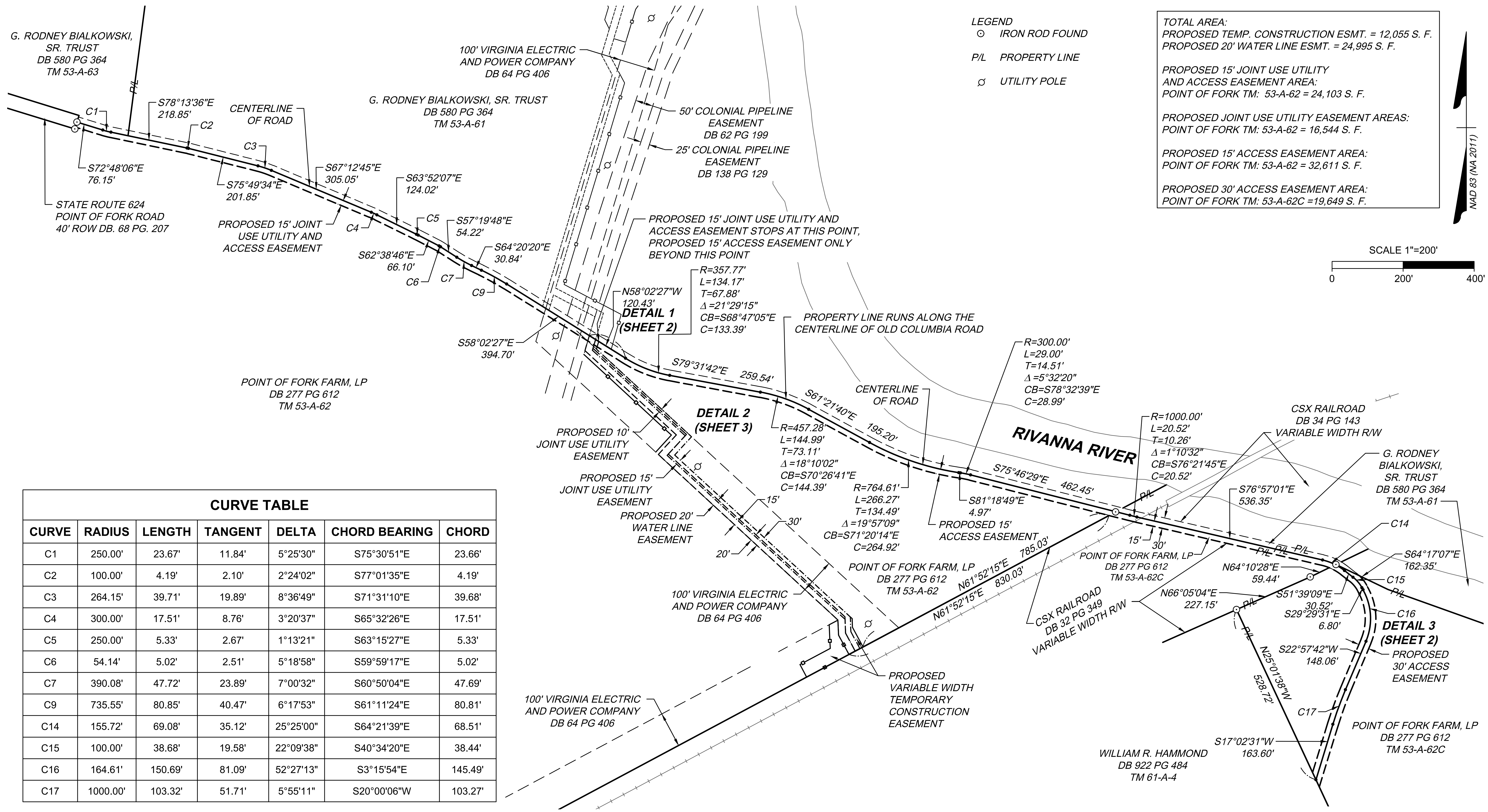

TOTAL AREA:
PROPOSED TEMP. CONSTRUCTION ESMT. = 12,055 S. F.
PROPOSED 20' WATER LINE ESMT. = 24,995 S. F.

PROPOSED 15' JOINT USE UTILITY AND ACCESS EASEMENT AREA:
POINT OF FORK TM: 53-A-62 = 24,103 S. F.

PROPOSED JOINT USE UTILITY EASEMENT AREAS:
POINT OF FORK TM: 53-A-62 = 16,544 S. F.

PROPOSED 15' ACCESS EASEMENT AREA:
POINT OF FORK TM: 53-A-62 = 32,611 S. F.

PROPOSED 30' ACCESS EASEMENT AREA:
POINT OF FORK TM: 53-A-62C =19,649 S. F.

CURVE TABLE

CURVE	RADIUS	LENGTH	TANGENT	DELTA	CHORD BEARING	CHORD
C1	250.00'	23.67'	11.84'	5°25'30"	S75°30'51"E	23.66'
C2	100.00'	4.19'	2.10'	2°24'02"	S77°01'35"E	4.19'
C3	264.15'	39.71'	19.89'	8°36'49"	S71°31'10"E	39.68'
C4	300.00'	17.51'	8.76'	3°20'37"	S65°32'26"E	17.51'
C5	250.00'	5.33'	2.67'	1°13'21"	S63°15'27"E	5.33'
C6	54.14'	5.02'	2.51'	5°18'58"	S59°59'17"E	5.02'
C7	390.08'	47.72'	23.89'	7°00'32"	S60°50'04"E	47.69'
C9	735.55'	80.85'	40.47'	6°17'53"	S61°11'24"E	80.81'
C14	155.72'	69.08'	35.12'	25°25'00"	S64°21'39"E	68.51'
C15	100.00'	38.68'	19.58'	22°09'38"	S40°34'20"E	38.44'
C16	164.61'	150.69'	81.09'	52°27'13"	S3°15'54"E	145.49'
C17	1000.00'	103.32'	51.71'	5°55'11"	S20°00'06"W	103.27'

NOTES:

1. HORIZONTAL DATUM IS BASED ON NAD 83 (NA2011), VIRGINIA STATE GRID, SOUTH ZONE. DATUM ESTABLISHED THROUGH LEICA SmartNet.

2. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY DELINEATION SHOWN IS BASED ON RECOVERED MONUMENTS IN THE FIELD AND DEEDS OF RECORD. NO TITLE REPORT FURNISHED. EASEMENTS MAY EXIST WHICH ARE NOT SHOWN HEREON.

COMMONWEALTH OF VIRGINIA
PAUL N. HUBER
Lic. No.2379
09/06/16
LAND SURVEYOR

PLAT SHOWING PROPOSED 15' JOINT USE UTILITY AND ACCESS EASEMENT, PROPOSED JOINT USE UTILITY EASEMENT, PROPOSED 30' ACCESS EASEMENT, PROPOSED 20' WATER LINE EASEMENT AND PROPOSED VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF POINT OF FORK FARM, LP

Columbia District	Fluvanna County
Date: 09/06/2016	Scale: 1"=200'
Sheet1 of 3	J.N.: 33927
Drawn by: MLH	Checked by: PNH

