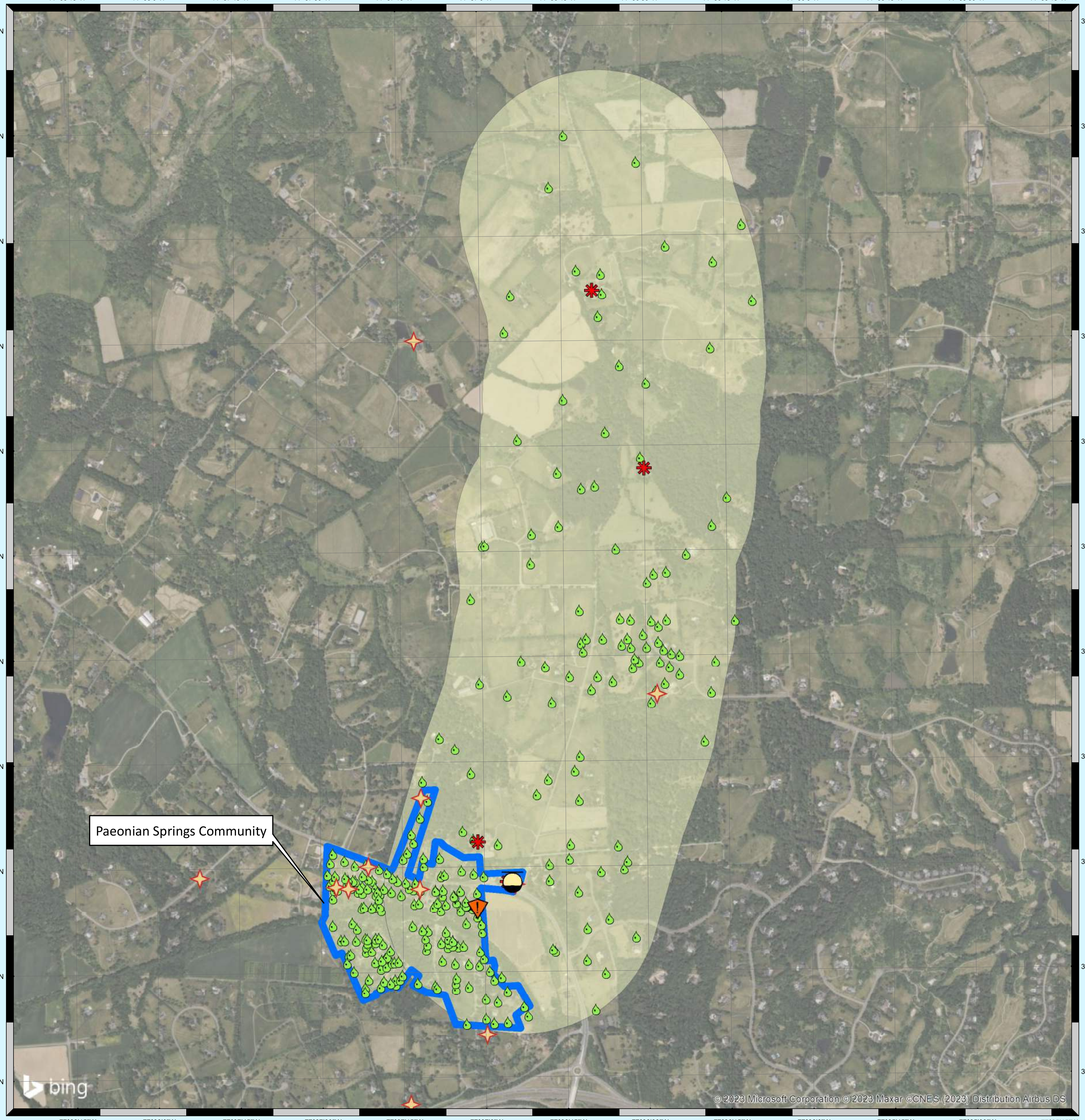
Northeast Mid Atlantic South Atlantic

May 2023

J:\33.0083000 to 33.0083099\33.0083070.00 PSD\33.0083070.01\Work\Ph1\Working\GIS\MXDs\PH1_PLATE-1_Lin_Geology.mxd (last modified:5/23/2023)

