

ADDENDA

Review Preliminary Engineering Report – Water Treatment Plant

History

In 2018, the Town Council commissioned a utility rate study to determine the future needs of the Town's water and sewer system and how to pay for those needs. The Town of Berryville Utility Rate Study (Study) was completed by Pennoni in July 2019. It is recommended that the work identified in the study be completed over the next twenty years to ensure that the Town's utilities are functioning in a manner that meets the needs of its customers.

Taking the results of the Study in to account, the Town Council began a series of five recommended rate/fee increases intended to ensure the fiscal stability of both the Town's enterprise funds. The last of those programmed increases will likely become effective in November 2023.

One of the projects that was identified in the Study was the upgrade of the Town's water treatment plant (WTP). The Study determined that the WTP, which was constructed in 1984, would soon reach functional obsolescence and recommended its replacement in 2026. The Study determined the estimated cost for the WTP upgrade (including engineering costs and work at the water intake) to be \$16,070,000.

In August 2022, the Town issued a request for proposals for professional engineering services-water treatment plant. Pennoni was chosen as the engineer for this project (estimated cost \$847,350). It is important to note that the total cost of planning and constructing the plant will, in addition to construction costs, include other items such as legal review, permitting, land acquisition, and the like.

The first major step in completing the engineering for a water treatment plant is the completion of a preliminary engineering report (PER). The PER outlines what will be done during the project and identifies the process or technology that will be used to treat the Town's water. Once the PER is approved by the Town Council, then it will be submitted to the Virginia Department of Health (VDH). After the PER is approved by VDH, Pennoni will begin plant design. Once the plant is designed, the project will be placed out to bid. After a contractor is chosen, the contractor will complete the work. The Town, contractor, and Pennoni will work cooperatively on WTP startup.

Pennoni has completed the PER and submitted it to the Town. The Town Council reviewed the PER at a work session on September 7, 2023.

The Town Council is tasked with approving a PER and thereby finalizing the document (and project approach) that will be submitted to VDH.

The schedule for completion of the WTP project provides for substantial completion by the end of 2026.

The Town Council established a Water Treatment Plant reserve. The reserve currently contains \$2.2 M. The Council has self-funded the WTP engineering costs.

The Town Council has applied for project funding through VDH and has prepared to apply for project funding through the USDA.

Project Approach and Estimated Costs

Pennoni reviewed several WTP upgrade options. They determined that the Town has two treatment technology options that it can reasonably utilize in the new WTP.

Pennoni determined that the Town could utilize a mixed-media filter process or a membrane filter process. As a part of the PER, Pennoni rated the two options and determined that use of a membrane filtration process is superior in this instance. Pennoni is of the opinion that in this application the membrane filtration process is superior to the mixed-media filtration process because it will provide better water quality and provide the Town with a greater ability to address emerging contaminants and more stringent treatment requirements. Accordingly, the PER that was submitted to the Town Council for review recommends that the Town install a membrane filter process in the new WTP.

The PER provided the following cost estimates of the plant upgrade:

<u>Process</u>	<u>Capital Costs</u>	<u>Life-cycle Costs</u>
Mixed-media	\$8.956 M	\$29.284 M
Membrane	\$11.146 M	\$31.225 M

Attachments

- PER
- Concept Plan
- Draft minutes of the September 7, 2023 Town Council work session

Recommended Action

Approve the PER and authorize the Town Manager to submit the document to the Virginia Department of Health for review and approval.

Recommended Motions

I move that the Council of the Town of Berryville approve the Preliminary Engineering Report titled *Water Treatment Plant Improvements, Berryville, Virginia* and authorize the Town Manager to have the report submitted to the Virginia Department of Health for approval.

OR

I move that the Council of the Town of Berryville approve the Preliminary Engineering Report titled *Water Treatment Plant Improvements, Berryville, Virginia*, provided that mixed-media filters be identified as the Council's desired treatment process, and authorize the Town Manager to have the revised report submitted to the Virginia Department of Health for approval.

PRELIMINARY ENGINEERING REPORT

WATER TREATMENT PLANT IMPROVEMENTS

Berryville, Virginia



Prepared For:

Town of Berryville
Keith Dalton, Town Manager
101 Chalmers Court, Suite A
Berryville, Virginia 22611
(540)-955-4081

August 2023
TBVLL22002



PARTNERS FOR WHAT'S POSSIBLE

pennoni.com

TABLE OF CONTENTS

1. PROJECT PLANNING.....	5
1.1 Introduction	5
1.2 Location.....	5
1.3 Environmental Resources Present.....	5
1.4 Population and Demographic Trends	5
1.5 Community Engagement.....	9
2. EXISTING FACILITIES	10
2.1 Location Map.....	10
2.2 History	11
2.3 Condition of Existing Facilities	11
2.3.1 Plant Performance.....	11
2.3.2 Water Treatment Plant Flow	12
2.3.3 Structural Condition Evaluation.....	13
2.3.4 Structural Observations & Findings	14
2.4 Financial Status of Any Existing Facilities.....	16
2.5 Water/Energy Waste Audits.....	16
3. NEED FOR THE PROJECT	17
3.1 Health, Sanitation and Security	17
3.2 Aging Infrastructure	18
3.3 Reasonable Growth	18
4. ALTERNATIVES CONSIDERED	20
4.1 Alternative No. 1 – No Action.....	20
4.1.1 Description	20
4.2 Alternative No. 2 – Purchase Finished Water and Defer Renewal of Raw Water Supply and Treatment Facilities.....	20
4.2.1 Description	20
4.3 Alternative No. 3 – Rehabilitate Package Treatment Facility within Same Location	21
4.3.1 Description	21
4.4 Alternative No. 4 – Install New Conventional (“Mixed Media”) Treatment Facilities.....	22
4.4.1 Description	22
4.4.2 Design Criteria	23
4.4.3 Map	24

4.4.4	Environmental Impacts.....	24
4.4.5	Land Requirements	24
4.4.6	Potential Construction Problems.....	25
4.4.7	Sustainability Considerations.....	25
4.4.8	Water and Energy Efficiency.....	25
4.4.9	Green Infrastructure.....	26
4.4.10	Other	26
4.4.11	Cost Estimates	26
4.5	Alternative No. 5 – Install New Membrane Treatment Facilities.....	26
4.5.1	Description	26
4.5.2	Design Criteria	27
4.5.3	Map	27
4.5.4	Environmental Impacts.....	28
4.5.5	Land Requirements	28
4.5.6	Potential Construction Problems.....	28
4.5.7	Sustainability Considerations.....	28
4.5.8	Water and Energy Efficiency.....	29
4.5.9	Green Infrastructure.....	29
4.5.10	Other	29
4.5.11	Cost Estimates	29
5.	SELECTION OF AN ALTERNATIVE	30
5.1	Short-Lived Assets	30
5.2	Life Cycle Cost Analysis.....	30
5.3	Non-Monetary Factors	31
6.	RECOMMENDED ALTERNATIVE	33
6.1	Preliminary Design.....	33
6.2	Project Schedule.....	34
6.3	Permit Requirements	35
6.4	Sustainability Consideration	35
6.5	Water and Energy Efficiency	35
6.6	Green Infrastructure	35
6.7	Other	35
6.8	Total Project Capital Cost Estimate	35

6.9	Financing Plan - Annual Operating Budget	37
6.9.1	Income.....	37
6.9.2	Annual O&M Costs	37
6.9.3	Debt Repayment.....	38
6.9.4	Debt Service Reserve	38
6.9.5	Short-Lived Asset Reserve	38
7.	CONCLUSIONS AND RECOMMENDATIONS.....	39

LIST OF TABLES

Table 1-1 Town of Berryville Historical Population.....	6
Table 1-2 Town of Berryville Demographic Data	6
Table 1-3 Clarke County Historical and Forecasted Population.....	7
Table 1-4 Town of Berryville Future Population Forecast	8
Table 2-1 WTP Flow Summary.....	12
Table 3-1 Water Production Summary 2018-2022.....	19
Table 3-2 Forecasted Water System Maximum Day Demand Growth	19
Table 6-1 Estimate Project Schedule.....	34
Table 6-2 Capital Budget for Preferred Alternative – Membrane Treatment.....	36
Table 6-3 Annual Operation & Maintenance Costs for Preferred Alternative – Membrane Treatment.....	38

LIST OF FIGURES

Figure 2-1 General Location Map.....	10
Figure 2-2 Schematic System Flow Diagram.....	11

APPENDICES

Appendix A – Waterworks Operating Permit No. 2043125

Appendix B – Photographs of Water Treatment and Raw Water Facilities

Appendix C – Reference Drawings

Appendix D – Basis of Design for Alternatives No. 4 and No. 5

Appendix E

- Preliminary Opinion of Capital Project Costs – Alternative No.4
- Preliminary Opinion of Capital Project Costs – Alternative No. 5
- Forecasted Operation & Maintenance Costs – Alternatives No. 4 & 5
- Table of Short-Lived Assets
- Life Cycle Cost Comparison

Appendix F

- Adopted Budget for FY 2022-23
- Financial Audit for FY 2021-22
- Current and Proposed Water Rate Schedules
- Table of Water Users by Monthly Usage (to be added if USDA funding sought)
- Financing Plan for USDA Rural Development Loan Application for Preferred Alternative (to be added if USDA funding sought)

1. PROJECT PLANNING

1.1 Introduction

The Berryville Water Treatment Plant is a dual train conventional treatment facility with a design average flow of 0.864 MGD. The flocculation, sedimentation, and filtration stages of treatment are provided as a single package unit. The plant serves the Town of Berryville and limited adjacent areas that are planned for future annexation. The facility supplies all potable water needs to the Town, including residential, commercial, and industrial facilities. The plant's water supply is the Shenandoah River, through a river intake facility southeast of the Town, connected by underwater piping to a raw water pumping facility near the river shoreline, and a raw water pipeline carrying pumped flow to the treatment plant.

The Town also collects wastewater generated from properties served drinking water and treats the wastewater at an advanced wastewater treatment facility before discharging the effluent into the Shenandoah River. The treated wastewater discharge is downstream of the water supply intake.

The existing water treatment facility and the raw water intake, pumping and transmission were all designed by Clifford & Associates and constructed in the early 1980s. It was state-of-the-art conventional treatment at the time of its construction and has generally served the Town very well for 40 years with only minor added improvements. However, many of the process units are now advancing beyond the expected useful life and showing signs of failure and need for rehabilitation or replacement, and this facility is the Town's only source of drinking water. This report discusses alternatives and recommendations to "renew" the water treatment and raw water supply facilities through an evaluation of existing facilities and consideration of rehabilitation and replacement options.

Operation of the water treatment and raw water supply facilities are governed by Virginia Department of Health Waterworks Operating Permit No. 2043125 dated July 16, 2012. A copy of this permit is included in Appendix A to this report. The permit requires a Licensed Class II Virginia Waterworks Operator

1.2 Location

The Town of Berryville is an incorporated town located in central Clarke County and west of the valley formed by the Shenandoah River. The Town lies at the intersection of U. S. Route 340 and Virginia State Route 7. Berryville is located approximately 10 miles east of the Interstate 81 north-south corridor and approximately 27 miles north of the Interstate 66 east-west corridor.

The Water Treatment Facility is located southeast of the Town of Berryville at 2970 Springsbury Road (See Figure 2.1).

Photographs of the existing Berryville Water Treatment and Raw Water Facilities are provided in Appendix B of this report.

1.3 Environmental Resources Present

Environmental resources have been identified in the document entitled "Environmental Report in Support of the Categorical Exclusion" prepared by Wetlands Studies and Solutions, Inc. (WSSI) dated July 2023. A copy of this report is contained herein as Volume II.

1.4 Population and Demographic Trends

The population of the Town of Berryville has been relatively stable over the past seventy years except for two separate decades of accelerated growth, including the period between 1980 and 1990 (87% growth in

10 years or average 6.46% per year) and a second period between 2000 and 2010 (39% growth in 10 years or average 3.38% per year). The overall growth rate between 1950 and 2020 has averaged 1.7% per year, with more recent growth between 1990 and 2020 averaging 1.1% per year.

Table 1-1 Town of Berryville Historical Population

Year	US Census Population (US Census Bureau)	Annual Growth Rate
1950	1,401	
1960	1,645	1.62%
1970	1,569	-0.47%
1980	1,752	1.11%
1990	3,277	6.46%
2000	3,002	-0.87%
2010	4,185	3.38%
2020	4,534	0.80%
Total Average Annual Growth Rate from 1950 - 2020		1.69%
Total Average Annual Growth Rate from 1970 - 2020		2.15%
Total Average Annual Growth Rate from 1990 - 2020		1.09%

The 2021 demographic data for the Town is summarized in Table 1-2.

Table 1-2 Town of Berryville Demographic Data

Category	Value
Land Area (square miles)	2.3
Estimated Population	4,494
Median Age	45.9
Average Household Size (persons)	2.6
Median Household Income	81,765
Per Capita Income (\$/Person)	35,828
Unemployment Rate	7.1%
Poverty Rate	10.5%
Source: Unemployment Rate from HomeArea.com; other data from Census data - American Community Survey 2021 5-Year	

Within the Commonwealth of Virginia there are two well-respected organizations that are considered to conduct research and publish reliable data on local population growth for many years. One is a state agency known as the Virginia Employment Commission, and the second is an academic research agency within the

University of Virginia called the Weldon Cooper Center. Neither of these agencies publish population forecasts for towns with a population less than 5,000; accordingly, the Town of Berryville's population growth forecast is not directly provided. However, both agencies publish and regularly update forecasts for all counties in Virginia, including Clarke County within which the Town of Berryville is the county seat. For this report, growth forecasts for the Town of Berryville will be extracted from published forecasts for Clarke County, further taking into account an historical comparison of Town and County growth.

As shown in Table 1-3, the Virginia Employment Commission projects future population growth for Clarke County to average about 0.51% per year, from a census of 14,783 in 2020 to a forecasted population of 17,199 in 2050. The Weldon Cooper Center projects a lower average of about 0.39% per year, with a forecasted population of 15,965 in 2040. Weldon Cooper does not forecast beyond 2040. Historically, Clarke County grew at an average rate of greater than 1% per year between 1950 and 1990, but growth has slowed since 1990. The average growth rate between 1990 and 2020 has been 0.67% per year. Comparing the growth rate for the past 30 years to the forecast for the next 30 years suggests that this trend of slower growth will continue.

