CITY of HARRISONBURG

Raw Water Supply

Management Plan

December 31, 2015

Revised January 23, 2020

Table of Contents

I. EXECUTIVE SUMMARY SCORECARD:

Harrisonburg's value in this Raw Water Supply Management Plan (RWSMP) is to ensure that the City will have future opportunity to:

- sustain or alter current land use within the current City boundaries
- bring into use the remaining undeveloped land within the current City boundaries
- understand the requirements to sell water to future external markets.

The underlying principle to the RWSMP is to provide a roadmap to a reliable 15.0 MGD raw water supply that will meet an 12.9 MGD average annual water demand. A scorecard of recommendations and the status of progress follows:

VAC Local and Regional Water Supply Plan

Plan Recommendation #1	Status - FY 2019
Maintain compliance with Virginia Administrative Code requirements for a regional and local water supply plan.	✓ 2013: Original "Plan" was adopted by resolution of City Council and approval by DEQ ✓ 2018: Updated "Plan" was reapproved • 2023: "Plan" update and re-approval due

VWWP #16-0730

Plan Recommendation #2	Status - FY 2019
Renew Virginia Water Withdrawal Permit #16-0730 Comply with the requirements of the re-issued permit	✓ 2016 permit was re-issued; expires 2031 • Permit requirements: ✓ Conservation Ordinance adopted ▪ Install aquatic protection screens at all intakes: $4M 2025 CIP ▪ Comply with maximum withdrawals

Dry River

Plan Recommendation #3	Status - FY 2019
• Upgrade 55,000' raw water pipe • Transition 1959 pipe to potable water • Decommission 1929 pipe • Decommission 1898 pipe	✓ 22,000 feet complete • 11,400 feet 2025 CIP: $4.3M • 21,600 feet 2040 CIP: $8.2M

North River

Plan Recommendation #4	Status - FY 2019
• Upgrade Bridgewater Pump Station ▪ Variable output; energy efficient ▪ Retire critical assets ▪ Add power loss response ▪ Model for PDPS & GMPS • 20" Pipe retirement	✓ BWPS Project 100% complete $1.6M • 20" pipe retirement forecast CIP 2040

Silver Lake

Plan Recommendation #5	Status - FY 2019
• Address lease expiration with Dayton • Configure intake for temporary connection • Understand long term need to Silver Lake water	✓ Lease revised and renewed • FY2020 CIP: Intake project • Potential need included in RWSMP pending actual water growth of the City

South Fork Shenandoah River

Plan Recommendation #6	Status - FY 2019
Finalize scope, cost, schedule and completion of the South Fork Shenandoah River Raw Water Project 90,000 feet pipe $37M –	• PD & GM PS……. 2021-2022 • 256.1 ……. 2020-2022 Intake to GMPS • 256.2A …….. 2020-2022 Port Republic Road Corridor • 256.2B …….. 2019-2020 Port Republic Road to ECL ✓ 256.3A-E …….. Complete ECL to WCL ✓ 256.4 ……. Complete WCL to Rt 33 ✓ 256.5 A&B …… Complete WCL to WTP 25,000 feet completed 65,000 feet 2020-2022

II. BACKGROUND:

A strong supporting raw water supply has given the City of Harrisonburg the opportunities to realize its current community, economic, social, cultural, and political status. The City's record for water supply planning has been quite impressive. The Harrisonburg journey began with the use of the "Big Spring" at Court Square in 1779. Appendix A of this document provides a chronology that recovers much of the history of this journey which is an evolution to current status that now brings greatest attention to:

- Under drought conditions: Balancing the reliability of raw water supply versus simultaneously providing environmental stewardship;
- Under normal Operations: Managing the sustainability of assets through lifecycle analysis and through energy use;
- Panning for emergency preparedness under risk.

The table below shows recent history of Harrisonburg's water supply development.

Harrisonburg Raw Water Supply History

Raw Water Source	1990	1995	2000	2010	2019
North River Intake (NRI)	7.6	7.6	5.5	5.5	1.3
Dry River Intake (DRI)	8.3	5.5	0.0	0.0	0.0
South Fork Intake (SFI)	N/A	N/A	8.0	8.0	9.1
Other	N/A	N/A	N/A	N/A	4.6
Total	17.4	14.6	15.0	15.0	15.0

Note: First rights to 1.5 MGD from Silver Lake became available in 2014 and thus eligible as "Other"

1990: HPU emphasized rating NRI to 3 pumps at 7.6 MGD and developing Switzer Reservoir to the DEQ defined drought safe yield of 8.3 MGD.

1995: HPU abandoned Switzer pipeline (due to environmental permitting constraints) for overland flow and recapture concept.

2000: Collectively, HPU

- moved its focus to the Shenandoah River as the future drought and growth source.
- abandoned the Switzer overland flow concept upon completion of in-situ studies with release of 8.3 MGD from Switzer Lake (resulted in recapture of 5.5 MGD at DRI).
- removed DRI as partial drought source; augmentation from Switzer Lake reserves determined to be unacceptable at 132-180 days.
- accepted request not to pursue NRI beyond the scrutiny of a proposed SWMA which recognized 5.5 MGD as the maximum safe environmental withdrawal.

2005: VWWP was issued and SFI intake structure was installed; withdrawal permitted to 8.0 MGD.
2010: VWWP was re-issued with minimal influence to raw water planning strategy.

2016: VWWP re-issued with withdrawal restrictions at SFI (10%+recycle), NRI (12%) and DRI (0.5 MGD bypass).

III. INTRODUCTION TO THE RWSMP:

The RWSMP was drafted in the format of five components:

1) ***Water demand forecasting*** takes focus upon how much usage of potable water will drive required raw water supply.

2) ***Drought supply planning*** addresses water supply reliability with the perspectives of balance of environmental stewardship.

3) ***Optimized operations planning*** forecasts the most probable use of water supply sources against water quality, treatability, electrical energy consumption and cost.

4) ***RISK Management*** provides insight to mitigate "what if" scenarios involving low probability / high consequence events (ie: contamination, power loss, unit failures) that might incapacitate the reliability of one or more water sources.

5) "***Asset Management***" identifies the inventory of assets and their attributes as pertain to operating them effectively and efficiently throughout their life cycle and then retiring them at the most appropriate time.

IV. OVERVIEW OF EXISTING RAW WATER SYSTEM

Virginia Administrative Code (VAC) has incorporated requirements for water purveyors to develop a "Regional and Local Water Supply Plan". This plan is then reviewed and approved by the Department of Environmental Quality (DEQ) to assure that the water purveyor has a grasp of their future demands. In addition, the review requires a sustainable plan for use of available water supply to meet the forecast. . ***Recommendation #1*** of this RWSMP is to maintain compliance with the requirements of VAC.

The principles and recommendations established under VAC have been applied to Harrisonburg within its Virginia Water Withdrawal Permit #16-0730. Highlights of the permit included 1) maximum instream withdrawals at all raw water intakes, 2) requirements for adoption of a conservation ordinance with specific conditions and 3) construction of eco-aquatic protection screens at all intakes. ***Recommendation #2*** of the RWSMP is to retain the permit in an effective status and to become and remain compliant with the requirements of the referenced permit.

The City of Harrisonburg raw water system includes:

Dry River Source

North River Source

Silver Lake Source

South Fork Shenandoah River Source

- Primary source: **Dry River** provides approximately 50% of the annual raw water to the water treatment plant; Appendices B and C provide detailed information; highlighted topics include:

Dry River preferred characteristics

- ✓ Soft and pristine water quality;
- ✓ Full range of delivery from 0.0 to 4.0 MGD;
- ✓ Gravity delivery with zero energy requirements; this source is a key component to energy sustainability;
- ✓ Effective and efficient treatment at the city water plant.

Constraints to use of the Dry River Source include:

- ➢ Water quantity; during times of drought the in-stream flow can approach zero as would be reflective of the "Dry River" nomenclature;
- ➢ The City's raw water system maximum conveyance capacity is currently 4.0 MGD.

- Secondary source, **North River** provides approximately 50% of the annual raw water. Appendix D provides information in detail; highlighted topics include:

North River preferred characteristics

- ✓ Available 7.6 MGD supplement to Dry River

Constraints to use of the North River Source include:

- ➢ Withdrawal quantity during drought will become constrained to 12% of in-stream flow under VWWP 16-0730. In-stream flows are small and variable in the presence of high withdrawal demands;
- ➢ Water quality is subject to detrimental change due to agriculture in combination with the previously stated in stream flow characteristics;
- ➢ Requires power demand and electrical energy consumption. (2,000+kWhrs/MG)

- Inactive source: **Silver Lake;** Appendix D provides details; highlighted topics include.

Silver Lake preferred characteristics

- ✓ Available supply of 1.5 MGD under drought conditions to supplement Dry River and North River sources;
- ✓ Low threat of contamination; appears to be an asset available for risk mitigation upon the loss of other sources;
- ✓ Lower energy usage compared to North River and future Shenandoah River. (1,800+kWhrs/MG)

Constraints to use of Silver Lake:

- ➢ Town of Dayton's reliance on Silver Lake;
- ➢ Quality of water is characterized as groundwater under the influence of surface water and has an elevated level of hardness and algae growth;
- ➢ Higher energy consumption than Dry River; (1,800+kWhrs/MG)
- ➢ Permanent pump station asset is nonfunctional.

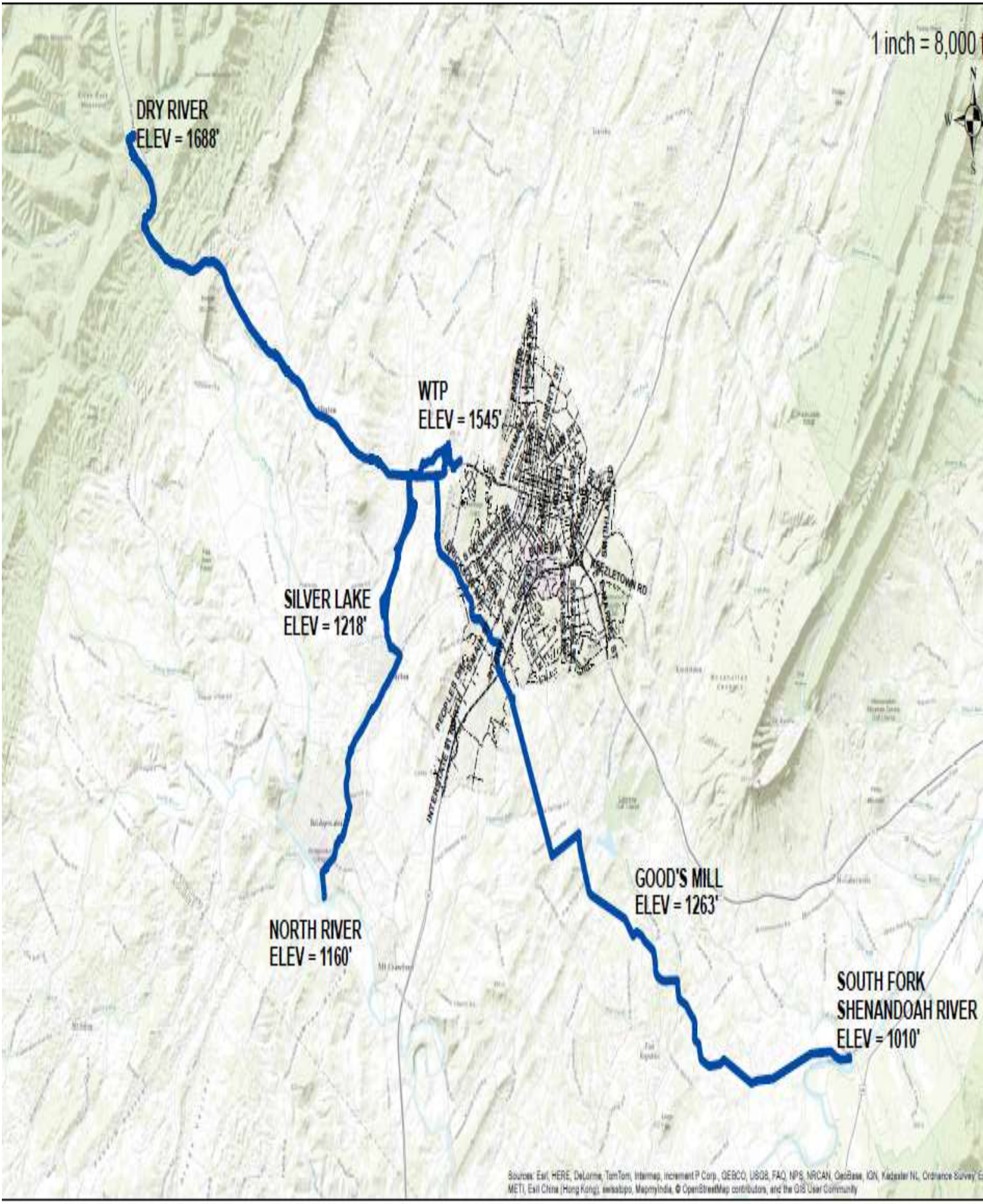
- Future source: **South Fork of the Shenandoah River;** refer to Appendix G for additional information; highlighted topics include:

Shenandoah River preferred characteristics

- ✓ Maximum withdrawal limitations are per VWWP #16-0730 conditions;
- ✓ In stream flow is highest of all sources with the intake located downstream of HRRSA in the lower watershed; best source for aquatic environmental stewardship.

Constraints to use of Shenandoah River:

- ➢ Highest energy consumption of all sources (3,100 + kWhrs /MG)
- ➢ Withdrawal has been permitted at 10% in-stream flow (plus 66% of withdrawal in recognition of the recycle effect through discharge at the HRRSA sewer treatment).
- ➢ Water quality is generally less desirable overall than other sources.


1 inch = 8,000
DRY RIVER
ELEV = 1688'
WTP
ELEV = 1545'
SILVER LAKE
ELEV = 1218'
NORTH RIVER
ELEV = 1160'
GOOD'S MILL
ELEV = 1263'
SOUTH FORK
SHENANDOAH RIVER
ELEV = 1010'
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

V. FY2019 STATUS:

Average Annual Daily City Sales (AADCS)

A team of Harrisonburg City Departments have optimized the methodology and enhanced the use of GIS capabilities to better evaluate existing city water demands. Using most recent sales and land use data from FY2019, the City departments of Economic Development, Community Development, IT & GIS, City Manager and Public Utilities have collaborated and determined the existing 4.742 MGD of AADCS to be generated as follows:

Developed Lands, Existing Land Use *includes lawn and irrigation meter use*	Consumption per acre	Consumption per unit (million gal/day)	Total Consumption
COMMERCIAL - LODGING	0.001831	0.003901	0.117
COMMERCIAL - OFFICE	0.000335	0.000212	0.066
COMMERCIAL - RETAIL SERVICE	0.000428	0.000496	0.429
GOLF COURSES	0.000011	0.000514	0.004
INDUSTRIAL	0.002102	0.007798	1.279
INSTITUTIONAL	0.000616	0.000286	0.127
MIXED USE	0.003150	0.000116	0.051
PARKS AND RECREATION	0.000041	0.000657	0.017
PUBLIC FACILITIES	0.000076	0.000280	0.019
RESIDENTIAL - MULTI-FAMILY	0.001241	0.000118	0.784
RESIDENTIAL - SINGLE FAMILY ATTACHED	0.000644	0.000105	0.279
RESIDENTIAL - SINGLE FAMILY DETACHED	0.000350	0.000120	0.634
RESIDENTIAL SINGLE FAMILY GREATER THAN 2 ACRES	0.000027	0.000128	0.003
ROW	0.000000	0.000000	0.000
SCHOOLS, COLLEGES, AND UNIVERSITIES	0.000918	0.005273	0.933
VACANT	0.000009	0.000016	0.002
BASELINE TOTAL			**4.742**

Existing Treatment Capacity

The existing Harrisonburg Water Treatment Plant, when provided with adequate raw water supply, can be rated to 15.0 MGD at 6.0 gallons per minute per square foot of filter area. This upgrade can be achieved without any capital investment. Two factors will influence the average demand that the 15.0 MGD treatment facility can accommodate. These influences are seasonal peak demand patterns and conservation.

- By historic analysis, HPU has determined that the water treatment capacity must be 1.29 times the average daily demand (see below); this allows WTP output during the observed maximum two weeks period to refill the potable water system storage reserves (this is much like the engineering analysis that is typically performed to size reservoirs, but the format is reversed to determine input / output).

- VWWP #16-0760 requirements for conservation are assumed to be in place and will reduce withdrawals by 10% during the most difficult drought conditions.

The existing 15.0 MGD treatment plant can accommodate a 12.9 MGD annual average daily demand.

Raw Water Capacity:

Shown below is an existing raw water supply capacity of 11.6 MGD; however, reduced to 5.5 to 9.5 MGD during drought.

Source	*Normal Capacity*	*Drought Capacity*
Dry River	4.0 MGD	0.0 -4.0 MGD
North River	7.6 MGD	5.5 MGD
Total	**16.0 MGD**	**5.5 -9.5 MGD**

- Dry River is only reliable during drought with adequate reserves and releases from Switzer Lake.

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VI. RAW WATER RELIABILITY UNDER DROUGHT MANAGEMENT

Drought conditions dictate the critical parameters under which Harrisonburg must evaluate its water system reliability. This section of the RWSMP has been prepared for Harrisonburg to understand how, when and why its future demands will play upon raw water and treatment capacities.

Future Average Annual Daily City Sales (AADCS)

Referencing the work completed by a team of Harrisonburg City Departments in understanding existing water use patterns in Harrisonburg in FY2019, the same team has collaborated to forecast future internal City water sales to reach 7.861 MGD by growing an additional 3.119 MGD. The tabulation is shown below:

Vacant Lands, Land Use Guide	gal/day per unit	Number of units per ac	Multiplier value (mgd/ac)	Apply to ac from LUG	Growth Factor	Projected Use (mgd)
Conservation, Recreation, Open Space	-	-	0.000041	15.9	-	0.001
Low density residential	-	-	0.000350	143.7	-	0.050
Low density mixed residential	104	10	0.000001	618.2	-	0.643
Neighborhood residential	-	-	0.000420	60.6	-	0.025
Medium Density Residential	114	15	0.000001	77.0	-	0.132
Medium Density Mixed residential	114	20	0.000001	151.4	-	0.345
High density Residential	118	24	0.000001	5.7	-	0.016
Mixed Use	-	-	0.001418	317.0	-	0.449
Limited Commercial	-	-	0.000513	42.9	-	0.022
Commercial	-	-	0.000513	208.1	-	0.107
General Industrial	-	-	0.002102	567.6	-	1.193
Governmental/Quasi-Governmental	-	-	0.000798	140.3	1.2	0.134
Institutional	-	-	0.000546	2.0	1.2	0.001
USE BY FUTURE LAND USE GUIDE MULTIPLIERS TOTAL						**3.119**

Future Average Annual Daily Demand (AADD)

Average annual daily city sales is only one component of the total demand that must be reliably met by the water system. Other components include external city sales, contracted commitments, potable water used in the treatment plant to backwash filters and unaccounted for water (inaccurately metered or not metered). Shown in the table below is a tabulation for each component both in FY2019 and for the total future planning of Harrisonburg. AADD was 7.6 MGD in FY2019 and is expected to grow to 12.9 MGD.

Average Daily Demand Forecast	
Existing City Sales	4.7 MGD
Existing External Sales	0.8 MGD
Rockingham County Tier 1 Contract	0.5 MGD
External Reserved Commitments	0.2 MGD
WTP Processing	0.1 MGD
Unaccounted water	1.3 MGD
Existing Total Demand	**7.6 MGD**
Future City Sales	3.2 MGD
Open Market External Sales	1.1 MGD
Rockingham County Tier 2 Contract	0.5 MGD
WTP Processing	0.1 MGD
Unaccounted water	0.4 MGD
Demand Potential	**5.3 MGD**
Total	**12.9 MGD**

- Existing and future sales were provided in previous sections of this document
- Rockingham County Tier 1 contract commitments are firm; Tier 2 refers to the contract language that identifies an additional 0.5 MGD without reason of denial.
- External Reserved Commitments are letter commitments for easements for Daley (170,000 gpd) and Erwin Michael (90,000 gpd).
- WTP processing is backwash daily volume at future output and current unit volume generation rate (2.2%)
- Unaccounted water loss is 15%

Future Treatment Capacity Analysis

The framework of the RWSMP is to understand the concerns and benefits to fully utilizing the existing 15.0 MGD water plant capacity.

Raw Water Capacity Analysis:

Why?

Shown below is a future raw water supply inventory upon completion of the South Fork Shenandoah River Project (Phases 1 & 2) and the Dry River Upgrade Project. Normal capacity will increase to 35.0 MGD; however, reduced to 10.4 MGD during drought.

Source	*Normal Capacity*	*Drought Capacity*
Dry River	4.0 - 13.6 MGD	0.00 -4.0 MGD
North River	7.6 MGD	1.3 MGD
South Fork Shenandoah River	9.1 - 13.8 MGD	9.1 MGD
Total	**20.7 - 35.0 MGD**	**10.4- 14.4 MGD**

- At Dry River, completion of the 30" pipe will expand current 4.0 MGD capacity to 13.6 MGD. Dry River is only reliable during drought with adequate reserves and releases from Switzer Lake.
- North River is limited to 12% on-stream withdrawals.
- The South Fork Shenandoah pipe capacity will accommodate 13.8 MGD; the pump station will be built to 9.1 MGD capacity in Phase 1 but will be expandable to pipe capacity in Phase 2. At all times, intake will be limited to 10% instream withdrawal plus recycle.

Conclusion to this analysis:

With completion of the South Fork Shenandoah Project, Harrisonburg will not have enough drought raw water to supply build out as forecasted. Without augmentation from Switzer Lake, 4.6 MGD of added supply must be realized. With Switzer and accepting the risk of 132 days maximum reliability, 0.6 MGD of additional source would be needed.

How?

Options for Harrisonburg are summarized as follows:

1) Cap water sales to internal city growth only; thus, establishing the total future AADD at about 11.0 MGD. This would require treatment and raw water capacities at 12.8 MGD. Under this scenario, the City would leave 2.2 MGD capacity unused at the treatment plant but would reduce the need for added drought reliable raw water sources to only 2.4 MGD. Silver Lake is available to offset 1.5 MGD of the drought shortfall. Risk acceptance on Switzer Reservoir has potential to 4.0 MGD for about 132-180 days of drought.