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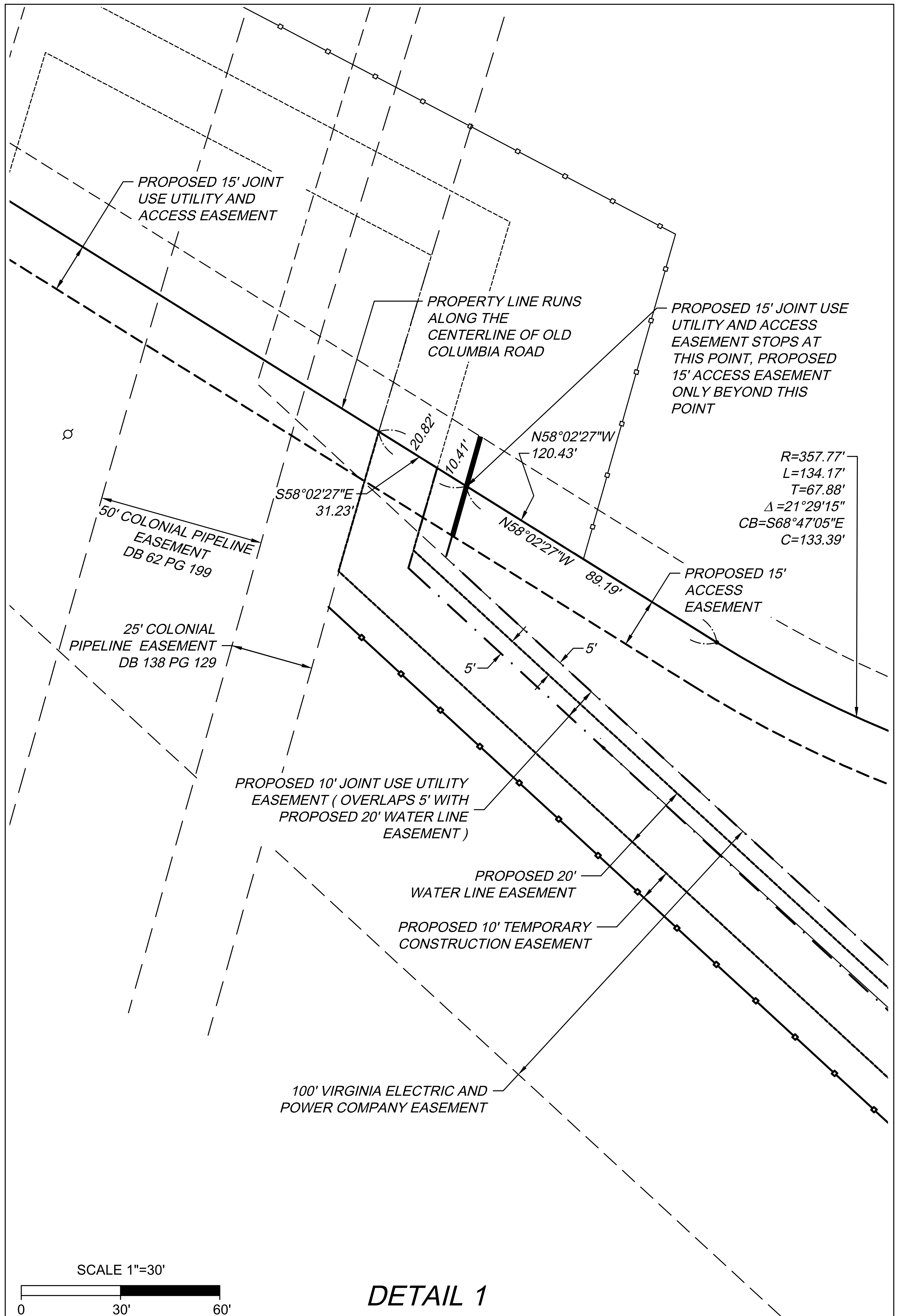
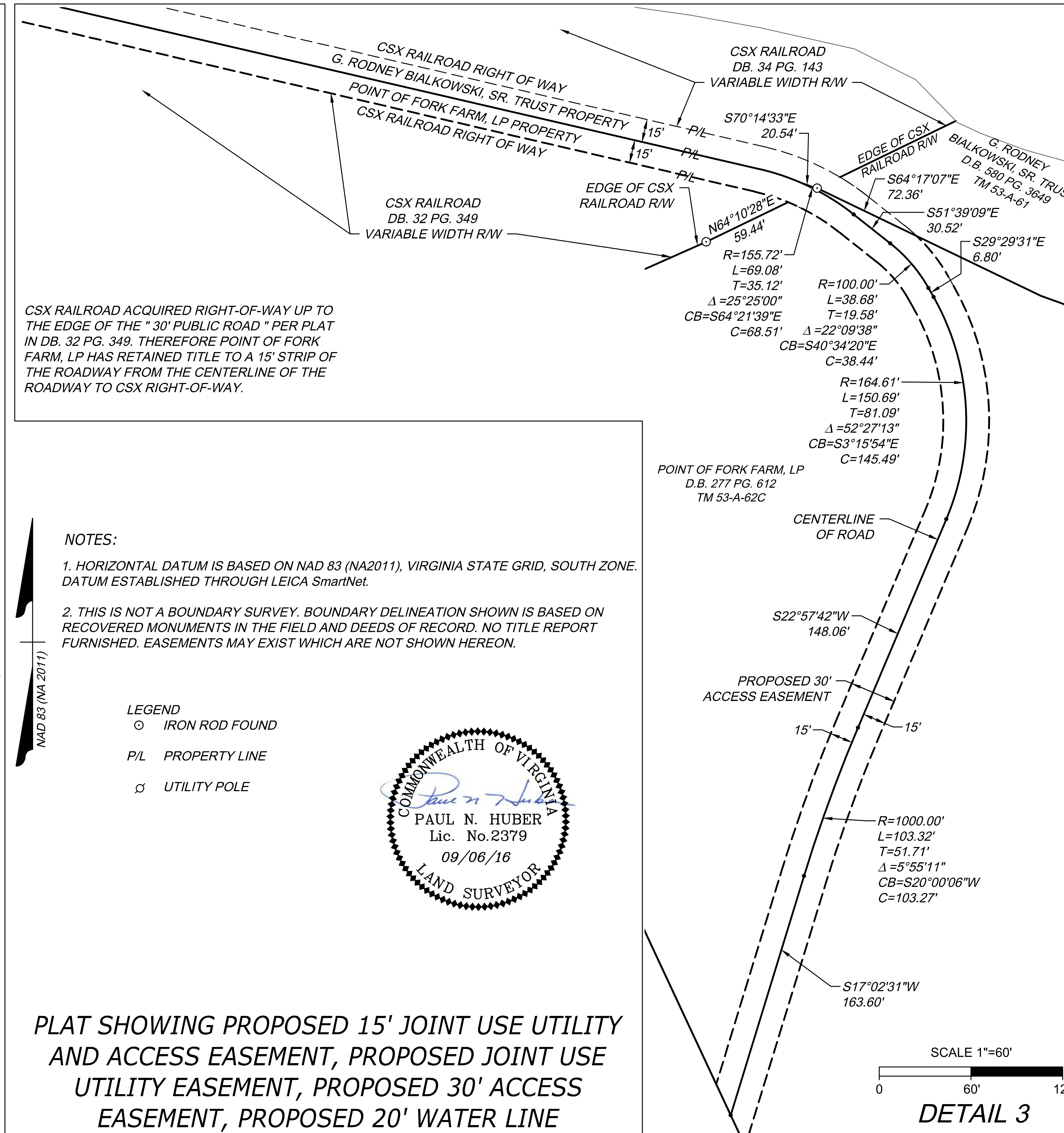


DETAIL 1



DETAIL 3

NAD 83 (NA 2011)

NOTES:

1. HORIZONTAL DATUM IS BASED ON NAD 83 (NA2011), VIRGINIA STATE GRID, SOUTH ZONE. DATUM ESTABLISHED THROUGH LEICA SmartNet.

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LEGEND

⊙ IRON ROD FOUND

P/L PROPERTY LINE

ø UTILITY POLE

COMMONWEALTH OF VIRGINIA
PAUL N. HUBER
Lic. No.2379
09/06/16
LAND SURVEYOR

PLAT SHOWING PROPOSED 15' JOINT USE UTILITY AND ACCESS EASEMENT, PROPOSED JOINT USE UTILITY EASEMENT, PROPOSED 30' ACCESS EASEMENT, PROPOSED 20' WATER LINE EASEMENT AND PROPOSED VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF POINT OF FORK FARM, LP

Columbia District	Fluvanna County
Date: 09/06/2016	Scale: AS SHOWN
Sheet2 of 3	J.N.: 33927
Drawn by: MLH	Checked by: PNH

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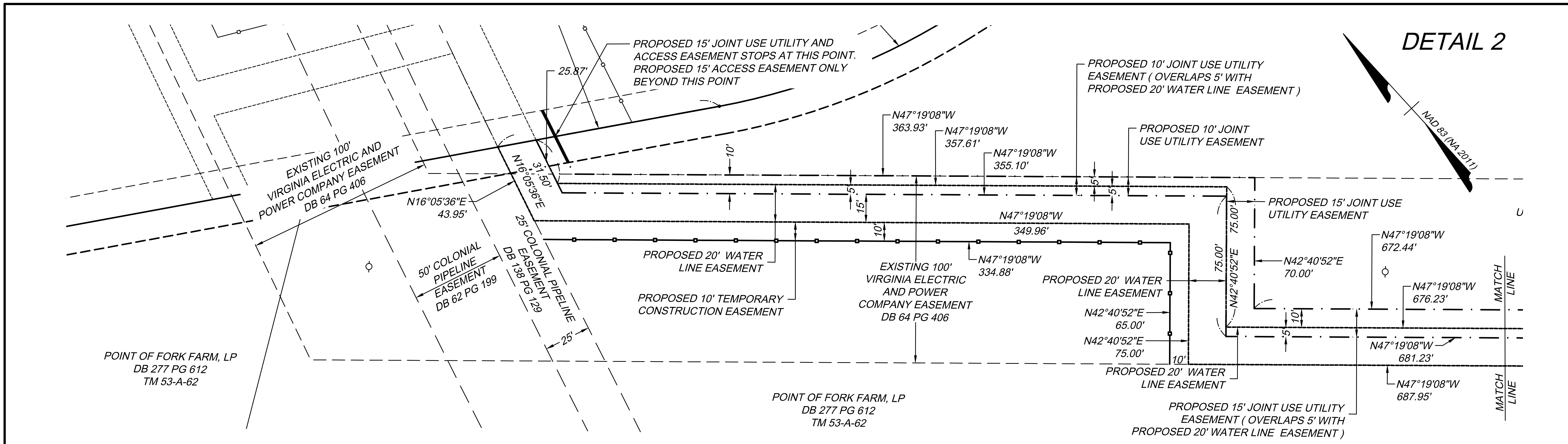
Y:\904\33927-James_River_Water\DWG\2016-0819_EDIT_Bialkowski-POF\33927V-ESMT_53-A-62_REVISED_08-19-19.dwg | Plotted on 9/7/2016 11:00 AM | by Michael Harris