Table 1-3 Clarke County Historical and Forecasted Population

Year	U S Census		Virginia Employment Commission		Weldon Cooper Center	
	Population	Annual Growth Rate	Population	Annual Growth Rate	Population	Annual Growth Rate
1950	7,074					
1960	7,942	1.16%				
1970	8,102	0.20%				
1980	9,965	2.09%				
1990	12,101	1.96%				
2000	12,652	0.45%				
2010	14,034	1.04%				
2020	14,783	0.52%				
2030			15,309	0.35%	15,266	0.32%
2040			16,133	0.53%	15,965	0.45%
2050			17,199	0.64%		
Total Average Annual Growth Rate from 1950 - 2020						1.06%
Total Average Annual Growth Rate from 1970 - 2020						1.21%
Total Average Annual Growth Rate from 1990 - 2020						0.67%
Forecast Annual Growth Rate from 2020 -2050 (VEC)						0.51%
Forecast Annual Growth Rate from 2020 -2040 (Weldon Cooper)						0.39%

Sources: US Decennial Census, www.vec.virginia.gov/pdf/pop_projs.pdf and <https://demographics.coopercenter.org/virginia-population-estimates/>

Historical population growth of Clarke County can be compared to the historical population growth rate for the Town of Berryville by comparing results in Table 1.1 for the Town with Table 1.3 for the County. When looking at growth rates for each decade, the Town grew at a faster rate in four decades while the County grew faster in three decades. The spread was more dramatic in the decades when the Town growth exceeded the County. When comparing the average growth rates for longer periods (1950-2020, 1970-2020, and 1990-2020) the data indicates Town has been growing at a faster rate than the County. In 1950 the Town population was 1,401 or 20% of the County's population of 7,074. By 2020 the Town's population was 31% of the County's population (4,534 people compared to 14,783 people). Over the historical period shown in the two tables, the trend is toward a growth rate for the Town that is 1.6 to 1.75 times the County growth rate.

Over the period of this analysis, the Town has grown in area through annexations in addition to growth through development of infill property. The Town experienced a significant increase in population between 1980 and 1990 through the addition of 350 acres of Annexation Area A to include 922 people. Since 1990 the Town has grown within the boundary of Annexation Area B. This growth area is administered by both the Town of Berryville and the County of Clarke.

The Town of Berryville and Clarke County both adopted a 2015 Berryville Area Plan in May 2016, which provides for three potential areas along the Town's southern border to be added in the coming decades to continue to meet the anticipated housing and economic demands of the region. Most of the area considered in this Plan was vacant at the time of adoption of the plan, suggesting that it is more a direction for which organic growth can occur than an inducement that could or would accelerate growth.

Applying the Weldon Cooper future growth forecast for Clarke County (0.39% per year) and the lower ratio of 1.6 for Town growth compared to County growth, a lower end forecast for Town of Berryville growth would be 0.625% per year. This rate would correspond to a growth of 20.6% over 30 years. Applying the Virginia Employment Commission future growth forecast for Clarke County (0.51% per year) and the higher Town/County ratio of 1.75 would yield a higher end future growth rate for the Town of 0.89% per year. This rate would correspond to a growth of 30.4% over 30 years.

Table 1-4 Town of Berryville Future Population Forecast

Year	Lower End Population Forecast	Higher End Population Forecast
2020	4,534	4,534
2030	4,830	4,950
2040	5,140	5,410
2050	5,470	5,910

Over the next 30 years, the Town of Berryville is likely to grow in population at a rate of between 20% and 30% of current population. A mid-point rate of 25% in 30 years will be used as a basis for forecasting future water demand.

1.5 Community Engagement

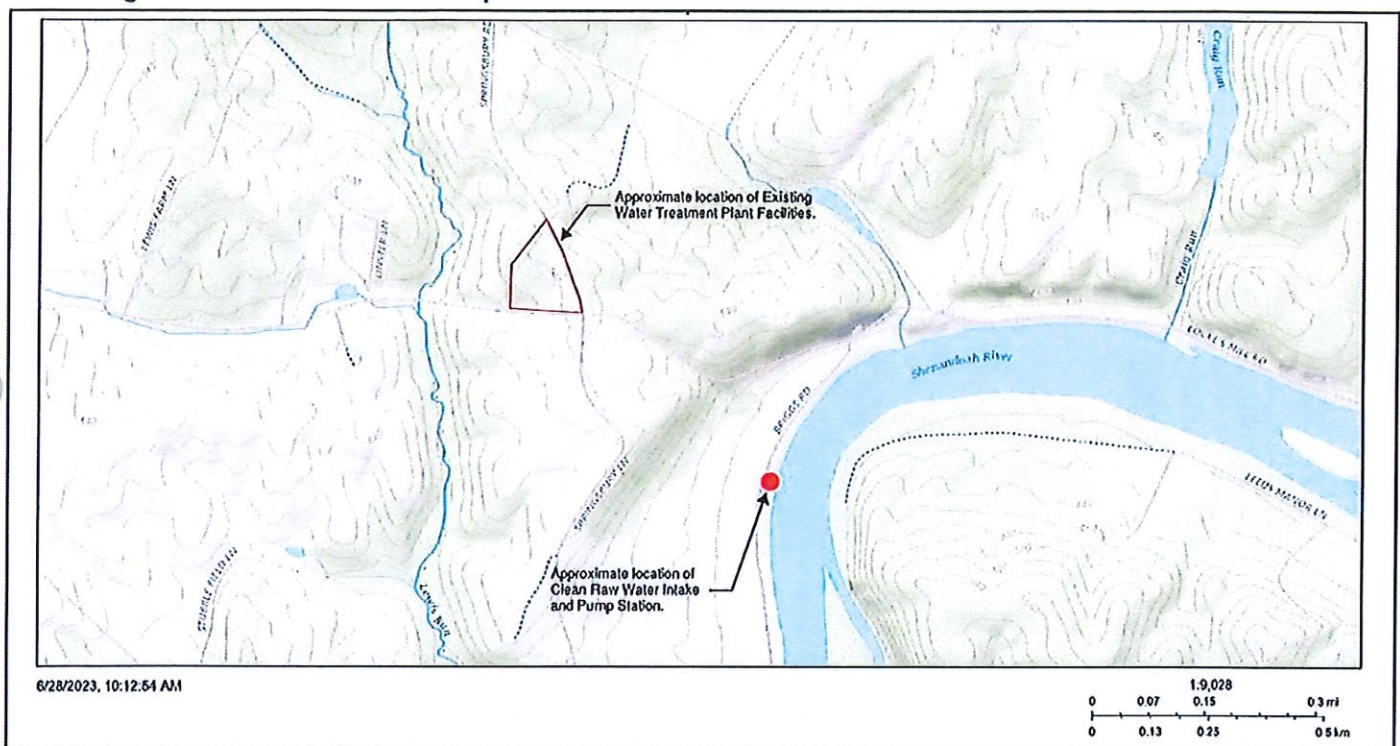
Decisions regarding this project have been made by the Berryville Town Council after consulting with Pennoni. The Town Council determined that the water treatment plant should be improved by 2027 in accordance with the 2019 Utility Rate Study. The review of this study and subsequent budget and capital improvement plan determinations have occurred during the course of public meetings. Prior to the approval of the Preliminary Engineering Report the Town Council will engage with the public to seek additional input.

2. EXISTING FACILITIES

2.1 Location Map

The Town of Berryville WTP is located on the northwest corner of Lockes Mill Road (VA. SEC. RTE 618) and Springsbury Road (VA. SEC. RTE 613) with an access drive entrance along Springsbury Road. The general location of the Town of Berryville WTP, raw water intake, and booster pump station are shown in the plan sheets provided within Appendix C of this report. Both historical as-built plans and concept design plans are provided. General site plans for the raw water intake and booster pump station, raw water transmission pipe and the WTP, taken from the original drawings by Gilbert W. Clifford & Associates (GWCA) dated October 1982 and 1983.

Figure 2-1 General Location Map



Sheet 2 of the GWCA plans in Appendix C provides a schematic diagram to illustrate how the unit processes of the original facilities were designed to operate. The present treatment facilities continue to operate as provided in this schematic diagram with the exception that gas chlorinators have been replaced with a sodium hypochlorite tank and chemical feed system for the chlorination step. The sodium hypochlorite tank and feed system are located in a separate utility building that was added to the site east of the Control and Operations Building.

Photographs of the existing facility are included in Appendix B of this report.

2.2 History

The Town of Berryville provides public water and sewer services for the Town residents and businesses. Constructed in 1983, the Town's raw water intake, booster pump station, and the water treatment plant (WTP) were placed outside of the Town limits, but within Clarke County. The raw water for the WTP is surface water sourced from the Shenandoah River. The Berryville Water System provides approximately 1,879 residential and commercial service connections. The average daily water production is 380,000 gallons per day, with a permitted design capacity of 864,000 gallons per day. The Town also owns and maintains three water storage tanks which together provide 3.5 million gallons of water storage.

The existing water intake facilities consist of a screened water intake from the Shenandoah River, a raw water pump station and transmission pipeline to the Pre-Settling Tank at the WTP. The water treatment facilities utilize an in-line rapid mix, followed by flocculation, sedimentation, and mixed media filtration. The residual floc and filtered by-products are removed and settled in the sludge lagoons. The water receives chemical treatment before heading to the clearwell and entering the distribution system via high service pumping.

Figure 2-2 Schematic System Flow Diagram

2.3 Condition of Existing Facilities

The existing WTP and the raw water intake, pumping and transmission were all designed by Clifford & Associates and constructed in the early 1980s. It was state-of-the-art conventional treatment at the time of its construction and has generally served the Town well for 40 years with only minor added improvements. However, many of the process units are now advancing beyond the expected useful life and showing signs of failure and need for rehabilitation or replacement.

2.3.1 Plant Performance

The Town's operational personnel provided copies of the Town's WTP Production Data for the eighteen-year period from 2005 to 2022:

From a review of the Monthly Operating Reports submitted by the Town to the Virginia Department of Health, the treatment process yields excellent results in the overall quality of water to the distribution system. Filtered water turbidities are consistently less than 0.1 NTUs, which is well below the allowed maximum level of 0.3 NTU. Alkalinity is in a range generally between 80 and 150, representing a water that is neither too hard nor too soft. The Town uses a corrosion inhibitor and lead and copper testing is consistently in compliance. Chlorine levels at the high service pumping is generally in an acceptable range between 1.4 and 2.5 mg/L. pH is generally between 7.0 and 7.6. The Town chooses to add fluoride to the water for prevention of tooth decay and maintains a level between 0.55 and 1.00 mg/L.

Turbidity of the clarified water generally varies between 3.0 and 5.0 NTU but some reports show spikes as high as 20 to 25 NTU. From a visual inspection of the treatment units, one end of the tube settler assembly has slipped below the water level in one of the treatment units, most likely from one or more fasteners under the water surface that has failed. This condition would affect the performance of the clarification or sedimentation step and may be a part of the cause of performance spikes. Fortunately the filtration step to-date is compensating for any limitations in the clarification step, but these observations represent an indicator that age of the treatment units is beginning to affect performance, whereby replacement with new units or an alternative membrane process is important.

The Town is also required to meet the federal Disinfection/Disinfection Requirements Rule, which includes quarterly sampling at two locations in the water distribution system analyzed for trihalomethanes and haloacetic acids. An average of the most recent four samples must be averaged for each site and compared to the federal maximum contaminant level. Unfortunately, the Town marginally failed to meet the limit for haloacetic acids in the third quarter of 2022 and the first quarter of 2023, and while samples for trihalomethanes were compliant during this period, results were above 80% of the limit.

The Town initiated an investigation in June 2023 to obtain samples in the water treatment plant and the distribution system to better understand the formation of disinfection by-products (DDBPs) and how to balance and optimize the process to limit their production. DDBPs form from the reaction of chlorine with trace residual organic matter in the treated water. Organic matter is normally harmless in water and is present in nature but form DDBPs when reacting in the water system with chlorine. DDBPs injected in elevated quantities over a lifetime can lead to chronic health concerns. To remove all organic matter from water would be extremely costly, and chlorine is necessary for disinfection of water from viruses, bacteria, and microbial material, therefore the goal is a balanced process to keep DDBPs below harmful ranges while maintaining cost-effective water treatment and adequate disinfection.

2.3.2 Water Treatment Plant Flow

The annual average flows were as follows:

Table 2-1 WTP Flow Summary

Year	Annual Average Water Filtered (MGD)
2013	0.324
2014	0.342
2015	0.339
2016	0.322
2017	0.322
2018	0.403
2019	0.450
2020	0.431
2021	0.466
2022	0.429

Over the ten years (2013-2022) the WTP operated at slightly less than 45% of its operational design capacity, with up and down trends seen month to month reflective of seasonal water usage patterns. Using the most recent five years of data the average water filtered is 0.436 MGD, which bring the WTP to just over 50% of its capacity. Based upon the past five years and a higher end projected population growth of 30% by 2040, the annual average flow projected to be 0.557 MGD or approximately 65% of the design capacity. The most water filtered in a single day was 0.977 MG on October 26, 2018.

2.3.3 Structural Condition Evaluation

2.3.3.1 Raw Water Intake and Pumping Station

The Town owns a single raw water pump station which is contained within an existing 14-foot by 7-foot underground concrete vault. The station houses the pump station controls and other electrical equipment. There is an existing 8-inch pipeline which carries water from the pump station to the WTP and electrical conduit which runs adjacent to the pipeline.

2.3.3.2 Control & Operations Building

The building occupied by the existing pre-engineered package water treatment units, most of the chemical feed equipment, and the high service pumps as well as used for control & operations of the water treatment process is a single-story pre-engineered metal building (PEMB) supported on conventional shallow concrete spread and continuous strip footings with reinforced concrete foundations walls. The structure includes a subterranean reinforced concrete structure for a clearwell and a partial basement used for high-service pumping equipment. The level one slab generally consists of reinforced concrete on grade, and a reinforced concrete flat plate slab over the basement, supported by reinforced concrete basement walls.

The above grade PEMB is a proprietary structural system that consists of a corrugated metal roof deck supported by light-gage cold-formed metal "Z"- shaped purlins supported by non-prismatic wide flange steel girders and columns. Wall panels are supported on several courses of concrete masonry block (CMU) and consist of corrugated metal exterior panels, with horizontal light-gage cold-formed metal "Z"- shaped girts between columns and vertical sag rods. The lateral system of the building consists of moment connections between steel columns and girders creating moment frames, as well as steel rod "X" bracing between columns located in the plane of the wall, opposite the span of the moment frames.

2.3.3.3 Pre-Settling Basin

The existing pre-settling tank is located south of the Control and Operations Building as a separate structure with an open top for receiving the water pumped from the raw water pumping station. The tank structure is a proprietary precast concrete. The base slab consists of a reinforced concrete slab on grade, and walls consist of reinforced precast, watertight concrete wall panels. Wall panels are continuously braced by the base slab with vertical dowels and concrete fillets, with concrete wall stiffener "tees" and the top of the wall is supported by a reinforced precast concrete cap beam. The tank is segmented into two holding zones with a precast wall, stiffeners and cap walk down the center of the tank. Original construction drawings indicate that tank walls were designed to be free standing or could be backfilled. The existing tank was observed to be backfilled full height on the north side of the tank, and freestanding full height on the south side. The tank also includes penetrations in both the concrete base slab and wall panels for pipes and valves.