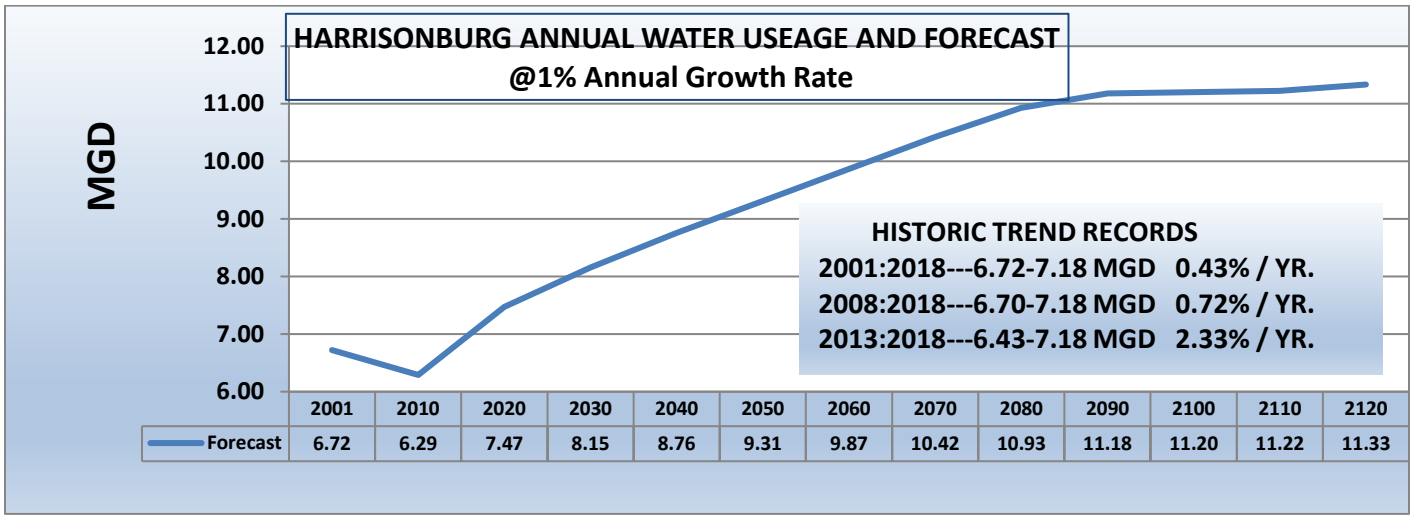
2) Take the aggressive growth perspective, fully utilizing WTP capacity but extending future drought water supply needs to 4.6 MGD. The key understanding herein is that adding external market for rural or wholesale commits Harrisonburg to pursue added drought source water.

Under either approach, the following are integral to the Harrisonburg RWSMP:

- Silver Lake is available to offset 1.5 MGD of the drought shortfall.
- The Shenandoah Pump Station can be upgraded to supply 13.8 MGD even though drought limitation may apply at 9.1 MGD. This gives opportunity to use groundwater to augment the SFI intake waters.
- The City has completed groundwater studies along its western raw waterlines; some smaller limited potential for source water has been identified.
- Risk acceptance on Switzer Lake has potential to 4.0 MGD for about 132-180 days of drought.
- The local Frazier quarry has undefined potential in the same context of augmentation as applied to Switzer Lake.

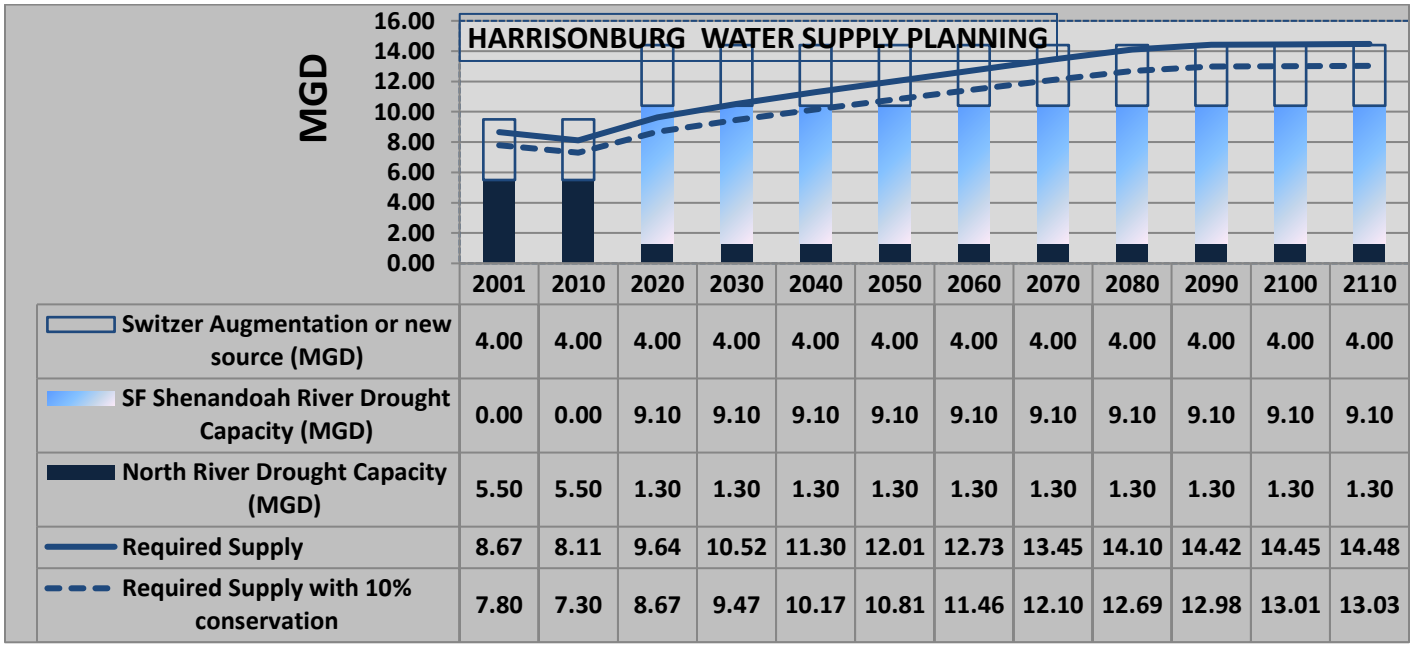
When?

The graph below shows the annual growth rate for water demand for Harrisonburg at 1.0%. The average of 1.0% growth rate is one quarter to one half percentage point more aggressive than observed over the previous 10 to 20 years records.



	2001	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110	2120
Forecast	6.72	6.29	7.47	8.15	8.76	9.31	9.87	10.42	10.93	11.18	11.20	11.22	11.33

The history and future of Harrisonburg water supply planning is shown in the graph below; a 100% reliable water supply during drought is the target requirement.



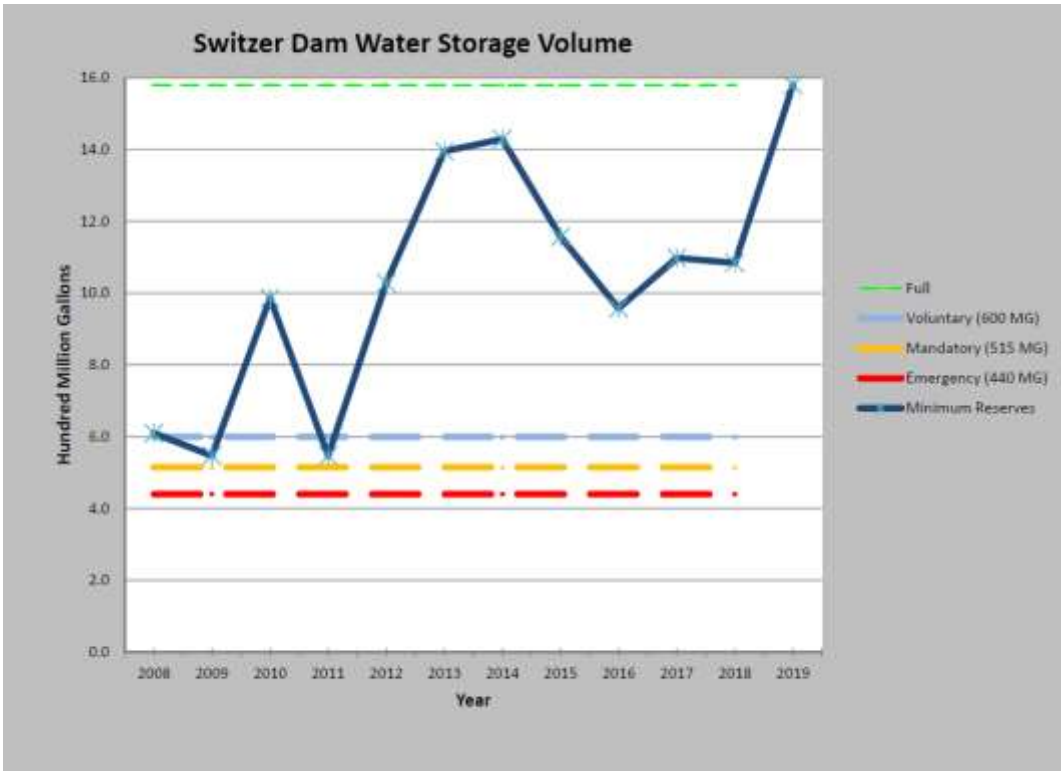
	2001	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100	2110
Switzer Augmentation or new source (MGD)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
SF Shenandoah River Drought Capacity (MGD)	0.00	0.00	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10	9.10
North River Drought Capacity (MGD)	5.50	5.50	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30
Required Supply	8.67	8.11	9.64	10.52	11.30	12.01	12.73	13.45	14.10	14.42	14.45	14.48
Required Supply with 10% conservation	7.80	7.30	8.67	9.47	10.17	10.81	11.46	12.10	12.69	12.98	13.01	13.03

<u>2001-2019:</u>

The reliable water supply during drought is itemized below; during the referenced period Harrisonburg has relied on available water reserves in Switzer Lake. This is a risky condition as shown below. This RWSMP suggests replacing Switzer Lake as a drought source of water.

- North River 5.8 MGD
- Dry River 0.0 MGD; add 4.0 MGD when Switzer has reserves and full release.
- New Sources 0.0 MGD
- Total 5.8 MGD; 9.8 MGD

Throughout times of reference, Harrisonburg has successfully depended upon the reserves in Switzer Lake to avoid deficit water supply status. The following graph gives indication of actual minimum level reserves that were incurred in Switzer Lake from 2008 through 2019. In the years of 2009 and 2011 the City approached water supply deficit status.



2020-2040:

Referring to the Water Supply Planning Graph at 1.0% growth, by 2020 (most probably 2022), the addition of the South Fork of the Shenandoah River will increase water supply to 10.4. MGD without Switzer Lake and 14.4MGD with Switzer Lake. The dependency on reserves in Switzer Reservoir, or the need for the suggested new drought reliable source) will not return until around the year 2045.

- North River 1.3 MGD
- Dry River 0.0 MGD add 4.0 MGD with Switzer augmentation
- Shenandoah River 9.1 MGD
- Total 10.4 MGD 14.4 MGD

It should be noted that VWWP #16-0730 engages several conditions of environmental stewardship when the Shenandoah source becomes active.

1) Dry River: Withdrawals shall be adjusted at the Dry River Intake so that a minimum of 0.744 cfs (0.5 MGD) is released to the Dry River below the low-head dam. The Dry River supply may decrease to less than 1.0 MGD when the reserves at Switzer are exhausted (132 days drought; such events are on record in 20th and 21st centuries).

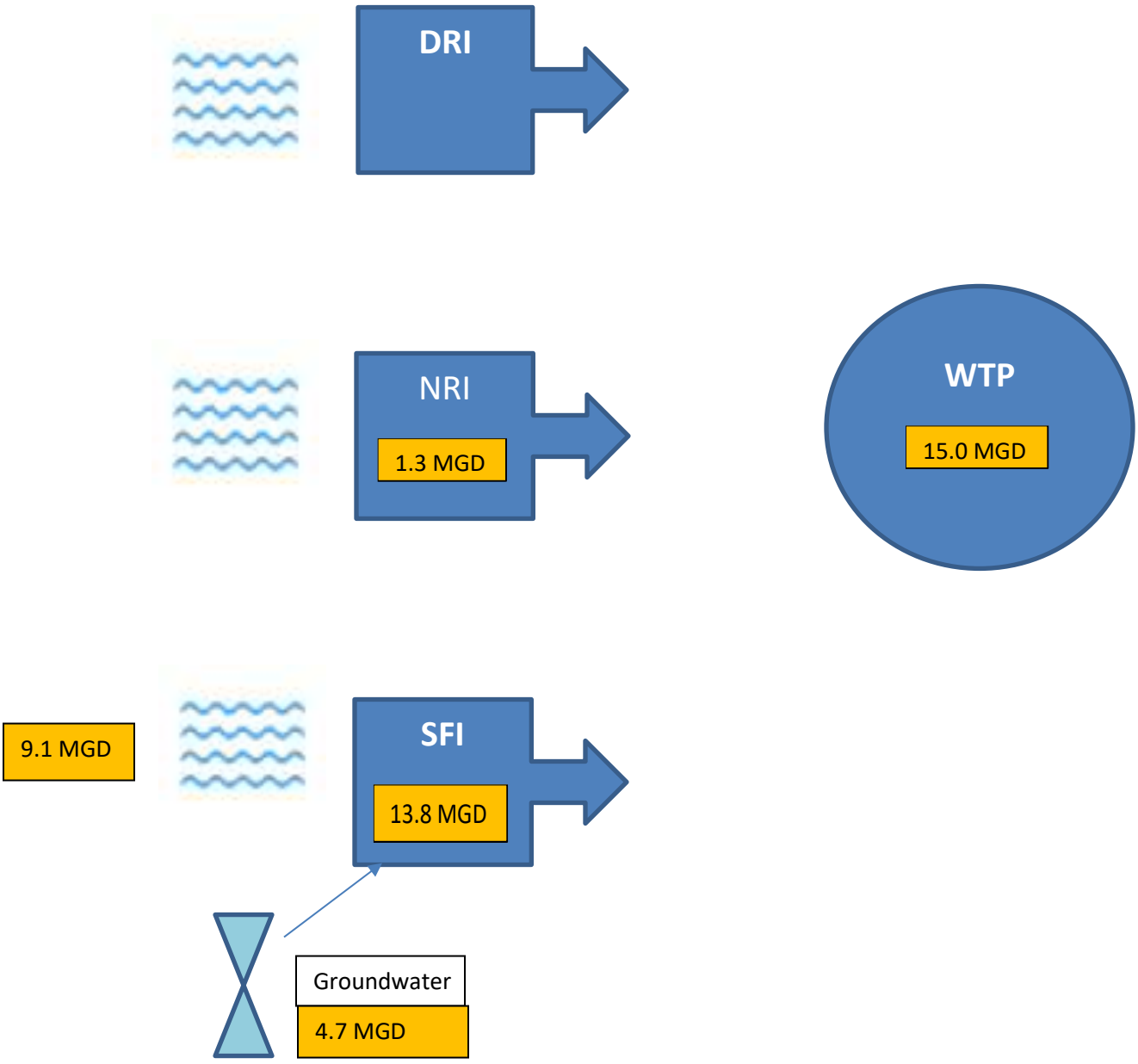
2) North River: At no time shall the withdrawals from North River exceed 12% of the stream flow as estimated at the intake. The City recognizes that North River is a target for water protection; this effort began with the proposed Surface Water Management Area (SWMA) in the 1990s and takes even greater focus under the Local and Regional Water Supply Plan (9VAC 780) and VWWP #16-0730 that are relevant today. The withdrawal limitation has progressively decreased from the 1Q10 criteria of 13.6 MGD prior to the 1990s, to 5.5 MGD (13% MAF) with the SWMA, to 1.3 MGD (12% in-stream flow) with the VWWP.

3) South Fork: At no time shall "Net Withdrawal" exceed 10% of the stream flow at the South Fork Intake. Net withdrawal equals the total volume withdrawn from the South Fork plus 66% in recognition of the "Return Flow" at HRRSA. Under historic low flow in stream conditions, Shenandoah Project will provide 9.1 MGD of reliable water supply.

Post 2045: As Harrisonburg moves toward the ultimate withdrawal need of 15.0 MGD, the following are possible additional water sources:

- Groundwater in the Western Source Water Area
- Groundwater in the Eastern Source Water Area (well locations have been identified)
- Local quarries for limited use from storage
- Contractual requirements for wholesale customers to provide water supply.

The diagram below shows use of eastern groundwater into the South Fork Intake (SFI).



VII. RAW WATER SUSTAINABILITY UNDER NORMAL OPERATIONS:

Beyond the reliability of adequate source water under drought, other criteria for sustainability come into play under normal operating conditions. WTP operating strategy shall require selection and proportioning of differing source waters among Dry River, North River and the South Fork Shenandoah River. Priority and balance shall require consideration of the following

1) Water Quality & Effectiveness and efficiency of treatment
2) Electrical power and energy requirements

Shown in the table below is the preferred source of raw water for each of the decision criteria as listed above. Preferred sources are listed higher in the table. Dry River is the preferred source for all three parameters. The Shenandoah River is the least preferred source with respect to its higher specific energy requirements. The North River is a difficult source to qualify or quantify for water quality and treatability because its makeup varies so widely with its high range of in-stream flows and its accompanying influences from agriculture.

The general theme for operations of the future Harrisonburg Raw Water System and Treatment Plant is generalized as follows:

- Maximize the usage of raw water from Dry River
- Minimize the usage of raw water from Shenandoah River:
- Gap fill with raw water from the North River:

Harrisonburg Source Water Preference Table

Water Quality & Treatability	Specific Energy
Dry River	Dry River
Shenandoah River	North River
North River	Shenandoah River

Water Quality & Treatability

Dry River is a pristine source with little concern from human wastes. The highest concern for this source is a corrosive index and an absence of alkalinity. The corrosive characteristic, if not properly addressed at selected stages of conveyance and treatment, can be a concern as a contributing cause for leaching metal from pipes and plumbing. The absence of alkalinity must be addressed to enhance the coagulation process that is essential to the water treatment process.

The Shenandoah River is a lower watershed source. This source is subject to more exposures to natural and human wastes. Therefore, the variety of contaminants is greater; however, the higher volume of water creates an effect by which contaminant concentrations can be diluted to generally lower levels.

The North River is a wild card for water quality and treatability. The North River is downstream of Dry River and therefore has potential to have similar favorable water characteristics; however, quick rising tributaries and agricultural exposure can push contaminant levels to the undesired extreme for specific parameters such as TOC, bacteria, and nutrients.

Specific Energy Management

Specific Energy (SE) is the benchmark for managing energy and indirectly managing contributions to carbon emissions. SE is simply the kilowatt hours of electricity required to pump one million gallons of water. The lower is the benchmark value, then the better is the management performance. Within Harrisonburg's Electrical Energy Management Plan (HEEMP), the concept of SE is:

- strategically designed into the pump station and raw water system
- tactically monitored and evaluated through automation controls
- provided maintenance under asset management principles

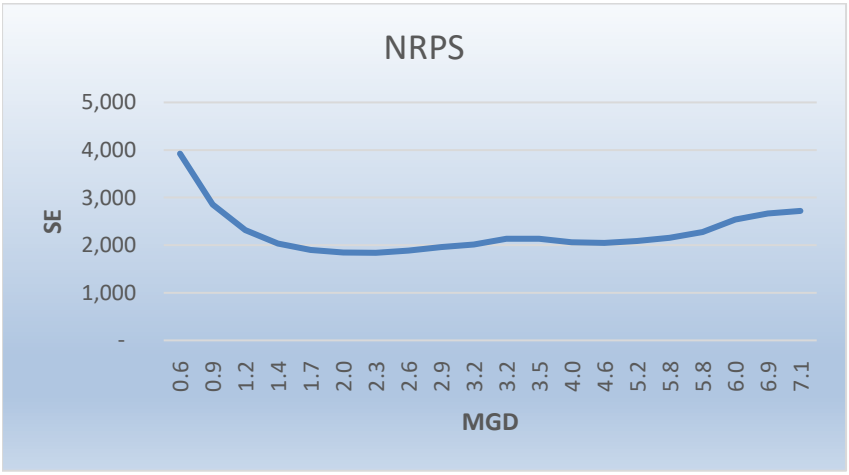
Strategic Specific Energy Management

Strategic advantages for SE management currently exist at Dry River and North River. The Shenandoah source is not yet commissioned but the design is active. The summary of system components and the raw water system features follows:

- Dry River: Since 1898, Harrisonburg has enjoyed the zero specific energy requirements to deliver raw water from the Dry River source.

- North River: At North River, the future scheme to optimize energy management recognizes that North River will be the second most efficient raw water source (unless Silver Lake Pump Station becomes a permanent water source). ***Recommendation #4*** of the RWSMP was a 2015 upgrade project that added variable speed drives to the North River Pump Station; this now allows the City to operate any pump at the most optimum output. Shown below is the strategic design for operating from the North River source.