PLATE 2 RESULTS of the HYDROGEOLOGIC INVESTIGATION FOR PAEONIAN SPRINGS PROJECT SITE, LOUDOUN COUNTY, VIRGINIA

A) Potential Contaminant Threats



Legend

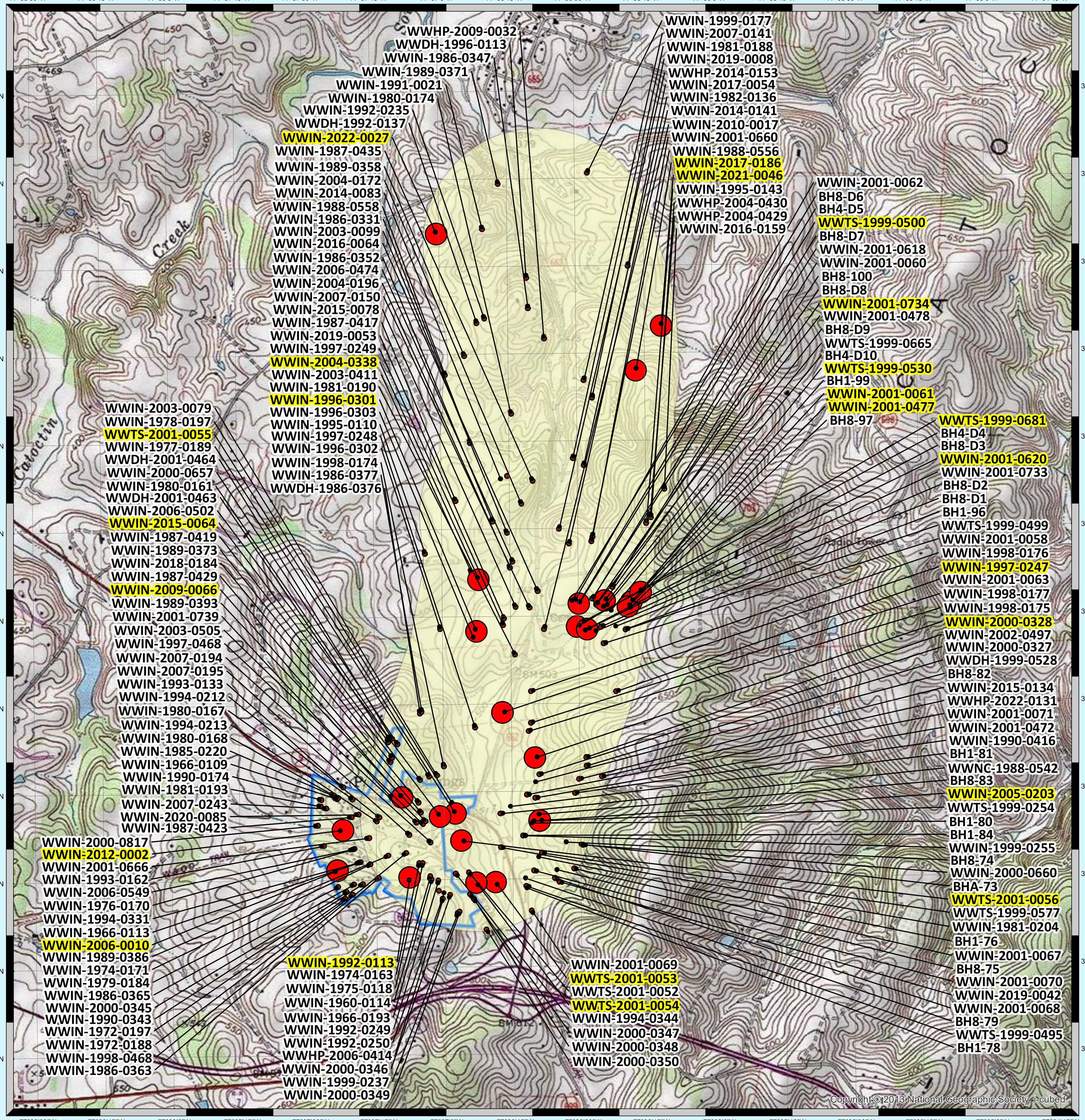
- Registered Petroleum Tank Facilities
- DEQ Pollution Response Report
- Petroleum Release Sites
- Pollution Sources
- Drainfields