2.3.3.4 Backwash Storage

Two backwash storage lagoons are located west of the pre-settling basins, each with a synthetic impermeable liner to prevent leaching of the contents from the lagoons into the groundwater. When sludge from the sedimentation zone of the treatment plant or backwash water from the filter zone are discharged, the water enters one of these two lagoons, controlled by the operator by valves, where the wastewater settles to remove particulate matter and suspended solids. Treated water is released from the lagoons and discharged to Lewis Run, a tributary of the Shenandoah River.

2.3.3.5 Clearwell

The clearwell is a reinforced concrete structure located underneath the filter zone of the treatment plant and below the floor slab for the Control & Operations Building. Purified water from the filters are treated with sodium hypochlorite for disinfection and released into the clearwell where the water is stored until it is pumped through high service pumps into the distribution system.

2.3.4 Structural Observations & Findings

2.3.4.1 Raw Water Intake and Pumping Station

The mechanical and electrical equipment, and inside the vault have degraded over time and need to be replaced. The project will include the replacement of all piping, valves, screens, pumps, electrical, grating and hatch within the existing concrete structure. The concrete structure as inspected from the inside was in good condition and will be cleaned, repair any minor concrete defects if found after cleaning, and the inside wall will receive an epoxy coating to preserve the concrete for longer future use. The existing 12-inch pipeline which carries water from the pump station to the WTP is in good condition and is suitable for continued use. The electrical conduit which runs adjacent to the pipeline has reached its useful life cycle and requires full replacement to ensure a reliable electricity transmission to the pump station.

2.3.4.2 Control and Operations Building

During an initial ground level, walk thru site visit, readily observable deficiencies were noted as they pertain to the primary structural systems and cladding systems of the Control and Operations Building. The following observations are considered typical and suitable for preliminary engineering evaluation, and a more thorough condition assessment would be required if building restoration is selected for final design to determine accurate quantities of deficiencies requiring repair.

1. Light-gage, cold-formed metal framing utilized for roof purlins and wall girts were observed to have varying quantities of section loss and surface corruptions. Evidence of previous repairs of cold-formed metal framing was observed on purlins and girts around the building.
2. Metal roof deck was observed and discussed to have several holes and leaks. Roof system was discussed to be original to the building with numerous patches and repairs thru its service life. Insulation was observed to be sagging and falling from the roof deck.
3. Metal wall panels were observed and discussed to have holes and leaks, generally not providing a closed building envelope.
4. Wide flange steel columns and girders were observed to have varying levels of surface corrosion. Column baseplates were observed to be deteriorating.
5. Concrete Masonry (CMU) knee walls around the perimeter of the building were observed to have cracks. Concrete slab on grade was observed to have cracking and spalling in various locations.
6. The slab around the subterranean clearwell was observed to be cracked at re-entrant corners, and it was discussed that the interior surfaces of the clearwell walls were spalling.
7. Interior and exterior stairs were observed to have corruptions.
8. Concrete loading dock was observed to have cracks and spalls.
9. The structure is a minimally conditioned space, with temperatures kept just above freezing in the winter and no cooling in the summer. Operation of open top treatment tanks within the building result in higher-than-normal relative humidity and minimal ventilation was noted while on site.

2.3.4.3 Pre-settling Basin

1. The Pre-Settling Basin was in use at the time of our first visit. Our second visit the Town was cleaning the basin and we were able to observe the condition of the interior walls and base slab. The walls showed significant deterioration and spalling particular around the water surface elevation. The base slab of the basin had no concrete spalling and no significant cracks that were apparent during the cleaning. The tank has been repaired at some time between the walls and the base slab to prevent the basin from leaking, the repairs still appear to be in good condition.
2. The north walls of the tank were observed to be backfilled the full height and only the cap beam could be observed. The south walls were almost fully exposed (freestanding) and the exterior surfaces could be observed. The east and west walls were partially observable along their lengths from fully exposed to fully backfilled. In general, it was observed that the wall panels have been previously patched at the joints between panels as well as numerous vertical cracks were observed. Vertical and diagonal cracking was observed at the corners of the tanks and active water leaks thru the wall panels were observed around the exterior to the tank indicating the watertight joints are deteriorating.
3. The cap beams and cap walkway were observed to have weather roughened surfaces, cracks and spalls.
4. It was discussed that the valves located in the base slab of the tank were deteriorated and inoperable.

2.3.4.4 Sludge and Backwash Lagoons

The sludge and backwash could not be removed from active surface during the plant inspection and evaluation but were inspected visually from the surface. The lagoons are performing well in removing solids from the sludge and backwash water, releasing clean effluent to the river. There were no visible signs that the lagoons liners had failed as the water level is maintained. Some surface cracking typical of liners with long exposure to the sun and other elements were forming in early stages. The project will include replacement of the liners. An allowance is also provided in the cost estimate for minor latent defects that are presently unknown but may be observed when the liners are removed.

2.3.4.5 Backwash Storage & Clearwell

The exterior of the concrete structure was visually inspected by a structural engineer above the ground level, and an access hatch was opened and a visual inspection of the interior walls above the water line were observed. The observed surfaces are in good condition, the interior walls showed minor concrete defects typical of reinforced concrete clearwells from gases that escape from the chlorination process. Treated water was being stored in the clearwell during the inspection as required to maintain the operation of the water treatment plant.

The project will include the construction of a second clearwell under the Building Addition. Once the new clearwell is in service, the existing clearwell will be taken out-of-service and dewatered. Interior walls will be epoxy coated to restore to near new condition. An allowance will be included in the cost estimate for any unknown latent defects that may be observed once the clearwell is drained.

2.4 Financial Status of Any Existing Facilities

The Town of Berryville owns and provides both water and sewer service to its residents and provides a separate Enterprise Water Fund and separate Sewer Fund for these services whereby expenses are sustained by revenues derived from user charges. For the fiscal year ending June 30, 2023, the Town budgeted \$2,021,000 in Water Fund revenues from user fees, miscellaneous charges, and \$200,000 from prior Fund Balance. The Town budgeted expenses of \$2,021,000, of which \$1,236,550 represents operating expenses, and \$747,353 represents capital improvements to the system, and \$37,097 represents contingency. The Town presents has General Fund and Sewer Fund debt service but no Water Fund debt. The Town of Berryville plans capital needs for the management of its water system assets through its annual budgetary process. The Town recently confirmed with the Virginia Resources Authority that no covenants associated with existing General Fund and Sewer Fund Debt would prevent the Town from obtaining new debt for this project that could not be on parity with existing debt.

Of the \$1,236,550 for operating and maintenance expenses, \$709,000 was budgeted for allocated salaries and employee benefits, and energy costs were budgeted at \$74,000. Energy costs favorably represented 6% of total operating and maintenance expenses.

The Town retains a Certified Public Accountant to prepare an independent annual audit as required by Virginia law. Appendix F of this report provides a copy of the most recent Audit for the fiscal year ending June 30, 2022. A review of Page 18 of the Audit shows a Net Position for the Water Fund totaling \$6,195,597 (as of June 30, 2022) of which \$4,973,670 is unrestricted with the remainder restricted to investment in capital assets. It is best accounting practice to maintain in liquidity assets at least 60 days of operating expenses and 100% to 120% of a full year of debt service for the event of an emergency. Based on this practice of minimum of \$206,090 in available liquidity would be required; the Town's available assets significantly exceed this minimum.

Of the \$4,973,670 reported by the auditor as unrestricted cash reserves, the Town Council has self-encumbered \$2,200,000 for this project to renew and rehabilitate the raw water supply and treatment facilities.

Appendix F also includes a copy of the current water rate schedules, and a copy of the Town's adopted budget for Fiscal Year 2022-2023. Line items 501-4012222-5110 and 501-4012222-5120 within the budgeted operation and maintenance expenses provide a breakout for energy costs.

Further, Appendix F provides a table summarizing the number of water accounts by customer class and the water use of each class for the 12 months of calendar year 2022.

2.5 Water/Energy Waste Audits

No energy or waste audit has been conducted as a part of this project and no known audit information was available at the time this report was prepared.

3. NEED FOR THE PROJECT

3.1 Health, Sanitation and Security

The Virginia Department of Health (VDH) maintains regulations governing drinking water supply treatment systems in accordance with state and federal law, to include the issuance of Operations Permits regulating the quality of drinking water supplied to businesses and homes. This quality is essential to the public health. The Virginia Department of Environmental Quality (DEQ) maintains regulations regarding the consumptive withdrawal of water from rivers and streams as well as wastewater discharges to streams for the protection of aquatic life and the sanitation and security of the environment. When deficiencies exist resulting in violation of regulations or permits, agencies may issue a Notice of Violation and take other authorized enforcement actions.

Except for the federal Disinfection/Disinfection Byproducts Rule authorized by the Safe Drinking Water Act, the Town of Berryville has been able to maintain compliance with all Health, Sanitation and Security requirements with respect to its drinking water systems operations, even as equipment is showing advanced signs of wear and degradation commonly associated with aging infrastructure.

Although in today's regulations DEQ will require any person desiring to withdraw water from the waters of the state for drinking and other consumptive purposes to obtain a Virginia Water Protection Permit (VWPP), the Town of Berryville is exempt from such requirement as long as the Town operates and maintains but does not modify its existing intake within its existing capacity, as the construction of this intake precedes the adoption of regulations requiring the VWPP. The objectives of this Project include the continued operation and maintenance of this intake, limited to the purpose of its original construction and limited to a capacity of 864,000 gallons per day, therefore no VWPP is being sought for this Project.

The Town's purpose further desires to retain the existing capacity for raw water pumping and transmission, treatment and distribution of drinking water, although some of the means and methods may be modified to design for long-term compliance with current regulations and anticipation of future regulations, as outlined in Alternatives 4 and 5 discussed in Chapter 4 of this report. Approval and authorization to construct this Project will be sought from the Virginia Department of Health before any construction begins, providing the opportunity for modification or reissuance of the Waterworks Operating Permit to the extent needed.

As a part of his report, Monthly Operating Reports the Town has submitted to VDH from 2005 through 2022 were reviewed. With the exception of the recent exceedances in haloacetic acids (HAAs) more fully described in Chapter 2, the plan has demonstrated the capability to maintain compliance with all regulatory requirements.

In order to provide more robust treatment of organics in the source water for control of HAAs, and to renew the aging infrastructure that otherwise would eventually lead to failures that could adversely affect public health, this Project has been determined as necessary and essential for Health, Sanitation and Security.

3.2 Aging Infrastructure

Water treatment facilities include many different elements operating as a system, to include concrete water bearing structures, piping, pumps and other mechanical equipment, electrical equipment, wiring and conduit, and communications and control system. With proper operation and maintenance, concrete structures and piping can serve a useful life of 50 years or longer, but mechanical and electrical equipment generally have a useful life of about 20 years and control and communications system have a reliability less than 20 years. The facilities at the Berryville Water Treatment Facility, including mechanical and electrical equipment are reaching 40 years old and many components have survived well beyond their useful life. Structural evaluations and other observations were included in the preparation of this report as described further in Chapter 2, resulting in a finding that there is a current need for a project to provide for the renewal of the raw water supply and water treatment facilities owned by the Town of Berryville.

3.3 Reasonable Growth

Section 1.4 of this Report summarized the evaluation of historical growth data for the Town of Berryville and Clarke County, the forecasted future growth for Clarke County as represented by two independent and widely respected research agencies, and the representation of likely growth in the Town of Berryville by comparison to Clarke County. It was concluded that this project should plan for population growth within the Town of Berryville of between 20% and 30% over the next 30 years.

From the range of forecasted population growth, this report assumed the Town should plan for an increase in customer water demand of 25% over the next 30 years.

The current Berryville Water Treatment Plant has a capacity to produce 0.864 million gallons per day according to the Town's water supply permit obtained from the Virginia Department of Health (VDH). Based upon an evaluation of the data from monthly operating reports prepared by the Town over a five-year period between 2018 through 2022, the average daily quantity of water treated was 0.436 MGD, or about 50% of the total treatment capacity.

It is water industry accepted practice that a potable water system should have sufficient treatment capacity to deliver a quantity sufficient to meet the highest single day demand averaged over a 24-hour period, defined in the industry as the Maximum Day Demand. According to this practice, higher instantaneous peak demands within the Maximum Day rely upon stored water in the distribution system, with any volume consumed from storage replenished by the end of the day. Because the monthly operating reports provide the measured quantity of water treated on a daily basis, one means of searching for the Maximum Day Demand is through the review of the quantity treated each day of a calendar year seeking the highest day treated volume.

Table 3-1 summarizes measured treated water quantity for each of five years between 2018 and 2022, expressed both in terms of the average daily volume for the year and the maximum day. The data suggests that the maximum day production in 2018 (0.977 MGD) and 2021 (0.889 MGD) exceeded the VDH-rated capacity of the existing plant, and the maximum day production was at least 93% of the rated capacity in each of the five years. This data would suggest on the surface that the Town needs to expand its water treatment capacity. However, a closer look at the data reveals that the Town does not operate its water plant every day. In most weeks the plant will shut down at least one day (on a weekend or holiday) and when customer demand is low enough. Some shutdowns are extended for two consecutive days. This operating schedule can be maintained because the Town has a significant volume of distribution system storage for the size of its customer base, allowing it to operate the plant in excess of system demand to fill storage, then rely upon storage to meet system demands while the plant is in shutdown. As a result, the

reported highest single day treated volume does not accurately reflect the Maximum Day Demand of the customer base. This report uses a 7-Day Running Average of Water Production as a means to estimate the ratio of Maximum Day Demand to Average Day Demand.

Table 3-1 Water Production Summary 2018-2022

Year	Average Annual Water Production (MGD)	Maximum Day Water Production (MGD)	Maximum 7-Day Running Average Water Production (MGD)
2018	0.403	0.977	0.690
2019	0.450	0.819	0.689
2020	0.431	0.808	0.569
2021	0.466	0.889	0.521
2022	0.429	0.804	0.662

Table 3.1 also shows the average annual daily water production, maximum single day water production, and the highest seven-day running average. The highest running average for each of the five years varied from 0.521 MGD in 2021 to 0.690 MGD in 2018. The highest seven-day production average for the five-year period (0.690 MGD) represents 80% of the water plant's rate production capacity, and further represents a ratio of 1.6 times the average day production of the five-year period. The 1.6 ratio is within the typical range of Maximum Day Demand/Average Day Demand ratios seen across the industry.

Using a demand growth rate of 25% over the next 30 years and a Maximum Day/Average Day ratio of 1.6, Table 3-2 illustrates that the Berryville Water Treatment Plant presently has adequate capacity to meet the forecasted 30-year (Year 2053) Maximum Day Demand.

Table 3-2 Forecasted Water System Maximum Day Demand Growth

Year	Lower End Population Forecast	Higher End Population Forecast
2020	4,534	4,534
2030	4,830	4,950
2040	5,140	5,410
2050	5,470	5,910

This forecast suggests that the current water treatment plant capacity (0.864 MGD) is adequate for the next thirty years but may require a water treatment capacity expansion to meet demand beyond 30 years. Inasmuch as the current project to renew the water treatment plant facilities will be designed for a useful life of 30 years, it is concluded that the design capacity for the current renewal project may retain the same capacity (0.864 MGD) as the existing facilities.