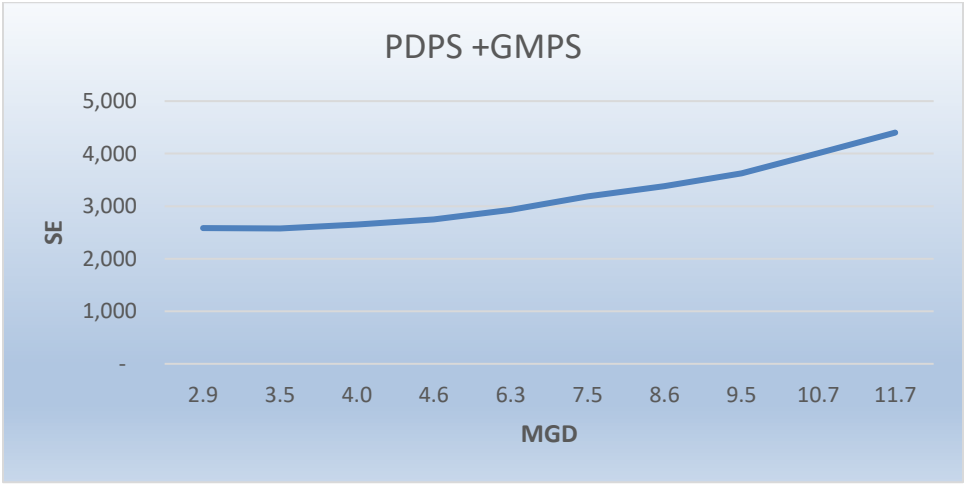
NRPS		
MGD	Pumps	SE
0.6	1	3,924
0.9	1	2,852
1.2	1	2,319
1.4	1	2,038
1.7	1	1,898
2.0	1	1,844
2.3	1	1,840
2.6	1	1,884
2.9	1	1,958
3.2	1	2,015
3.2	2	2,137
3.5	2	2,135
4.0	2	2,063
4.6	2	2,047
5.2	2	2,086
5.8	2	2,154
5.8	2	2,280
6.0	3	2,540
6.9	3	2,669
7.1	3	2,721



- South Fork Shenandoah River: ***Recommendation #6***

of this RWSMP is to complete and commission the Shenandoah Project. HPU has completed a preliminary engineering report (PER) for the pump stations; it will serve as a guide for the inaugural design for 450 horsepower pump motors (Capacity may expand to 600 or 900 horsepower units to deliver 13.8 MGD). The table shows the integration of SE into the initial design:

Combined PDPS and GMPS				
MGD	Pumps	PDPS-SE	GMPS-SE	Total-SE
2.9	1	1,476	1,110	2,586
3.2	1	1,476	1,093	2,569
3.5	1	1,490	1,086	2,576
3.7	1	1,516	1,087	2,603
4.0	1	1,552	1,097	2,650
4.3	1	1,566	1,113	2,679
4.6	1	1,613	1,134	2,746
5.8	2	1,621	1,217	2,838
6.3	2	1,676	1,252	2,928
6.9	2	1,746	1,300	3,045
7.5	2	1,829	1,358	3,187
8.1	2	1,926	1,425	3,351
8.6	3	1,909	1,469	3,379
8.9	3	1,950	1,505	3,455
9.5	3	2,043	1,580	3,623
10.1	3	2,144	1,662	3,807
10.7	3	2,256	1,752	4,008
11.7	3	2,474	1,927	4,401

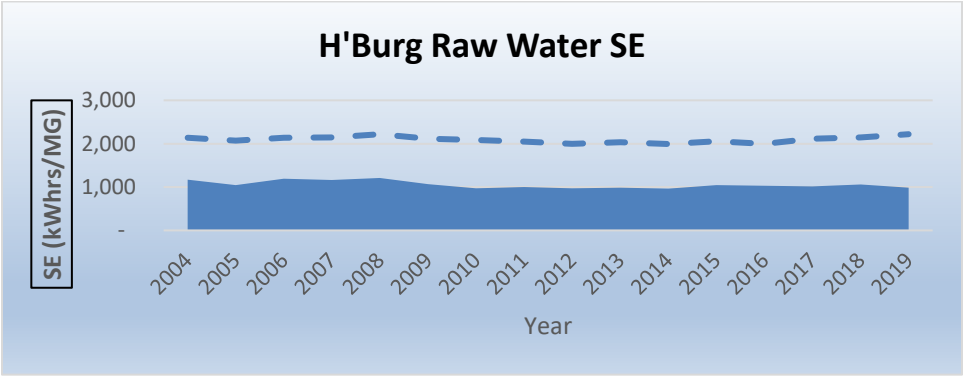


- Silver Lake: The City's withdraw capacities of Silver Lake are now constrained to mobilizing temporary pumps. Therefore, the Silver Lake source is currently not a viable permanent source, however, ***Recommendation #5*** shall retain complete arrangements for temporary use and to recognize possible options for future permanent arrangements.

- Total Raw Water System: The Harrisonburg Raw Water System is a combination of the Dry River, North River and South Fork Shenandoah River components. Shown in the table below are the SE optimum energy targets presented holistically for the future system. Future success in tactical and operational management for SE will be determined by the strengths and weaknesses of the design.

Source Option	Flowrate MGD			SE		
	Minimum	Optimum	Maximum	Minimum	Optimum	Maximum
DRI	0.0	0.0	4.0-13.6	0	0	0
BWPS-1	0.6	2.3	3.2	3,924	1,840	2,015
BWPS-2	3.2	4.6	5.8	2,137	2,047	2,280
BWPS-3	6.0	6.0	7.1	2,540	2,540	2,721
SRPS-1	2.9	3.2	4.6	2,586	2,569	2,746
SRPS-2	5.8	5.8	8.1	2,838	2,838	3,351
SRPS-3	8.6	8.6	11.7	3,379	3,379	4,401

For historical reference, shown in the graph below is the SE for the HPU raw water system (965-1,210) and the NRPS component (1,993-2,219) of the raw water system between 2004 and 2019.



Specific Energy Management at the Tactical Level

The goal of SE management at the tactical level is to monitor changing conditions and to provide a foundation for adapting operations to the prevailing conditions. Under current conditions, water treatment plant operators continuously monitor SE from North River Pump Station. The HPU SCADA system provides this information as a snapshot in a graphical display and by trending pattern in an SE versus timeline display.

The current tool is very basic with limited comparison or valuation. As the design of the Shenandoah source moves forward, it will include considerations for:

- Monitoring and manipulating data necessary to provide information that optimizes selection of options among combined sources of raw water
  - ❖ Developing in-situ pump performance and specific energy curves
  - ❖ Developing methodology to identify best performance among single and multiple source options.
- Transforming data into recommendations
- Implementing automated controls versus relying on a manual user interface to implement recommendations

Specific Energy Management at the Operation Level

The goals of SE management at the tactical level are underlaid in operation choices and in predictive maintenance, preventive maintenance, repair and rehab/retirement decision made under adopted asset management principles. Asset Management is generally discussed in Section IX of this RWSMP

VIII. RAW WATER RISK MANAGEMENT STRATEGY

Risk planning for the Harrisonburg Raw Water System consisted of identifying and evaluating major potential risks to reliable water supply and then identifying potential countermeasures to reduce or mitigate the effects. The following risks were identified:

- Total Loss of Water Source: The cause would most likely be contamination, effects from flood or other natural disasters, or a catastrophic failure of system infrastructure. Occurrence of this type is generally not easily or quickly remediated so multiple alternative sources are preferred mitigating options.
- Electrical Failures: The cause would be failed service delivery by the electric purveyor through some type of grid failure. Occurrence of this type can generally be mitigated by installing an electrical backup generator. In some cases, pumps using an alternative fuel can be used.
- Unit Failure: The cause would be mechanical, electrical or other physical failure of one or more units of the on-site infrastructure of the pump station, intake or conveyance system. Occurrence of this type can generally be mitigated by installation of duplicity for applicable components.
- Drought: This Raw Water Supply Management Plan includes a section dedicated entirely to drought; this condition is a very prominent area of the planning agenda.

The table as follows itemized each of the risks above. The benchmark goal for success was a total raw water supply of 15.0 MGD or greater. The evaluation included:

- Independent loss of total source, power or single unit operations at each source.
- Simultaneous loss of power at all sources
- Simultaneous effects of drought at all sources; DRI included analysis with and without augmentation from Switzer Lake
- Simultaneous loss of power to all sources during the effects of drought; DRI included analysis with and without augmentation from Switzer Lake

Mitigations were listed at the end of the table.

CITY OF HARRISONBURG RAW WATER RISK ANALYSIS									
Source	**SRI**			**NRI**			**DRI**		**Total**
	Pumps	Generator	MGD	Scenario	Generator	MGD	Scenario	MGD	MGD
Total Loss of Source									
...SRI (Mitigation #1)	out of service	None	0.0	3 pumps	1 pump (demand)	7.6	max flow	4.0+	**11.6+**
...NRI (Mitigation #2))	3 pumps	1 pump (power mgmt.)	13.8	out of service	none	0.0	max flow	4.0+	17.8+
...DRI (Mitigation #2)	3 pumps	1 pump (power mgmt.)	13.8	1 pump	none	3.5	out of service	0.0	17.5
	2 pumps	None	9.2	3 pumps	1 pump (power mgmt.)	7.6	out of service	0.0	16.8
Power Loss									
...SRI (Mitigation #3)	1 pump	1 pump	4.6	3 pumps	1 pump (power mgmt.)	7.6	max flow	4.0+	16.2+
	2 pumps	2 pumps	9.2	1 pump	none	3.5	max flow	4.0+	16.7+
...NRI	2 pumps	None	9.2	None	none	0.0	max flow	4.0+	13.2+
...SRI & NRI (Mitigation #5)	2 pumps	2 pumps (reliability)	9.2	1 pump	1 pump	3.5	max flow	4.0+	16.7+
Loss of Single Unit									
...SRI or NRI	2 pumps	None	9.2	1 pump	none	3.5	max flow	4.0+	16.7+
...SRI or NRI	1 pump	None	4.6	2 pumps	none	5.7	max flow	4.0+	14.3+
...DRI	3 pumps	1 pump (power mgmt.)	13.8	1 pump	none	3.5	out of service	0.0	17.3
	2 pumps	None	9.2	3 pumps	1 pump (power mgmt..)	7.6	out of service	0.0	16.8
Drought									
...SRI & NRI &DRI (Mitigation #4 & #7)	2 pumps	1 pump (power mgmt.)	9.1+	1 pump	None	1.3	w/ Switzer	4.0	14.4
...SRI & NRI &DRI (Mitigation #4 and #7)	3 pumps	1 pump (power mgmt.)	9.1+	1 pump	None	1.3	wo / Switzer	0.0	**10.4**
Drought + Power Loss									
...SRI & NRI &DRI (Mitigation #6 and #7 or #8)	2 pumps	2 pumps (reliability)	9.1	1 pump	1 pump	1.3	w/ Switzer	4.0	14.4
...SRI & NRI &DRI (Mitigation #6 and #7 or #8)	2 pumps	2 pumps (reliability)	9.1	1 pump	1 pump	1.3	wo / Switzer	0.0	**10.4**

Mitigations	
DRI Upgrade	1: Total loss of the SRI source supports upgrading DRI pipeline to 8.4 MGD minimum.
SRI Generator Design	2: Total loss of NRI or DRI source supports 1 generator at SRI for power cost management. 3: Loss of power at SRI supports 1 generator at SRI. 4: Drought sources too SFI would support 1 generator for power cost management. 5: Loss of power at SRI and NRI supports 2 pump generator capacity at SRI 6: Loss of power at NRI during drought supports 2 pump generator capacity at SRI
Drought Mitigation	7: Add 4.6 MGD reliable drought sources; 8: Add 0.6 MGD and control reserves in Switzer Lake to provide up to 4.0 MGD during peak drought. Risky due to duration and counter-productive to downstream aquatic protection.

IX. ASSET MANAGEMENT

"***Asset Management***" is operating the inventory of assets effectively and efficiently throughout their life cycle and then retiring them at the most appropriate time. The asset management approach at HPU is organized to include:

- Inventory by use of asset register and GIS
- Defining Level of Service (LOS)
- Assigning RISK
- Providing predictive, preventive and repair maintenance with budget funds
- Engaging rehab & retirement with CIP funds

Management of raw the raw water system assets is performed with the potable system assets as described in the "HPU Potable Water System Management Plan"; however, an overview follows:

Inventory

Individual asset records are of large volume and are held in registers within the HPU GIS system. On a higher collective level, attributes for Current Asset Replacement Value (CARV), Net Book Value (NBV) and Annual Depreciation (ADEP) have been summed to convey total raw water system value. These values for asset status at the end of FY2019 were as follows:

Western Raw Water System	CARV	NBV	ADEP
Total Asset Summary	$61,394,100	$37,925,145	$2477,877
910161-48621 Western Utilities	$33,419,055	$ 9,950,100	$247,877
Land	$1,777,000	$1,777,000	$0
Switzer Reservoir	$26,198,045	$26,198,045	$0

Level of Service (LOS)

In simplest form, HPU desires that the raw water system function in a manner of reliability such that an interruption of delivery is relatively invisible to the customers on the potable side of the water system. Other performance goals such as water quality, energy management and cost management have been discussed in Section VII.

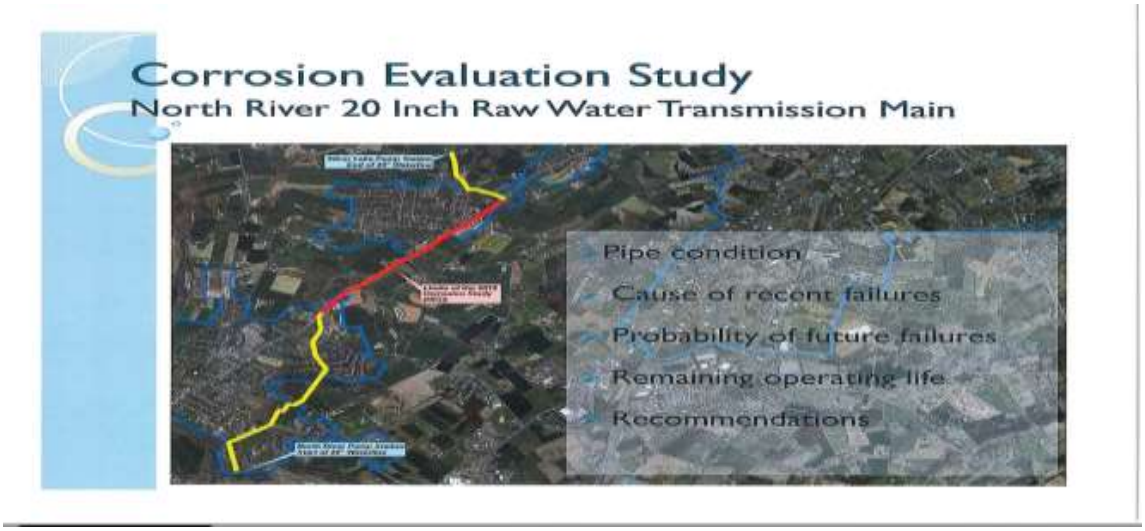
RISK

Risk comes with elevating levels of criticality and likelihood of failure. Final quantitative risk analysis is not yet available, but from a qualitative perspective the risk has been defined around the previously stated LOS. This qualitative analysis has been presented in both Section V for drought management and Section VII for risk analysis.

Operating Budget Maintenance

Typical examples of predictive maintenance currently in play are continuous SCADA monitoring of the NRPS for performance, vibration and heat parameters.

Another example of predictive maintenance was the corrosion assessment of a section of the 20" North River pipe between Turner Ashby High School and Cargill facility at Dayton. (Shown in the red section below).



Typical examples of preventive maintenance currently in play are the manufacturers recommended PMs for NRPS being placed in CMMS work order scheduling.

Repair protocol calls for 7/24/365 available response.

Rehab & Retirement (R&R)

For CIP funding purposes, HPU forecasts asset retirement dates and corresponding costs using Manufacturer's Anticipated Service Life (MASL). Asset replacement is then scheduled after completing condition assessments for criticality and for likelihood of failure. The City's western source system of assets has a partial exception in its planning agenda. Raw water assets along the Route 33 corridor will be converted to potable use rather than retired.

The raw water pumping and conveyance system from Dry River follows the referenced standard procedures. The raw water pumping and conveyance system from the South Fork Shenandoah has not yet been commissioned and therefore it is not included in the planning. The exception is the Dry River system 16" pipe with 40 years possible remaining life that will be converted to potable use (the potable 12" and 10" pipes will be abandoned). The concept and funding is shown in Appendix XIX.

X. SUMMARY

Effective integration of Harrisonburg's raw water assets will have value to:

- Optimizing sustainability and efficiency during normal operations;
- Achieving reliability of delivery during drought;
- Achieving reliability of delivery during incurred risk.

The RWSMP closes with focus as follows:

- **The quantity and quality of the City's existing and future needs for raw water supplies must be known and then frequently revalidated or revised.**
- **The operating theme for raw water supply to Harrisonburg can be summarized as follows: "Maximize use of Dry River, minimize use of the South Fork of the Shenandoah River, gap fill with North River, and know the value of Silver Lake."**
- **Meet applicable requirements of the Virginia Water Withdrawal Permit #16-0730 as a RWSMP management tool;**
- **Remain current and compliant with the "The Upper Shenandoah Basin Water Supply Plan" as a RWSMP management tool.**

Individual recommendations to make possible a reliable and sustainable water supply, to provide 100% reliability for 11.3 MGD raw water withdrawal under normal and drought conditions and to provide for risk mitigation in the event of the loss of a raw water source include:

- **VAC Compliance – *Recommendation #1***

  Harrisonburg shall complete the initial plan and all subsequent five years updates of 9VAC-780 Local and Regional Water Supply Plan.

- **Water Withdrawal Compliance – *Recommendation #2***

  Harrisonburg shall operate within VWWP #16-0730 defined requirements when the South Fork Shenandoah River is commissioned.

  - Conform to maximum instream withdrawal limits

- Adopt and implement specified a conservation ordinances per permit.
- Install screens for aquatic protection per permit.

- **Dry River – *Recommendation #3***

CIP planning should direct the installation of a new parallel 30" diameter pipe that will be efficient and effective in the life cycle management of existing pipes while simultaneously expanding the maximum raw water delivery capacity to 13.5 MGD.

Future expanded use of the Dry River source will require the City to better understand its management options in how to control releases from Switzer Dam Reservoir. This will include balancing storage reserves versus releases downstream augmentation.

- **North River – *Recommendation #4***

Upgrade the BWPS to: 1) include variable speed pumps, 2) include risk mitigation against flood and power failure, 3) enhance electrical energy management and 4) facilitate integrating North River into a supply scheme that will include the Shenandoah River source. In addition, appropriately replace 20"raw water pipe as it retires.

- **Silver Lake – *Recommendation #5***

The City has now acquired the first right of withdrawal for the initial 1.5 MGD of water in Silver Lake but must develop means to use the water and to also remain supportive to the Town of Dayton for normal daily use. In addition, Silver Lake has current and future value to Harrisonburg and should be used in terms of advantages toward energy efficiency, supplemental supply during drought, and contingency during catastrophic loss of one of its other sources.

- **South Fork Shenandoah River – *Recommendation #6***

Complete the design and construction, followed by commissioning to use this source, should be foremost in Harrisonburg's water supply agenda.

APPENDIX A: HARRISONBURG WATER SUPPLY CHRONOLOGY

History of Harrisonburg Water Supply:

- 1779 – Thomas Harrison deeds the "Big Spring" for public use.
- 1798 – Town Council commits $35.00 to wall the Big Spring (See Spring House replica at Court Square)
- 1890-s – Ten miles of hand laid 10" cast iron pipe supplies pristine waters from Dry Run, Gum Rum and Rocky Run surface water dams.
- 1914 – Construction of a 5 million gallons reservoir at Tower Street improves service reliability to town customers.
- 1920-s – Two projects significantly enhance water supply

1. A 12" cast iron waterline was constructed in parallel to the previous 10" pipe.
2. Construction of a 16 million gallons reservoir at Tower Street increases storage to 21 million gallons.

- 1930's – the Research Service in Washington D.C. designs and oversees town forces to construct a unique below ground collection gallery at Rawley Springs.
- 1950's – A 16" cast iron waterline is constructed parallel to the 10" and 12" pipes from Rawley Springs.
- 1960's – A pump station and pipeline for use of Silver Lake is implemented as the auxiliary drought supply option.

<u>Clean Water Act mandates filtration technology: City targets 5.0 MGD</u>

- 1970's – A 7.5 miles pipeline to the North River in Bridgewater and the city's first filtration plant are placed in operation. Switzer dam is constructed as a flood control dam, but the City pays to increase the capacity for water supply purposes.
- 1980's – The City's filtration capacity is increased from 5.0 MGD to 7.7 MGD by operation management practices and without capital dollars; this is the first plant in the state to operate at 6 gpm/sf filtration.

<u>Annexation: City targets 10.0 MGD interm to 15.0 MGD</u>

- 1989-1991: The City upgraded its water supply line from Silver Lake to Grandview Drive and then upgraded its North River Pump Station capacity rating to 7.6 MGD from VDH
- 1990-1993: The city's filtration capacity is increased to 10.0 MGD, again without capital dollars. The plant remains today as the first 8 gpm/sf filtration plant in Virginia.

Annexation: City targets 10.0 MGD interm to 15.0 MGD

- 1991-1993: City considers a pipeline to Switzer Dam for long term planning agenda; this alternative was rejected due to environmental constraints
- 1993-1997: Bridgewater requests designation of the North River Surface Water Management Area; concludes with Harrisonburg statement to reject a supporting role. However, Harrisonburg established agenda to pursue an alternative source of water such that future needs can be met with no greater than 5.5 MGD withdrawals from the North River.
- 1993-1997: Harrisonburg pursues groundwater in the Dry River and North River corridors as an alternative to the Riven Rock to Switzer pipeline. This alternative was abandoned due to the small yields of recommended well sites.
- 1994: Dry River Underground upgrade
- 1995: Harrisonburg proposes to participate in Rockingham County's construction of its "Three Springs Water Treatment Plant"; joint proposal rejected by Rockingham County.
- 1996-1999: City studies and chooses the South Fork of Shenandoah River as third raw water source.
- 1996-2009: Completed various sections of 30" pipe between Dry River Intake and Water Treatment Plant
- 1999: VWWP #98-1672 issued for ten years
- 2000: City evaluates the optimum location for WTP for Shenandoah water source
- 2001: Groundwater source evaluated on South Fork of Shenandoah River as an augmentation source to the river intake for purposes that would address temporary concerns for water quality and for environmental stewardship.
- 2002: Harrisonburg evaluates Dry River Dam as an enhancement of the Dry River water supply; alternative abandoned due to environment objections and cost.
- 2002: Shenandoah pipeline easement acquisition begins.
- 2004: Remnant of old hydroelectric dam removed on South Fork of Shenandoah River
- 2005: City constructs intake in South Fork of Shenandoah River
- 2005: Shenandoah project organized into 20 different subprojects which are in various phases of planning, design, construction, managerial and closure.
- 2007-2011: Completed various phases of 30" pipe to Shenandoah River
- 2009: VWWP #98-1672 re-issued for five years
- 2014: Dayton's water lease rights at Silver Lake expire; Harrisonburg gains first right of withdrawal.
- 2015: Bridgewater Pump Station Upgraded
- 2016: VWWP #16-0730 re-issued to replace VWWP #98-1672; 15 year period

APPENDIX B: DRY RIVER SOURCE

Longitude 78.971 Latitude 38.371

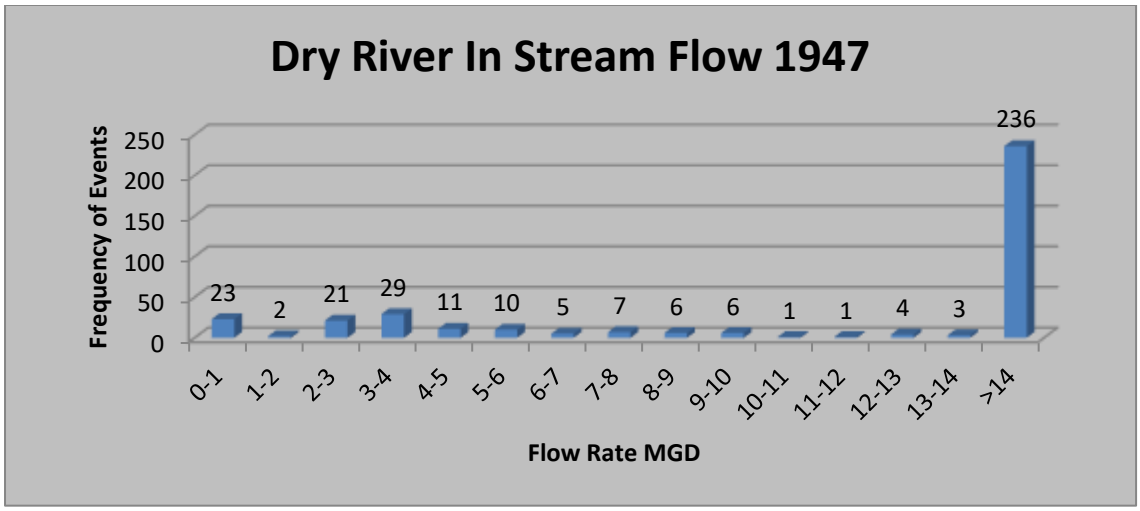
Intake Capacity 4.0 MGD

Dry River Source:

The **Dry River** was Harrisonburg's original viable raw water source when commissioned in the late 1890's. M*aximizing the use of the Dry River source water remains an inherent priority to the City's past, current, and future raw water management strategies.* Use patterns for this source are typically constant and at 100% capacity (4.0 MGD) under all scenarios of normal operations. Harrisonburg's withdrawal is a regulated under VWWP #16-0730. The City is required to bypass a minimum of 0.5 MGD around its intake to maintain an in-stream flow. The bypass originated through a handshake agreement with local Verona based DGIF staff during the drought in the late 1990's and has been carried forth through the withdrawal permit.