0 1,250 2,500 5,000 Feet

1:15,000

1 inch = 1,250 feet

B) Existing Wells



Well Site ID	Yield (gpm)	Well Depth (feet)	Well Site ID	Yield (gpm)	Well Depth (feet)
WWIN-2003-0411	7	600	WWIN-1986-0363	n/a	120
WWIN-2003-0505	2	500	WWIN-1986-0365	n/a	147
WWTS-2001-0052	15	420	WWIN-1986-0377	n/a	95
WWTS-2001-0053	20	420	WWIN-2001-0472	10	420
WWTS-2001-0054	20	420	WWIN-2001-0477	30	420
WWTS-2001-0055	20	320	WWIN-2001-0478	12	440
WWTS-2001-0056	20	380	WWIN-2020-0085	15	200
WWDH-1996-0113	n/a	520	WWIN-1966-0193	n/a	300
WWIN-1988-0556	n/a	645	WWIN-1997-0247	40	200
WWIN-1988-0558	n/a	128	WWIN-1989-0358	n/a	505
WWIN-1992-0235	n/a	600	WWIN-1989-0371	n/a	500
WWIN-1992-0249	n/a	300	WWIN-1989-0373	n/a	405
WWIN-1992-0250	n/a	300	WWIN-1989-0386	n/a	500
WWIN-2000-0817	5	300	WWIN-1989-0393	n/a	270
WWDH-1986-0376	n/a	515	WWIN-1997-0248	8	440
WWIN-1993-0133	n/a	140	WWIN-1997-0249	5	640
WWIN-1998-0174	10	350	WWIN-1960-0114	n/a	160
WWIN-1998-0175	10	380	WWIN-1977-0189	n/a	325
WWIN-1998-0176	9	280	WWIN-1982-0136	n/a	160
WWIN-1998-0177	12	260	WWHP-2022-0131	n/a	400
WWIN-2001-0058	6	440	WWIN-2016-0064	7	500
WWIN-2001-0060	15	420	WWIN-2021-0046	20	495
WWIN-2001-0061	30	420	WWIN-2018-0184	5	420
WWIN-2001-0062	5	620	WWIN-2014-0083	2.5	600
WWIN-2001-0063	10	700	WWIN-2019-0008	1.5	500
WWIN-2006-0474	5	800	WWIN-1994-0212	n/a	63
WWIN-2006-0502	3	800	WWIN-1994-0213	n/a	300
WWIN-2001-0067	5	1000	WWIN-2007-0243	n/a	600
WWIN-2001-0068	9	320	WWIN-2014-0141	3	600
WWIN-2001-0069	10	1000	WWHP-2014-0153	n/a	600
WWIN-2001-0070	10	260	WWIN-2004-0338	20	220
WWIN-2001-0071	6	400	WWIN-2012-0002	20	400
WWIN-1993-0162	n/a	125	WWIN-2016-0159	8	440
WWIN-2004-0172	9	420	WWHP-2004-0429	n/a	80
WWIN-2006-0549	5	500	WWHP-2004-0430	n/a	80
WWIN-2004-0196	2	700	WWIN-1978-0197	n/a	90
WWDH-1992-0137	n/a	600	WWHP-2006-0414	n/a	70
WWIN-1976-0170	n/a	75	WWIN-1990-0174	n/a	280
WWIN-1981-0188	n/a	125	WWIN-1987-0417	n/a	435
WWIN-1981-0190	n/a	125	WWIN-1987-0419	n/a	500
WWIN-1981-0193	n/a	125	WWIN-1987-0423	n/a	200
WWIN-1981-0204	n/a	405	WWIN-1987-0429	n/a	445
WWIN-1998-0468	8	300	WWIN-1987-0435	n/a	145
WWIN-2017-0186	30	260	WWIN-1994-0331	n/a	100
WWIN-1966-0109	n/a	73	WWIN-1994-0344	n/a	245
WWIN-1966-0113	n/a	72	WWIN-1999-0237	18	220
WWIN-1986-0331	n/a	275	WWIN-2003-0079	1	600
WWIN-1986-0347	n/a	600	WWIN-2002-0497	3	580
WWIN-1986-0352	n/a	400	WWIN-2007-0141	n/a	640