4. ALTERNATIVES CONSIDERED

4.1 Alternative No. 1 – No Action

4.1.1 Description

This alternative involves continuing to operate the existing Berryville water treatment plant and Berryville intake and pumping station without further improvements or rehabilitation. This alternative is not recommended for serious consideration. As described in detail in Chapter 2 of this report, most of the systems are already serving beyond the intended service life and showing significant evidence of deterioration that will lead to failure. Continued long-term operation is expected to result in unacceptable loss of service or the failure of necessary treatment processes and will eventually result in a public health crisis. Additionally, the existing treatment facilities will not keep pace with the water treatment requirements due to the age and condition of the chemical feed systems.

4.2 Alternative No. 2 – Purchase Finished Water and Defer Renewal of Raw Water Supply and Treatment Facilities

4.2.1 Description

In developing a project around the need to rehabilitate aging infrastructure, it is worth considering if it is economically feasible to purchase finished water from another community water system, thereby allowing the existing supply and treatment infrastructure to be phased out-of-service. Such an alternative, when feasible, also presents the opportunity for regional cooperation which if implemented successfully is aligned with regulatory interests, particularly within the area of resiliency.

A map of the Town of Berryville and surrounding areas would confirm the Town as the county seat of Clarke County, and the areas of the county surrounding the Town are rural in nature. The County encourages the preservation of these rural assets across most of its land area by encouraging development to occur within the Town or land adjacent to the Town that is planning for future annexation. As a result, the Town operates the largest community water system in Clarke County, with the only other available system being the Clarke County Sanitary Authority. The Authority operates a small community water system south of Berryville to serve 400 accounts within the communities of Boyce, Millwood, and White Post, along with the small commercial uses at the intersection of US Routes 17, 50 and 340. The Authority lacks the capacity to serve the Town of Berryville, and to expand that capacity would require expanded water source, pumping, treatment and transmission that would significantly exceed the scope and cost of renewing and maintaining the Town of Berryville system.

Alternatives toward a regional approach beyond Clarke County would extend toward Frederick Water or the City of Winchester in Frederick County to the west, the City of Charles Town in Jefferson County WV to the north, or the Town of Round Hill in Loudoun County to the east. In all cases such connections would require greater than 15 miles of new transmission main as well as the expansion of supply and treatment capacity within the adjacent systems to meet Berryville's needs. The cost of new transmission alone would exceed the entire costs of the total project alternatives identified in Alternatives 4 and 5.

Collectively, purchasing water from neighboring water suppliers does not represent a cost-effective approach for the Town of Berryville and further lacks substantial non-monetary benefits, and therefore this alternative is not favorably considered in this report.

4.3 Alternative No. 3 – Rehabilitate Package Treatment Facility within Same Location

4.3.1 Description

This alternative would rehabilitate the existing two pre-engineered treatment units within the existing Control and Operations Building at the Berryville Water Treatment Plant, thereby eliminating the need to expand the building as represented in both Alternatives 4 and 5. Under this alternative, repairs to the water supply intake and raw water pumping station, Pre-Settling Basin, and Sludge and Backwash Lagoons may still be accommodated as defined in Alternatives 4 and 5.

The Town's existing water treatment plant is configured so that a single pre-engineered treatment unit can be operated while a second unit is being rehabilitated. To rehabilitate a unit, all existing process equipment within the flocculation, sedimentation and filtration zones would be removed, then the structural steel containment vessel now holding the units in place would be dewatered and carefully inspected. The need for repairs and for protective coatings or lining would be determined. The amount of lead time for completing this work would not be reasonably known before this inspection occurred. Once the repairs and new coatings were completed, new replacement equipment would be installed inside the rehabilitated containment. Once one pre-engineered unit were completed and placed back into service, the same process would need to take place with the second unit.

While this alternative has the attractiveness of a smaller completed footprint, a closer evaluation reveals many risks. An uncertain timeframe leads to the likelihood that the Town could be restricted to one-half its treatment capacity ($0.5 \text{ times } 864,000 \text{ gpd} = 432,000 \text{ gpd}$) for many months. In every month of calendar year 2022, water demands exceeded this capacity on multiple days as well as over a seven-day average at least one time per month, meaning that to make this alternative work would require leasing some additional temporary treatment and storage facilities to provide adequate capacity. Further, this alternative would require heavy construction activities immediately adjacent to active treatment facilities. In spite of the care and protective measures that may be taken, the risk of an accident or mishap that would interrupt treatment operations in such close proximity to construction at some time during the many months of rehabilitative construction is too great.

Another means of implementing this alternative would be to lease sufficient trailer-mounted treatment facilities to allow both existing pre-engineered units to be removed from service at the same time. While this step could shorten the construction time, the need for many temporary connections to chemical and electrical facilities and the limited footprint of the existing site to accommodate temporary facilities and construction activities at the same time would be very difficult and not without its own considerable risks.

After considering all of the risks with this alternative and recognizing that measures to protect against the risks of combining operations with construction activities in very close proximity will significantly increase the costs of this alternative, Pennoni has concluded that this alternative should be eliminated from further consideration.

4.4 Alternative No. 4 – Install New Conventional (“Mixed Media”) Treatment Facilities

4.4.1 Description

This alternative includes the installation of two pre-engineered treatment units based upon the Microfloc Trident or an approved equal. These units are similar in mass, scale, and overall operation to the two existing treatment units currently in operation. The new treatment units use a high rate upflow adsorption clarifier followed by a mixed media gravity filter. Each unit must be rated for at least 300 gallons per minute (gpm). The basis of design for this proposed equipment is 600 gpm or 864,000 gallons per day (gpd).

The new units would be housed in an addition to the existing Control and Operations Building on the west side of the existing building. The new building addition would include new chemical feed systems for chemicals similar to those currently in use at the plant, as the general operation of the plant would remain substantially the same, but with working automation systems and controls. A new electrical room will also be in the building addition to provide switchgear and other controls for all plant equipment.

The new treatment equipment would include motor operated valves, walkways, PLC control and integration into a SCADA system, and an air scour system for an air-assisted clarifier and filter backwashing. The configuration would be relatively similar to the existing treatment plant.

In addition to the treatment equipment, other aspects of the raw water pumping and water treatment facility will be rehabilitated or replaced and are applicable to both Alternatives 4 and 5. A brief summary of these improvements is outlined below:

- All raw water pumps and piping within the raw water pump station vault will be replaced. A temporary by-pass will be established to maintain water pumping to the water treatment facility during the installation, estimated to be one month. During design variable frequency drives will be considered to operate the raw water pumps.
- A new air compressor and control system in the Control and Operations Building will be provided to automatically backwash intake screens, with a new 2-inch diameter compressed air line within the raw water transmission right-of-way to the raw water pump station.
- A new pre-settling basin adjacent to the existing unit to receive raw water for oxidation with potassium or sodium permanganate and preliminary sedimentation, with new transfer pumping carry water to the treatment units in the Control and Operations Building addition. After start-up of new tanks, the existing tanks will be demolished to provide an area for parking or chemical delivery truck turnaround.
- New building addition as shown on Concept Plan in Appendix C. Further translucent paneling will be added in association with both the building addition and the rehabilitation of the outer structure and roof for the existing building, in order to add natural light within the building while maintaining an adequate insulation R-value for energy efficiency.
- New chemical storage and feed facilities with SCADA-operated controls in the new addition. Actual chemicals stored will depend upon the selection of Alternative 4 or 5 to provide the specific chemicals needed for the selected water treatment process. Space will be retained for the potential for future orthophosphate or polyphosphate feed to the finished water for corrosion control.
- New clearwell will be constructed and after being placed in service the existing clearwell will be drained and rehabilitated. The completed project will have two interconnected clearwells with added water storage.

- A new electrical room and new electrical equipment will be furnished, along with a new SCADA system for operator monitored automated control of the water treatment process. New electrical conductors will be installed in the raw water transmission line right-of-way to carry power to the raw water pumps, controlled from the water treatment plant.
- Backwash and sludge lagoons will be inspected and repaired as necessary and may include new lining systems.
- Perimeter fencing will be modified to provide a new sliding gate for the entrance to the facility which can be controlled by the operator from inside the plant site. Further additional space within the perimeter will be provided for construction staging and retained for Town use after construction. All site work design will pay close attention to permeable vs. non-permeable surfaces, in an attempt to minimize project effects on stormwater quantity and quality.
- Additional security will be provided to include the use of security cameras at the raw water pumping station, water treatment plant, and water plant site entrance.
- The Town already owns two new high service pumps being stored at the wastewater treatment plant and the Town proposes to install the new pumps during the preliminary design stage of this project. This project will include a new surge relief valve in an underground vault on the existing high service transmission main just north of the Control & Operations building; isolation valves will also be installed on the high service line and a surge relief line will carry treated water back to the clearwell should a surge condition occur.
- A new sodium hypochlorite storage and feed system will be a part of the chemical feed systems installed in the building addition, allowing the small building on the east side of the Control and Operations Building to be removed.

A proposed Site Plan and Building Floor Plan for this alternative is provided in Appendix C of this report. A complete description of the proposed equipment for this alternative is provided in a Basis of Design in Appendix D. A new sodium hypochlorite storage and feed system will be a part of the chemical feed systems installed in the building addition, allowing the small building on the east side of the Control and Operations Building to be removed.

4.4.2 Design Criteria

The criteria for this design includes selection of pre-engineered water treatment equipment to meet or exceed current industry requirements with a similar footprint and operation process to the existing treatment system. The existing system is past its useful service life and is operated in mostly manual mode out of necessity. The proposed parallel treatment units and controls will provide the plant operators with working automation and monitoring for plant operations. This alternative retains similar water treatment chemical feed systems and storage familiar to the operation staff and is expected to generate residuals no greater than the existing units.

Complete design criteria is provided in the Basis of Design in Appendix C of this report.

The building addition can proceed at the same time or immediately after the pre-settling basin, and the new treatment units and equipment installed. Part of the raw water stream can be diverted to the new treatment units and each unit tested prior to decommissioning the existing two treatment units. The selected contractor will identify the means and methods for the diversion and testing; the contract documents shall require that the complete treatment process, including pre-settling, the function of the pre-engineered treatment units, clear well storage and finished water pumping be maintained at all times during construction, except for necessary short duration tie-ins that are approved by the Town.

Once the new treatment units are tested and operational, the existing treatment units will be removed, and the building will be updated and renovated to allow for storage, meeting space, and an allocated area for potential future treatment equipment for emerging contaminants such as PFAS.

Further investigation will be performed during the design phase to identify an appropriate depth of a granular activated carbon (GAC) cap at the top of the filter units for optimal removal of natural organic matter for reduced disinfection byproduct formation after chlorine is added to the treated water. The GAC cap will rest on top of the mixed media.

Physical challenges at this site include sloping topography, remote road access and wooded areas. All the proposed improvements will fit on the existing property, except that additional width of right-of-way may be needed along the transmission line for the installation of buried new electrical conductors and compressed air piping to the raw water pump station. Operational challenges include the logistics of constructing a new facility while maintaining safe operation of the existing facility and processes. A plan will be generated with recommended steps to assure continuity of operations.

Long term maintenance of the proposed facility includes filter replacements approximately every 15 years, and major building maintenance in approximately 25 years.

4.4.3 Map

All improvements under Alternative No. 4 are located within property owned by the Town of Berryville at the site of the WTP as identified on the site plan provided in Appendix C.

4.4.4 Environmental Impacts

A complete Environmental Report was prepared for this alternative pursuant to environmental review requirements of the National Environmental Policy Act and United States Department of Agriculture requirements for use of federal funding.

Delineated wetland areas will be avoided and maintained outside of the Limits of Construction, with the exception of the stabilization of the Shenandoah Riverbank at the Raw Water Pump Station where avoidance is not possible. Further, an historic preservation area on the north end of the Town property will be protected and undisturbed throughout the project. Details are in the Environmental Report included as Section II of this Preliminary Engineering Report.

4.4.5 Land Requirements

Access to the site is via an existing gravel access drive entering from the west side of Springsbury Road. The existing access drive is generally in good condition. Alternatives with consideration of on-site construction should include provisions for improvements to the access drive entrance and parking areas to accommodate service vehicles and delivery trucks. A sight distance evaluation will be performed and minor improvements may be proposed to meet the requirements of the Virginia Department of Transportation for safe entry and exit of truck traffic delivering chemicals and other supplies to the site. It is expected that all work at the treatment plant site will be within land already owned by the Town.

The current raw water transmission line right-of-way includes some sections that are only ten feet wide. The construction effort for replacement of the existing electrical cable and placement of a new compressed air pipe will likely require an additional temporary construction easement and potentially a wider permanent utility easement. The Town is presently pursuing additional right-of-way along this route with the source of funding to be determined; an allowance of \$25,000 is included in the budget for this project toward land requirements for this purpose.

The work within the raw water pumping station vault will be on land owned by the Town. Restoration of the streambank and repairs within the intake structures will require Clean Water Act Section 401 and Section 404 permits but land acquisition is not anticipated.

4.4.6 Potential Construction Problems

No unusual construction problems are anticipated, but there are considerations to plan for mitigation of potential risks. The design effort will review the following considerations.

- General Soil Conditions for Infiltration of Stormwater
- Subsurface Soil Conditions for Bearing Capacity
- Topography and Grading
- Stabilization and Restoration of Disturbed Areas
- Erosion and Sediment Control
- Stormwater Discharge
- Backwash Discharge Control
- Site Access

The water treatment plant site is not within an identified floodplain area and flooding is not a concern for mitigation. The raw water pumping station, intake facilities, and a portion of the raw water line transmission easement are within the floodplain, and no new structures are proposed in these areas that would permanently alter the existing passage for flood waters.

4.4.7 Sustainability Considerations

Resilience and sustainability will be a consideration in all aspects of the project, to include equipment and materials of proven high quality and corrosion and wear resistance, effective operation and maintenance procedures and operator training for enhanced and sustained useful life, and anticipation of future regulations and long-term growth potential (sizing of new facilities) in design of new facilities. Moving mechanical parts in contact with other parts will be selected based on a long service life and wear with proper lubrication.

The plant upgrade will also be designed to allow significant flexibility for operators to adapt to a wide range of varying flow rates and seasonal temperatures.

Sustainability considerations for this alternative include limiting chemical consumption and providing a smaller footprint compared to conventional treatment systems. The design life for this system will be a minimum of 30 years with appropriate maintenance and replacement of expendable items, though many parts of the system are likely to carry a longer life.

4.4.8 Water and Energy Efficiency

Energy costs at the WTP are presently only 6% of total operating expenses. Energy costs will be a consideration in the design of the treatment system and improvements.