DEQ has not rated the Dry River for a safe yield; however, records from a long removed stream gage station, as well as common observations, suggested the flow approached nearly zero on many occasions. The following graph displays the frequency of stream flow quantities from 1947; this was a drought type year that was selected arbitrarily from the limited data that is available. Significant to the graph is the following frequency of low flow events.

- 23 days throughout the year the flow was less than 1.0 MGD;
- 75 days the flow was below the City's current system conveyance capacity of 4.0 MGD;
- On 129 days the flow was below (thus 236 days the flow was above), the future expanded raw water pipe network conveyance capacity at 13.5 MGD.



Harrisonburg Assets:

The City obtained access to the Dry River in the 1890s by installing 55,000 feet of 10" pipe that began at Dry River/Rocky Run/Gum Run intakes at Rawley Springs and extended to the reservoirs that were located within the City borders. Near the years of 1923 and 1947, 12" and 16" diameter pipes were respectively installed in parallel to the 10" diameter pipe. Along the way in 1934, a unique combined surface water / subsurface alluvial groundwater intake structure was installed; later to be upgraded in the early 2000's. The structure consisted of a concrete dam, a bar screen, underground collection pipe and a collection gallery. See 1934 ENR Article that follows.

Until 1970 the pipe system conveyed potable water until the addition of the water treatment plant at Grand View Drive. At that time all pipes were converted to raw water conveyance from Rawley Springs to the new water treatment plant; exception was the 10" diameter pipe that was retained to convey potable water, but in the direction from the new water treatment plant to Rawley Springs. Since early 2000s, the City has embarked a concept to install a new 30" diameter pipe, accompanied by conversion of the 12" and 16" pipes to potable water. This provides a progressive engagement of life cycle management approach to retire older assets and to simultaneously expand raw water conveyance capacity to 13.5 MGD when completed. The current Dry River Raw Water System currently includes the following assets:

- 30” pipe: 17,805 feet
- 30 pipe: 7,405 feet
- 16” pipe: 45,036 feet
- 12” pipe: 25,108 feet

Zero energy consumption is a primary advantage to maximizing the Dry River source as follows:

system:	143 feet TDH
energy:	0 kW-hrs/MG by gravity delivery
power:	0 kW

Dry River Risk:

Harrisonburg’s Dry River source is most susceptible to natural disaster and contamination whereas mechanical, electrical, and control failures are not as prominent with the inherent gravity intake features. In recent history, the hurricane events of 1985 and 1993 saw the pipe conveyance system lost for a substantial period of time. In contrast, no major contamination has been incurred from the Dry River; however, five miles of river bed in the upstream watershed can in some places be easily contaminated by a vehicular accident along the highly traveled Route 33 corridor. The frequent small in-stream flow in the presence of a contaminant poses special attention to this concern.

Groundwater Cutoff Wall Provides New Water Supply

Harrisonburg, Va., adds to its supply by building concrete wall in valley from surface to bedrock to intercept underflow

By A. B. McDaniel
Consulting Engineer, Washington, D. C.

LED BY the water shortage that developed during the great drought of 1930 to give consideration to an addition to its water-supply facilities, Harrisonburg, Va., has built an unusual groundwater-supply system, comprising essentially a concrete cutoff wall to intercept the underflow in the valley of the Dry River. Directly behind the wall there was built a collecting gallery, from which the water is conveyed by pipe line to the existing supply mains.

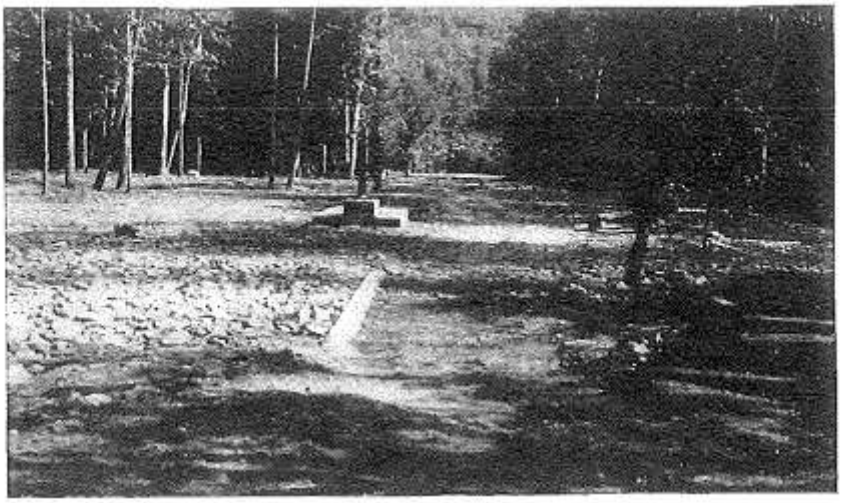


FIG. 1—TOP OF THE COLLECTING GALLERY and a portion of the top of the cutoff wall in new groundwater supply of Harrisburg, Va.

The city of Harrisonburg is situated in the Shenandoah Valley about 6 miles west of the southern extremity of Massanutten Mountain and about 12 miles east of the easterly slope of the North Mountain Range. The business section of the city lies at an elevation of 1,320 ft. above sea level, and the principal residential district is located on the eastern slope of a hill that rises to a height of about 100 ft. above Main Street. On this ridge above the city are the two distribution reservoirs, one having a capacity of 6,000,000 gal. and the other 15,000,000 gal.

In 1921 the city constructed a concrete dam 100 ft. long and 10 ft. high in the channel of Dry River, 15 miles west of the city. About a quarter of a mile below the dam and on the west side of the valley is the intake works, the construction of which was begun in 1899. It consists of a concrete flume and a pool or collecting basin that receives the flow from a spring-fed stream along the west side of the valley. A 12-in. pipe carries the water during the low-flow period of the summer months from a small collecting basin behind the dam in the river channel to a 12-in. cast-iron main that is one of two parallel supply lines from the intake pool to the city. The other supply line is a 10-in. cast-iron main. The 10-in. main is also supplied with water from the bed of the main river channel during low-water periods by an 8-in. cast-iron pipe which runs to a sump in the bed of the river about 800 ft. below the dam. The general layout of the intake works, dam and pipe lines are shown in Fig. 2. The watershed area above the intake works is about 57 square miles.

Due to the great deficiency of flow in the Dry River Basin during the summer of 1930, the city found it necessary to secure an auxiliary supply. This supply was provided by an 8-in. cast-iron pipe line 2 miles long from Silver Lake to the 12-in. main at Dale Enterprise. The water was pumped from the lake at the rate of 600,000 gal. a day for 133 days, at an operating expense of $10,305. Early in January, 1931, the surface-water supply at Rawley Springs picked up sufficiently to do away with the auxiliary supply, which was objectionable both for domestic and industrial use on account of its high total hardness of 251.

Preliminary investigation

At the request of the city council, the author's firm began a field investigation and study for the improvement of and addition to the water supply of the city. A survey was made of all existing sources of water supply, including springs, spring-fed lakes, surface-water streams, wells and storage. It was recommended that further investigation be made of the economic practicability of building an impounding and regulatory reservoir in the Skidmore Fork Basin in the headwaters of the Dry River watershed.

A field investigation was made that included core drill holes, churn drill borings and test pits at proposed dam sites in the Skidmore Fork and Gum Run basins, and in the territory adjacent to the city's intake. These investigations showed the economic impracticability of constructing a dam at either of the two proposed locations in the Skidmore Fork and Gum Run basins and of securing water from wells near the city's intake.

Geologic studies and pumping tests in the pits across the valley from the dam in the river channel clearly indicated the presence of groundwater flow over the valley floor in many isolated streams and the practicability of intercepting this flow by an underground dam extending across the valley. Recommendation was made to the city council to construct a system of groundwater intercepting and collecting works comprising a reinforced-concrete wall or dam extending from the old dam in the river channel to the rock cliff on the west side of the valley, a distance of about 900 ft. These works would be located 1,200 ft. up the valley from the city's intake and would make possible the diversion of the underflow from a collecting gallery in a natural gorge on the west side of the valley through a supply main by gravity flow to the existing intake works. The city council approved of this project. In November 1933, authorization was given for the preparation of an application on behalf of the city for a PWA loan and grant of $50,000. This application was approved by the state PWA engineer, but was indefinitely held up in Washington on account of the overallotment of funds for the state of Virginia for PWA projects. In March, 1934, the city council authorized the construction of the proposed ground-

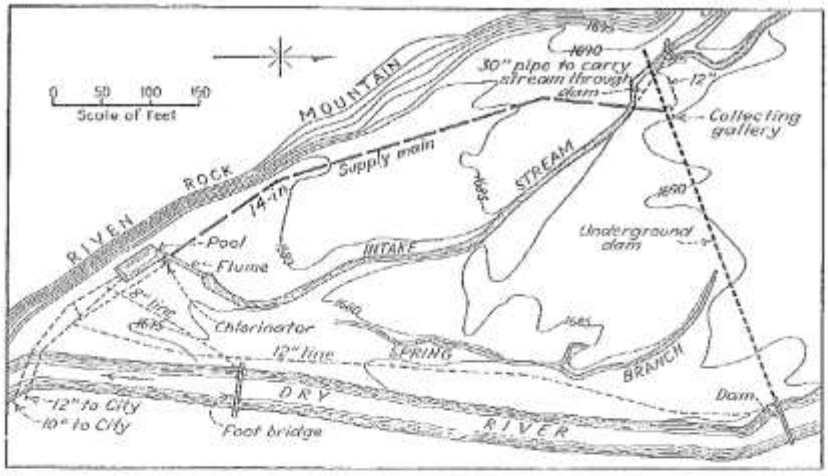


FIG. 2—UNDERFLOW down the valley of the Dry River is intercepted by the underground dam and is conveyed to the existing supply mains.

water collecting works with funds secured from local banks, the work to be done by local labor forces under the immediate supervision of the city engineer.

Construction of project

During the last week of March the city engineer initiated the construction work with the building of a small office building, tool house, blacksmith shop and cement sheds adjacent to the site of the proposed submerged dam. During the latter part of April, actual construction was begun with the excavation of the trench and the laying of 600 ft. of 14-in. cast-iron pipe at the intake end of the proposed supply line and 100 ft. of 30-in. cast-iron pipe and headwall for carrying the intake stream through the submerged dam. During the month of May the remaining 576 ft. of the 14-in. supply line were laid.

The excavation for the submerged dam was begun at the west side of the valley early in May. The first 150 ft. of this excavation was done entirely by hand labor. West of the 30-in. pipe line an excavator equipped with a 43-ft. boom and ½-yd. clamshell bucket excavated the trench to a top width of about 20 ft. and a depth of 10 to 12 ft. The lower section of the trench was excavated by hand labor. The trench prism was so located as to provide sufficient space on the upstream side of the dam for the handling of the groundwater, which was largely confined in a channel along the upstream face of the trench. Along the west side of the valley especially there was some groundwater flow out of the downstream face of the trench, which was largely backflow from the intake stream. Every effort was made to confine this backflow to a minimum by carrying the intake stream in a wooden flume about 150 ft. below the downstream end of the 30-in. pipe.

The excavation of the footing trench

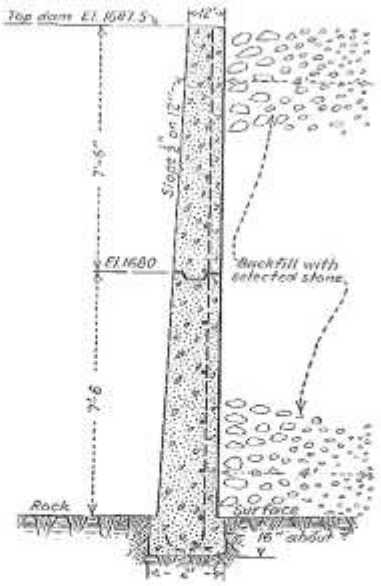


FIG. 4—THE CUTOFF WALL was built in two sections, the first extending from rock to within 7½ ft. of the top. The top is level with the spillway of the existing dam in Dry River.

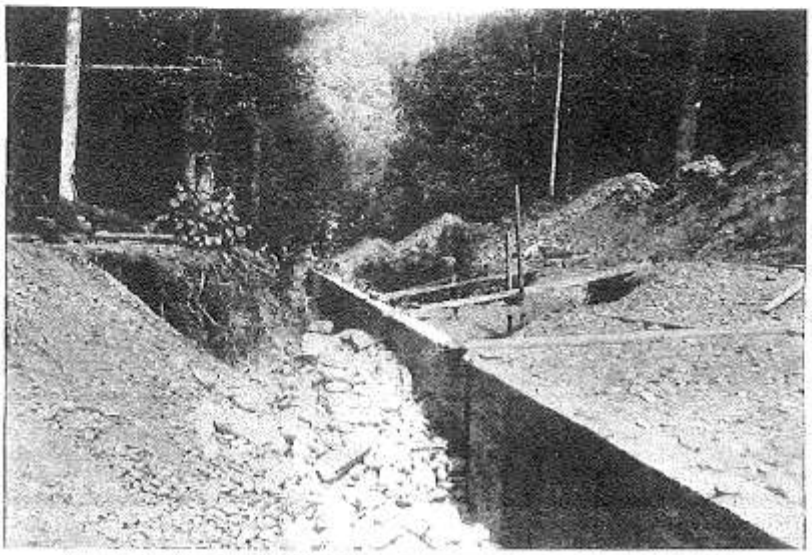


FIG. 3—SELECTED STONE from the excavated material was used as backfill on the upstream side of the wall and around the collecting gallery.

in the valley floor was done largely by quarrying, using a pavement breaker operated by a portable air compressor. In one or two sections it was necessary to blast out short lengths of the rock trench. This was done with center holes and light charges of 40 per cent dynamite, so as not to open up adjacent seams or contact planes in the valley floor.

The results of the excavation of the trench across the valley fully confirmed the indications made by the test pits and the reports of the consulting geologists, Charles Butts and Irving Crosby, who cooperated in the preliminary investigation of 1931-32. The valley floor consists of a fine-grained, closely cemented, hard sandstone, the Pocono sandstone. At the west side of the valley the narrow gorge exposed a narrow stratum of a hard, dark-colored, indurated shale. The preliminary investigation and subsequent excavation showed that this shale is as tight and impervious to the flow of water as is the sandstone.

About twelve large underground streams were encountered across the valley. Between these major streams there were minor flows through the overburden or drift. The flow of these streams varied from about 150 to 300 gal. per minute, as nearly as could be estimated. The most difficult part of the construction work was the intercepting of these streams, especially during the pouring of the footing sections of the concrete wall. The pumping requirements were taken care of by one 4-in. and one 6-in. centrifugal pump, and a gasoline-engine-driven diaphragm pump. The total pumping capacity of this equipment was about 800 gal. per minute.

To secure a fairly accurate estimate of the amount of groundwater flow during the construction period, three series of measurements were made by an engineer of the state water resources and power office. These measurements were made on July 19, Aug. 27 and Sept. 26, 1934. The following data give the essential results:

1. Flow in intake stream at upper end of 30-in. pipe on upstream side of submerged dam:
   1,407 g.p.m. on July 19.
   1,260 g.p.m. on Aug. 27.
   1,395 g.p.m. on Sept. 26.
2. Flow in intake stream at concrete flume of intake works:
   1,360 g.p.m. on July 19.
   1,170 g.p.m. on Aug. 27.
   1,630 g.p.m. on Sept. 26.
3. Groundwater flow collected along submerged dam at exit end of pipe at intake works:
   594 g.p.m. on July 19.
   650 g.p.m. on (includes estimated amount of about 10 per cent of total) Aug. 27.
   1,125 g.p.m. on (about 10 per cent of which was from extraneous sources) Sept. 26.

It will be noted that the groundwater flow on July 19 and Aug. 27 was about the same—namely, about 850,000 gal. per day. The surface flow decreased during this five-week period about 300,000 gal. per day, while the groundwater flow remained nearly constant. This condition is accounted for by the normal summer drop of surface flow and the increase in groundwater flow due to the extension of the excavation for the trench and the resulting addition of several underground streams. The considerable increase in both surface and groundwater flows shown by the Sept. 26 measurements was due to the excessive rainfall during the month of September. It should be noted in this connection that the rainfall shown by the records of the Dale Enterprise Weather Bureau station, for the first six months of 1934, indicate a subnormal condition. During July and August the rainfall was about that of the 54-year average.

The groundwater collecting works comprise a reinforced-concrete dam or wall and a collecting gallery on the upstream face of the wall in the gorge near the western side of the valley. The wall has a top width of 12 in.; the upstream face is vertical, and the downstream face has a slope of ¼ in. to the foot.

The wall was built in two sections, a footing section and a wall section, the former stopping at El. 1680. The wall section has a constant height of 7½ ft., and the top is level with the top of the dam in the river channel.

The collecting gallery is a rectangular chamber 25 ft. long, 5 ft. wide and 16.5 ft. high inside. At the ends of the gallery, about 2 ft. above the floor, are the intake openings, which are 3 ft. square and protected with cast-iron gratings. The water is carried from the collecting gallery in a 14-in. cast-iron outlet pipe, which is provided with a gate valve at its intake end in the chamber. The water in the intake stream flows through the 30-in. line and can be diverted to the collecting gallery through a 12-in. main. Such a diversion will be made during low water or drought periods, to avoid loss through seepage and evaporation. The intake openings are controlled by sluice gates operated by stands at the top of the collecting gallery, which extends about 3 ft. above the adjacent ground surface.

For drainage, a perforated concrete pipe line was laid along the upstream toe of the dam. Opposite each of the major underground streams, a tee was placed in the pipe line, and a line of smaller pipe extended to the outpouring of the stream at the upstream face of the trench.

On the upstream side of the dam the trench was backfilled over the drainage pipe with rock graduated from the large-sized stone on the bottom and against the wall to the smaller stone and sand at the top and along the outer face of the trench. Back of the wall the trench was backfilled with earth and small stone. About 8,300 cu.yd. of material was handled at an average unit cost of 37¢ per cu.yd.

The total cost of the project was $37,567, of which $17,624 was spent for labor and $14,875 for materials. Miscellaneous expenditures included $2,025 for the rental of the excavator, $30 for office expenses, $542 for workmens' compensation insurance, and $2,470 for engineering, testing and inspection. The estimated cost of the project, based on handling the work two years ago by competitive bids and lump-sum contract, was $35,000. Assuming a 20 per cent increase in the cost of executing the work during the summer of 1934 on the competitive contract basis, it is possible that the city of Harrisonburg may have effected a saving of about $4,500 by doing the work by force account—utilizing its available resources of labor, materials, equipment and machinery as far as practicable.

The field surveys, studies and design were made largely by the writer. He also supervised the later stages of the construction. Valuable assistance in the preparation of the working drawings and early supervision of construction was rendered by Harry W. Thompson. William G. Myers, city engineer of Harrisonburg, was in direct charge of construction.