DETAIL 2



NOTES:

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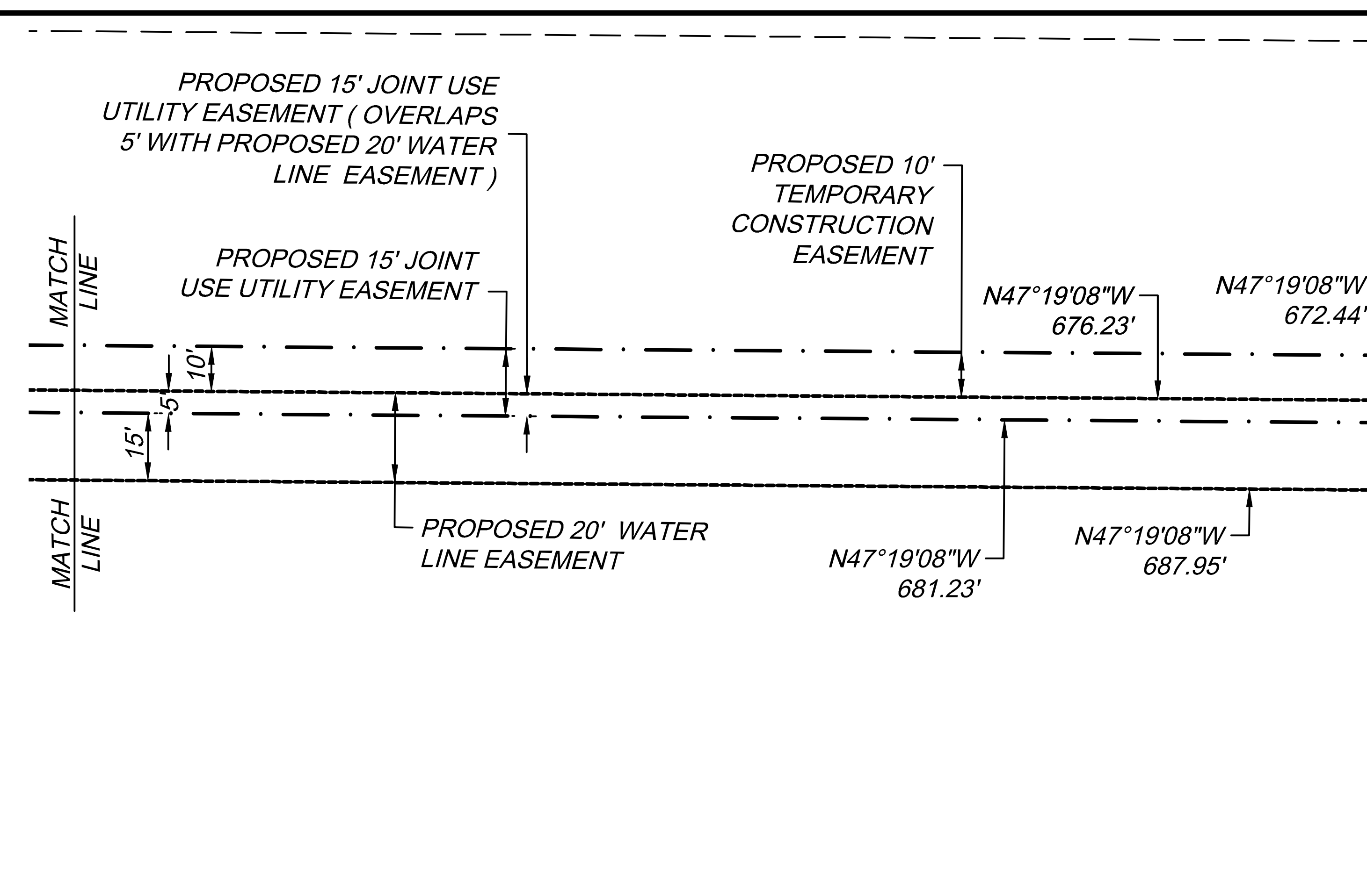
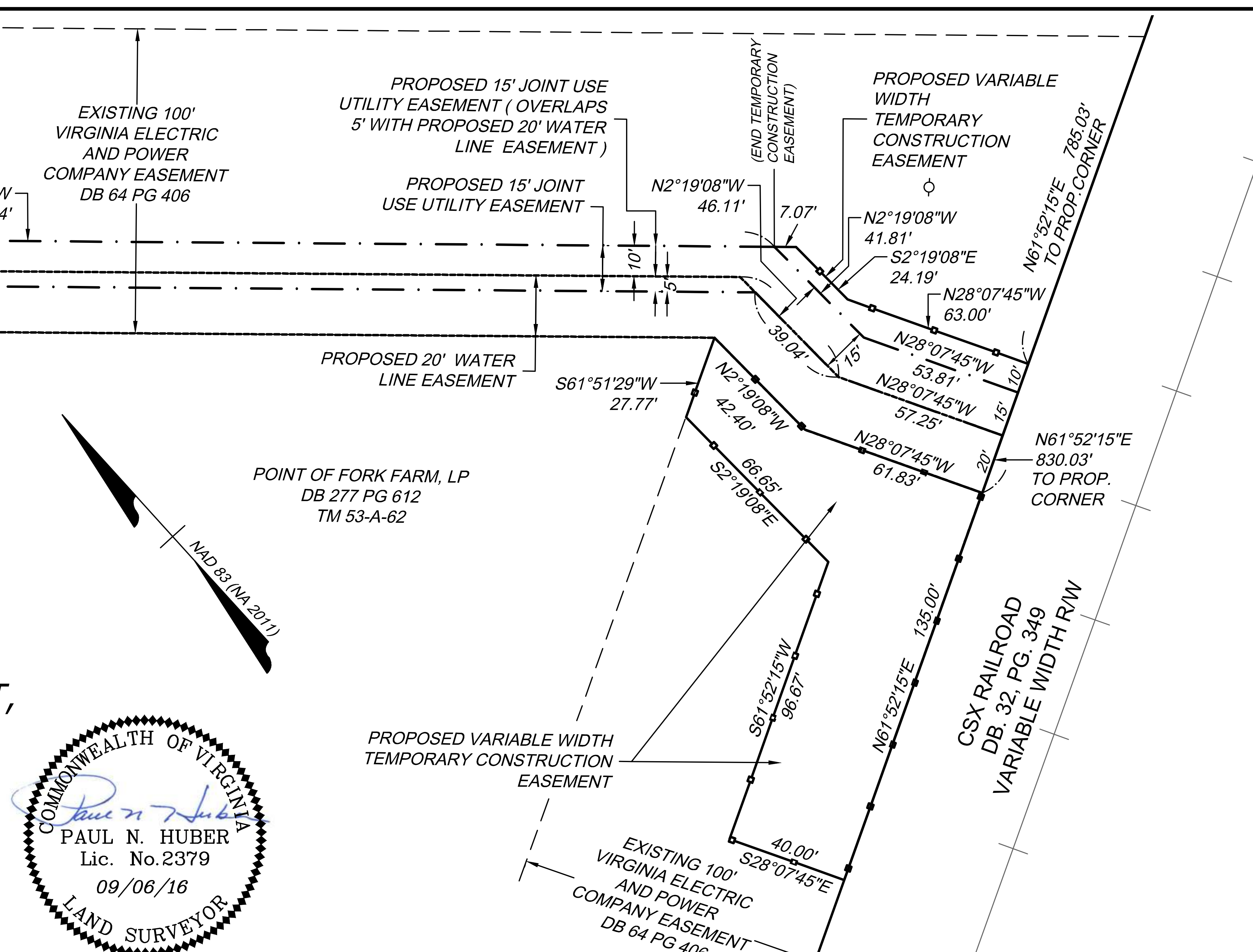
2. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY DELINEATION SHOWN IS BASED ON RECOVERED MONUMENTS IN THE FIELD AND DEEDS OF RECORD. NO TITLE REPORT FURNISHED. EASEMENTS MAY EXIST WHICH ARE NOT SHOWN HEREON.