Wherever possible, new pumps, motors, blowers, and other mechanical equipment will be designed to operate within optimal energy efficiency ranges, and higher than the efficiency of current equipment. Variable frequency drives will be used where appropriate to efficiently address variations in flow demand. Control systems will provide for automation where appropriate to adjust to actual WTP operating conditions.

4.4.9 Green Infrastructure

The site modification will be designed with considerations for improvements to stormwater management and water quality.

4.4.10 Other

Replacing old equipment with newer, updated, compliant, high-quality equipment and incorporating automated controls where appropriate will provide the Town with an efficient and productive water treatment system with reduced maintenance requirements and significant operation life.

4.4.11 Cost Estimates

The Engineer's Preliminary Opinion of Probable Project Costs for Alternative 4 with a 10% allowance for contingency on construction costs is \$8,956,000. A breakdown of the opinion of cost is in Appendix E of this report.

4.5 Alternative No. 5 – Install New Membrane Treatment Facilities

4.5.1 Description

This alternative includes the installation of two pre-engineered membrane filtration units based upon the Pall Aria AP-4 system or an approved equal. Each unit each utilize 26 hollow fiber membrane modules housed in PVC pipe. Each unit must be rated for at least 300 gallons per minute (gpm). The basis of design for this proposed equipment is 600 gpm or 864,000 gallons per day (gpd).

The new units would be housed in an addition to the existing Control and Operations Building on the west side of the existing building. The new building addition would include new chemical feed systems for chemicals similar to those currently in use at the plant, in addition to several chemicals required for operation and maintenance of the membrane filtration system, including Sodium Hydroxide, Citric Acid, and Sodium Bisulfite.

The new treatment equipment would include automated valves, PLC control and integration into a SCADA system, a compressed air system for membrane maintenance, and a prefiltration system upstream of the membrane system of either pressure filters or cartridge filters to maintain a membrane feed turbidity of approximately 5-50 NTU.

This alternative includes improvements that are in common with Alternative 4, which are stated in Section 4.4 of this report and are repeated below as follows:

- All raw water pumps and piping within the raw water pump station vault will be replaced. A temporary by-pass will be established to maintain water pumping to the water treatment facility during the installation, estimated to be one month. During design variable frequency drives will be considered to operate the raw water pumps.
- A new air compressor and control system in the Control and Operations Building will be provided to automatically backwash intake screens, with a new 2-inch diameter compressed air line within the raw water transmission right-of-way to the raw water pump station.
- A new pre-settling basin adjacent to the existing unit to receive raw water for oxidation with potassium or sodium permanganate and preliminary sedimentation, with new transfer pumping carry water to the treatment units in the Control and Operations Building addition. After start-up of new tanks, the existing tanks will be demolished to provide an area for parking or chemical delivery truck turnaround.

- New building addition as shown on Concept Plan in Appendix C. Further translucent paneling will be added in association with both the building addition and the rehabilitation of the outer structure and roof for the existing building, in order to add natural light within the building while maintaining an adequate insulation R-value for energy efficiency.
- New chemical storage and feed facilities with SCADA-operated controls in the new addition. Actual chemicals stored will depend upon the selection of Alternative 4 or 5 to provide the specific chemicals needed for the selected water treatment process. Space will be retained for the potential for future orthophosphate or polyphosphate feed to the finished water for corrosion control.
- New clearwell will be constructed and after being placed in service the existing clearwell will be drained and rehabilitated. The completed project will have two interconnected clearwells with added water storage.
- A new electrical room and new electrical equipment will be furnished, along with a new SCADA system for operator monitored automated control of the water treatment process. New electrical conductors will be installed in the raw water transmission line right-of-way to carry power to the raw water pumps, controlled from the water treatment plant.
- Backwash and sludge lagoons will be inspected and repaired as necessary and may include new lining systems.
- Perimeter fencing will be modified to provide a new sliding gate for the entrance to the facility which can be controlled by the operator from inside the plant site. Further additional space within the perimeter will be provided for construction staging and retained for Town use after construction. All site work design will pay close attention to permeable vs. non-permeable surfaces, in an attempt to minimize project effects on stormwater quantity and quality.
- Additional security will be provided to include the use of security cameras at the raw water pumping station, water treatment plant, and water plant site entrance.
- The Town already owns two new high service pumps being stored at the wastewater treatment plant and the Town proposes to install the new pumps during the preliminary design stage of this project. This project will include a new surge relief valve in an underground vault on the existing high service transmission main just north of the Control & Operations building; isolation valves will also be installed on the high service line and a surge relief line will carry treated water back to the clearwell should a surge condition occur.
- A new sodium hypochlorite storage and feed system will be a part of the chemical feed systems installed in the building addition, allowing the small building on the east side of the Control and Operations Building to be removed.

A proposed Site Plan and Building Floor Plan for this alternative is provided in Appendix C of this report. A complete description of the proposed equipment for this alternative is provided in a Basis of Design in Appendix D.

4.5.2 Design Criteria

Design Criteria for all improvements included with this Alternative are stated in the Basis of Design, Appendix D of this report.

4.5.3 Map

All improvements under Alternative No. 5 are located within property owned by the Town of Berryville at the site of the WTP as identified on the provided location map in Appendix C.

4.5.4 Environmental Impacts

A complete Environmental Report was prepared for this alternative pursuant to environmental review requirements of the National Environmental Policy Act and United States Department of Agriculture requirements for use of federal funding.

4.5.5 Land Requirements

Access to the site is via an existing paved access drive along state route 613. The existing access drive is generally in good condition. Alternatives with consideration of on-site construction should include provisions for re-pavement of the driveway and parking areas at completion of construction.

Land requirements for work within the raw water transmission easement, raw water pump station, streambank and the intake facility will be the same as described for Alternative 4.

4.5.6 Potential Construction Problems

No unusual construction problems are anticipated, but there are considerations to plan for mitigation of potential risks. The design effort will review the following considerations.

- General Soil Conditions for Infiltration of Stormwater
- Subsurface Soil Conditions for Bearing Capacity
- Topography and Grading
- Stabilization and Restoration of Disturbed Areas
- Erosion and Sediment Control
- Stormwater Discharge
- Backwash Discharge Control
- Site Access

The water treatment plant site is not within an identified floodplain area and flooding is not a concern for mitigation. The raw water pumping station, intake facilities, and a portion of the raw water line transmission easement are within the floodplain, and no new structures are proposed in these areas that would permanently alter the existing passage for flood waters.

4.5.7 Sustainability Considerations

Resilience and sustainability will be a consideration in all aspects of the project, to include equipment and materials of proven high quality and corrosion and wear resistance, effective operation and maintenance procedures and operator training for enhanced and sustained useful life, and anticipation of future regulations and long-term growth potential (sizing of new facilities) in design of new facilities. Moving mechanical parts in contact with other parts will be selected based on a long service life and wear with proper lubrication.

The plant upgrade will also be designed to allow significant flexibility for operators to adapt to a wide range of varying flow rates and seasonal temperatures.

4.5.8 Water and Energy Efficiency

Energy costs at the WTP are presently only 6% of total operating expenses. Energy costs will be a consideration in the design of the treatment system and improvements.

Wherever possible, new pumps, motors, blowers, and other mechanical equipment will be designed to operate within optimal energy efficiency ranges, and higher than the efficiency of current equipment. Variable frequency drives will be used where appropriate to efficiently address variations in flow demand. Control systems will provide for automation where appropriate to adjust to actual WTP operating conditions.

4.5.9 Green Infrastructure

The site modification will be designed with considerations for improvements to stormwater management and water quality.

4.5.10 Other

Replacing old equipment with newer, updated, compliant, high-quality equipment and incorporating automated controls where appropriate will provide the Town with an efficient and productive water treatment system with reduced maintenance requirements and significant operation life.

4.5.11 Cost Estimates

The Engineer's Preliminary Opinion of Probable Total Project Costs for Alternative 5 with a 10% allowance for contingency on construction costs is \$11,146,000. A breakdown of the opinion of cost is in Appendix E of this report.

5. SELECTION OF AN ALTERNATIVE

Chapter 4 of this report identifies five alternatives for the Town of Berryville, of which three were not practicably feasible. The Chapter then describes and analyzes the two technically and legally feasible alternatives (identified as Alternatives 4 and 5) in greater detail. A preliminary opinion of probable total capital project costs was provided for each feasible alternative, and forecasted annual operation and maintenance costs are also prepared for each feasible alternative. A breakdown of the capital costs and O&M costs are in Appendix E.

This section compares the two alternatives for both monetary and non-monetary factors. The monetarily consideration introduces short-lived assets (assets with expected useful lives less than the period of financing for the capital project) as well as life cycle costs for each alternative. The alternatives are also compared in a matrix of nonmonetary factors. The total comparisons from these two analyses form the basis for identifying the single preferred alternative recommended for implementation.

5.1 Short-Lived Assets

The Rural Development guidelines of the United States Department of Agriculture require a table of Short-Lived Assets be developed in the alternatives analysis when agency funding for a project is sought. Short-Lived Assets are those assets that make up the Town's water system that would expect to be reach the end of their service life and require replacement during the term of the financing for the capital project. Funding for the replacement of Short-Lived Assets are then programmed into the financial plan for how the organization will generate sufficient revenues to pay the debt service on the capital loan, annual operation and maintenance costs, and replacement of short-lived assets when they come due for replacement.

The Table of Short-Lived Assets is provided in Appendix E. Included are existing assets that will be retained after the project and are common to both Alternatives 4 and 5, new assets common to Alternatives 4 and 5, and new assets that are specific to either Alternative 4 or 5. Short-lived assets in this report are assets expected to have a useful life of 20 years or less.

5.2 Life Cycle Cost Analysis

The Life Cycle Cost Analysis compares Alternatives 4 and 5 through bringing together the estimated project capital costs, the estimated annual operation and maintenance costs, and the replacement of short-lived assets. The analysis is presented in Appendix E of this report. Each fiscal year is shown beginning with Fiscal Year 2024 through Fiscal Year 2047. Design, land acquisition, permitting, financing, and bidding of the project is expected to occur in Fiscal Years 2024 and 2045 with construction in Fiscal Years 2026 and 2027. Fiscal Year 2047 represents the 20th year after construction is completed. For each fiscal year, the forecasted capital cost, operation and maintenance costs, and replacement of short-lived assets scheduled to occur in that year are shown. Finally, the total annual cost for each year is discounted to present worth, using $i=4\%$ as the assumed time value of money. All costs are represented in current dollars (August 2023) and therefore do not account for inflation.

The Life Cycle Cost Analysis concludes that the present worth of all costs if Alternative 4 were chosen to be \$29.284 million. Similarly, the present worth life cycle cost for Alternative 5 is \$31.225 million.

5.3 Non-Monetary Factors

It is very important that non-monetary factors that reflect important project objectives be considered in the final selection as well as monetary factors. A matrix was developed using the factors chosen for this evaluation as identified and defined below:

- Capital Cost - The one-time capital cost associated with construction and non-construction of the alternative.
- Operation and Maintenance Costs - The cost associated with annual operation and maintenance of the alternative. This category includes the risk associated with the ability of the Town to control or manage future costs.
- Regulatory Compliance - The ability of the alternative to allow the Town to comply with all applicable regulations and permits. This category includes risk associated with the Town's ability to manage and control compliance, and potential liability of failure in compliance.
- Ease of Operation and Control - The ease or difficulty in keeping the water treatment process operating within the boundaries of regulatory limits and local water quality objectives as the quality of the raw water from the Shenandoah River changes due to weather and other environmental factors. This includes the level of training and certification requirements of plant operators to operate the technology provided by the alternative.
- Reliability - The extent of the capability of the alternative to continue to provide the water quality and quantity needs of the community in the event of mechanical failure or other unforeseen emergency condition.

Other important factors considered but not included in this evaluation were land acquisition and social and environmental impacts beyond regulatory compliance. The reason these factors were not included is that they are considered equal for the two alternatives, and therefore not a factor in the selection of a preferred alternative.

Table 5-1 Decision Matrix of Monetary and Non-Monetary Factors in Selecting a Preferred Alternative

Decision Factors	Rating of Factors			Score	
	Alternative 4: Mixed Media Package Units	Alternative 5: Membranes	Weight of Factors	Alternative 4: Mixed Media Package Units	Alternative 5: Membranes
Capital Costs	4	2	4	16	8
Operation & Maintenance Costs	2	3	3	6	9
Regulatory Compliance	3	4	5	15	20
Ease of Operation and Control	2	4	2	4	8
Resiliency	4	5	1	4	5
TOTAL				41	45

For each factor the rating is between one and five for each alternative, where one is least desirable and five is most desirable. Further, all factors are given a weight based on the relative importance of each factor

relative to the other factors in the matrix. Regulatory compliance carries the highest weight reflecting the very high importance of public health. The cost of the project itself and the cost of operating and maintaining the completed project are next in importance, followed by ease of operation and reliability. The matrix is shown in Table 5-1.

As represented in Appendix E, Alternative 4 has a lower capital cost but Alternative 5 has a lower operation and maintenance cost. As reflected in the life-cycle cost analysis, the lower operating and maintenance cost of Alternative 5 does not overcome the time value of money in financing the higher capital cost, and Alternative 4 provides an overall lower cost over time.

Alternative 5 provides better performance across all of the non-monetary factors considered. Membrane treatment should consistently provide a higher rate of removal of natural organics from the water and will therefore provide a higher assurance of consistent regulatory compliance, particularly compliance with the EPA Disinfection and Disinfection Byproducts Rule. Within the industry membranes have been represented over time to remove approximately 35 – 40% more natural organic matter when compared to conventional mixed media filtration and therefore should result in consistent compliance with haloacetic acid regulatory limits.

Membranes also offer better ease of operation and control by providing consistently high treated water quality with less intervention of a plant operator to adjust chemical feed rates by comparison to the coagulation step in the mixed media process.

Finally, the membrane alternative is considered more resilient in that the water treatment is provided through 52 hollow fiber membrane modules, the loss of any one module reducing plant capacity by only 2%. By contrast, a mechanical failure requiring one of only two mixed media package treatment units would result in a loss of 50% of treatment capacity.

Both alternatives are equally capable of meeting the capacity requirements of the Town when fully serviceable, and because the treatment units are inside an addition to the Operation and Control Building of equal size, their impact on the environment is essentially the same. The only land requirements for this project are along the raw water transmission line and are common to both alternatives.

The Decision matrix shown in Table 5-1, considering both monetary and non-monetary factors, provides a total score of 45 to the Membrane Alternative (Alternative 5) ahead of a total score of 41 for the Mixed Media alternative (Alternative 4).

6. RECOMMENDED ALTERNATIVE

Pennoni recommends the selection of Alternative 5 as the preferred alternative. The most important advantage of Alternative 5 is its superior ability to comply with all drinking water regulations, which is a highly important barometer of the Town ability to consistently meet the very important public health goals for the members of the community. As has been summarized in this report, the Town of Berryville has failed to comply with regulatory standards for measured Haloacetic Acids in two separate quarters within the past 18 months. Membranes have been known in the industry to increase the removal of natural organic matter by 35 – 40% when compared to mixed media (current treatment process as well as Alternative 4). Natural organic matter reacts with chlorine in drinking water to form haloacetic acids and other disinfection byproducts.