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December 13, 1934

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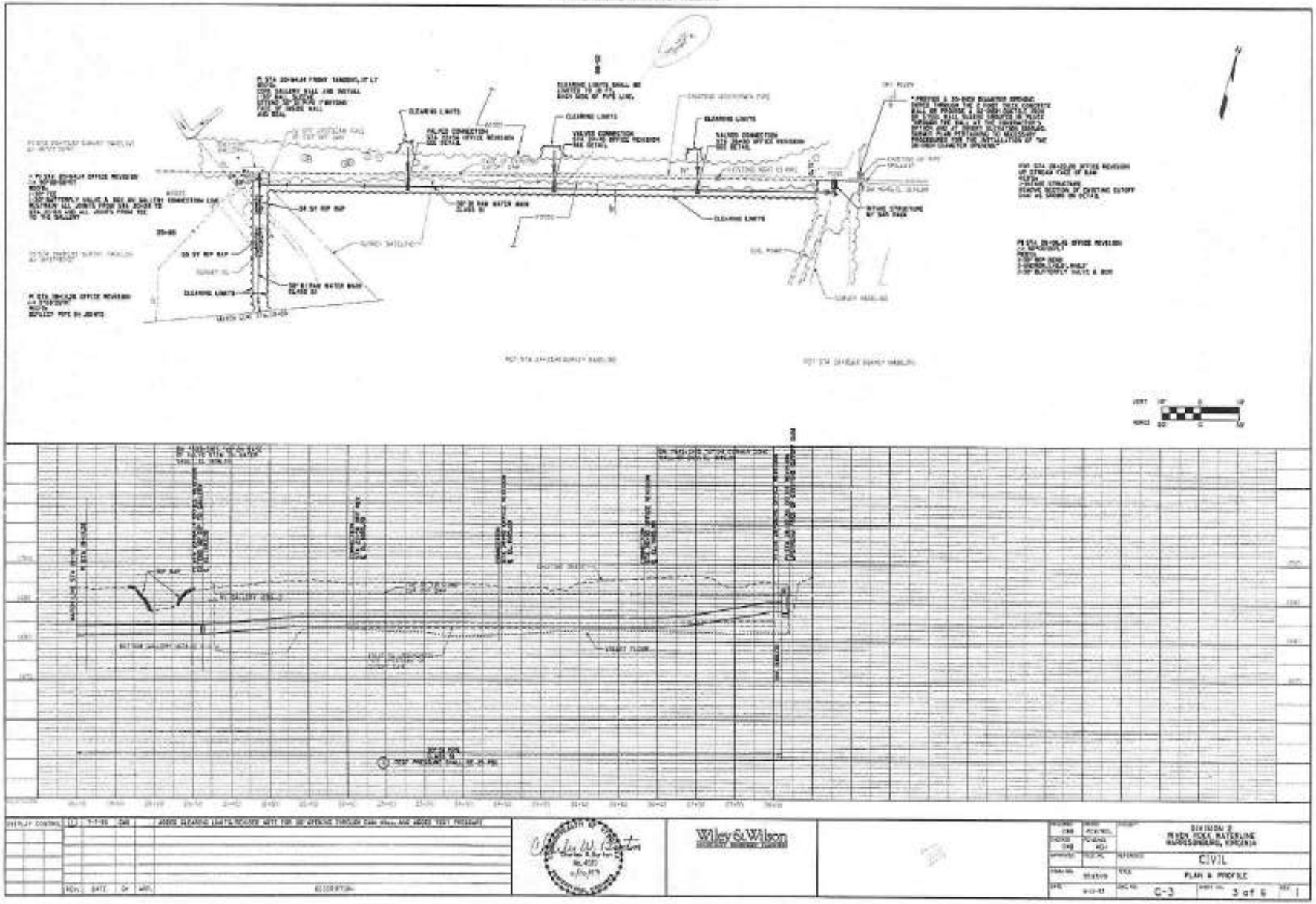
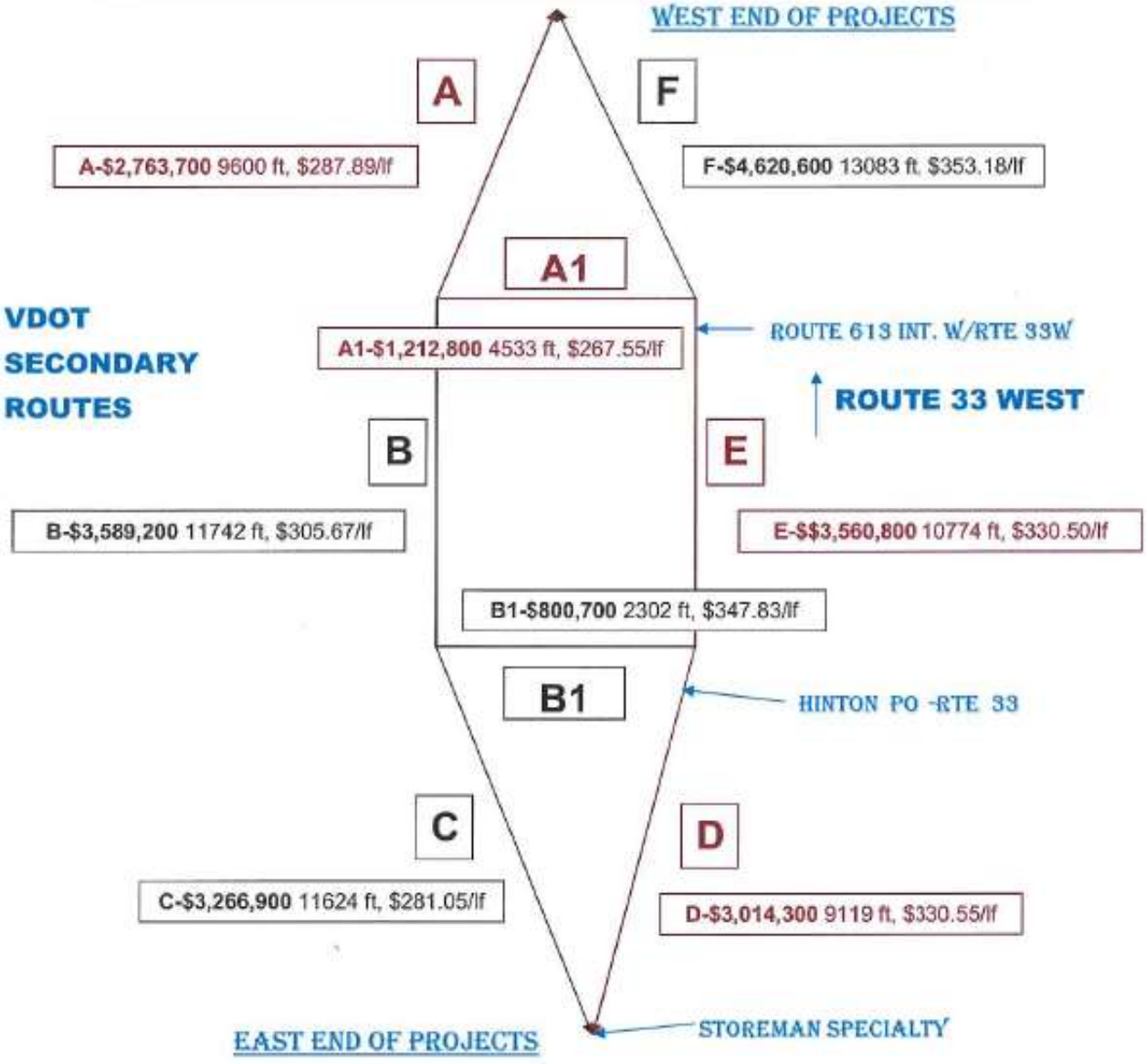
Below the Surface

GEOLOGICAL CONDITIONS in the valleys of streams frequently result in extensive subsurface flows. Understood and appreciated by geologists, this condition should not be overlooked by those communities which have developed surface supplies and subsequently find them inadequate in the normal process of expanding demand. The intercepting of the underflow of a stream from which the surface flow has been utilized may provide an economic supplemental supply, as in the case of Harrisonburg, Va., where an expenditure of $37,500 for a subsurface dam and collecting system developed 850,000 gal. per day, as described on another page in this issue. There is also the fundamental advantage that the use of underflow provides for complete development of a stream before another water supply resource must be sought. The possibilities for this type of inexpensive


Wiley & Wilson
DIVISION 2
RIVER ROCK WATERLINE
HARRISONBURG, VIRGINIA
CIVIL
PLAN & PROFILE
C-3
3 of 5

Western Raw Water
Route and Cost Summary Schematic
October 5, 2012



Note: Total Project Cost estimates shown include land/easements (5%); engineering (10%) and construction (85%)

WESTERN RAW WATERLINE DELIVERY PLANNING SCHEDULE

Updated: April, 2015

CURRENT AMOUNT OF 30" PIPE IN GROUND 22,562

REMAINING PIPE TO INSTALL 33,178

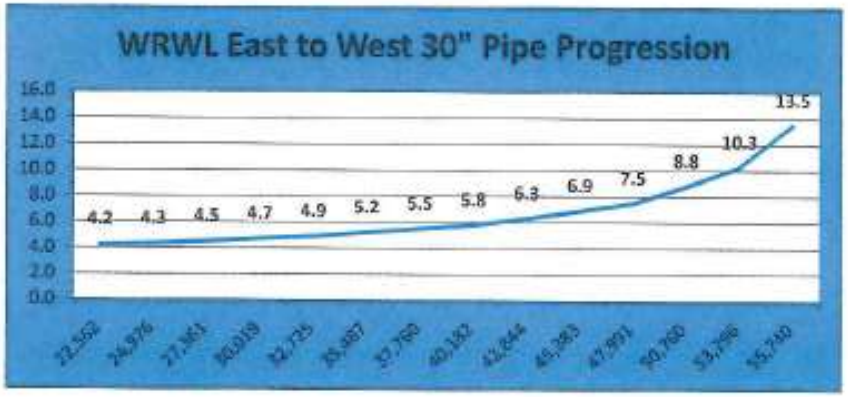
Project Completed West to East

#256	2,418
#273	1,180
#297	3,498
#345	2,364
#388	2,135
	11,595

Incomplete Projects	CUM FT	MGD
	22,562	4.2
2,414	24,976	4.3
2,385	27,361	4.5
2,658	30,019	4.7
2,706	32,725	4.9
2,762	35,487	5.2
2,273	37,760	5.5
2,422	40,182	5.8
2,662	42,844	6.3
2,539	45,383	6.9
2,608	47,991	7.5
2,769	50,760	8.8
2,536	53,296	10.3
2,444	55,740	13.5
33,178		

Projects Completed East to West

#199	3837
#99	2715
#136	4415
	10,967



Data taken from W&W Report "Updated Flow Projections and Implementation recommendations for the Western Raw Waterline Upgrade Project; Feb 2008.

CURRENT AMOUNT OF 30" PIPE IN GROUND	22,562	feet	
REMAINING PIPE TO INSTALL	33,178	feet	
ROUTE D 9,119 feet to Hinton (cash funded)	31,681	feet	4.8 MGD
ROUTE E 10,774 feet to RT 613 (cash funded)	42,455	feet	6.3 MGD
ROUTE A1 & A 14,133 FEET (Bond Funded)	56,588	feet	13.5 MGD

APPENDIX C: SWITZER DAM ON DRY RIVER SOURCE

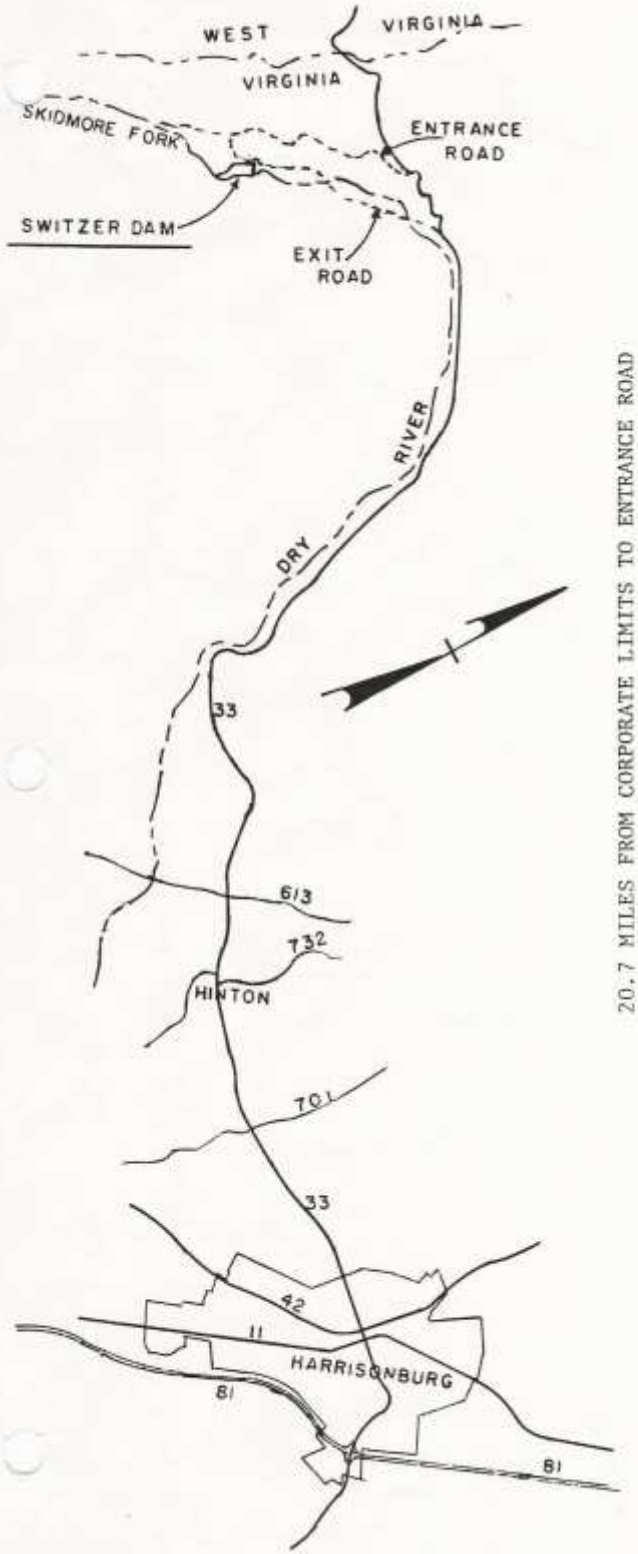
Dry River Source with Switzer Dam

Unlike conditions of 1947 in Dry River, the in-stream flow can be influenced by operations of a reservoir located upstream. Approximately five miles upstream of the City's Dry River intake is the aforementioned reservoir known as Switzer Dam. In the 1970s, the City added water supply functions to the original designed flood control dam. Switzer Dam was designed and constructed to hold 1.6 billion gallons of water; it has been rated by DEQ to have a safe yield of 8.3 MGD. Initially, the City could not use the water supply privileges until financing bond payments had been completed; a status which has now long passed (1990). There are currently no formal restrictions to the City's use of the dam.

Through the wetter part of the annual season the dam is at overflow level where flow out of the dam nearly equals flow into the dam (exception for precipitations and evaporation). During other times when the water is below overflow level, actions to control releases from the dam would be through one of the five gates in the outlet tower. One gate is a drain gate and two others are below a significant benchmark of 400,000,000 gallon reserve storage level. The remaining two gates are strategically placed above the 400,000,000 level. Controls for the gates are not readily usable and therefore it is somewhat infeasible for the City to make adjustments to the gate settings.

Informally, the City has engaged two environmental stewardship activities; the first to maintain a minimum 400,000,000 gallons in reserve and the second to maintain a release of water from the reservoir. The reserve storage concept was initiated by informal discussion with DGIF staff in the 1990s for purpose of protecting aquatic life in the lake. The release was is in recognition of certain local groups who expect the City to maintain a minimum release from Switzer Dam for the purpose of sustaining fish and aquatic life in the immediate downstream reaches of Skidmore Fork, a tributary to Dry River. The City generally leaves the second highest gate at a partially opened position and thereby allows the discharge to vary from approximately 8.0 MGD when water level is at overflow to 0.0 MGD when water level is at the open gate level. The stationary positioning of the gates, plus some escape of water from outlet structure leakage, generally provided environmental stewardship for both in lake and downstream aquatic protection.

In the fall season of a dry 1999, the City evaluated the dam release and intake capture relationship during the peak season for evaporation / transpiration. General conclusion was that a release of 8.3 MGD maintained a capture of 5.5 MGD at the City's intake located five miles downstream. During the study the water reservoir above 400,000,000 gallons was exhausted in 132 days. The Switzer Dam release – City intake recapture relationship must be recognized and refined in the RWSMP.



20.7 MILES FROM CORPORATE LIMITS TO ENTRANCE ROAD

SWITZER DAM

Joint Water Storage-Flood Control

Water Surface Area	119 acres
Drainage Area	9,414 acres
Storage to Emergency Spillway	2,255,000,000 gals.
Storage at Normal Ht.	1,600,000,000 gals.
Height of Dam	138 feet
Length of Dam Crest	1,500 feet
Thickness of Dam Base	720 feet
Width of Dam Top	40 feet
Volume of Fill	2,137,000 cu. yds.
Flood Storage Above Permanent Pool	27 feet
Concrete Riser Height	101 feet
Length of 42" Pipe Through Dam	720 feet
Sandstone Spillway-Ridge Cut	139,000 cu. yds.
Service Road Constructed	2 miles

	Cost
U. S. Soil Conservation Service	$1,900,000
City of Harrisonburg	$1,600,000
Total	$3,500,000

APPENDIX D: NORTH RIVER SOURCE

Longitude 80.847 Latitude 37.662

Intake Capacity 7.6 MGD

North River Source

The **North River** source was commissioned in the early 1970s. *The North River has given Harrisonburg a significant tool to adjust for daily and seasonal variations in demand.* Harrisonburg's Bridgewater Pump Station (BWPS) withdraws raw water from the North River. DEQ has rated North River to have a safe yield of 13.6 MGD. The source water has been under demand from Harrisonburg, Bridgewater, and irrigation practices such that a "Surface Water Management Declaration" was considered in the 1990s. The declaration did not move forward but Harrisonburg informally declared that its intention was not to use the North River beyond 5.7 MGD in times of drought. Under current VWWP regulations in combination with historic low flow in-stream records, the withdrawal is regulated by VWWP #16-0730 to no more than 12% of the in-stream flow. Harrisonburg's available withdrawal may be limited to 1.3 MGD.

Harrisonburg Assets

The City obtained access to the North River in 1970. The Bridgewater Pump Station / Intake and 20" pipe to adjoin the Silver Lake System (see Appendix F) were constructed. In the early 1990s, a 24" pipe was constructed in parallel to the pipe system from Silver Lake to Route 33. In the early 2000s, another 24" pipe was extended in the Route 33 corridor to the water treatment plant. These latter additions were made to accommodate growth from the 1983 City annexation by increasing North River capacity to 7.6MGD.

The current North River Raw Water System includes:

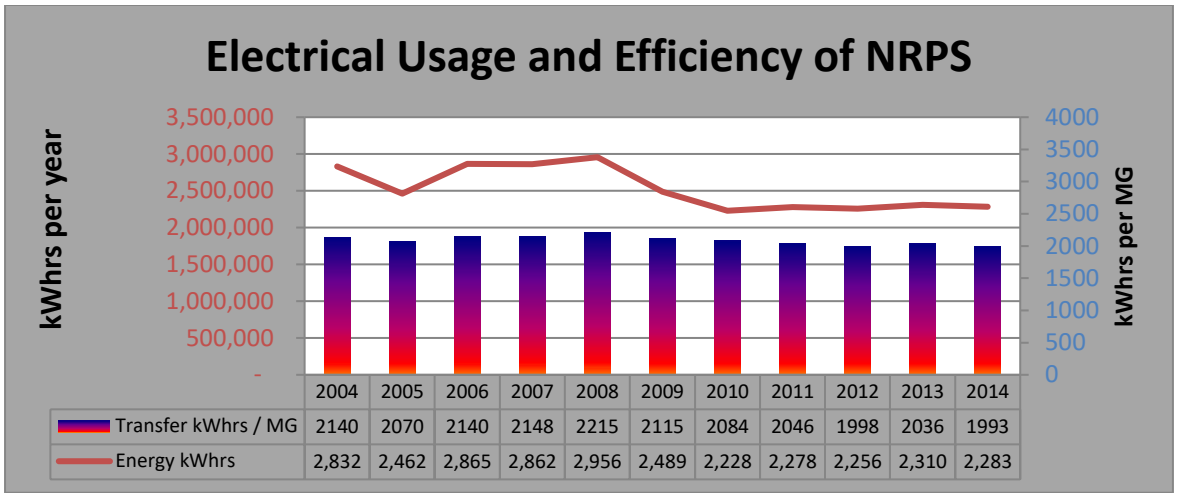
- 20” pipe: 26,312 feet
- 24” pipe: 12,591 feet
- 24” pipe: 3,969 feet
- Pump Station and Intake

A check valve in the 24” diameter pipe at the North River Valve Vault (NRVV) is scheduled for installation in 2016 and will provide risk reduction from back flow and from the introduction of higher pressures during static conditions. As a second risk management effort, the pipe network was isolated and separated to convey only North River water until it adjoins with the Dry River network at the water treatment plant. These arrangements provided risk reduction through prevention, mitigation, and enhanced recovery toward potential pipe ruptures.

The Virginia Department of Health rates the pump station at 7.6 MGD. At the intake is an in stream concrete structure where bar screens provide protection from debris entering into two parallel pipes that route water to the pump station wet well. From 1970 until mid 2015, the station had three vertical turbine pumps in active service; each pump driven by a 350 horse-power motor. The pumps and motors were started with across the line configurations and then operated at full speed for any and all individual pumps and motors. Output performances with one, two, and three pumps in parallel operations provided the City wastewater treatment plant with 3.7 MGD, 5.7 MGD, and 7.6 MGD, respectively.

Electrical power and energy usage are constraints to using this source. The Bridgewater Pump Station at the North River is the single biggest demand for electricity for HPU as it accounted for 2,283,200 kW-hrs of usage or 63% of the total water system energy usage in FY 2014. The associated power demand was 530+ kW.

system:	3,950 gpm @ 514 feet TDH @ 79% PE & 90% ME
energy:	2,150 kW-hrs/MG
power:	530 kW plus house load



North River Risk

Harrisonburg's North River source is most susceptible to several potential causes of risk.

- The hurricane event of 1985 inundated the pump station with severe impacts upon electrical equipment.
- As for contamination, recent alerts have been issued due to contamination from agricultural activities which are intense along the banks of the North River and upstream tributaries of Dry River and Mossy Creek. As similar to Dry River, the frequent small in-stream flow in the presence of a contaminant poses special attention to the concern.
- And finally, the Bridgewater Pump Station has potential for mechanical, electrical and instrumentation failure. Generally, the City has in place some abilities to operate one pump under most causes of mechanical, electrical, and instrumentation duress.

POTOMAC RIVER BASIN

01622000 NORTH RIVER NEAR BURKETOWN

LOCATION: LATITUDE 382025 LONGITUDE 0785450 HYDROLOGIC UNIT: 02070005 COUNTY: ROCKINGHAM

PERIOD OF RECORD: OCT 1925 TO SEP 1972
MAY 1975 TO SEP 1986

DRAINAGE AREA: 379 MI^2.

AVERAGE DISCHARGE: 372 CFS

REMARKS: THE HIGH FLOW MONTHS ARE NOT CONTIGUOUS. THE HIGH FLOW 7 DAY 10 YEAR FLOW CANNOT BE CALCULATED.