PLAT SHOWING PROPOSED 15' JOINT USE UTILITY AND ACCESS EASEMENT, PROPOSED JOINT USE UTILITY EASEMENT, PROPOSED 30' ACCESS EASEMENT, PROPOSED 20' WATER LINE EASEMENT AND PROPOSED VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF POINT OF FORK FARM, LP

COMMONWEALTH OF VIRGINIA
PAUL N. HUBER
Lic. No.2379
09/06/16
LAND SURVEYOR

SCALE 1"=40'
0 40' 80'

Columbia District	Fluvanna County
Date: 09/06/2016	Scale: 1" = 40'
Sheet 3 of 3	J.N.: 33927
Drawn by: MLH	Checked by: PNH

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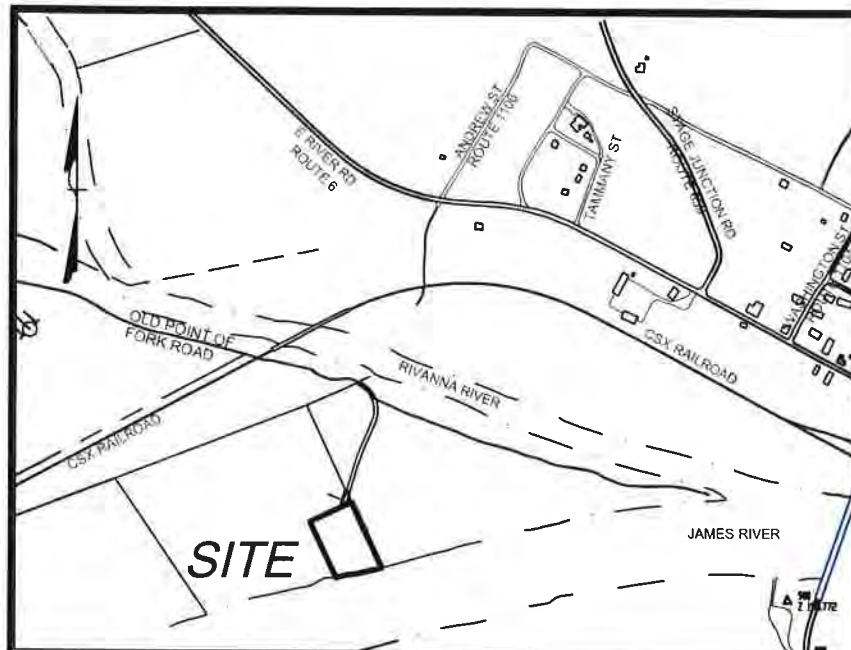
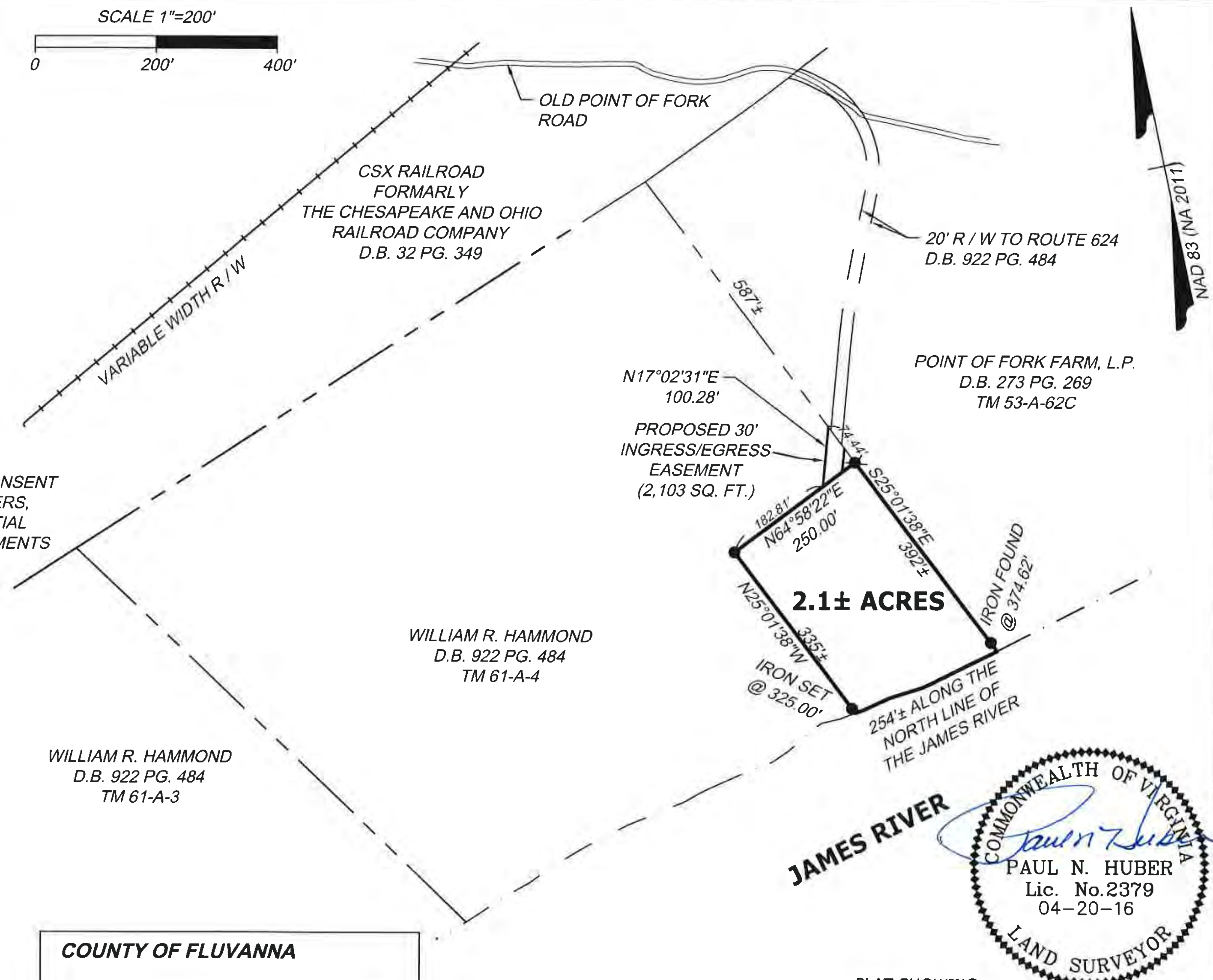
Y:\904\33927-James_River_Water\DWG\2016-0819_EDIT_Bialkowski-POF\33927V-ESMT_53-A-62_REVISED_08-19-19.dwg | Plotted on 9/7/2016 10:43 AM | by Michael Harris



SCALE 1" = 1000'



OWNER'S APPROVAL:

THE DIVISION OF THE LAND DESCRIBED HEREIN IS WITH THE FREE CONSENT AND IN ACCORDANCE WITH THE DESIRE OF THE UNDERSIGNED OWNERS, PROPRIETORS AND TRUSTEES. ANY REFERENCE TO FUTURE POTENTIAL DEVELOPMENT IS TO BE DEEMED AS THEORETICAL ONLY. ALL STATEMENTS AFFIXED TO THIS PLAT ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

____
WILLIAM R. HAMOND

STATE OF: ______________________
COUNTY OR CITY OF:

THE FOREGOING WAS ACKNOWLEDGED BEFORE ME ON
THIS _____ DAY OF , 2016,
BY:

____
NOTARY PUBLIC

MY COMMISSION EXPIRES:

NOTES:

1. THIS PLAT IS BASED ON A FIELD SURVEY CONDUCTED BY TIMMONS GROUP ON APRIL 20, 2016.

2. HORIZONTAL DATUM IS BASED ON NAD83 (NA2011), VIRGINIA STATE GRID, SOUTH ZONE. DATUM ESTABLISHED THROUGH LEICA SmartNet.

3. THE 2.1± ACRE PARCEL DEPICTED HEREON IS A PORTION OF FLUVANNA COUNTY TAX MAP PARCEL 61-A-4 IN THE NAME OF WILLIAM R. HAMMOND.

4. BASED ON FEMA FLOOD INSURANCE RATE MAP (FIRM), MAP NO 51065C0193C, PANEL 193 OF 295, EFFECTIVE MAY 16, 2008, AND MAP NO 51065C0281C, PANEL 281 OF 295, EFFECTIVE MAY 16, 2008, THE PROPERTY SHOWN LIES IN ZONE AE, AREAS DETERMINED TO BE IN SPECIAL FLOOD HAZARD ARES (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD.

COUNTY OF FLUVANNA

____
DESIGNATED AGENT

____
DATE

NOTE:
THIS PARCEL IS INTENDED FOR UTILITY PURPOSES AND IS NOT FOR RESIDENTIAL USE.

This survey was prepared without the benefit of a title binder and may therefore not show all existing easements or other pertinent facts which may affect the property.