Well Data from EGGI Database

Well Site ID	Yield (gpm)	Total Depth (feet)
BH8-75	n/a	n/a
BH1-81	n/a	n/a
BH8-D3	30	360
BH1-96	6	380
BH8-D6	5	620
BH8-82	n/a	n/a
BH8-100	15	420
BH1-78	7.5	450
BH8-D1	6	440
BH8-79	n/a	n/a
BH4-D4	20	260
BH8-74	n/a	n/a
BHA-73	1.25	760
BH1-80	2.75	600
BH1-76	6	420
BH8-97	30	420
BH8-83	n/a	n/a
BH1-84	6	680
BH4-D10	16	320
BH1-99	80	440
BH4-D5	24	260
BH8-D7	4	425
BH8-D8	12	440
BH8-D2	3.5	900
BH8-D9	20	340

Well Site ID	Yield (gpm)	Well Depth (feet)	Well Site ID	Yield (gpm)	Well Depth (feet)	Well Site ID	Yield (gpm)	Well Depth (feet)	Well Site ID	Yield (gpm)	Well Depth (feet)
WWIN-2007-0150	n/a	463	WWIN-2000-0350	8	420	WWNC-1988-0542	n/a	310	WWIN-1992-0113	75	160
WWIN-2019-0042	6	400	WWIN-2003-0099	6	800	WWTS-1999-0499	6	380	WWIN-1996-0301	100	120
WWIN-2019-0053	15	420	WWIN-2005-0203	20	200	WWTS-1999-0500	24.5	260	WWIN-1996-0302	15	260
WWDH-1999-0528	n/a	540	WWIN-1990-0416	1	600	WWTS-1999-0530	85	440	WWIN-1996-0303	5.5	340
WWIN-1990-0343	n/a	265	WWDH-2001-0463	n/a	98	WWTS-1999-0577	6	420	WWIN-1974-0163	n/a	160
WWIN-2000-0327	10	300	WWDH-2001-0464	n/a	100	WWIN-2009-0066	30	145	WWIN-1974-0171	n/a	100
WWIN-2000-0328	25	550	WWIN-1979-0184	n/a	150	WWIN-2006-0010	25	140	WWIN-1980-0161	n/a	150
WWIN-2007-0194	n/a	480	WWIN-1999-0177	5	540	WWIN-2000-0657	1	600	WWIN-1980-0167	n/a	250
WWIN-2007-0195	n/a	500	WWTS-1999-0681	20	260	WWIN-2010-0017	15	300	WWIN-1980-0168	n/a	125
WWIN-1972-0188	n/a	125	WWIN-2017-0054	8	700	WWIN-2001-0618	4	425	WWIN-1980-0174	n/a	370
WWIN-1972-0197	n/a	125	WWIN-2022-0027	100	200	WWIN-2001-0620	30	360	WWIN-1975-0118	n/a	140
WWIN-1991-0021	n/a	480	WWIN-1997-0468	1	400	WWIN-2001-0660	3	800	**Maximum =**	100	1200
WWIN-1995-0110	n/a	350	WWIN-2015-0064	20	140	WWIN-2001-0666	5.5	500	**Minimum =**	1	63
WWIN-1995-0143	n/a	390	WWTS-1999-0254	2.75	600	WWIN-2001-0733	3.5	900	**Average =**	16	388
WWIN-2000-0345	1	625	WWTS-1999-0495	7.25	450	WWIN-2001-0734	20	340	***Wells with no data available**		
WWIN-2000-0346	15	480	WWTS-1999-0665	15	320	WWIN-2001-0739	12	240	**excluded from table**		
WWIN-2000-0347	12	280	WWHP-2009-0032	n/a	350	WWIN-2000-0660	1.5	760	****Wells yielding 20 gpm or more are**		
WWIN-2000-0348	12	300	WWIN-2015-0078	7	560	WWIN-1999-0255	6	680	**highlighted in yellow.**		
WWIN-2000-0349	7	380	WWIN-2015-0134	1	1200	WWIN-1985-0220	n/a	160			