Although the overall costs of Alternative 5 are higher than Alternative 4, the superior performance in removing natural organic matter is worth the cost. Further, the Town has been engaging in prudent financial planning for several years in anticipation of the need to renew the water treatment plant. Though the current total project cost for Alternative 5 is estimated at \$11.146 million, the May 2019 Utility Rate Study estimated the cost of this project to be \$15.9 million for the purpose of establishing a financial plan and water rates to permit the project's financing. A premise of the rate study was to establish the sound financials including debt service coverage, adequate to obtain a favorable loan to finance the project.

The remainder of this Chapter discusses the plan for implementation of the preferred alternative (Alternative 5).

6.1 Preliminary Design

Preliminary design effort will expand upon the Concept Plan drawings provided in Appendix C and will follow the Basis of Design for Alternative 5 outlined in Appendix D.

The preliminary design will layout the three new replacement pumps and appurtenant equipment to pump raw water from the intake through the existing 8-inch raw water transmission main to the water treatment plant. New buried conduit will be installed in the raw water main right-of-way to carry electrical energy to energize these pumps from starters and controls in the electrical room at the water treatment plant. A new air compressor with controls will be located at the water plant and a new 2-inch pipe will carry compressed air via the raw water transmission right-of-way to the raw water pump station where it will connect to existing air piping to blow against the intake screens to remove debris. New right-of-way adjacent to the 10-foot-wide existing right-of-way will be acquired to accommodate these installations. All other design will be located on property already owned by the Town.

The preliminary design will develop the layout for the installation of two new pre-settling tanks to be installed while the existing tanks remain in operation. Some sediment in the raw water will settle in these tanks and the water will be oxidized with potassium permanganate to oxidize iron or manganese in the raw water. The pre-settling tank location includes new service pumps to transfer raw water to the expanded control and operations building.

The expanded area of the control and operations building will provide a location for a pre-filter followed by a new membrane filter systems capable of handling the rated capacity of the WTP. The expanded area will also house new chemical storage and feed systems and a new electrical room. A new electrical service entrance will be provided, and the current electrical switchgear and generator will be replaced. A one-line diagram of the electrical facilities and a layout drawing will be provided during preliminary design.

A new clearwell will be constructed below the building addition to provide 36,000 gallons of additional treatment water storage. A layout for this new facility will be provided during preliminary design.

A new vault over the finished water line will be designed to house two isolation valves and a surge relief valve, with surge piping to send flow back to the clearwell. Due to the urgency of this need, complete design of this surge relief system will be performed during preliminary design, offering the Town the option of desired to construct it ahead of the other facilities. The Town already owned new high service pumps which will be installed during the design phase.

Once the new addition, new membrane treatment facilities, new chemical storage and feed, and new electrical facilities are in operation and have passed tests for continuous duty, the existing package treatment units and existing chemical storage and feed facilities can be demolished, and the space will be available for other facilities. A temporary layout for this space is provided within the Concept Plan in Appendix C, and during preliminary design the floor plan for this area will be refined in an effort to provide the utilization for this area that is listed in the Basis of Design, to the extent feasible space is available. It is anticipated an architect will become a part of the design team to assist in this effort. A new floor plan for renovation of this space will be the result.

Preliminary design will also provide an initial layout for expanded parking and truck turnaround space, a relocation of perimeter fencing with a sliding gate entrance, and some security will be added to the site. Stormwater treatment is also expected, and any needed detention facilities will be laid out during preliminary design in an area near the backwash lagoons. Depending on the results of the building space floor plan, the septic system may also be expanded.

6.2 Project Schedule

The project schedule is anticipated to continue over the next three years for design and construction.

Table 6-1 Estimated Project Schedule

MILESTONE	TENTATIVE SCHEDULE
Funding Application	October 2023
Design Notice to Proceed	November 2023
Design Kick-off Meeting	November 2023
Evaluation/Planning/Design – 60% Submission	April 2024
Stake Holder Review Meeting	May 2024
Evaluation/Planning/Design – 90% Submission	September 2024
Permitting Submission	September 2024
Stake Holder Review Meeting	October 2024
Permitting Re-Submission	December 2024
Advertisement for Bid	February 2025
Bid Opening	March 2025
Construction Award/Notice to Proceed	June 2025
Construction Substantial Completion	August 2026
Construction Final Completion	October 2026

6.3 Permit Requirements

The Town of Berryville will submit all required permits for the construction of this project. Among those permits it is anticipated that a permit and approval to construct waterworks facilities will be required from the Virginia Department of Health, and stormwater management and erosion control permitting will be required from the Virginia Department of Environmental Quality and/or Clarke County. Nationwide permitting will be required for streambank stabilization near the raw water pump station. An agreement will be required with the Virginia Department of transportation for any modification of the driveway entrance and for the use of highway right-of-way for the new electrical conduits and air piping. Clarke County approval will be required for modifications to the development of the site and for modifications to the septic system.

6.4 Sustainability Consideration

The project will consider sustainability during design and construction for effect use of materials, reuse of existing structure, material sourcing, and monitoring of electric use. The WTP and water system will be reviewed to implement solutions for improved monitoring of raw water intake, treated water production and treated water use. The design will incorporate the rehabilitation of and existing building framing to reduce the steel structural members required for the building construction.

6.5 Water and Energy Efficiency

Rehabilitation and upgrades to the existing WTP will provide water and energy efficiency improvements throughout the treatment process. Wherever possible, new pumps, motors, and other mechanical equipment will be designed to operate within optimal energy efficiency ranges, and higher than the efficiency of current equipment. Variable frequency drives will be used where appropriate to efficiently address variations in flow demand. Control systems will provide for automation where appropriate to adjust to actual plant conditions efficiently. An upgraded digital-based control system will give operators better information at their fingertips for improved process control and management of energy demand.

New chemical storage and feed systems will improve the efficiency as well as the monitoring of chemical use.

6.6 Green Infrastructure

Surrounding woodland disturbance will be minimized during design, and an effort will be made to minimize the quantity of new impervious surfaces. The on-site stormwater runoff will be controlled using appropriate BMPs.

6.7 Other

By replacing old equipment with newer, high-quality equipment and incorporating automated digital controls where appropriate, operator access through vehicular use can be less frequent.

6.8 Total Project Capital Cost Estimate

Pennoni prepared an engineering opinion of probable construction cost for Alternative 5 as referred to in Chapter 4. The estimate is summarized in Table 6-2 on the next page and the complete estimate is included in Appendix E.

Table 6-2 Capital Budget for Preferred Alternative – Membrane Treatment

Description	Project Cost
CONSTRUCTION CAPITAL COSTS	
Mobilization & Demobilization	\$789,400
Existing Raw Water Intake & Pump Station	480,200
Pre-Settling Basin	870,000
Existing Control & Operations Building	993,000
Expansion Control & Operations Building	903,400
Water Treatment Process	2,448,600
Clearwell	645,000
Chemical Feed Systems	425,000
Backwash & Sludge Lagoons	102,600
Electrical Work & Generator	964,600
Other	306,000
CONSTRUCTION SUBTOTAL (August 2023)	\$8,928,000
Construction Contingency (10%)	\$893,000
TOTAL PROBABLE CONSTRUCTION COSTS (August 2023)	\$9,821,000
NON-CONSTRUCTION CAPITAL COSTS	
Land Acquisition	\$25,000
Engineering Design (8% of Total Construction)	786,000
Construction Engineering & Inspection (7% of Total Construction)	687,000
Permitting, Legal, Financing	80,000
NON-CONSTRUCTION SUBTOTAL (August 2023)	\$1,578,000
TOTAL ESTIMATE OF PROBABLE PROJECT CAPITAL COST (August 2023)	\$11,399,000

For the Non-Construction Capital Costs, 10% is used for construction contingency as required by USDA Rural Development requirements for the Preliminary Engineering Report and as also shown in Appendix E. Engineering services are shown as Engineering Design, Construction Administration Services, and Construction Observation (Inspection) Services. Permitting costs provide for permit application fees as well as professional services required to obtain the permits described in the Permitting Requirements section of this report above. Legal Services and Administration and Financing provide costs associated with obtaining the financing for the project, to include bond attorney fees and any underwriting expenses the Town is required to pay.

6.9 Financing Plan - Annual Operating Budget

The Town of Berryville intends to submit this Preliminary Engineering Report as a part of a requirement of VDH for waterworks improvements and may also submit this report as a part of a request to USDA Rural Development for loans for the permanent financing of at least part of the total capital costs of the Water Treatment Plant Improvements project. Appendix F includes a Financing Plan required by USDA for the anticipated period of the loan. The Financing Plan includes multiple scenarios as specifically requested by the USDA as a part of the loan application package.

If USDA financing is accepted, an interim loan from a private financing source will be needed to provide funding for construction not financed by the Town's reserves or financed by other sources (such as VDH). This interim financing is necessary because USDA will not close on the loan and disperse funds until construction has been completed and accepted by USDA. The Financing Plan in the Appendix F assumes the Town will utilize up to \$2,200,000 in held reserves toward the implementation of the project and provide interim financing for any balance less funds, if any, provided by VDH.

6.9.1 Income

Income is shown on the Financing Plan under the heading of "Revenues", which represent the total anticipated revenue to the Water Fund. Total Revenues or Income include annual charges for water use, tap fee revenue, and other revenue. The income projections are based upon existing income, increased by an estimated future system growth rate (new customers) of 0.75% (equivalent to 25% growth in 30 years – See Chapter 2 for growth forecasting) per year, and further changed from anticipated future changes in the water rates. Income from new customers added to the system after 2023 are shown in a separate column for reference. A column entitled "Percent Change in Rates (Composite)" represent an average increase or decrease in water rates and availability fees as a percentage of the prior year rates and are estimated to be needed to finance the payback of the loan, the changes in operating costs associated with the Water Treatment Plant Improvements, and to provide adequate reserves.

This area reserved for further discussion of specific financial scenarios requested by USDA. The scenarios will be defined in discussions with USDA once the Town has authorized pursuing USDA financing.

6.9.2 Annual O&M Costs

Annual Operating and Maintenance Costs have been estimated for the future operation of the Town's raw water pumping and water treatment system based on the completion of the construction of the preferred alternative. The estimate was prepared using current O&M costs as a baseline from the Fiscal Year 2022-23 budget, then identifying changes to annual operating costs associated with the project. Based upon the value of the dollar and market conditions as of August 2023, the annual operation and maintenance costs for the Water Fund are estimated to be \$1,259,500 and reflect a \$13,500 decrease in annual expenses compared to the Mixed Media Alternative (Alternative 4). These costs are summarized in Table 6-3 below and are also detailed in Appendix E.

Table 6-3 Annual Operation & Maintenance Costs for Preferred Alternative – Membrane Treatment

Description	Project Cost
OPERATING & MAINTENANCE COSTS	
Administration	\$346,000
Raw Water Pumping & Water Treatment	484,500
Water Distribution	429,000
TOTAL ESTIMATE OF PROBABLE ANNUAL O&M COSTS FOR ALTERNATIVE 5 (August 2023)	
	\$1,259,500

6.9.3 Debt Repayment

This section of report reserved for summary related to the Financing Plan required by USDA. The Plan cannot be written until the Town authorizes negotiations with USDA whereby USDA will provide the scenarios as well as interest rates to be used in the Plan. It is intended that this section of the PER be written at a future time if USDA funding is sought, or deleted if USDA funds are not sought.

6.9.4 Debt Service Reserve

This section of report reserved for summary related to the Financing Plan required by USDA. The Plan cannot be written until the Town authorizes negotiations with USDA whereby USDA will provide the scenarios as well as interest rates to be used in the Plan. It is intended that this section of the PER be written at a future time if USDA funding is sought, or deleted if USDA funds are not sought.

6.9.5 Short-Lived Asset Reserve

A table showing a replacement schedule for short-lived assets, both for the existing water system and the proposed improvements, has been developed and is found in Appendix E. The values in this replacement schedule for short-lived assets applicable to the Preferred Alternative are carried forward to the Financing Plan also in Appendix F and are represented as an expense in the column of the Financing Plan entitled "Short-Lived Asset Repair/Replace".

The "Minimum Reserves Recommended" column in the Financing Plan is a benchmark upon which the Account Balance is maintained after all estimated expenses are accounted for, including Short-Lived Asset Repair/Replace expenses. Therefore, Short-Lived Assets are fully accounted for as well as all other water expenses in setting the total reserves maintained in the Financing Plan, and it is not necessary or recommended to set up an additional reserve fund specifically for short-lived assets.

7. CONCLUSIONS AND RECOMMENDATIONS

Pennoni recommends the Town of Berryville design and construct a complete renewal of its Raw Water Pumping facilities and Water Treatment Plant facilities as defined in this report as Alternative 5. The project includes in-kind replacement of raw water pumps, improved facilities and control for air burst cleaning of intake screens, new replacement pre-settling tanks, an expanded Operations and Control facility with new membrane water treatment facilities in the new addition along with improved space utilization through renovation in the existing section of the building. The existing building renovation will also include a new roof and badly needed repairs to several structural members.

Pennoni also recommends that the Town seek grants and low interest loan financing opportunities available from the Virginia Department of Health (VDH) and/or the USDA Rural Development program and other available agencies to cover at least a significant portion of the cost of the Water Treatment Plant Improvements project, based upon the plan that is in the best financial interest of the Town's water system customers. If necessary, the Town also has a reserve of \$2,200,000 available that can be used to assist in financing the project. The Town applied for financial assistance through the VDH Financial Capital Assistance Program in May 2023 and is expected to hear the results of such application in September 2023.

The specific terms of a loan will depend upon the selected financing agency.

NOT FOR CONSTRUCTION

NOT FOR CONSTRUCTION



C0002

DATE

APPROVAL

DESIGNER

SCALE

PROJECT

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

NO.