PLAT SHOWING

2.1± ACRES OF LAND LYING ON THE NORTH LINE OF THE JAMES RIVER AND WEST OF ITS JUNCTION WITH THE RIVANNA RIVER

FORK UNION DISTRICT
FLUVANNA COUNTY, VIRGINIA

DATE: APRIL 20, 2016	SCALE: 1" = 200'
SHEET 1 OF 1	J.N.: 33927
DRAWN BY: MLH	CHECK BY: PNH

THIS DRAWING PREPARED AT THE STAUNTON OFFICE
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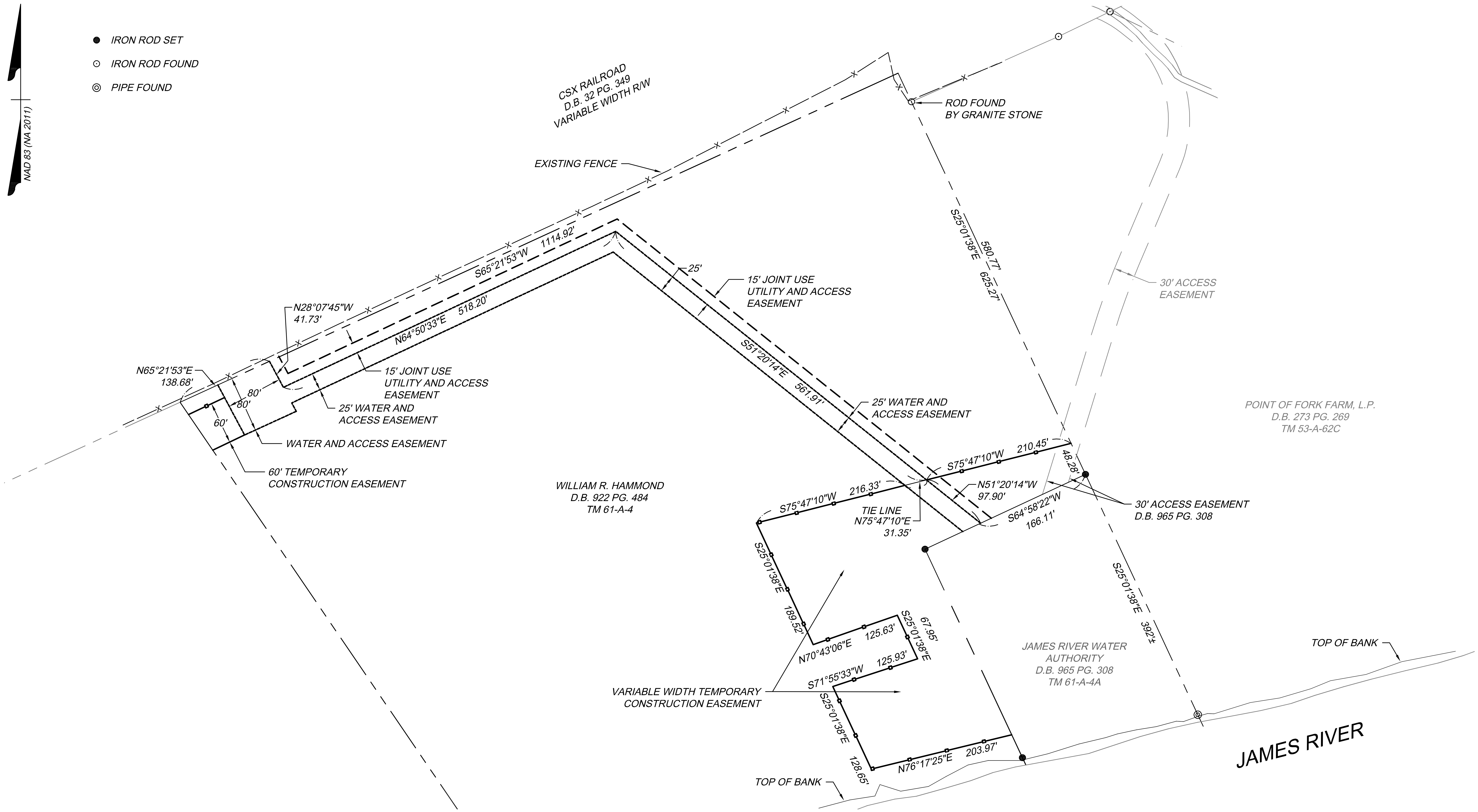
TIMMONS GROUP



NOTES:

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2. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY DELINEATION SHOWN IS BASED ON RECOVERED MONUMENTS IN THE FIELD AND DEEDS OF RECORD. NO TITLE REPORT FURNISHED. EASEMENTS MAY EXIST WHICH ARE NOT SHOWN HEREON.

TOTAL AREA:
TEMP. CONSTRUCTION ESMT. = 85,796 S. F.
WATER AND ACCESS ESMT. = 35,302 S. F.
JOINT USE UTILITY AND ACCESS ESMT. = 18,271 S. F.

SCALE 1"=100'
0 100' 200'

COMMONWEALTH OF VIRGINIA
PAUL N. HUBER
Lic. No.2379
04-7-17
LAND SURVEYOR

PLAT SHOWING A 25' WATER AND ACCESS EASEMENT, A 15' JOINT USE UTILITY AND ACCESS EASEMENT AND VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF WILLIAM R. HAMMOND

Columbia District	Fluvanna County
Date: 04/7/17	Scale: 1"=100'
Sheet1 of 1	J.N.: 33927
Drawn by: MLH	Checked by: PNH
Revised:	

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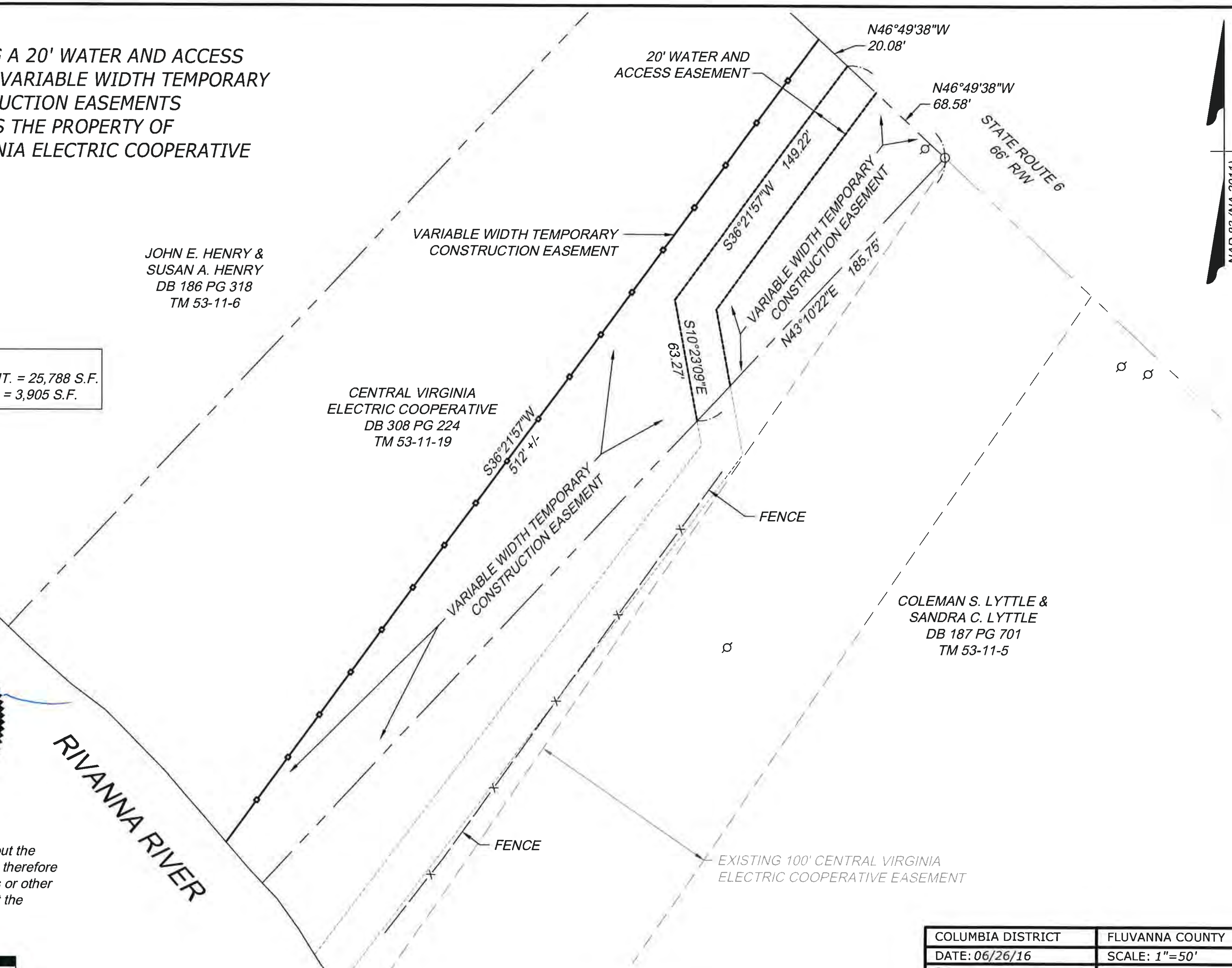
Y:\904\33927-James_River_Water\DWG\33927V-ESMT_61-A-4-REV 4-7-17.dwg | Plotted on 4/7/2017 3:54 PM | by Paul Huber

PLAT SHOWING A 20' WATER AND ACCESS EASEMENT AND A VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF CENTRAL VIRGINIA ELECTRIC COOPERATIVE

TOTAL AREA:
TEMP. CONSTRUCTION ESMT. = 25,788 S.F.
WATER AND ACCESS ESMT. = 3,905 S.F.