PLATE 2

HYDROGEOLOGIC INVESTIGATION RESULTS for Paeonian Springs Project Site, Loudoun County, Virginia

EXISTING WELLS and POTENTIAL THREATS to GROUNDWATER QUALITY

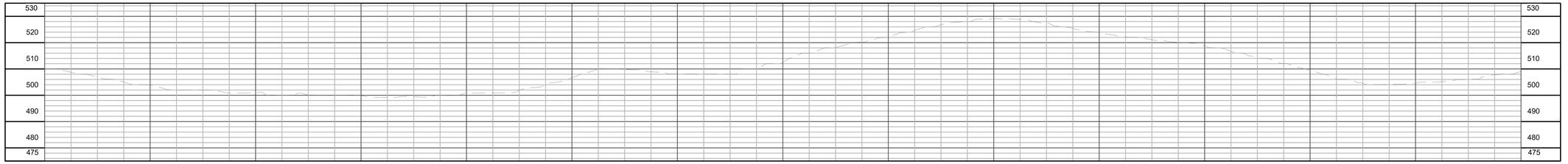
Emery & Garrett Groundwater Investigations, A Division of GZA

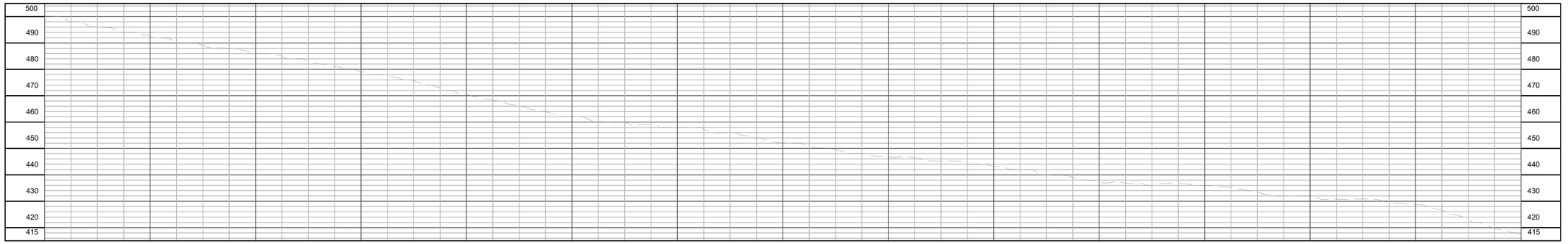
Groundwater Exploration, Development, and Protection

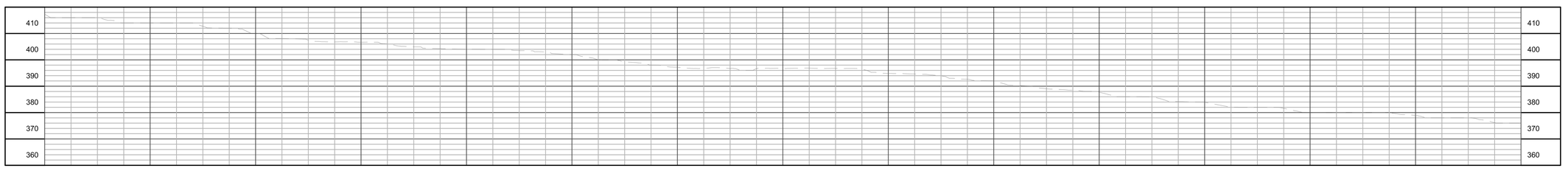
Emery & Garrett Groundwater Investigations
A Division of GZA GeoEnvironmental, Inc.