JANUARY - MAY

Correct

********** FLOW STATISTICS (CFS) **********

7 DAY 10 YR FLOW:	40
HIGH FLOW 7 DAY 10 YR FLOW:	NONE 65

1 DAY 30 YR FLOW:	27
HARMONIC MEAN:	142

********** MONTHLY FLOW (CFS) **********

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MINIMUM	87	107	140	174	213	263	251	182	128	93	85	79
MEAN	253	289	327	392	524	693	605	476	325	199	237	185
MAXIMUM	1486	1478	1388	1384	1786	2567	1981	1860	1623	685	1129	847

********** DAILY FLOW DURATION (CFS) **********

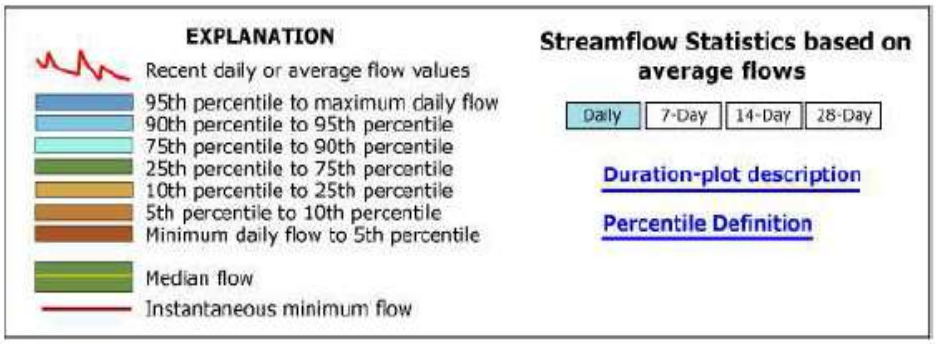
PERCENT OF TIME FLOW EXCEEDS INDICATED VALUE									
5%	10%	15%	20%	25%	30%	35%	40%	45%	50%
1251	809	604	40	406	348	300	265	231	200
174	150	130	113	98	84	73	63	52	---
55%	60%	65%	70%	75%	80%	85%	90%	95%	---

486

74 CFS = 20%

********** LOW FLOW FREQUENCY (CFS) **********

RECURRENCE IN YRS	DURATION IN DAYS								
	1	3	7	14	30	60	90	183	365
100	23	26	29	31	32	35	36	38	111
50	25	29	32	33	35	38	39	44	133
40	26	30	33	34	36	39	40	47	141
25	28	32	35	36	38	41	42	53	161
20	29	33	36	37	39	42	44	56	172
10	33	37	40	41	44	47	49	70	211
5	39	43	45	47	50	54	58	91	263
2	54	58	60	63	67	75	86	152	373



Duration Table of Daily Streamflow

Flow values in cubic feet per second

01622000 NORTH RIVER NEAR BURKETOWN, VA

	Minimum daily flow	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile	Maximum daily flow		Years of record
January	28.0	58.0	71.2	147	271	479	888	1,370	13,700		85
February	35.0	78.0	108	194	326	588	1,020	1,530	6,230		85
March	52.0	142	187	293	477	820	1,400	2,090	13,600		85
April	80.0	154	188	258	396	703	1,250	1,780	10,000		85
May	84.0	118	144	210	328	572	1,010	1,460	14,500		85
June	49.0	83.0	96.0	130	182	308	627	1,030	29,900		87
July	30.0	55.0	66.8	90.0	123	190	340	566	6,300		87
August	32.0	44.0	52.0	71.0	105	196	413	772	12,700		87
September	22.0	46.0	53.0	66.0	95.0	171	379	687	32,000		87
October	25.0	48.0	54.0	66.0	99.0	190	430	747	20,100		86
November	24.0	48.0	57.0	76.0	128	297	631	965	30,000		85
December	25.0	52.0	60.0	106	225	403	772	1,150	14,800		85

Instantaneous minimum flow for period of record = 16.0 cubic feet per second.

The current daily value for 12/06/2015 is 730 cubic feet per second.

---- Provisional Data Subject to Revision ----

APPENDIX E: SOUTH FORK SHENANDOAH RIVER SOURCE

Longitude 78 43.8' Latitude 38 20.2'

Intake Capacity TBD MGD

South Fork of the Shenandoah River Source

Harrisonburg's Power Dam Road Pump Station will withdraw raw water from the South Fork of the Shenandoah River; the withdrawal is permitted under Virginia Water Withdrawal Permit #16-0730. The lower reaches of the water shed lends to a lesser quality of raw water as compared to other available sources. A submerged structure is located in stream where bar screens provide protection from debris entering into two parallel pipes that route water to the pump station wet well. At the same location, DEQ has rated the in stream safe yield at 78.0 MGD.

Harrisonburg Assets

The intake structure and pump wet well are a unique collaboration between the City, DEQ, and various agencies responding under the input format of the Virginia Marine Resources Commission. The City pump station is located in an abandoned hydroelectric canal at the site of the original turbines; the initial intake design proposed to somewhat resurrect the hydroelectric concept that used a flow through side stream to bring source water to the turbines (pumps). The concept was also planned to facilitate boat access through the canal to overcome the hindrances to float travel caused by the in-stream dam remnants.

Through collaboration previously mentioned, an alternative concept was chosen. The concept avoided placement of difficult to maintain small screens into the mainstream river. The in stream hydroelectric dam remnants were removed, an intake with debris screen was installed at an alternative in stream location, and a flow through pump station wet well was installed at the site of the original turbines. The latter was a unique installation that allowed water to flow continuously from the in-stream structure to the pump wet well and then back into the original canal as it returns to the mainstream of the river. This unique design retained provisions to

avoid the intake and impingements of aquatic organisms by pumps and upon smaller screens, respectively, while allowing the City to have its 2 millimeter micro-screens located for easy access and repair. VWWP #16-0730 requires the City to re-evaluate using 1 millimeter size screens.

The pump station housing structure has been constructed on the old turbine support structures. The pumps to this facility are expected to be three units with 500 horsepower motors. The operation and control configuration will be much similar to the North River Pump Station as the latter's 2015 upgrade will serve as a model for the final design at Power Dam Road Pump Station. The Power Dam and Goods Mill Pump Stations have not yet been commissioned but have the following characteristics:

system	2,778 gpm @ 651 feet TDH @ 72% PE & 90% ME
energy:	3,108 kW-hrs/MG
power:	705 kW

note: subject to change with final design decisions

Shenandoah River Source Risks:

In contrast to the Dry River and North River, the Shenandoah River has a much higher in-stream flow pattern with characteristics that are typical of its location in the lower drainage basin. Changes in flow rate and water quality generally occur over longer durations. More pollution and more dilution are prevalent; the latter has significant mitigation influence. And finally, the future Power Dam Road Pump Station will have potential for mechanical, electrical and instrumentation failure. Future design will attempt to mitigate these risks.

DAM LOCATION MAP

McGAHEYSVILLE DAM

McGAHEYSVILLE QUADRANGLE

7.5 MINUTE SERIES (TOPOGRAPHIC)

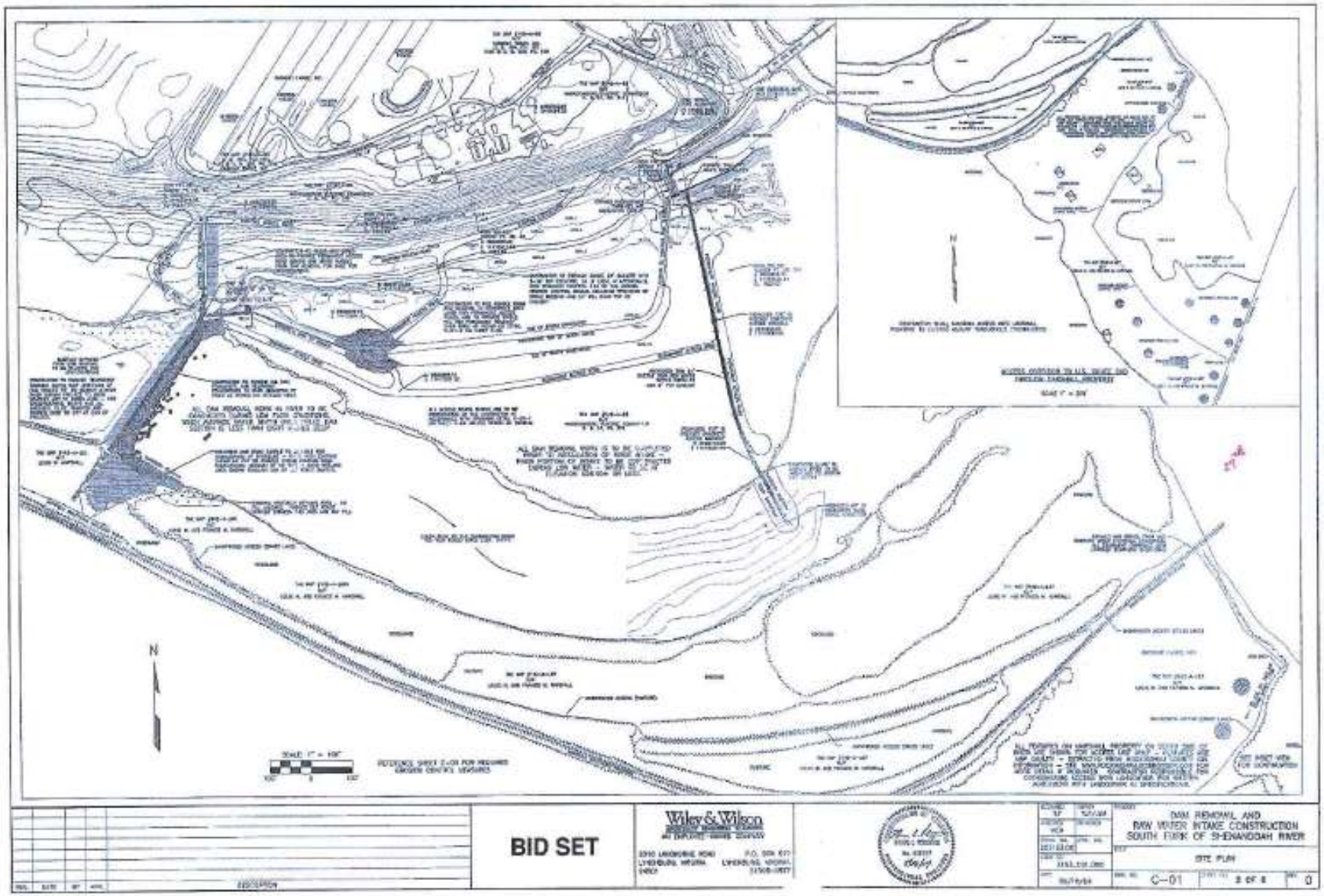
QUADRANGLE LOCATION

SCALE 1:24000

1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 KILOMETER


BID SET
Wiley & Wilson
DAM REMOVAL AND
RAW WATER INTAKE CONSTRUCTION
SOUTH FORK OF SHENANDOAH RIVER
SITE PLAN
C-01

STREAM FLOW DATA

South Fork Shenandoah River near Lynnwood
Gaging Station 1-6285

Location: 1.2 miles northeast of Lynnwood, Rockingham County and 3.3 miles downstream from confluence of North and South rivers.

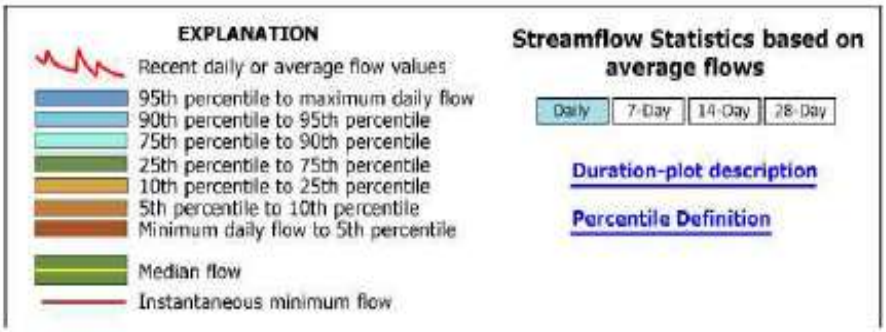
Drainage Area: 1,084 square miles

Average Discharge: 977 cfs

Length of Record: 46 years

Flow Duration Data

Percent Exceedance	Flow in C.F.S.
99.8	120
97.7	170
94.0	200
87.5	240
81.1	280
73.5	340
66.8	400
58.4	480
50.8	570
43.2	680
35.7	810
28.9	960
24.0	1100
17.1	1400
14.0	1600
10.5	1900
7.5	2300
4.1	3200
2.0	4600



Duration Table of Daily Streamflow

Flow values in cubic feet per second

01628500 SOUTH FORK SHENANDOAH RIVER NEAR LYNNWOOD, VA

	Minimum daily flow	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile	Maximum daily flow		Years of record
January	130	218	267	462	798	1,370	2,460	3,430	39,300		84
February	133	270	390	600	952	1,600	2,690	3,940	21,100		84
March	148	449	532	817	1,250	2,080	3,570	5,220	52,400		84
April	292	452	550	726	1,040	1,760	3,060	4,250	30,800		84
May	250	388	451	593	880	1,350	2,270	3,170	22,400		84
June	134	267	310	411	560	840	1,440	2,360	41,500		84
July	84.0	206	240	310	407	562	886	1,310	7,720		84
August	84.0	174	204	259	348	533	973	1,600	32,600		84
September	95.0	175	192	235	315	499	994	1,800	63,500		84
October	100	178	190	237	318	539	1,210	2,090	42,700		84
November	114	185	220	268	405	792	1,630	2,540	60,000		84
December	129	193	225	332	650	1,100	2,040	3,040	31,200		84

Instantaneous minimum flow for period of record = 32.0 cubic feet per second.

The current daily value for 12/06/2015 is 1750 cubic feet per second.

---- Provisional Data Subject to Revision ----

APPENDIX F: SILVER LAKE SOURCE

Longitude 79.057 Latitude 38.521

Intake Capacity 0.0 MGD

Silver Lake Source

Harrisonburg owns **Silver Lake**. DEQ has rated Silver Lake to have a safe yield of 1.5 MGD. The City's withdrawal is a grandfathered activity as compared to a Virginia Water Withdrawal permit. The feed location to Silver Lake is an underground spring opening from which the groundwater enters into Silver Lake. The Town of Dayton has installed horizontal well screens into the spring by which raw water is routed through a manifold and suction pipe to the Town's pump station. In contrast, the City's intake pipe lays supported on wooden cross ties from the pump station structure to a location just outside the spring / lake interface. The City's intake location is not ideal from the perspectives of both water quality and water quantity. As for water quality, City intake water is subject to high algae contents which have significant deleterious effects to water treatment filter operations. As for water quantity, the City has first rights to 1.5 MGD.

Formal privileges and restrictions upon the City's withdraws are relevant to a contractual relationship with the Town of Dayton. The Silver Lake source was purchase by the City in 1947 as a drought supplement to the Dry River source. The purchase, however, came with significant restrictions in the format of first rights of withdrawal to the Town of Dayton. The Town has held a ninety nine year lease of first rights to water withdrawal under a contract that preceded the City's1947 purchase. The lease ran from 1915 to 2014.

Harrisonburg Assets

Upon purchase, the City immediately constructed a pump station plus 10,854 feet of 16" pipe from Silver Lake to adjoin the Dry River pipe system at Route 33. Silver Lake Pump Station is inactive but has the following characteristics:

system:	929 gpm @ 378 feet TDH @72% PE & 90% ME
energy:	1,805 kW-hrs/MG
power:	137 kW

As the need for water grew, the City operated the pump station as a significant component for water supply, but not without careful respect to the Town of Dayton. Beginning with mild drought conditions, the City's raw water supply from the Silver Lake source would come into unreliable status that depended upon the relationship between the available water and the unrestricted withdrawals made by the Town of Dayton. This constraint prevailed as significant in the City's water management operations until the North River source became available in 1970.

From 1970 until 1990, the City used Silver Lake under limited application except for the catastrophic effects of the hurricane of 1985 which disabled both the Dry River and North River sources for a short period of time. As the 1990's approached, the pump station needed consideration for an upgrade as it had reached the end of its useful life and became non-functional. Given the City's longer term raw water supply needs, the smaller safe yield of Silver Lake, the water quality and quantity issues, and contractual obligations / future considerations to the Town of Dayton, the City opted not to invest at Silver Lake but to undertake efforts to the South Fork of the Shenandoah River. In conclusion, the decision to upgrade the Silver Lake Pump Station was delayed until the City could consider its own first rights to the water and with perspective to the progress made towards the Shenandoah project.

Silver Lake Risks:

The Silver Lake source is fed from groundwater feed that is under the influence of surface water. Although the surface water influence is a concern for contamination, its risk for exposure is far less than any other Harrisonburg raw water source. The Silver Lake Pump Station is currently out of operations and considered to be in non-salvageable status.

Obligations and Considerations

The Town of Dayton lease agreement for Silver Lake expired in 2014. On July 29, 2014, the City of Harrisonburg and the Town of Dayton entered into an extension of the Silver Lake Lease Agreement therein permitting the Town of Dayton to continue its withdrawal of raw water from Silver Lake. However, the terms now give Harrisonburg the first right of withdrawal for the first 1.5 MGD.

It should be noted and addressed that the City has little ability to effectively capture raw water from Silver Lake unless it gains access to the spring. Two options can achieve this goal. Harrisonburg can either share the current infrastructure owned by the Town of Dayton or the City can obtain sole ownership of the infrastructure by purchase or new installation. Condition No. 4 in the referenced lease extension provides to Harrisonburg the former option. The lease follows on the following pages.

SILVER LAKE AGREEMENT

This Silver Lake Agreement ("Agreement") is made and entered into this 24th day of July, 2014, by and between the CITY OF HARRISONBURG, VIRGINIA, a Virginia municipal corporation (the "City"), and the TOWN OF DAYTON, VIRGINIA, a Virginia municipal corporation (the "Town").

RECITALS:

A. The City owns Silver Lake in Rockingham County, Virginia.

B. The Town has drawn water from Silver Lake to provide water to the residents and businesses located within the Town since 1915.

C. The Town previously entered into a 99 year lease with the Silver Lake Improvement Company, Inc., the predecessor in interest to the City in order to withdraw water from Silver Lake. This lease term commenced on August 2, 1915 for a term of 99 years, which term shall shortly expire.

D. The Town desires to continue to draw water from Silver Lake to provide water to the residences and businesses located within the Town.

NOW, THEREFORE, for and in consideration of the promises and mutual benefits and covenants contained herein, the City and Town agree as follows:

1. Subject to paragraph two, the Town shall be allowed to withdraw water as needed from Silver Lake.

2. The first 1.5 million gallons per day of water from Silver Lake will always be available to the City upon notice to the Town of Dayton. This would be in effect if the City needs the water for any reason, including drought conditions or if any other City water source is unavailable for any reason.

3. The Town shall pay to the City $1,100 per month in consideration for taking water from Silver Lake.

4. The Town has installed a well screen at the 5 foot by 2 foot cave that leads to the Town's pump. This limits access by the City to the clear water that the City wants. The Town shall cooperate in providing access to the Spring by allowing the City to join in to the Town's pumping infrastructure or otherwise providing access that is acceptable to the City.

5. This Agreement shall be for a term of six months, and thereafter shall be on a month to month basis until terminated by either party upon 30 days written notice.

6. This Agreement embodies the entire contract and agreement between the parties and there are no other agreements or understandings, oral or written, between the City and Town except as recited herein. No amendment of this Agreement shall be valid unless in writing and signed by the parties thereto.

IN WITNESS WHEREOF, each of the undersigned has caused this Silver Lake Agreement to be signed on their behalf by their duly authorized representative.

CITY OF HARRISONBURG, VIRGINIA

By: _____
Kurt D. Hodgen

Its: City Manager

Approval as to form:

By: _____
Chris Brown

Its: City Attorney

TOWN OF DAYTON, VIRGINIA

By: _____
John D. Crim

Its: Town Superintendent

Approval as to form:

By: _____
Jason J. Ham

Its: Town Attorney

APPENDIX G: VAC LOCAL AND REGIONAL WATER SUPPLY PLAN

Internal Compliance 9VAC25-780

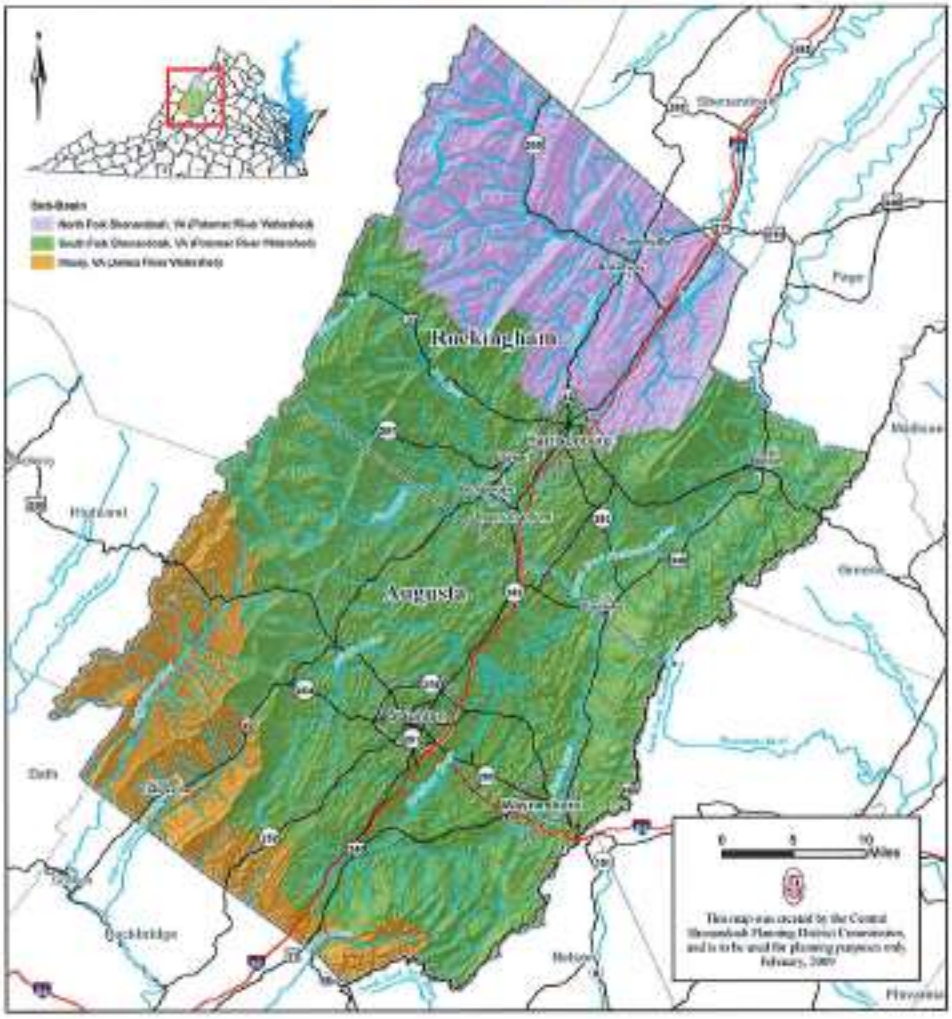
The Commonwealth of Virginia is comparatively a water rich state; however, following the drought of 1999-2002 the state engaged a statute (9VAC25-780) calling for Local and Regional Water Supply Planning. Under this statute each locality was required to submit a plan that identified their water needs throughout 2040. The City was one of 48 plans submitted by the 2011 deadline. The City optioned to submit the plan using a regional approach that culminated by action of Harrisonburg City Council to adopt the "Upper Shenandoah River Basin Water Supply Plan"

The information from 48 plans has been under review by the Department of Environmental Quality (DEQ) with purpose to develop a State Water Resources Plan (SWRP). The purpose is to make recommendations that will protect all beneficial uses to the maximum. DEQ has analyzed the data and has forecasted that the daily statewide water usage will increase by 32% to 450 MGD by 2040. In a proactive approach, DEQ has published a list of 12 recommendations that reflects how they plan to meet the intent of the statute base on the data in the SWRP. DEQ's intentions toward Harrisonburg are on display in the reissuance of VWWP #16-0730.