COMMONWEALTH OF VIRGINIA
PAUL N. HUBER
Lic. No.2379
06–26–16
LAND SURVEYOR

This survey was prepared without the benefit of a title binder and may therefore not show all existing easements or other pertinent facts which may affect the property.

SCALE 1"=50'
0 50' 100'

COLUMBIA DISTRICT	FLUVANNA COUNTY
DATE: 06/26/16	SCALE: 1"=50'
SHEET 1 OF 1	J.N.:33927
DRAWN BY: MLH	CHECK BY: PNH

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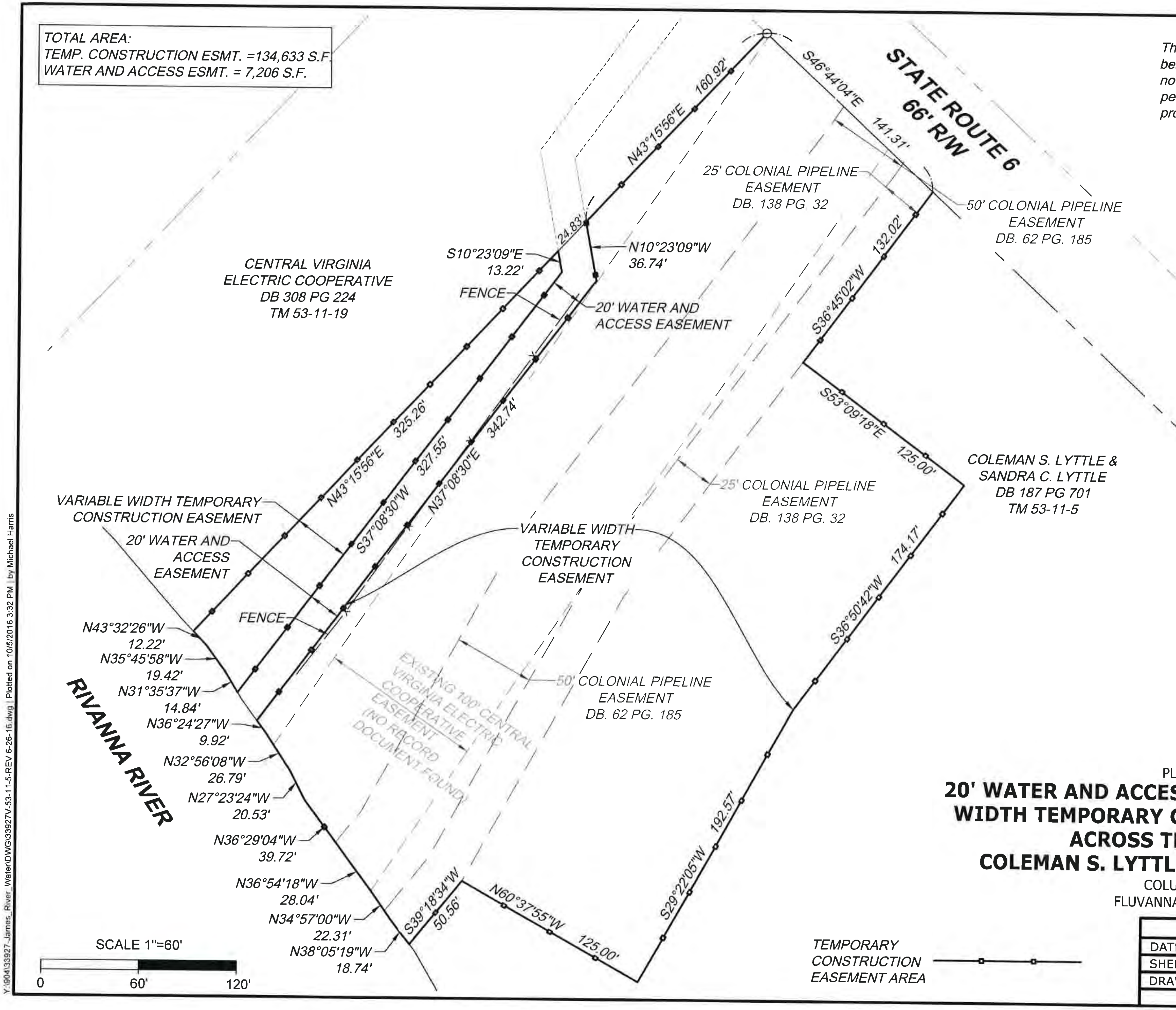
TIMMONS GROUP



PLAT SHOWING

20' WATER AND ACCESS EASEMENT AND VARIABLE WIDTH TEMPORARY CONSTRUCTION EASEMENTS ACROSS THE PROPERTY OF COLEMAN S. LYTTLE AND SANDRA C. LYTTLE

COLUMBIA DISTRICT
FLUVANNA COUNTY, VIRGINIA

DATE: 10/05/16	SCALE: 1"=60'
SHEET 1 OF 1	J.N.:33927
DRAWN BY: MLH	CHECK BY: PNH

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TIMMONS GROUP

Y:\904\33927-James_River_Water\DWG\33927V-53-11-5-REV 6-26-16.dwg | Plotted on 10/5/2016 3:32 PM | by Michael Harris

APPENDIX E-3
GEOTECHNICAL AND BATHYMETRIC REPORTS

APPENDIX E-3-1

SUBSURFACE EXPLORATION AND GEOTECHNICAL EVALUATION JAMES RIVER WATER AUTHORITY PUMP STATION AND INTAKE

SUBSURFACE EXPLORATION AND GEOTECHNICAL EVALUATION

James River Water Authority Pump Station and Intake

Point of Fork Farm

Fluvanna County, VA

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

Prepared For:

Timmons Group

Senior Project Manager:

Wes Hunnius, P.E.

COMMONWEALTH OF VIRGINIA
RICHARD M. SIMON
Lic. No. 035103
3/13/2015
PROFESSIONAL ENGINEER

March 13, 2015

Prepared By:

Draper Aden Associates

Engineering • Surveying • Environmental Services

DAA Project Number: H15102R-02G

3RD PARTY REVIEW

This Report has been subjected to technical and quality reviews by:

3/13/15

Name: Daniel J. Anderson, E.I.T. Signature Date
Staff Engineer

3/13/15

Name: Jessica L. Ewald, P.E., LEED AP Signature Date
Project Manager

3/13/15

Name: Richard M. Simon, P.E., Ph.D., D. GE. Signature Date
Quality Reviewer

TABLE OF CONTENTS

TABLES

PHOTOGRAPHS

APPENDICES

1.0 AUTHORIZATION

Draper Aden Associates is pleased to present our report of the geotechnical study completed for the proposed James River Water Authority Pump Station and Intake at Point of Fork Farm in Fluvanna County, Virginia. This geotechnical study was completed in general accordance with Draper Aden Associates' letter proposal dated January 20, 2015.

2.0 OBJECTIVE AND SCOPE OF SERVICES

The objective of this study was to generally characterize subsurface conditions to provide information and develop geotechnical engineering recommendations related to the subsurface conditions, floor slab design, foundation design, earthwork and construction related to the proposed pump station and intake. Our scope of services included:

- Four (4) exploratory soil borings with Standard Penetration Testing (SPT), advanced at locations selected by Timmons Group, within the footprint of the proposed pump station site. Two borings were advanced to a depth of 20 feet below existing grade and two borings were advanced to auger refusal conditions. Upon reaching auger refusal conditions at the two deeper borings, a 10-foot rock core sample was extracted.
- One (1) exploratory soil boring, with SPT, advanced at a location selected by Timmons Group, within the footprint of the proposed intake site advanced to auger refusal conditions. Upon reaching auger refusal conditions, a 10-foot rock core sample was extracted.
- Laboratory testing of representative split-spoon samples in order to develop pertinent data related to the on-site soils to support our design recommendations.
- Preparation of this geotechnical engineering report, which summarizes our exploration program, laboratory testing, and geotechnical recommendations.

3.0 SUBSURFACE EXPLORATION

3.1 General Site Description

The project site is located near the confluence of the Rivanna and the James Rivers on the Point of Fork Farm. The site is relatively flat from the pump station to the edge of the north bank of the James River. Surface elevations fall from approximately 200 feet, near the pump station site, to approximately 194 feet near the top of the river bank, to 182 feet near the intake.