Appendix D
Clarkes Gap Road Surface Profile

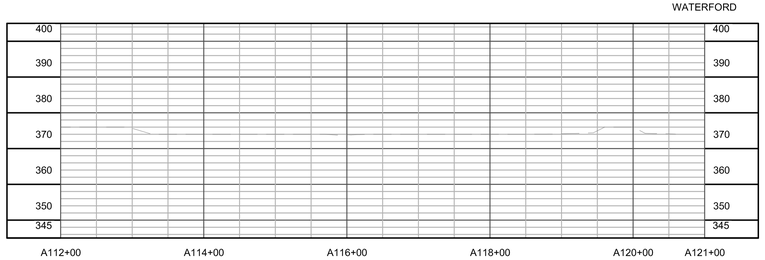
PAEONIAN SPRINGS







WATERFORD



Dewberry

Dewberry Engineers Inc.
8401 Arlington Boulevard
Fairfax, Virginia 22031-4666
PHONE: 703.849.0100
www.dewberry.com

PAEONIAN SPRINGS AND WATERFORD WATER & SEWER

LOUDOUN WATER

LOUDOUN COUNTY, VIRGINIA

SEAL

KEY PLAN

SCALE

No.	DATE	BY	Description

REVISIONS

DRAWN BY	AMJ
APPROVED BY	PJL
CHECKED BY	SAA
DATE	NOVEMBER 2023

TITLE

CLARKES GAP RD CORRIDOR SURFACE PROFILE

PROJECT NO. 50146469

D

SHEET NO.

Appendix E
Project Schedule

WASTEWATER COLLECTION, PUMP STATION, FORCE MAIN, WWTP, & PAEONIAN + WATERFORD WATER DISTRIBUTION SCHEDULE

Description	Approximate Completion Date
Initiate Property Owner Approval for Infrastructure Improvements (Pump Station Site)	October 2024
Basis of Design Report (Preliminary Design)	November 2024
30% Design - Paeonian Springs Wastewater Collection System, Pump Station and Force Main	January 2025
30% Design - Paeonian Springs Wastewater Treatment System	April 2025
Land Acquisition Completed for Paeonian Springs Pump Station	May 2025
Submit Commission Permit/SPEX (Sewage Pump Station & WWTP)	June 2025
60% Design - Paeonian Springs Wastewater Collection System, Pump Station and Force Main	July 2025
60% Design - Paeonian Springs Wastewater Treatment System	August 2025
90% Design - Paeonian Springs Wastewater Collection System, Pump Station and Force Main	November 2025
90% Design - Paeonian Springs Wastewater Treatment System	December 2025
Commission Permit/SPEX Process Approval (Sewage Pump Station & WWTP)	June 2026
100% Design	August 2026
Permit Approvals	September 2026
Bid Ready Documents	November 2026
Bid Phase Services*	November 2027
Construction NTP*	January 2028
Construction Substantially Complete*	September 2029
Final Completion*	October 2029
*Assumes Wastewater Infrastructure Project is Bid & Constructed simultaneously to Water System Project	