DATE

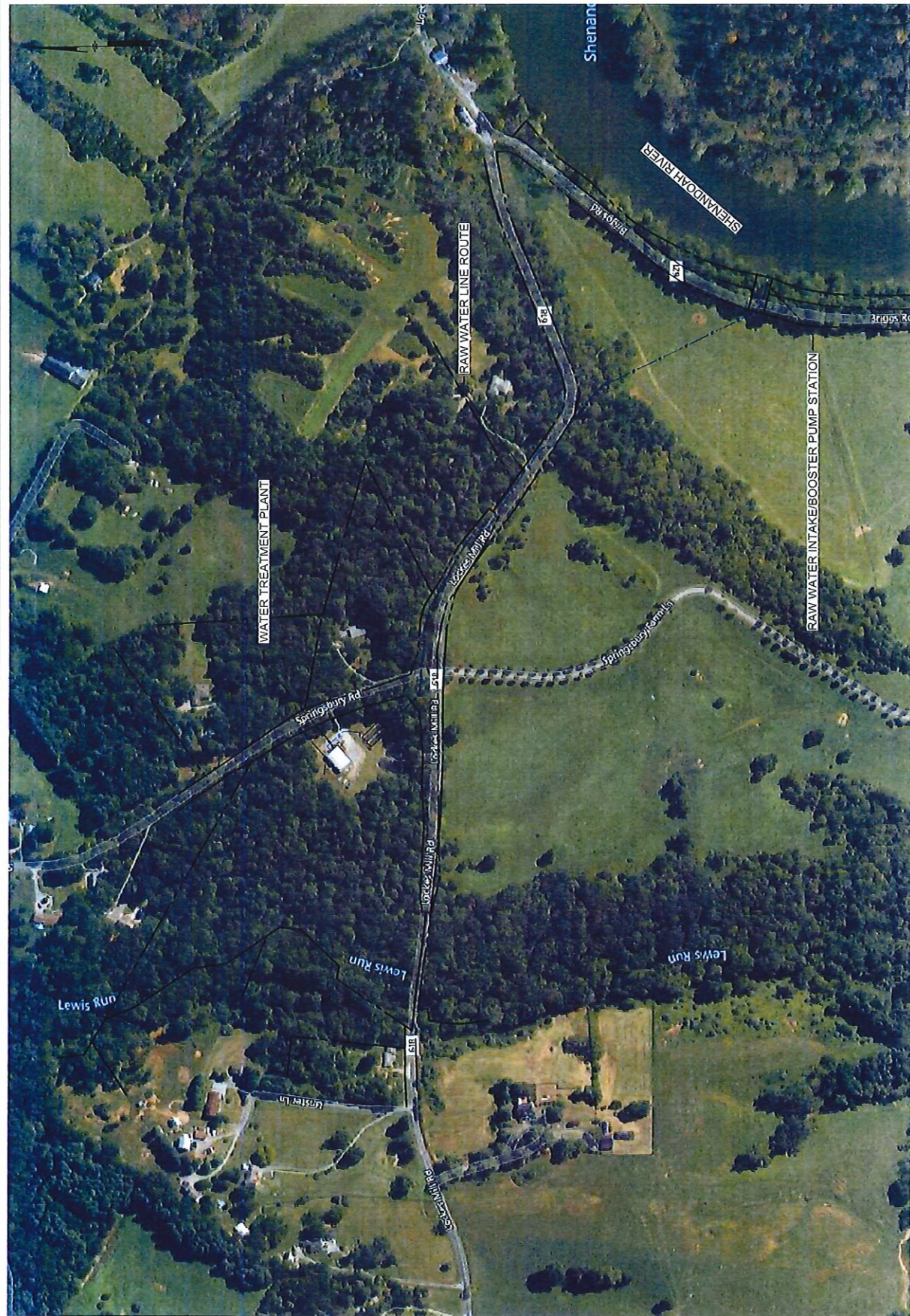
NO.

DATE

NO.

DATE

NO.



Pennoni Associates Inc.
111 East Pocomoke Street
Winchester, VA 22091
T 540.677.2139 F 540.655.0493

ALL DRAWINGS MUST BE VERIFIED BY CONTRACTOR
AND OWNER MUST BE NOTIFIED OF ANY
DISCREPANCIES BEFORE PROCEEDING WITH WORK

BERYVILLE WATER TREATMENT PLANT

2076 SPRINGBURY RD
BERYVILLE VA

LOCATION MAP

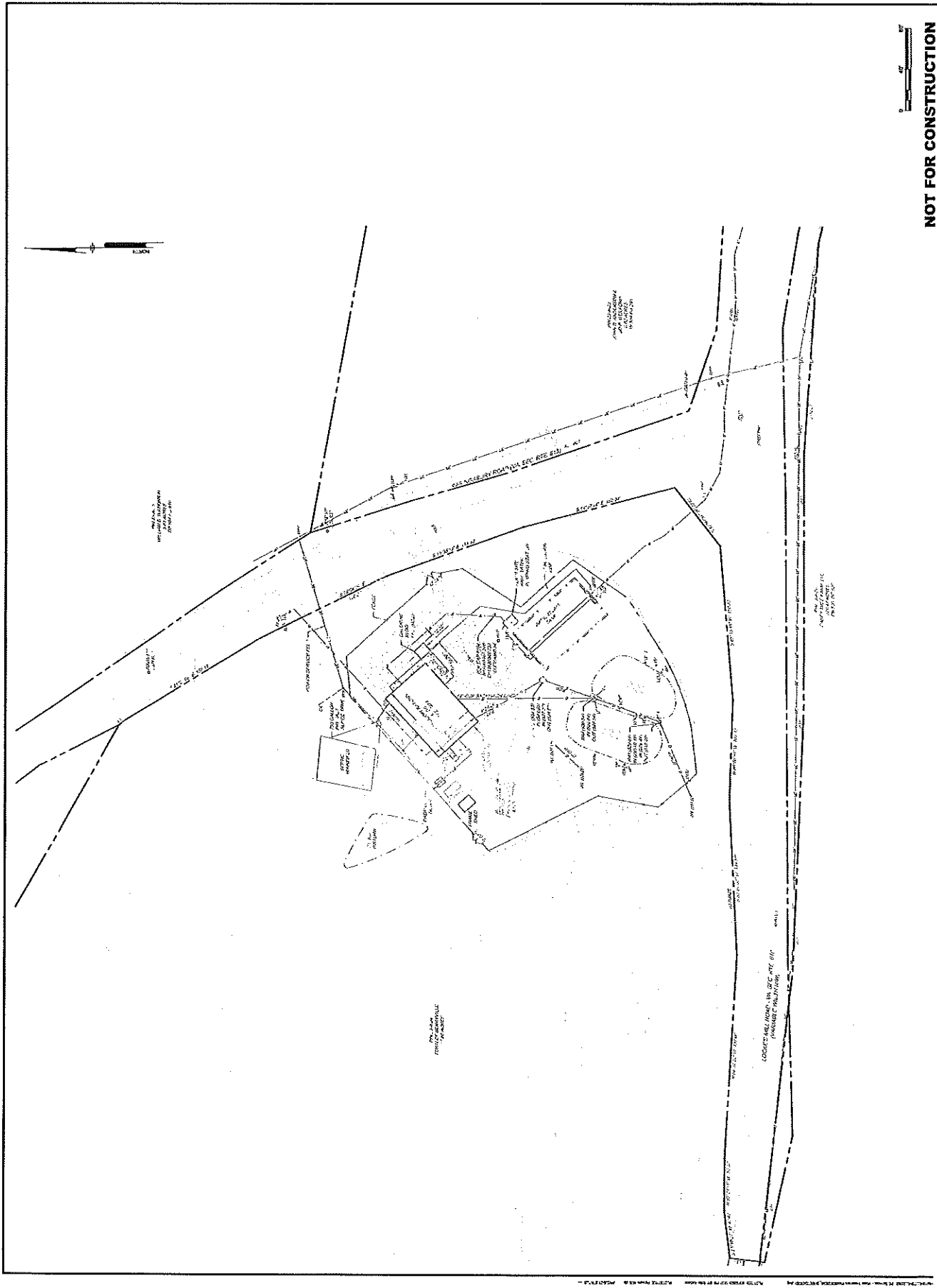
TOWN OF BERYVILLE
101 CHALKERS COUNTRY BLVD A
BERYVILLE VA 22011

[illegible]

able to make. The 1994 survey of 1,200 U.S. physicians found that 60 percent of respondents had used a computer in the last 12 months, and 30 percent had used a computer in the last 6 months. The survey also found that 60 percent of respondents had used a computer in the last 12 months, and 30 percent had used a computer in the last 6 months. The survey also found that 60 percent of respondents had used a computer in the last 12 months, and 30 percent had used a computer in the last 6 months.

BERYVILLE WATER TREATMENT PLANT
2012 APPROVED BY
BERYVILLE, VA
WATER TREATMENT PLANT
EXISTING CONDITIONS
TOWN OF BERYVILLE
151 DOWNS COURT, SUITE A
BERYVILLE, VA 22011

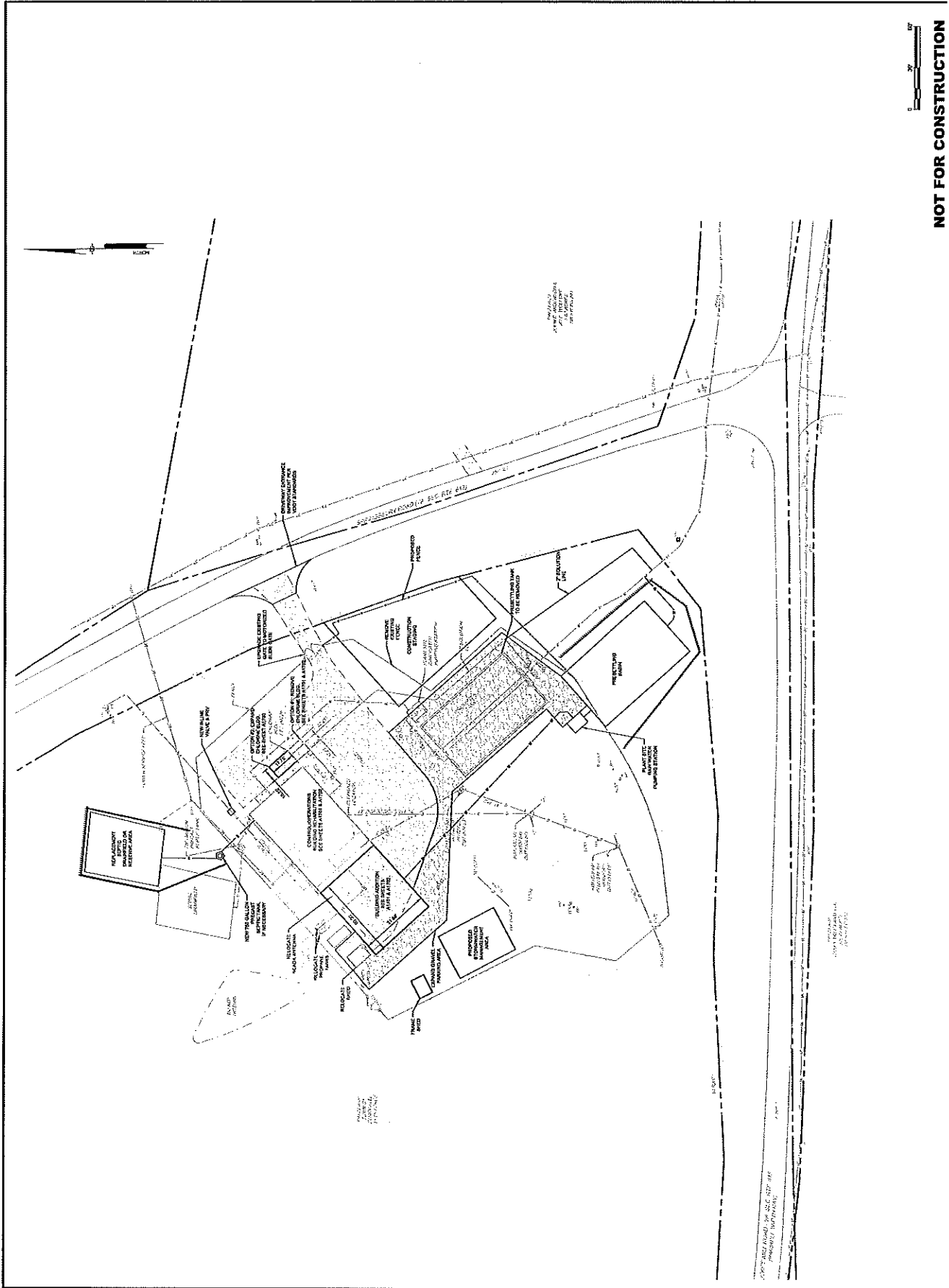
Pennoni
117 East Pocomoke Street
Winchester, VA 22601
T 541.667.2139 F 540.665.0493
PENNONI ASSOCIATES INC.



[illegible]

BERRYVILLE WATER TREATMENT PLANT
2020 SEPTEMBER 03
BERRYVILLE, VA
WATER TREATMENT PLANT CONCEPT PLAN

Pennoni



[illegible]

TOWN OF BERRYVILLE
121 CHATELAIN COURT, SUITE A
BERRYVILLE VA 22811

Pennoni

PENNONI ASSOCIATES INC.
117 East Pecos Street
Winchester, VA 22601
T 540/667-2139 F 540/665-0433



PLAN & ELEVATION LINETYPE LEGEND

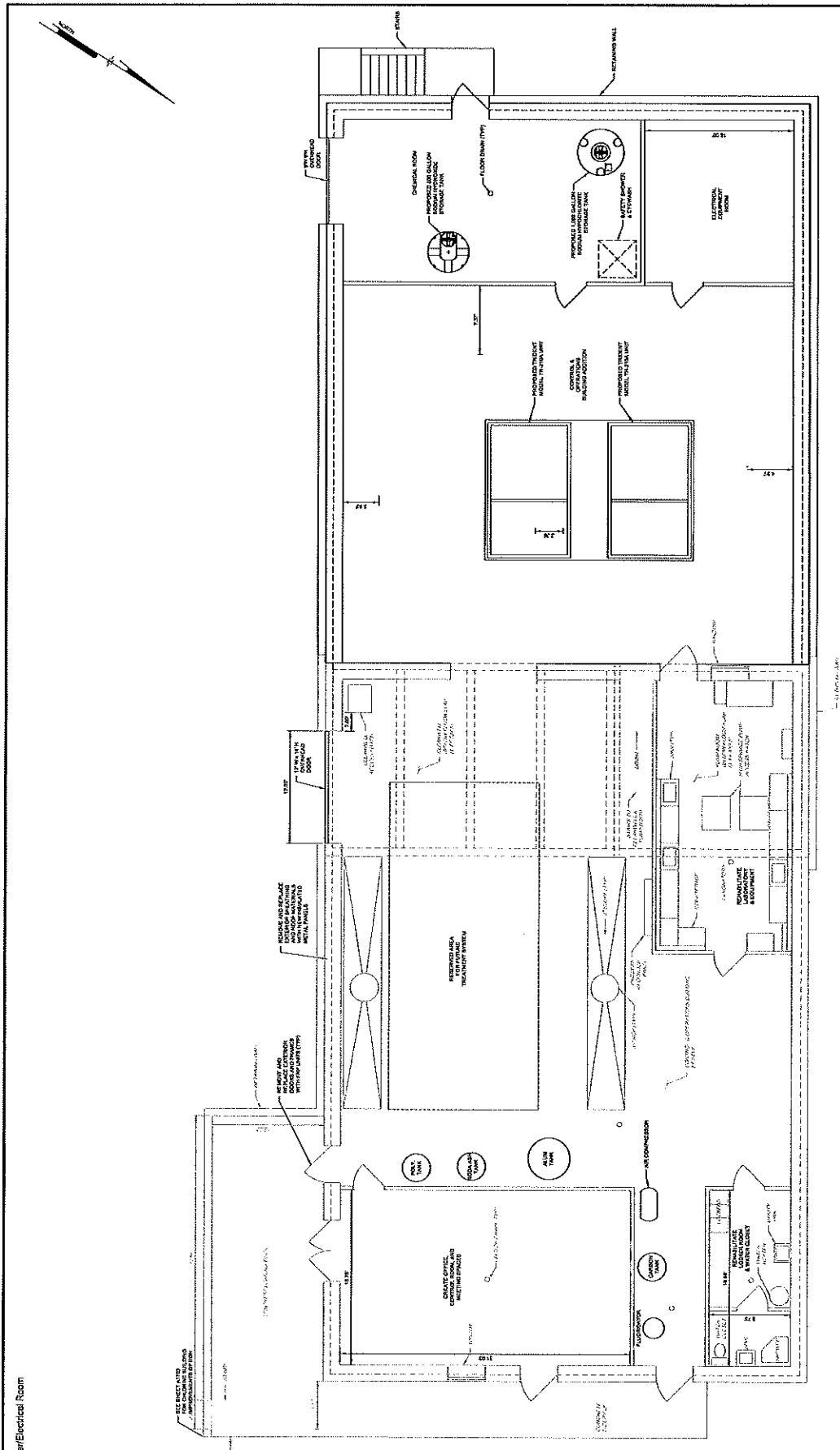
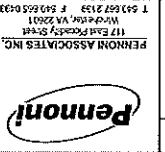
 MAIN
 NOTIONNEL