Update 9VAC-780

At current status Harrisonburg has made no updates to the original submittal.

Upper Shenandoah River Basin
Water Supply Plan



Prepared and Submitted By:

Central Shenandoah Planning District Commission

November 2011

Upper Shenandoah Water Supply Plan

And

Drought Preparedness and Response Plan

Covering:

Counties of Augusta, Rockingham
Cities of Harrisonburg, Staunton, Waynesboro
and
Towns of Bridgewater, Timberville, Broadway,
Dayton, Elkton, Craigsville, Grottoes, and Mt. Crawford

---

prepared by:

Central Shenandoah
Planning District Commission
112 MacTanly Place
Staunton, VA 24401

CSPDC

November 2011

The preparation of this plan was financed in part through
a grant from the Virginia Department of Environmental Quality and complies with
Virginia State Regulations 9 VAC 25 780, Local and Regional Water Supply Planning.

Table of Contents

List of Tables

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 8

List of Figures

Chapter 4

Chapter 5

Appendices

Appendix H

VWWP #16-0730

Issued June 28, 2016

Expired June 28, 2031

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

June 28, 2016

SENT VIA E-MAIL: Mike.Collins@harrisonburg.va.gov
RECEIPT CONFIRMATION REQUESTED

City of Harrisonburg
c/o Mr. A. Mike Collins, Director of Public Utilities
21255 Beery Road
Harrisonburg, Virginia 22801

Re: Virginia Water Protection (VWP) Individual Permit Number 16-0730
City of Harrisonburg Public Water System, Rockingham County, Virginia
Notice of Final Permit

Dear Mr. Collins:

Pursuant to the VWP Permit Program Regulation 9 VAC 25-210-10 and § 401 of the Clean Water Act Amendments of 1977, Public Law 95-217, the Department of Environmental Quality has enclosed the VWP Individual Permit for the "City of Harrisonburg Public Water System" project.

This permit is valid for 15 years from the date of issuance. No re-issuance or extension of the permit may occur, as the permit term cannot exceed the maximum of 15 years.

As provided by Rule 2A:2 of the Supreme Court of Virginia, you have **30 calendar days** from the date of service (the date you actually received this decision or the date it was mailed to you, whichever occurred first) within which to appeal this decision by filing a notice of appeal in accordance with the Rules of the Supreme Court of Virginia with the Director, Department of Environmental Quality. In the event that this decision is served on you by mail, three days are added to that period. Refer to Part 2A of the Rules of the Supreme Court of Virginia for additional requirements governing appeals from administrative agencies.

Alternatively, an owner may request a formal hearing for the formal taking of evidence upon relevant fact issues under Section 2.2-4020 of the Administrative Process Act. A petition for a formal hearing must meet the requirements set forth in 9 VAC 25-230-130.B of the Virginia Administrative Code. In cases involving actions of the board, such petition must be filed within 30 calendar days after notice of such action is sent to such owner by certified mail.

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

VWP Individual Permit Number 16-0730
Effective Date: June 28, 2016
Expiration Date: June 28, 2031

VIRGINIA WATER PROTECTION PERMIT ISSUED PURSUANT TO THE STATE WATER CONTROL LAW AND SECTION 401 OF THE CLEAN WATER ACT

Based upon an examination of the information submitted by the owner, and in compliance with § 401 of the Clean Water Act as amended (33 USC 1341 et seq.) and the State Water Control Law and regulations adopted pursuant thereto, the State Water Control Board (board) has determined that there is a reasonable assurance that the activity authorized by this permit, if conducted in accordance with the conditions set forth herein, will protect instream beneficial uses and will not violate applicable water quality standards. The board finds that the effect of the impact, together with other existing or proposed impacts to surface waters, will not cause or contribute to a significant impairment to state waters or fish and wildlife resources.

Permittee: City of Harrisonburg

Address: c/o Mr. A. Mike Collins,
2155 Beery Road
Harrisonburg, Virginia 22801

Activity Location: The project consists of three separate existing surface water intakes that comprise an integrated surface water supply project. These intakes are 1) the South Fork intake on the South Fork of the Shenandoah River, 2) the North River intake on the North River, and 3) the Dry River intake on the Dry River near Rawley Springs. All three intakes are located in Rockingham County.

Activity Description: The City of Harrisonburg proposes to continue operation of an integrated surface water withdrawal system to withdraw surface water at the following intake locations:

a. South Fork Intake on the South Fork of the Shenandoah River
b. North River intake on the North River, a tributary to the South Fork of the Shenandoah River
c. Dry River intake on the Dry River, a tributary to the North River

The permitted activity shall be in accordance with this Permit Cover Page, Part I - Special Conditions, and Part II - General Conditions.

Director, Office of Water Supply

6/28/16
Date

Should you have any questions, please contact Brian McGurk at (804) 698-4180, Brian.McGurk@deq.virginia.gov, or at the above address.

Respectfully,

Scott W. Kudlas
Director, Office of Water Supply

Enclosures: Permit Cover Page, Part I - Special Conditions, Part II - General Conditions, Attachment A, Permit Fact Sheet

cc: VDH Office of Drinking Water – VIA EMAIL

Part I – Special Conditions

A. Authorized Activities

1. This permit authorizes the operation of an integrated surface water supply project to withdraw surface water at the following intake locations as described in Part I.D:
   a. South Fork Intake on the South Fork of the Shenandoah River
   b. North River intake on the North River, a tributary to the South Fork of the Shenandoah River
   c. Dry River intake on the Dry River, a tributary to the North River
2. Authorized activities shall be conducted as described in the Joint Permit Application dated July 2, 2014 and received July 2, 2014, as well as supplemental materials, revisions and clarifications received through January 29, 2016.

3. The permittee shall notify the DEQ prior to any impacts to surface waters, including wetlands; and of any modifications to any of the intake structures. Any additional impacts, modifications, or changes shall be subject to individual permit review and/or modification of this permit.

B. Permit Term

1. This permit is valid for fifteen (15) years from the date of issuance. A new permit may be necessary for the continuance of the authorized activities, including water withdrawals, or any permit requirement that has not been completed. If the authorized activities will continue beyond the expiration date of the permit, submittal of an application for reissuance shall be made within 180 days of the date of permit expiration.

C. Standard Project Conditions

1. The activities authorized by this permit shall be executed in such a manner that any impacts to beneficial uses are minimized. As defined in § 62.1-10(b) of the Code, "beneficial use" means both instream and offstream uses. Instream beneficial uses include, but are not limited to, the protection of fish and wildlife habitat, maintenance of waste assimilation, recreation, navigation, and cultural and aesthetic values. Offstream beneficial uses include, but are not limited to, domestic (including public water supply), agricultural, electric power generation, commercial, and industrial uses. Public water supply uses for human consumption shall be considered the highest priority.

2. No activity shall substantially disrupt the movement of aquatic life indigenous to the water body, including those species that normally migrate through the area, unless the primary purpose of the activity is to impound water.

3. Flows downstream of the project area shall be maintained to protect all uses.

4. Virginia Water Quality Standards shall not be violated in any surface waters as a result of the project activities.

5. All required notifications and submittals shall include project name and permit number and be submitted to the DEQ office stated below, to the attention of the Water Withdrawal Permit Manager, unless directed in writing by DEQ subsequent to the issuance of this permit: Department of Environmental Quality-Office of Water Supply, P.O. Box 1105, Richmond, Virginia 23219.

6. All reports required by this permit and other information requested by DEQ shall be signed by the permittee or a person acting in the permittee's behalf, with the authority to bind the permittee. A person is a duly authorized representative only if *both* criteria below are met. If a representative authorization is no longer valid because of a change in responsibility for the overall operation of the facility, a new authorization shall be immediately submitted to DEQ.

   a. The authorization is made in writing by the permittee.

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, superintendent, or position of equivalent responsibility. A duly authorized representative may thus be either a named individual or any individual occupying a named position.

7. All submittals shall contain the following signed certification statement:

   a. "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

8. Any fish kills or spills of fuels or oils shall be reported to DEQ immediately upon discovery at (804) 698-4000. If DEQ cannot be reached, the spill shall be reported to the Virginia Department of Emergency Management (DEM) at 1-800-468-8892 or the National Response Center (NRC) at 1-800-424-8802.

9. DEQ shall be notified in writing within 24 hours or as soon as possible on the next business day when potential environmentally threatening conditions are encountered which require debris removal or involve potentially toxic substances. Measures to remove the obstruction, material, or toxic substance or to change the location of any structure are prohibited until approved by DEQ.

D. Surface Water Withdrawals

1. Surface water withdrawn from the South Fork of the Shenandoah River, the Dry River and the North River and authorized under this permit shall be only used for public water supply.

2. The safe yield of the surface water withdrawal project as authorized under this permit is the annual average daily volume of 11.88 million gallons per day (mgd).

3. The combined total withdrawal of water from the permittee's intakes on the South Fork of the Shenandoah River, the North River and the Dry River shall not exceed the limits established in the table below. The withdrawal limits described as Tier 2 are to be phased in based upon documentation of a higher total demand growth rate in comparison with that used to forecast the Tier 1 withdrawal volume and/or completion of service agreements and related capital improvements necessary to begin water service to new customers that would cause demand to exceed the Tier 1 limits.

Tier	Maximum Daily Withdrawal (mgd)	Maximum Annual Withdrawal (mg)
1	12.24	3158
2	15.33	4348

   a. Tier 1 contains the withdrawal limits to meet the justified demands of the Harrisonburg service area for the 15-year permit period ending in 2031.

   b. Tier 2 contains the withdrawal limits to meet the justified demands of the service area identified in Tier 1, plus additional demands documented by the submittal of one or more signed agreements for new customers and/or documentation of increased service to previously unserved portions of the City's service area.

4. The permittee may submit to DEQ for review and approval a request for authorization of withdrawal limits established for Tier 2. Any such request shall include a justification for the requested increase in allowable withdrawal volumes. Justification shall consist of one or more of the following:
   a. Sales or usage records over a minimum period of five years that indicate an increasing trend in demand growth rate that would cause the Tier 1 withdrawal limits to be exceeded prior to the permit expiration date,
   b. A signed agreement(s) for providing water service to new commercial, industrial or municipal customer(s) that would cause the Tier 1 withdrawal limits to be exceeded prior to the permit expiration date ,
   c. A schedule for completion of capital improvements needed to supply water to new commercial, industrial or municipal customer(s) identified in Part I.D.4.b prior to the permit expiration date.

   Upon review and approval by DEQ of the request, the allowable maximum daily and maximum annual withdrawal volumes shall equal those listed for Tier 2 in Part I.D.3. If the justification for an increase in withdrawal limits indicates that the demand will exceed the Tier 1 limits, but not reach the Tier 2 limits listed in Part I.D. 3 within the 15-year permit term, DEQ may revise the Tier 2 limits to equal the revised demand projected for the end of the permit term. Unless and until a request is made and approved for Tier 2 limits, the total allowable withdrawal volumes equal the Tier 1 values in Part. I.D.3.

South Fork Intake:

5. The permittee shall estimate stream flows at the South Fork Intake in units of cubic feet per second (cfs) on a daily basis by monitoring the stream flow gage described below and by applying the equation "Flows at the intake = Q_{SF} * 1.01," where:

    a. Q_{SF} is the previous day's provisional mean daily flow at the DEQ gage no. 01628500 (South Fork Shenandoah River near Lynnwood, VA);

    b. 1.01 is the adjustment factor for drainage area.

6. At no time shall Net Withdrawals from the South Fork Intake exceed 10% of the stream flow at the South Fork Intake as estimated using the equation described by Part I.D.5, where:
    a. Net Withdrawal = the total volume withdrawn from the South Fork intake minus Return Flow, where
    b. Return Flow = ($Flow_{SFI}$ * 0.1) * 0.66, where
    c. $Flow_{SFI}$ = flow at the South Fork Intake estimated as described by Part I.D.5, and 0.66 represents the approximate portion of the total withdrawal returned to the South Fork of the Shenandoah River upstream via treated wastewater discharge
    d. Example calculation for the lowest recorded flow at DEQ gage no. 01628500 (84 cfs):
        i. FlowSFI = 84 * 1.01 = 84.8 cfs
        ii. Return Flow = (84.8 * 0.1) *.0.66 = 5.6 cfs
        iii. Maximum Net Withdrawal = 84.8 * 0.1 = 8.5 cfs
        iv. Maximum Total Withdrawal = 8.5 + 5.6 = 14.1 cfs (9.1 mgd)

North River Intake:

7. The permittee shall estimate flows at the North River Intake in cfs on a daily basis by monitoring the stream flow gage described below and by applying the equation "Flows at the intake = Q_{NR} * 0.75," where:

    a. Q_{NR} is the previous day's provisional mean daily flow at the DEQ gage no. 01622000 (North River near Burketown, VA);

    b. 0.75 is the adjustment factor for drainage area.

8. At no time shall withdrawals from the North River Intake exceed 12% of the stream flow at the North River Intake as estimated using the equation described by Part I.D.7.
    a. Example calculation for the lowest recorded daily mean flow at DEQ gage no. 01622000:
        i. Flow at the North River intake = 22 cfs * 0.75 = 16.5 cfs
        ii. Maximum allowable withdrawal from the North River Intake = 16.5 cfs * 0.12 = 2 cfs (1.3 mgd)

Dry River Intake:

9. The permittee shall estimate flows in the Dry River in cfs on a daily basis and adjust withdrawals from the Dry River intake so that a minimum of 0.774 cfs (0.5 mgd) is released to the Dry River

below the low-head dam at the Dry River intake. No withdrawals will be allowed from this intake if the estimated flow at the intake is 0.774 cfs or less

10. The permittee shall submit a plan to DEQ review and approval for monitoring stream flow at the Dry River intake within 120 days of permit issuance. The monitoring plan shall contain, at a minimum:

    a. A detailed description of the methodology used to monitor flow at the location of the intake to ensure that withdrawals will be in compliance with Part I.D.9.
    b. A detailed design and description of any existing or planned structure(s) to be used or installed for stream flow monitoring at the intake location.

Intake Screens and Drought Management:

11. Within two years of permit issuance, the permittee shall submit for DEQ review and approval a plan to install new screens at the South Fork intake, the North River intake and the Dry River intake in order to protect aquatic species from impingement and entrainment. The plan shall include, at a minimum:

    a. A schedule for installing new screens at each intake that are designed so that screen openings are not larger than 1 millimeter in width and height and the screen face intake velocities are not greater than 0.25 feet per second. The permittee may propose alternative screen mesh and intake velocity designs for each intake. For each alternative design proposed, the plan shall include an entrainment/impingement monitoring strategy. Each entrainment/impingement monitoring strategy shall be designed with the input of the Virginia Department of Game and Inland Fisheries (VDGIF) and shall include a schedule for implementation of entrainment/impingement monitoring. The results of the impingement/entrainment monitoring shall be submitted to DEQ and VDGIF for review and approval. If the monitoring results indicate that the proposed alternative design is not protective of aquatic species, maximum screen openings of 1 millimeter in width and height and a maximum screen face intake velocity of 0.25 feet per second will be required.
    b. Detailed design plans for each intake that will allow withdrawals at the maximum allowable rates while remaining in compliance with Part I.D.11.a.

12. The permittee shall submit a drought management plan to DEQ for review and approval within 120 days of permit issuance. Any future revisions to the approved plan shall be submitted to DEQ for review and approval prior to implementing the change. The plan shall include, at a minimum, the following:

    a. Development of drought stages, including when and how each stage will be implemented. The emergency drought stage shall be initiated when a drought emergency is declared by the Commonwealth of Virginia in the Shenandoah Drought Evaluation Region or by either Rockingham County or the City of Harrisonburg in compliance with either municipality's Drought Management Ordinance.
    b. A description of the conservation measures to be implemented during each drought stage.

13. When a drought emergency is declared by the Commonwealth of Virginia in the Shenandoah Drought Evaluation Region or by either Rockingham County or the City of Harrisonburg in accordance with either municipality's Drought Management Ordinance, the permittee shall implement either the provisions directed by the Commonwealth, the Drought Management Ordinance, the Drought Management Plan required by Part I.D.13 of this permit or the mandatory conservation measures as detailed in Attachment A of this permit, whichever is the most restrictive. The permittee shall be responsible for determining when drought emergencies are declared. The permittee shall retain records documenting that mandatory conservation measures were implemented during declared drought emergencies.

E. Monitoring, Recordation and Reporting Conditions

1. The permittee shall monitor withdrawals from the South Fork of the Shenandoah River, the North River and the Dry River on a daily basis using flow totalizer technology to confirm that the withdrawals at each intake are in compliance with this permit. Such meters shall produce volume determinations within plus or minus 10% of actual flows. A defective meter or other device must be repaired or replaced within 60 days. A defective meter is not grounds for not reporting the withdrawals. During any period when a meter is defective, generally accepted engineering practice shall be used to estimate withdrawals and the period during which the meter was defective must be clearly identified in the report.

2. On each day that pumping occurs, the permittee must monitor and record the following, for each intake:

   a. Date and time.

   b. Total amount of water withdrawn each day.

   c. The maximum rate of withdrawal that occurred each date (in gpm).

   d. The provisional stream flow in cfs as measured at the following stream gages: DEQ gage no. 01628500 (South Fork Shenandoah River near Lynnwood, VA) and DEQ gage no. 01622000 (North River near Burketown, VA)

   e. The provisional stream flow at the South Fork intake and at the North River intake in cfs as estimated in accordance with Part I.D.5 and Part I.D.7, respectively

   f. The stream flow at the Dry River intake in cfs as estimated in accordance with Part I.D.9

3. The permittee shall submit a water withdrawal monitoring report to DEQ semi-annually. The semi-annual monitoring period shall be as follows: January through June and July through December. The daily records shall be tabulated by month. The report shall be submitted to DEQ by January 31st and July 31st of every year within the permit term. Submittal of the report may take the form of electronic reporting or another form determined to be acceptable by DEQ. In the

event the electronic reporting system is not available, the permittee may submit the report by electronic mail. The report shall include the following information:

a. The permittee's name and address.

b. The permit number.

c. The source(s) from which water is withdrawn.

d. The location (latitude and longitude) of the water withdrawal.

e. Information listed in Part I.E.2.

f. The cumulative volume (million gallons) of water withdrawn each month and for the calendar year.

g. The average daily volume (mgd) of water withdrawn as calculated the last day of the monitoring period.

h. In the last report for the calendar year, the largest single day withdrawal volume (mgd) that occurred in the year and the month in which it occurred.

i. The method of measuring each withdrawal.

j. If during a semi-annual reporting period a drought emergency is declared, the report shall include a summary of mandatory conservation measures implemented during the drought event.

4. Water withdrawal monitoring and reporting activities shall comply with this section, Part I.C, and Part II. All records and information that result from the monitoring and reporting activities required by this permit, including any records of maintenance activities to the withdrawal system, shall be retained for the life of the permit. This period of retention shall be extended automatically during the course of any unresolved litigation regarding the regulated activity or as requested by the State Water Control Board.

Part II – General Conditions

A. Duty to Comply

The permittee shall comply with all conditions of the VWP permit. Nothing in the VWP permit regulations shall be construed to relieve the permittee of the duty to comply with all applicable federal and state statutes, regulations and prohibitions. Any VWP permit violation is a violation of the law, and is grounds for enforcement action, VWP permit termination, revocation, modification, or denial of an application for a VWP permit extension or reissuance.

B. Duty to Cease or Confine Activity

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the activity for which a VWP permit has been granted in order to maintain compliance with the conditions of the VWP permit.

C. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or prevent any impacts in violation of the permit which may have a reasonable likelihood of adversely affecting human health or the environment.

D. VWP Permit Action

1. A VWP permit may be modified, revoked and reissued, or terminated as set forth in 9 VAC 25-210 et seq.

2. If a permittee files a request for VWP permit modification, revocation, or termination, or files a notification of planned changes, or anticipated noncompliance, the VWP permit terms and conditions shall remain effective until the request is acted upon by the board. This provision shall not be used to extend the expiration date of the effective VWP permit. If the permittee wishes to continue an activity regulated by the VWP permit after the expiration date of the VWP permit, the permittee must apply for and obtain a new VWP permit or comply with the provisions of 9 VAC 25-210-185 (VWP Permit Extension).

VWP permits may be modified, revoked and reissued or terminated upon the request of the permittee or other person at the board's discretion, or upon board initiative to reflect the requirements of any changes in the statutes or regulations, or as a result of VWP permit noncompliance as indicated in the Duty to Comply subsection above, or for other reasons listed in 9 VAC 25-210-180 (Rules for Modification, Revocation and Reissuance, and Termination of VWP permits).

E. Inspection and Entry

Upon presentation of credentials, any duly authorized agent of the board may, at reasonable times and under reasonable circumstances:

1. Enter upon any permittee's property, public or private, and have access to, inspect and copy any records that must be kept as part of the VWP permit conditions;

2. Inspect any facilities, operations or practices (including monitoring and control equipment) regulated or required under the VWP permit; and

3. Sample or monitor any substance, parameter or activity for the purpose of ensuring compliance with the conditions of the VWP permit or as otherwise authorized by law.

F. Duty to Provide Information

1. The permittee shall furnish to the board any information which the board may request to determine whether cause exists for modifying, revoking, reissuing or terminating the VWP permit, or to determine compliance with the VWP permit. The permittee shall also furnish to the board, upon request, copies of records required to be kept by the permittee.