Photo 1: Pump Intake Boring Location, north of the James River

3.2 Exploration Program

Our exploration program was performed on February 12th and 13th, 2015. The approximate locations of the five (5) borings selected by Timmons Group are indicated on the Boring Location Plan included in Section I of the Appendices. The subsurface borings, executed by Fishburne Drilling, were logged and observed by a Draper Aden Associates field representative. Appendix Section II contains logs of the five (5) borings prepared by Draper Aden Associates. Boring elevations included on the logs were interpolated from the available site topographic information and should be considered accurate only to the degree implied by the method used.

During advancement of the five (5) soil borings, utilizing 3¼-inch hollow-stem auger, the subsurface soils were continuously sampled for the first 10 feet and at intervals of 5 feet thereafter. Split spoon samples were taken by driving a 1⅜-inch-I.D. split spoon sampler in accordance with ASTM D1586-11. The sampler was first seated 6 inches to penetrate loose cuttings and then driven an additional 18 inches with a 140-pound hammer free falling 30 inches. The number of hammer blows required to drive the sampler the middle 12 inches was designated as the standard penetration resistance or N-value. The N-value provides an indication of the relative density of the subsurface soil, and it is used in empirical geotechnical correlation to estimate the approximate shear strength properties of the soils.

In limited instances during our subsurface exploration, the static weight of the hammer, rods, and split-spoon sampler penetrated into the subsurface soil without the aid of hammer blows. This condition is represented on our boring logs as weight of hammer (WOH).

Alternatively, it is not always practical to drive the split spoon sampler the full 24 inches. During a subsurface exploration whenever more than 50 blows are required to drive the sampler 6 inches, the condition is called spoon refusal (SR). Split spoon refusal conditions will occur when the material being tested has very dense or hard soil strength or if an obstruction is encountered. The blow count recorded at spoon refusal conditions indicates the depth of sampler penetration over the 6 inch increment, i.e. 50/4 or 50 blows over 4 inches. The N-value for split spoon refusal conditions is typically estimated as greater than 100 blows per foot (bpf) for this condition.

The Draper Aden Associates representative noted cave-in and groundwater depth measurements on the boring log notes, when applicable, at each soil boring. The soil test borings were backfilled with excavated spoil prior to departure from the site. No long term groundwater measurements were taken as a part of this study.

4.0 SUBSURFACE CONDITIONS

4.1 Regional Geology

The project site is located within the Piedmont Physiographic province of Virginia. It is bounded to the east by the Fall Zone and the Coastal Plain and to the west by the Blue Ridge Physiographic province. To the east the Piedmont is distinguished by rolling hills, deeply weathered bedrock, and a lack of solid rock outcrops. Near the Blue Ridge province, the topography becomes steeper and difficult to access due to localized resistant formations.

A range of igneous and metamorphic rocks make up the bedrock of the Piedmont province. Most of these rocks range in age from the Proterozoic (greater than 570 million years (M.Y.)) to the Paleozoic (240 to 570 M.Y.). Triassic-aged (205 to 240 M.Y.) sedimentary rocks are present in a number of grabens that formed during the early stages of rifting associated with the opening of the Atlantic Ocean. Rivers carrying sand, silt, and mud flowed into these grabens burying swamps and marshes that later produced small coal formations. These basins are referred to as the Mesozoic Basins.

4.2 Local Geology

According to the Geologic Map of Virginia (1993)[1], the Columbia Pluton encountered in this area is light gray, medium- to coarse-grained, and foliated. It includes biotite-muscovite granite, granodiorite, tonalite, and granitic pegmatite; contains xenoliths of biotite gneiss, amphibolite, and felsic metavolcanic rocks.

4.3 Encountered Soil Conditions

4.3.1 General

Section II of the Appendices contains the boring logs, which represent the subsurface conditions encountered at the time of exploration. Soil strata inferences, discussed below and indicated on the boring logs, represent an estimate of the subsurface conditions encountered based on visual

---

[1] Rader, E.K., and Evans, N.H., editors, 1993, Geologic Map of Virginia: Virginia Division of Mineral Resources.

classifications of soils and laboratory classification test results. It should be noted that the transitions between soil strata are generally less distinct than shown on the boring logs and are interpolated between the boring locations. For specific subsurface soil information refer to the boring logs.

4.3.2 Subsurface Soils

Draper Aden Associates observed a depth of approximately 1 to 3 inches of topsoil at our field explorations. The following descriptions generally describe the subsurface conditions encountered at our exploration locations:

Stratum S1: Stratum S1 consisted of fine- and coarse-grained soils that were visually classified as Fat CLAY (CH), Lean CLAY with Sand (CL), and Clayey SAND (SM) and observed at damp to moist. At the base of the stratum a saturated layer of Clayey SAND (SC) was typically encountered. The S1 material was encountered below the topsoil and extended to auger refusal depths ranging from 29 to 29.5 feet below existing grade. The S1 material exhibited N-values ranging from 2 to 15 blows per foot (bpf).

Stratum S2: Stratum S2 consisted of Partially Weathered Rock (PWR) and Bedrock. PWR is a transitional material between soil and rock, with very hard to dense relative densities. The S2 material was encountered below the Stratum S1 soils and extended to boring termination depths ranging from 38 to 39 feet below existing grade. The S2 material exhibited N-values of 100+ bpf.

Stratum S3 - Bedrock: Auger refusal conditions were encountered at depths ranging from 29 to 29.5 feet below existing grade. The recovered rock cores generally consisted of hard igneous rock with variable mineral content. The assessed Rock Quality Designation (RQD) ranged from 0 to 100 percent, but typically resided between 60 to 100 percent. For specific description of the recovered rock specimens, refer to the boring logs in Appendix Section II.

4.3.3 Anomalous Subsurface Conditions

At boring location B-5, located near the river along the proposed intake pipe alignment, at a depth of approximately 23 feet (El. 171) below existing grade, an obstruction was encountered resulting in auger refusal. A split-spoon sample was recovered from 23 to 25 feet consisting entirely of woody organics believed to be from a buried tree. The boring was offset 10 feet to the east and re-drilled. Lithology on boring log B-5, deeper than 23 feet, describes S1 material encountered at the offset boring.

In Draper Aden Associates' opinion, the clay and sand above the woody organics are naturally occurring alluvium deposits. Therefore, the woody material is also likely to be naturally occurring. This anomalous condition must be carefully considered in the design of foundations for the proposed structures.

4.4 Cave-In Depths

During our exploration, cave-in depths, recorded following the removal of the auger flights, ranged from 3 to 20 feet below existing grade.

4.5 Subsurface Water

River level data was not available for the James at the project site, however the nearest upstream James River gauge, located at Bremo Bluff, and downstream gauge, located at Cartersville, indicated that the river level at the time of our study was at least 10 feet below flood level.

Subsurface water was first encountered in the borings at depths ranging from 23 to 28 feet below existing grade (approximate elevations of 171 to 172 feet), or a few feet above the level of auger refusal. Based on the results of or borings, contractors should anticipate the need for groundwater control if the wet well and intake pipe are installed lower than the surface of bedrock. Should construction proceed during river flood stages, the contractor should anticipate groundwater control requirements for excavations at even higher elevations. Contractors must determine and implement appropriate groundwater control if any excavation is to extend within 24 inches of the groundwater table. Clayey subgrade materials encountered above the observed rock level are easily susceptible to disturbance in the presence of static or flowing water.

Note that groundwater levels may fluctuate due to rainfall, season, temperature, river flood stage and other factors that are different from those prevailing at the time of our subsurface exploration. Contractors should refer to historical river flood stage publications in preparing their bids. If dewatering becomes an issue during construction the contractor should determine and employ appropriate dewatering methods.

5.0 LABORATORY TEST RESULTS

Select split-spoon samples, obtained during our field exploration, were tested in accordance with applicable American Society for Testing and Materials (ASTM) methods for Classification (ASTM 2487), Percent passing No. 200 sieve (ASTM D1140), Natural Moisture Content (ASTM D2216), and Atterberg Limits (ASTM D4318).

The following table summarizes the results of index laboratory testing conducted by Draper Aden Associates' U.S. Corps of Engineers Qualified Materials Testing Laboratory, which was performed to aid in our design recommendations. Detailed laboratory results are contained within Section III of the Appendices.

Table 1: Summary of Laboratory Results

Sample ID	Sample Depth	Natural Moisture Content	% Passing the No. 200 Sieve	Atterberg Limits			USCS Classification
				L.L.	P.L.	P.I.	
B-2	2'-4'	22.2%	96.2%	50	22	28	Fat CLAY (CH)
B-5	8'-10'	24.6%	72.6%	37	23	14	Lean CLAY with Sand (CL)

6.0 DESIGN RECOMMENDATIONS

The following conclusions and recommendations are made subject to the limitations set forth in Section 8.0.

6.1 General

Our recommendations and geotechnical evaluations are based on observations made during our subsurface explorations, results of the laboratory test program, our understanding of the proposed construction, and experience with similar projects. Our foundation recommendations as well as estimation of geotechnical design criteria have been developed based on laboratory data, using generally established correlations and methods commonly exercised by members of the geotechnical engineering profession. If structure locations, loading conditions, or finish floor elevations are changed, or differ from our assumptions, we request that we be advised and be allowed to re-evaluate our recommendations. We request the opportunity to review the final foundation design to verify that the intent of our recommendations is met.