WATER WELL, SUPPLY, STORAGE AND TREATMENT SCHEDULE

Description	Approximate Completion Date
Groundwater Investigation Phase II - Test Well Siting and Geophysical Survey	April 2024
Written Approval from Property Owners for Water System Phase II - IV	August 2024
Groundwater Investigation Phase III - Exploratory Well Drilling & Testing	September 2024
Groundwater Investigation Phase IV - Production Well Drilling	December 2024
Groundwater Investigation Phase V - Long-Term Pumping Tests	March 2025
Groundwater Investigation Phase VI - Draft Hydrogeological Report	June 2025
Basis of Design Report (Preliminary Design)	September 2025
30% Paeonian Springs Water Well, Supply, Storage and Treatment System	September 2025
Land Acquisition Completed for Well, Supply, Storage, Treatment Facility	January 2026
Submit Commission Permit/SPEX ((Well, Supply, Storage, Treatment Facility)	February 2026
60% Paeonian Springs Water Well, Supply, Storage and Treatment System	April 2026
90% Paeonian Springs Water Well, Supply, Storage and Treatment System	July 2026
Commission Permit/SPEX Process Approval (Well, Supply, Storage, Treatment Facility)	February 2027
100% Design	July 2027
Permit Approvals	August 2027
Bid Ready Documents	August 2027
Bid Phase Services	November 2027
Construction NTP	January 2028
Construction Substantially Complete	September 2029
Final Completion	October 2029

ATTACHMENT 2

Waterford FOUNDATION, INC.
Post Office Box 142 • Waterford, Virginia 20197 • 540-882-3018
www.waterfordfoundation.org • info@waterfordfoundation.org

October 15, 2024

Ernie Brown, LC DGS
Scott Fincham, LC DGS

Nancy Boyd, LC DTCI

I am writing on behalf of the Waterford Foundation Board of Directors to express our continued support for the water project envisioned by Loudoun County. At our last Board meeting on September 17, 2024, our Executive Director, Stephanie Thompson, presented an overview of salient issues for discussion, including concerns presented by a new citizen group and research that has been conducted by the Waterford Foundation staff and others. The Board voted unanimously to continue supporting the project that has expanded to include connecting Waterford and Paeonian Springs for both water and sewer. Our reasons for continued support are detailed below.

Background: In 2019 the Waterford Foundation Board voted to sign a community petition to seek County assistance in exploring the possibility for a community water system for the village of Waterford. At the time, the Board made the decision to support the petition as a property owner because several of the Foundation's properties do not have water and their use and income potential is limited by the lack of water. Having received the requisite percentage of signatures on the community petition, and as directed by the Board of Supervisors, Loudoun County Department of General Services (LCDGS) began a community water feasibility study in January 2021.

Detailed Analyses and Conclusions

Issue 1: Protecting the National Historic Landmark

Previous Waterford Foundation (WF) studies of undeveloped parcels within the proposed Waterford community water service area demonstrated that none of the undeveloped parcels are currently prohibited from development because of their lack of access to water. In other words, access to community water would not change the development potential of those parcels. The combined system would serve only service areas defined in Waterford and Paeonian Springs and would not serve parcels along the supply main running down the Clarkes Gap Road right-of-way. While WF has not studied the 89 undeveloped parcels in Paeonian Springs to determine whether access to water is a determining factor, Paeonian Springs lies well outside the boundaries of the Waterford National Historic Landmark (NHL) and is therefore outside the purview of the Foundation's mission.

Furthermore, development of any kind in Loudoun County is governed by the General Plan as outlined in the Zoning Ordinance. Access to community water does not unilaterally change the allowed development density of the parcels served by the water system without additional action by

the Planning Commission and Board of Supervisors, through processes that are transparent and open to public comment.

A significant threat to the integrity of the Landmark is the inability for homes without access to water to remain livable for the residents who maintain them. If a contributing historic structure is not livable it is likely to be abandoned and eventually lost. Therefore, bringing community water to the village to address water needs supports the long-term preservation of the NHL. In addition, a combined system with Paeonian Springs allows for the water supply infrastructure to be located outside the boundaries of the Landmark, eliminating potential negative impacts to the undeveloped rural viewshed critical to the integrity of the Waterford NHL. The combined system therefore represents a better solution for the Landmark than a system that would serve Waterford only. Given that the open spaces in Waterford are largely owned by the WF, our greatest fear was that there would be pressure to use WF land for the water infrastructure.