2. Plans, specifications, maps, conceptual reports and other relevant information shall be submitted as required by the board prior to commencing construction.

G. Monitoring and Records Requirements

1. Monitoring of parameters, other than pollutants, shall be conducted according to approved analytical methods as specified in the VWP permit. Analysis of pollutants will be conducted according to 40 CFR Part 136 (2000), Guidelines Establishing Test Procedures for the Analysis of Pollutants.

2. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

3. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart or electronic recordings for continuous monitoring instrumentation, copies of all reports required by the VWP permit, and records of all data used to complete the application for the VWP permit, for a period of at least three years from the date of the expiration of a granted VWP permit. This period may be extended by request of the board at any time.

4. Records of monitoring information shall include:

   a. The date, exact place and time of sampling or measurements;

   b. The name of the individuals who performed the sampling or measurements;

   c. The date and time the analyses were performed;

d. The name of the individuals who performed the analyses;

e. The analytical techniques or methods supporting the information such as observations, readings, calculations and bench data used;

f. The results of such analyses; and

g. Chain of custody documentation.

H. Transferability

This VWP permit may be transferred to a new permittee only by modification to reflect the transfer, by revoking and reissuing the permit, or by automatic transfer. Automatic transfer to a new permittee shall occur if:

1. The current permittee notifies the board within 30 days of the proposed transfer of the title to the facility or property;

2. The notice to the board includes a written agreement between the existing and proposed permittee containing a specific date of transfer of VWP permit responsibility, coverage and liability to the new permittee, or that the existing permittee will retain such responsibility, coverage, or liability, including liability for compliance with the requirements of any enforcement activities related to the permitted activity; and

3. The board does not within the 30-day time period notify the existing permittee and the new permittee of its intent to modify or revoke and reissue the VWP permit.

I. Property rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize injury to private property or any invasion of personal rights or any infringement of federal, state or local law or regulation.

J. Reopener

Each VWP permit shall have a condition allowing the reopening of the VWP permit for the purpose of modifying the conditions of the VWP permit to meet new regulatory standards duly adopted by the board. Cause for reopening VWP permits includes, but is not limited to when the circumstances on which the previous VWP permit was based have materially and substantially changed, or special studies conducted by the board or the permittee show material and substantial change, since the time the VWP permit was issued and thereby constitute cause for VWP permit modification or revocation and reissuance.

K. Compliance with State and Federal Law

Compliance with this VWP permit constitutes compliance with the VWP permit requirements of the State Water Control Law. Nothing in this VWP permit shall be construed to preclude the institution of any legal action under or relieve the permittee from any responsibilities, liabilities, or other penalties established pursuant to any other state law or regulation or under the authority preserved by § 510 of the Clean Water Act.

L. Severability

The provisions of this VWP permit are severable.

M. Permit Modification

A VWP permit may be modified, but not revoked and reissued except when the permittee agrees or requests, when any of the following developments occur:

1. When additions or alterations have been made to the affected facility or activity which require the application of VWP permit conditions that differ from those of the existing VWP permit or are absent from it;

2. When new information becomes available about the operation or activity covered by the VWP permit which was not available at VWP permit issuance and would have justified the application of different VWP permit conditions at the time of VWP permit issuance;

3. When a change is made in the promulgated standards or regulations on which the VWP permit was based;

4. When it becomes necessary to change final dates in schedules due to circumstances over which the permittee has little or no control such as acts of God, materials shortages, etc. However, in no case may a compliance schedule be modified to extend beyond any applicable statutory deadline of the Act;

5. When changes occur which are subject to "reopener clauses" in the VWP permit; or

6. When the board determines that minimum instream flow levels resulting from the permittee's withdrawal of water are detrimental to the instream beneficial use and the withdrawal of water should be subject to further net limitations or when an area is declared a Surface Water Management Area pursuant to §§ 62.1-242 through 62.1-253 of the Code of Virginia, during the term of the VWP permit.

N. Permit Termination

After notice and opportunity for a formal hearing pursuant to Procedural Rule No. 1 (9 VAC 25-230-100) a VWP permit can be terminated for cause. Causes for termination are as follows:

1. Noncompliance by the permittee with any condition of the VWP permit;

2. The permittee's failure in the application or during the VWP permit issuance process to disclose fully all relevant facts or the permittee's misrepresentation of any relevant facts at any time;

3. The permittee's violation of a special or judicial order;

4. A determination by the board that the permitted activity endangers human health or the environment and can be regulated to acceptable levels by VWP permit modification or termination;

5. A change in any condition that requires either a temporary or permanent reduction or elimination of any activity controlled by the VWP permit; and

6. A determination that the permitted activity has ceased and that the compensatory mitigation for unavoidable adverse impacts has been successfully completed.

O. Civil and Criminal Liability

Nothing in this VWP permit shall be construed to relieve the permittee from civil and criminal penalties for noncompliance.

P. Oil and Hazardous Substance Liability

Nothing in this VWP permit shall be construed to preclude the institution of legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under § 311 of the Clean Water Act or §§ 62.1-44.34:14 through 62.1-44.34:23 of the State Water Control Law.

Q. Unauthorized Discharge of Pollutants

Except in compliance with this VWP permit, it shall be unlawful for the permittee to:

1. Discharge into state waters sewage, industrial wastes, other wastes, or any noxious or deleterious substances;

2. Excavate in a wetland;

3. Otherwise alter the physical, chemical, or biological properties of state waters and make them detrimental to the public health, to animal or aquatic life, to the uses of such waters for domestic or industrial consumption, for recreation, or for other uses;

4. On or after October 1, 2001 conduct the following activities in a wetland:

a. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions;

b. Filling or dumping;

c. Permanent flooding or impounding;

d. New activities that cause significant alteration or degradation of existing wetland acreage or functions.

R. Permit Extension

Any permittee with an effective VWP permit for an activity that is expected to continue after the expiration date of the VWP permit, without any change in the activity authorized by the VWP permit, shall submit written notification requesting an extension. The permittee must file the request prior to the expiration date of the VWP permit. Under no circumstances will the extension be granted for more than 15 years beyond the original effective date of the VWP permit. If the request for extension is denied, the VWP permit will still expire on its original date and, therefore, care should be taken to allow for sufficient time for the board to evaluate the extension request and to process a full VWP permit modification, if required.

Attachment A – Water Conservation

Mandatory Non-essential Water Use Restrictions

The following non-essential water uses will be prohibited during periods of declared drought emergencies. Please note the exceptions that follow each prohibited use. These prohibitions and exceptions will apply to uses from all sources of water and will only be effective when the Governor of Virginia or the Virginia Drought coordinator declares a Drought Emergency. Water use restrictions shall not apply to the agricultural production of food or fiber, the maintenance of livestock including poultry, nor the commercial production of plant materials, *provided that best management practices are applied to assure the minimum amount of water is utilized.*

1. ***Unrestricted irrigation of lawns is prohibited.***

   - Newly sodded and seeded areas may be irrigated to establish cover on bare ground at the minimum rate necessary for no more than a period of 60 days. Irrigation rates may not exceed one inch of applied water in any 7-day period.

   - Gardens, bedding plants, trees, shrubs and other landscape materials may be watered with hand held containers, hand held hoses equipped with an automatic shutoff device, sprinklers or other automated watering devices at the minimum rate necessary but in no case more frequently than twice per week. Irrigation should not occur during the heat of the day.

   - All allowed lawn irrigation must be applied in a manner to assure that no runoff, puddling or excessive watering occurs.

   - Irrigation systems may be tested after installation, routine maintenance or repair for no more than ten minutes per zone.

2. ***Unrestricted irrigation of golf courses is prohibited.***

   - Tees and greens may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at the minimum rate necessary.

   - Localized dry areas may be irrigated with a hand held container or hand held hose equipped with an automatic shutoff device at the minimum rate necessary.

   - Greens may be cooled by syringing or by the application of water with a hand held hose equipped with an automatic shutoff device at the minimum rate necessary.

   - Fairways may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at the minimum rate necessary not to exceed one inch of applied water in any ten-day period.

- Fairways, tees and greens may be irrigated during necessary overseeding or resodding operations in September and October at the minimum rate necessary. Irrigation rates during this restoration period may not exceed one inch of applied water in any seven-day period.

- Newly constructed fairways, tees and greens and areas that are re-established by sprigging or sodding may be irrigated at the minimum rate necessary not to exceed one inch of applied water in any seven-day period for a total period that does not exceed 60 days.

- Fairways, tees and greens may be irrigated without regard to the restrictions listed above so long as:

    - The only water sources utilized are water features whose primary purpose is stormwater management;

    - Any water features utilized do not impound permanent streams;

    - During declared Drought Emergencies these water features receive no recharge from other water sources such as ground water wells, surface water intakes, or sources of public water supply; and,

    - All irrigation occurs between 9:00 p.m. and 10:00 a.m.

- All allowed golf course irrigation must be applied in a manner to assure that no runoff, puddling or excessive watering occurs.

- Rough areas may not be irrigated.

3. ***Unrestricted irrigation of athletic fields is prohibited.***

    - Athletic fields may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. at a rate not to exceed one inch per application or more than a total of one inch in multiple applications during any ten-day period. All irrigation water must fall on playing surfaces with no outlying areas receiving irrigation water directly from irrigation heads.

    - Localized dry areas that show signs of drought stress and wilt (curled leaves, foot-printing, purpling) may be syringed by the application of water for a cumulative time not to exceed fifteen minutes during any twenty four hour period. Syringing may be accomplished with an automated irrigation system or with a hand held hose equipped with an automatic shutoff device at the minimum rate necessary.

    - Athletic fields may be irrigated between the hours of 9:00 p.m. and 10:00 a.m. during necessary overseeding, sprigging or resodding operations at the minimum rate necessary for a period that does not exceed 60 days. Irrigation rates during this restoration period may not exceed one inch of applied water in any seven-day period. Syringing is permitted during signs of drought stress and wilt (curled leaves, foot-printing, purpling).

- All allowed athletic field irrigation must be applied in a manner to assure that no runoff, puddling or excessive watering occurs.

- Irrigation is prohibited on athletic fields that are not scheduled for use within the next 120-day period.

- Water may be used for the daily maintenance of pitching mounds, home plate areas and base areas with the use of hand held containers or hand held hoses equipped with an automatic shutoff device at the minimum rate necessary.

- Skinned infield areas may utilize water to control dust and improve playing surface conditions utilizing hand held containers or hand held hoses equipped with an automatic shutoff device at the minimum rate necessary no earlier than two hours prior to official game time.

4. ***Washing paved surfaces such as streets, roads, sidewalks, driveways, garages, parking areas, tennis courts, and patios is prohibited.***

   - Driveways and roadways may be pre-washed in preparation for recoating and sealing.

   - Tennis courts composed of clay or similar materials may be wetted by means of a hand-held hose equipped with an automatic shutoff device at the minimum rate necessary for maintenance. Automatic wetting systems may be used between the hours of 9:00 p.m. and 10:00 a.m. at the minimum rate necessary.

   - Public eating and drinking areas may be washed using the minimum amount of water required to assure sanitation and public health.

   - Water may be used at the minimum rate necessary to maintain effective dust control during the construction of highways and roads.

5. ***Use of water for washing or cleaning of mobile equipment including automobiles, trucks, trailers and boats is prohibited.***

   - Mobile equipment may be washed using hand held containers or hand held hoses equipped with automatic shutoff devices provided that no mobile equipment is washed more than once per calendar month and the minimum amount of water is utilized.

   - Construction, emergency or public transportation vehicles may be washed as necessary to preserve the proper functioning and safe operation of the vehicle.

   - Mobile equipment may be washed at car washes that utilize reclaimed water as part of the wash process or reduce water consumption by at least 10% when compared to a similar period when water use restrictions were not in effect.

- Automobile dealers may wash cars that are in inventory no more than once per week utilizing hand held containers and hoses equipped with automatic shutoff devices, automated equipment that utilizes reclaimed water as part of the wash process, or automated equipment where water consumption is reduced by at least 10% when compared to a similar period when water use restrictions were not in effect.

- Automobile rental agencies may wash cars no more than once per week utilizing hand held containers and hoses equipped with automatic shutoff devices, automated equipment that utilizes reclaimed water as part of the wash process, or automated equipment where water consumption is reduced by at least 10% when compared to a similar period when water use restrictions were not in effect.

- Marine engines may be flushed with water for a period that does not exceed 5 minutes after each use.

6. ***Use of water for the operation of ornamental fountains, artificial waterfalls, misting machines, and reflecting pools is prohibited.***

   - Fountains and other means of aeration necessary to support aquatic life are permitted.

7. ***Use of water to fill and top off outdoor swimming pools is prohibited.***

   - Newly built or repaired pools may be filled to protect their structural integrity.

   - Outdoor pools operated by commercial ventures, community associations, recreation associations, and similar institutions open to the public may be refilled as long as:

     - Levels are maintained at mid-skimmer depth or lower;

     - Any visible leaks are immediately repaired;

     - Backwashing occurs only when necessary to assure proper filter operation;

     - Deck areas are washed no more than once per calendar month (except where chemical spills or other health hazards occur);

     - All water features (other than slides) that increase losses due to evaporation are eliminated; and

     - Slides are turned off when the pool is not in operation.

   - Swimming pools operated by health care facilities used in relation to patient care and rehabilitation may be filled or topped off.

- Indoor pools may be filled or topped off.

- Residential swimming pools may be filled only to protect structural integrity, public welfare, safety and health and may not be filled to allow the continued operation of such pools.

8. ***Water may be served in restaurants, clubs, or eating-places only at the request of customers.***

Appendix I

CIP and Project Management

Capital Improvement Program
FY2021 thru FY2025
Project Request Form

Project Title: WESTERN RAW WATERLINE (910161-48621)
Project Code: proj202
Project Priority: Priority 2 **Project Type:** REPLACEMENT **Start Date (FYE):** 1995
Department: 2011 **Status:** Active **Completion Date (FYE):** 2072

Description:

The code will be funded to replace all assets scheduled for retirement in the 20 year horizon. The annual appropriations are desired to match the adjusted Annual Cost of Sustainable Ownership, ACSO shown below. CIP appropriation and expenditure schedules have been adjusted to reflect the Department's Long Term Financial Modeling strategy. The strategy balances debt, expenses, rate increases and other factors. The funds will be expended from the code as required to maintain both a high level of service and maintain a positive balance in the code, preferably above 2% of the Current Asset Replacement Value, CARV.

Project 48261, as pertains to the Dry River system, targets to maximize use of the City's priority water source while also enhancing risk management, electrical energy management and asset management for the adjacent potable water system in the Route 33 West corridor. Project 48261, as pertains to the North River system targets to retain the use of this water source with continued 20" pipeline condition assessments/rehabilitation and River Pump Station intake improvements.These assets are operated and maintained under budget 332061.

CARV (Western Raw Assets): $33,419,055
20 Year CARV: $623,098 (2%)
Adjusted ACSO per year (level funding at 2.5% APR): $31,151
Depreciated Asset Value (Western Raw Assets): $11,189,485 (33%)
Current ENR Value: 11,293

Justifications:

Mandated
x-Remove hazards
x-Maintains service
x-Increase efficiency
x-Increase revenues
x-Improves service
New service
Convenience
Other

Goals and Objectives

G 14
O 14.1

Explanation:

Program 48261 will complete the construction of a new larger 30" pipe from the City Dry River intake to the Water Treatment Plant. There will be no retirement of existing raw water assets as the existing 16" raw water pipe assets will be simultaneously converted to use in delivering potable water; older existing potable water pipe assets will be retired instead. The 30" pipe from Bellview Road to VPGA, risk mitigations, DRI intake screening requirements from VWWP, intake improvements, and Dry River Dam Rehabilitation & lower water access bridge will be constructed using proceeds from a bond sale ($10.23M) issued in FY2025. Remaining 30" pipe construction ($8.44M) from VPGA to Coopers Mountain will be programmed later pending condition assessment of both raw and potable water pipe.

Anticipated year expenses are summarized as follows:
2021: $142,900 Asset Replacements; $42,393 Dry River Stream Stabilization; $100,000 NR 20" & West 16" Condition Assessments; $35,000 Easement Aquisitions (Bellview to VPGA)
2022: $129,073 Asset Replacements; $100,000 NR 20" & West 16" Condition Assessments; $35,000 Easement Aquisitions (Bellview to VPGA)
2023: $100,000 North River 20" & Western 16" Condition Assessments; $35,000 Easement Aquisitions (Bellview to VPGA)
2024: $100,000 North River 20" & Western 16" Condition Assessments; $35,000 Easement Aquisitions (Bellview to VPGA)
2025: $149,260 #197 Dry River Dam Repair; $90,000 Dry River Low Water Bridge; $100,000 NR 20" & West 16" Condition Assessments; #508 VWWP Compliance Screens ($962,103 PDPS Shen. R; $2,212,837 NRPS & $1,635,575 RR Intake); $1,000,000 Mt. View to WTP Pipeline Risk Reduction; $2,326,425 #489 Western Raw Water Line (Bellview to VPGA).

Future scheduling will be programmed pursuant to asset management risk, lifecycle analysis and condition assessments.

Alternative:

Limited oppurtunity to change project scope but schedule can be altered with acceptance of risk. Screens at source intakes are mandated by VWWP 16-0730 (Alternaives to be negotiated)

Expenditures:	Prior	2021	2022	2023	2024	2025	Future	Total
Planning	$676,780							$676,780

Land	$338,390							$338,390
Construction	$5,752,628	$66,155	$66,155	$66,155	$66,155	$10,259,930	$8,910,324	$25,187,502
Equipment								$0
Other Expenses								$0
Total	$6,767,798	$66,155	$66,155	$66,155	$66,155	$10,259,930	$8,910,324	$26,202,672

Funding Sources:	Prior	2021	2022	2023	2024	2025	Future	Total
General Revenue								$0
Enterprise Revenue	$6,767,880	$66,151	$66,151	$66,151	$66,151	$31,151	$467,262	$7,530,897
Bond Proceeds						$10,228,775	$8,443,000	$18,671,775
Grants								$0
Capital Project Fund								$0
Other Revenue								$0
Total	$6,767,880	$66,151	$66,151	$66,151	$66,151	$10,259,926	$8,910,262	$26,202,672

Operating Impacts:	Prior	2021	2022	2023	2024	2025	Future	Total
Personnel								$0
Operating								$0
Capital								$0
Offsets								$0
Total	$0	$0	$0	$0	$0	$0	$0	$0

Asset Inventory			CARV	Net Book Value	Net Book Value YR+N	Annual Depreciation
Source of Supply Western Raw Water 910161-48621	Pipes		$32,297,365	$10,677,066	$9,499,285	$235,556
	Valves		$1,121,690	$512,419	$450,815	$12,321
	Subtotal		$33,419,055	$11,189,485	$9,950,100	$247,877

DATE/ENR July 2019/11293

508 - VWWP Compliance Dry River Riven Rock Intake SCREENS	TBD- NRPS Intake Piping R&R (River Intake to Pump Building)	Raw Water Mt. View to WTP pipeline Risk Reduction (DESIGN)	Raw Water Mt. View to WTP pipeline Risk Reduction (LAND)	Raw Water Mt. View to WTP pipeline Risk Reduction (CONST)	489-Western Raw Waterline (Bellview to VPGA) Land	489-Western Raw Waterline (Bellview to VPGA) DESIGN	489-Western Raw Waterline (Bellview to VPGA) CONSTRUCT	489-Western Raw Waterline (VPGA to Coopers Mt. Rd.) Land	489-Western Raw Waterline (VPGA to Coopers Mt. Rd.) DESIGN	489-Western Raw Waterline (VPGA to Coopers Mt. Rd.) CONSTRUCT	Asset R&R Expenses / Yr	Total Cash Expenses/Yr	Total Bond Expenses/Yr	Cummulative Cash Expences	Averages	BALANCE Cummmulative
ital Projects		Life Cycle Cost from HPU Capital Projects			Life Cycle Cost from HPU Capital Projects			Life Cycle Cost from HPU Capital Projects								
$1,700,000	TBD	$100,000	$50,000	$850,000	$217,950	$435,900	$3,705,150	$422,150	$844,300	$7,176,550						
ear 2020					Remaining Balance after Year 2020			Remaining Balance after Year 2020				N/A		$ 6,406,125	N/A	$ 236,755
$1,635,575	TBD	$100,000	$50,000	$850,000	$177,950	$435,900	$3,705,150	$422,150	$844,300	$7,176,550		$ 361,672		$ 6,767,797	N/A	$ 83
					$ 35,000						$ 31,155	$ 66,155		$ 6,833,952		$ 79
					$ 35,000						$ 31,155	$ 66,155		$ 6,900,107	5 YEAR AVERAGE	$ 75
					$ 35,000						$ 31,155	$ 66,155		$ 6,966,262		$ 70
					$ 35,000						$ 31,155	$ 66,155		$ 7,032,417		$ 66
$ 1,635,575		$ 100,000	$ 50,000	$ 850,000	$ 37,950	$ 435,900	$ 1,852,575				$ 31,155	$ 31,155	$ 8,376,200	$ 7,063,572	$ 59,155	$ 62
							$ 1,852,575				$ 31,155	$ 31,155	$ 1,852,575	$ 7,094,727		$ 58
											$ 31,155	$ 31,155		$ 7,125,882	10 YEAR	$ 54
											$ 31,155	$ 31,155		$ 7,157,036	AVERAGE	$ 50
											$ 31,155	$ 31,155		$ 7,188,191		$ 46
								$ 422,150	$ 844,300		$ 31,155	$ 31,155	$ 1,266,450	$ 7,219,346	$ 45,155	$ 41
										$ 7,176,550	$ 31,155	$ 31,155	$ 7,176,550	$ 7,250,501		$ 37
											$ 31,155	$ 31,155		$ 7,281,656	15 YEAR	$ 33
											$ 31,155	$ 31,155		$ 7,312,811	AVERAGE	$ 29
											$ 31,155	$ 31,155		$ 7,343,966		$ 25
											$ 31,155	$ 31,155		$ 7,375,121	$ 40,488	$ 21
											$ 31,155	$ 31,155		$ 7,406,276		$ 17
											$ 31,155	$ 31,155		$ 7,437,431	20 YEAR	$ 12
											$ 31,155	$ 31,155		$ 7,468,586	AVERAGE	$ 8
											$ 31,155	$ 31,155		$ 7,499,741		$ 4
											$ 31,155	$ 31,155		$ 7,530,895	$ 38,155	$ -