DATE	2024-01-02
DRAWN BY	CLW
CHECKED BY	CLW
APPROVED BY	
PROJECT	TSVLL220002
SHEET	2024-01-02

REV	NO	DESCRIPTION
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
32		
33		
34		
35		
36		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
47		
48		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		
60		
61		
62		
63		
64		
65		
66		
67		
68		
69		
70		
71		
72		
73		
74		
75		
76		
77		
78		
79		
80		
81		
82		
83		
84		
85		
86		
87		
88		
89		
90		
91		
92		
93		
94		
95		
96		
97		
98		
99		
100		

BERRYVILLE WATER TREATMENT PLANT
CONTROL & OPERATIONS BUILDING FLOOR PLAN
CONCEPT 2
TOWN OF BERRYVILLE
151 CHATELAIN COURT, SUITE A
BERRYVILLE, VA 22011

ALL DIMENSIONS UNLESS OTHERWISE NOTED
AND OWNERS MUST BE NOTIFIED OF ANY
CHANGES BEFORE PROCEEDING WITH WORK
PENNONI ASSOCIATES INC.
117 East Packer Street
Winchester, VA 22091
T 541 687 2139 F 541 655 0433



PLAN & ELEVATION LINETYPE LEGEND

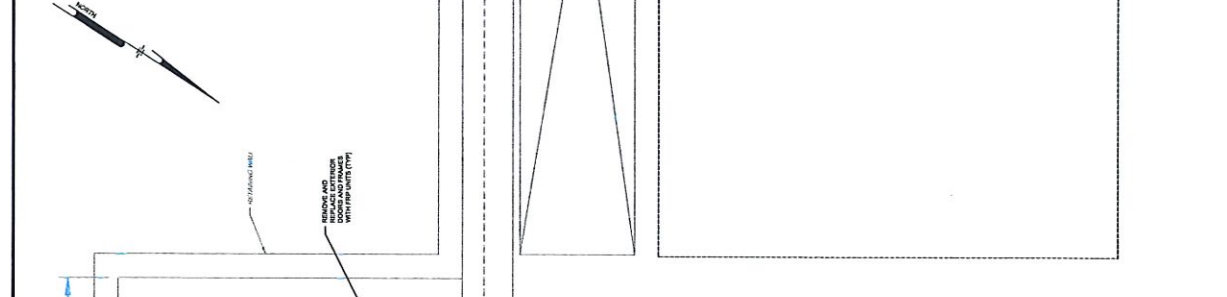
NEW

4
 7
 8

NEW —————

TING —————

© 2000 The McGraw-Hill Companies. All rights reserved. Printed in the United States of America.



BERRYVILLE WATER TREATMENT PLANT

BERNARD, VA



MINUTES
BERRYVILLE TOWN COUNCIL
Berryville-Clarke County Government Center
Work Session
September 07, 2023
4:00 p.m.

Town Council: Present--Harry Lee Arnold, Jr., Mayor; Erecka L. Gibson, Vice Mayor; William Steinmetz; Diane Harrison; Grant Mazzarino; Participating by telephone: Ryan Tibbens.

Staff: Present—Keith Dalton, Town Manager; Christy Dunkle, Community Development Director; Paul Culp, Town Clerk; Jean Petti, Deputy Town Manager

Media: Mickey Powell, *The Winchester Star*

Also present: Tom Frederick and Matt Youngblood of Pennoni Associates.

1. Call to Order

Mayor Arnold called the meeting to order at 4:00 p.m.

Mr. Steinmetz moved that the Council of the Town of Berryville, in accordance with Town Council Policy 2016-01 – Electronic Participation in Meetings from Remote Locations, and in recognition that a quorum of the Council was present in the meeting room, approve Council Member Ryan Tibbens’ participation in this meeting by telephone because of a scheduling conflict. The motion passed by unanimous voice vote.

2. Approval of Agenda

Mayor Arnold invited a motion to approve the agenda.

Vice Mayor Gibson moved to approve the agenda. The motion passed by unanimous voice vote.

3. Unfinished Business

Review of Preliminary Engineering Report—Water Treatment Plant

Mr. Dalton introduced Mr. Frederick and Mr. Youngblood, who were present to brief the Council on the PER and ask questions regarding the future direction of upgrades to the water treatment plant, with an eye to the Council’s approval of the PER, which must then be submitted to regulatory bodies.

Mr. Frederick said that certain financial details would be added later in the event of the need for a USDA grant, and that debt financing had been factored into Pennoni's cost estimates.

Mr. Frederick said the Town's current facility was more than forty years old and that sound operation and maintenance had stretched the use of its mechanical equipment far beyond the usual twenty to thirty years. He then described the forecasting models related to future population and water use, explaining that a 20 to 30 percent increase in use was to be expected during the next thirty years and that current capacity would accommodate 25 percent. Ms. Harrison asked about the effect of new industry, and Mr. Frederick said employment forecasts align with population.

In the arena of structural evaluation, Mr. Frederick said the raw water intake is sufficient, as is the structure of the pumping station, which he said will need new mechanical equipment. He said the pre-setting basin will need replacement, that the control and operations building will need refurbishing and roof replacement, and that the backwash lagoon and clearwell can be repaired as needed.

Mr. Frederick said the PER presents four alternatives: 1) Taking no action; 2) Purchasing finished water and deferring renewal of facilities; 3) Installing new conventional mixed media treatment facilities; and 4) Installation of new membrane treatment facilities. He said numbers one and two are not feasible, while membrane technology, an advanced innovation dating from within the last forty years, had become increasingly feasible because of price reduction.

Mr. Frederick said options four and five had in common certain improvements to be made to Town facilities: cleaning of intake screen; replacing raw water pump equipment and electrical equipment; replacing the pre-setting tank; expanding the control and operations building; repairing the lagoon, clearwell, and septic tank; general site work; an inline valve and surge relief system for treated water; and improving security and environmental protection. He then displayed maps and floor plans, describing proposed construction and explaining the process for estimating the size of needed facilities.

Mr. Frederick then showed the Council a decision matrix of fiscal and non-fiscal factors involved in choosing between mixed media and membranes. He explained that the former would carry lower capital costs, \$9.2 million versus \$11.3 million, while regulatory compliance—which he said is the largest consideration—would favor membranes, as would resilience and ease of operation and control.

The project schedule as described by Mr. Frederick called for application for funding in October of this year, with a completion date in October of 2026.

Mr. Steinmetz asked if the fifteen-year life-span of membranes, mentioned in the PER, is guaranteed.

Mr. Frederick said the life-span depends on the character of the water and the skill of the operator, but that the worst-case scenario is ten years. He added that membranes carry warranties.

Ms. Dunkle asked about possible disruptions of service. Mr. Frederick said the new equipment will be fully tested and capable before the transition from the old, that brief interruptions for pipe adjustments might occur but that the Town has storage to cover six to twelve hours.

Ms. Dunkle and Mr. Youngblood briefly discussed site plan approval by Clarke County.

Mr. Dalton asked about the 2019 utility rate study Pennoni had prepared for the Town and how that study relates to the PER's cost estimates. Mr. Frederick said that in estimating the trajectory of utility fees and charges, the study had allowed for \$13 million as the cost of system upgrades. He said the required loans would be at market rate, and commended the Town on its astute planning.

Mr. Dalton said budget reserves had funded the PER and that he wished to install a pressure relief valve and an inline valve on the transmission line prior to commencement of other construction.

Ms. Harrison asked about water storage towers. Mr. Dalton said the Town would use storage to bridge production interruptions during plant construction.

There was a discussion of the pre-sedimentation basin.

There was a discussion of staffing. Mr. Frederick said membranes would require less on-site and allow for remote operation .

Mr. Youngblood described the isolation of membranes for maintenance.

Mr. Mazzarino and Mr. Frederick discussed water quality, with Mr. Frederick explaining that membranes would remove 30 percent more organics, using fewer chemicals and thereby alleviating problems with haloacetic acid byproducts such as the Town had recently experienced. Mr. Frederick also said that mixed media would waste more water during backwater cleaning than membranes would.

Mr. Dalton asked whether the Virginia Department of Health is favorably disposed toward the use of membranes rather than mixed media, and Mr. Frederick said he was under the impression that this was likely.

Mr. Tibbens asked about the respective life-spans of the two options, and Mr. Frederick said he was not aware of any inherent superiority either way, that care and maintenance are the crucial element in either case.

Mr. Tibbens asked if it would be possible to project the impact on residents' monthly bills of the \$2 million difference between mixed media and membranes. Mr. Frederick said more detailed information would be available after Rural Development provides interest rate information during the loan process. Mr. Tibbens asked whether it would be possible to obtain that information before the Council voted on the matter. Mr. Dalton asked Mr. Frederick whether this would be possible before the regular meeting of the Council five days hence. Mr. Frederick expressed doubt about this,

saying it would be necessary to know the term, rate, and expected utility rates relative to median household income.

Mayor Arnold said that funds had been set aside for the project and that the reduced use of chemicals would be a cost advantage with membranes.

Ms. Harrison said the influx of new residents would increase the funds the Town receives. She said the 2019 rate study had already provided the necessary information on the trajectory of utility billing.

Vice Mayor Gibson clarified that the Town had not raised rates for usage during its five-year program of rate increases, just the administrative fee.

There was a discussion of adjustment for inflation.

Mr. Dalton suggested that a projected completion date of October 2026 might be less realistic than expecting completion at the end of 2026.

4. New Business

None.

5. Other

None.

6. Closed Session

Mr. Mazzarino moved that the Council of the Town of Berryville enter closed session in accordance with §2.2-3711-A-29 of the Code of Virginia, for discussion of the award of a public contract involving the expenditure of public funds. The motion passed by unanimous voice vote.

The Council entered closed session at 5:39 p.m. and returned to open session at 6:11 p.m.

Mr. Steinmetz read the **attached** motion and certification of the closed session.

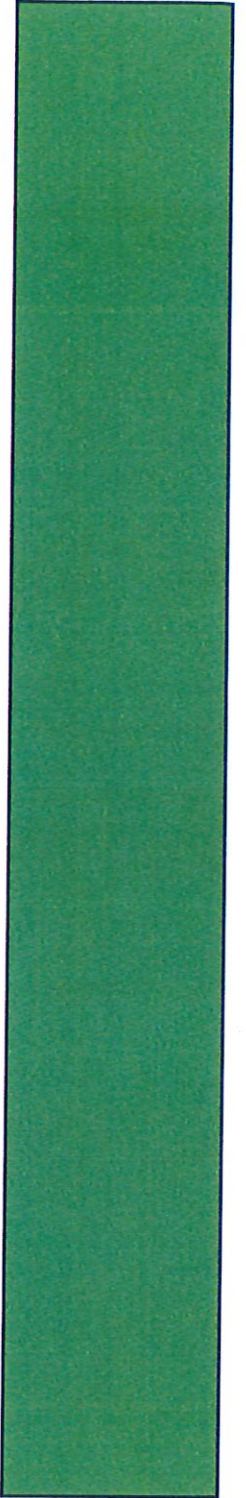
7. Adjourn

Mayor Arnold requested a motion to adjourn.

Vice Mayor Gibson moved to adjourn. The motion passed by consensus at 6:13 p.m.

Erecka L. Gibson, Vice Mayor

Paul Culp, Town Clerk





**TOWN OF
BERRYVILLE
VIRGINIA**

RESOLUTION OF GOVERNING BODY OF THE TOWN OF BERRYVILLE

The governing body of the Town of Berryville, Virginia, consisting of six members, in a duly called meeting held on the 12th day of September, 2023 at which a quorum was present, RESOLVED as follows:

A RESOLUTION: IN SUPPORT OF THE VDOT TRANSPORTATION ALTERNATIVES PROGRAM GRANT FOR ADDITIONAL FUNDING FOR SIDEWALK CONNECTIVITY ON MOSBY BOULEVARD (ID 10285)

WHEREAS the Council of the Town of Berryville ("Council") will be requesting Transportation Alternatives Program grant funding in order to complete sidewalk sections along the north side of Mosby Boulevard between Hancock Court and McNeil Drive; and

WHEREAS Council has identified the need for pedestrian connectivity on Mosby Boulevard to accommodate safe pedestrian access by residents of an existing multi-family development, residents of a single-family development, and students attending Clarke County High School to businesses and services on McNeil Drive; and

WHEREAS Council has committed to provide the 20 percent match and provide for future maintenance and upkeep of the completed project; and

WHEREAS this grant will provide additional funding for the project which was originally approved for a Transportation Alternatives Program grant in 2019;

NOW, THEREFORE, BE IT RESOLVED that the Council of the Town of Berryville, Virginia hereby supports the Transportation Alternatives Program grant application for additional funding for sidewalk sections on Mosby Boulevard.

Passed this 12th day of September, 2023.

TOWN OF BERRYVILLE

Attest: _____ By: Harry Lee Arnold Jr., Mayor

CERTIFICATION

I hereby certify that the above resolution was duly adopted by the Council of the Town of Berryville, in a duly assembled meeting on the 12th day of September, 2023.

Erecka L. Gibson, Vice Mayor

Harry Lee Arnold, Jr.
Mayor

Erecka L. Gibson
Vice Mayor

Council Members

William Steinmetz
Ward 1

Diane Harrison
Ward 2

Grant Mazzarino
Ward 3

Ryan Tibbens
Ward 4

Keith R. Dalton
Town Manager