Issue 2: Ensuring Public Health, Wellbeing, and Safety

The WF, as one of the largest property owners within the NHL, must be concerned with public health and safety of the village and surrounding areas. There are currently multiple parcels within the NHL, including WF properties that have no water, little water, and/or unhealthy water. This is no small concern, especially as the majority of residents of the village are 65 and older and may be especially susceptible to water borne illnesses. There are homes in the village dependent on hand-dug wells that cannot meet Virginia Public Health Codes.

While the WF is not responsible for the wellbeing of villagers, we strive to be good neighbors and support the people who live here. There are too many villagers who have to worry about how much water they will have and of what quality. This presents a strain to mental health as well as physical and financial health. If a solution exists, the WF Board believes it is only right to pursue it. While some in the village talk about ways to boost low performing wells, no reputable engineering resource has come forward to offer a meaningful alternative. Shared wells create legal impediments and performance boosting strategies do nothing for properties with no water and/or no land on which to drill a well. The studies show the problem is only getting worse as time goes on.

In terms of the required update to the Waterford Wastewater facility that was planned long before this project was envisioned, we understand that wastewater treatment facilities are highly regulated. As such, as part of their design manual and to meet commissioning requirements, Loudoun Water must study the environmental impacts of the new facility and demonstrate that the treated wastewater will not negatively affect the surrounding environment. **The existing Waterford wastewater facility does not meet current environmental regulations,** which is why it must be replaced. Designing a new, more modern system that is capable of serving both communities while meeting environmental regulations is possible and will be an improvement that will protect our environment more effectively than the current system. Similarly, we understand that to commission a new public water supply system, Loudoun Water must study the potential impact to surrounding existing wells and must demonstrate that construction of the new utility will not negatively impact existing wells.

Finally, there is no fire suppression system in Waterford. Our historic homes and buildings are one fire away from destruction. The danger to villagers and their belongings as well as to WF properties and the precious history they hold is high. The water project now envisions the potential for fire suppression which will increase public safety substantially.

Issue 3: Supporting the Adaptive Use of WF Historic Properties

The National Trust for Historic Preservation supports adaptive reuse of historic buildings as the best means of preserving these unique resources. Buildings that are used and can generate enough income to support their ongoing maintenance are much more likely to survive over time. Each of our properties has unique issues and opportunities:

The Old School: this building is zoned as a community center and is the site of most of our major meetings, educational programs, and events including the annual Waterford Fair. However, because there is both insufficient and poor quality water, we can only use the building for large gatherings 59 days per year. The water in the building cannot be used for drinking or cooking, meaning that catered events must include the cost of water and ice. If WF was able to rent out the space more frequently, we could generate the income needed to provide more than just baseline upkeep and be a more productive resource to the village. A new well could be dug for this property, but because it is in a "red zone" as designated by the water study, there is no guarantee that it would be money well spent.

The Corner Store: this building is our most successful case of adaptive reuse, but it shares a well with the Pink House. Shared wells present many concerns, including legal disputes, disagreements about quality and quantity, and damage to underground connections that run under heavily traveled roads. Community water would solve all of those problems and ensure its continued success as a building that is fully utilized.

The Mill: While this building has water, it is not potable and due to its location is unlikely to be successful in obtaining quality water within the flood plain on which it is sited. Since its renovation, the Mill presents opportunities to increase its value as an educational resource. Community water would allow us to envision holding Craft School classes there, hosting seminars on milling practices, or using the space to exhibit some of our many historic artifacts.

The Chair Factory: While this building is currently rented, it can only be rented by individuals who live in the village or who have access to someone's home in the village. With no water it is of limited use and we charge rental fees far below the actual value of the space.

The Three Barns of Waterford: All three offer space that could be used for many purposes. Without water, their use is extremely limited.

For all of these reasons, the WF Board remains supportive of the plan to bring community water to Waterford.

Sincerely yours,

Susan Manch
President, Waterford Foundation Board of Directors

cc. Waterford Foundation Board and Staff