6.2 Structure Characteristics

According to information provided by Timmons Group, via email, the following describes the general concept of the Point of Fork Farm Pump Station and Intake:

- Pump Station with an approximate footprint of 2,500 square feet bearing near original ground surface including—
  - Electrical pump control and communications gear
  - Pump Motors
  - Personnel operating facilities.
- Intake Pipe from the river to the Wet Well spanning approximately 200 to 250 feet
- Wet well to be situated within the Pump Station connecting to the intake pipe
- Both the wet well and the intake pipe will bear on bedrock (Stratum S3)
- Maximum column loads of the pump station of approximately 10 kips and wall loads of approximately 2 kips per linear foot were assumed for design analysis.

6.3 Shallow Foundations

In our opinion, the proposed Pump Station building can be supported by a shallow foundation system bearing on S1 soils. We recommend that foundations be designed based on a maximum net allowable bearing pressure of 1,500 pounds per square foot. We recommend minimum widths of 2 feet and 4 feet should be adopted for continuous and spread footings, respectively, to reduce the potential for local shear failures.

When founded on approved subgrade that has been prepared, tested, and protected in accordance with our recommendations, Draper Aden Associates estimates the footings will experience total settlement no greater than 1 inch and differential settlement no greater than a ½ inch.

Based on the result of our laboratory testing, the subgrade soils exhibit a moderate potential for shrink-swell. We recommend that exterior footings bear a minimum of 36 inches below final exterior grade to provide protection from shrink/swell. A coefficient of sliding friction of 0.30 may be used for design for mass concrete on approved soil subgrade.

6.4 Deep Foundations

If the proposed Pump Station, Wet Well and Intake Pipe structure foundations are situated a few (say less than 5 feet) above the rock surface, the contractor will be faced with a difficult challenge of dewatering below the top of rock to maintain a stable subgrade for the clay and sand subgrade above. If the bearing level of any of the structures will be situated within 5 feet of the top of rock, Draper Aden Associates recommends that the foundations bear at or below the top of rock or on crushed stone bearing on the top of rock.

Draper Aden Associates understands that the Pump Station finished floor elevation will be near existing grade whereas the wet well will extend to the bedrock. Foundations may be designed based on a maximum net allowable bearing pressure of 65 tons per square foot when founded on sound bedrock. Based on this configuration, you may consider the following foundation options for support of the Pump Station:

1. Use the cofferdam sheet piles or walls of the wet well as bearing piles for most or all of the Station including pump motors. A few structural steel bearing piles can be installed to support the structure outside the cofferdam.

2. Support the Pump Station floor and columns, outside the cofferdam, on shallow foundations underlain by compacted coarse aggregate (No. 57 crushed stone) to reduce fill material compressibility and differential settlement. The sheet piles might be removed or left in place. Provide a structural joint between the wet well and the shallow pump station floor and structure to accommodate differential settlement.

6.5 Slabs-on-Grade

The ground floor slabs may be designed as slabs-on-grade. We recommend that interior floor slabs, protected from frost action, be underlain by a minimum 6-inch-thick granular base course to provide uniform support and to act as a capillary break against moisture transmission through the slab. Where Portland cement concrete (PCC) slabs are exposed to exterior weather conditions, we recommend that the slabs be underlain by a minimum thickness of 12 inches of processed granular material.

The granular base course should consist of well-graded gravel or crushed rock with a maximum nominal size of 1 inch and having less than 7 percent by weight passing the No. 200 sieve. The base course should be compacted to at least 95 percent of its maximum dry unit weight as measured by the standard Proctor test (ASTM D698).

Based on the results of our laboratory testing, slabs-on-grade founded on native soils with a minimum 6-inch-thick base course may be designed based on a modulus of subgrade reaction of 150 psi/in.

If materials will be stored directly and permanently on the floor slab or a glued down impervious floor covering will be utilized, such as tile and linoleum, a minimum 10-mil-thick vapor barrier should be placed over the granular base course, prior to concrete placement, to reduce moisture transmission through the slab and joints. If the vapor barrier is required, it may be preferable to specify a base course of 4 inches of crushed stone covered by 2 inches of clean sand to reduce puncturing of the membrane.

6.6 Slope Stability and Earth Support for Excavations

During construction excavation, the contractor must evaluate slope inclinations in accordance with regulations established by Occupational Safety and Health Administration (OSHA). The contractor's "responsible person" must evaluate the slope protection requirements consistent with the soils encountered and the means and methods of excavation and dewatering selected by the contractor. Temporary spoil must be placed no closer than 10 feet from the surface edge of an excavation. Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Excavations shall be inspected and maintained by the contractor as required by OSHA.

Draper Aden Associates anticipates that the contractor will require a temporary cofferdam of interlocked steel sheeting driven to Stratum S2 for toe resistance. The cofferdam should be designed by a registered professional engineer licensed in the Commonwealth of Virginia and experienced in such design efforts. Dewatering may be required within the cofferdam to control groundwater flow. The contractor's cofferdam design should be submitted to the project engineer for review and comment prior to the start of construction. Note the presence of wood encountered within the soil above Stratum S2. This condition may require extra effort by the contractor to install sheets through the wood to top of rock.

6.7 Seismic Considerations

Per our review of the International Building Code (IBC 2012); Section 1613.3.2 Site class definitions and Chapter 20 of ASCE 7, we recommend that this site be classified as Site Class C. Based on our review of the US Seismic Hazard Map 2008, we recommend spectral acceleration coefficients of 24.7%g and 7.2%g for S_s and S_1 (for 0.2- and 1-second periods), respectively.

6.8 Lateral Earth Pressures

We recommend the below grade walls be designed to consider the linearly increasing lateral earth pressures influencing the wall. Additional pressures due to surcharge loads should be applied based on anticipated temporary construction or permanent loadings near the top of the wall. To prevent lateral earth pressures in significant excess of those listed below, we recommend that heavy equipment not operate within 5 feet of the below grade walls.

The recommended equivalent fluid pressures below assume that an effective drainage system is installed between the below grade wall and soil backfill to prevent the buildup of hydrostatic pressure. At a minimum, the drains should utilize a 6-inch perforated pipe. The pipe should be surrounded by a minimum of 6 inches of AASHTO No. 57. The aggregate should be wrapped in a non-woven drainage geotextile. The following parameters are recommended for evaluating lateral earth pressures on below grade walls with non-sloping backfill:

Table 2: Lateral Earth Pressure Parameters

Backfill Type	Moist Unit Weight of Soil	Approx. Internal Friction Angle	Earth Pressure Coefficients			Equivalent at rest fluid pressure
			At Rest (Ko)	Active (Ka)	Passive (Kp)	
Upper On-Site Soils (Stratum S1)	110 pcf	19°	0.67	0.51	1.97	75 psf/LF
Granular Fill (#57 Stone)	115 pcf	40°	0.36	0.22	4.60	42 psf/LF

*The coefficient of Passive Earth Pressure provided in the table above is the ultimate value; we recommend this value be reduced by a factor of safety of 3 for design.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Site Preparation

Based on the results of our laboratory testing, the existing subgrade should be generally suitable for earthwork activity. Prior to construction operations, all topsoil, roots, or other deleterious non-soil material should be stripped within and five feet beyond the proposed footprint of areas intended for foundations and slabs.

Proof rolling or other method of strength verification, observed and evaluated by a representative of the geotechnical engineer, should be performed on subgrade areas intended for support of the structures or fill material. Soils designated as unsatisfactory following strength verification operations should be removed and replaced as recommended by the Geotechnical Engineer or his/her designated representative. Proof rolls should be performed using a 20- to 30-ton loaded tandem axle dump truck or pneumatic-tired vehicle of similar weight. Alternatively, use a 2,000- to 5,000-pound vibratory roller. Proof rolling should not be performed while the site is wet, frozen, or severely dry. If conditions warrant, the extent of undercutting and/or in-place stabilization required can be best determined by the geotechnical engineer at the time of construction.

7.2 Foundation Construction

Excavations should be made in such a way as to provide bearing surfaces free of loose, soft, or wet soil and debris. We recommend that excavations for foundations be completed in manner that will limit disturbance of the bearing surface. All loose soil at or below subgrade level should be removed. Prior to placing forms and reinforcing, compact the bottom of foundations level. Cease compaction if unstable or wet subgrade conditions develop. If low strength soils are encountered during foundation construction, localized undercutting and/or in-place stabilization of bearing subgrade may be required as assessed and recommended by the Geotechnical Engineer or their designated representative. Foundation concrete must not be placed on frozen soil. Placement of concrete and backfilling of footings should occur as soon as practicable to limit water collection near the base of the foundation and damage to the bearing surface.

7.3 Reuse of Onsite Soils

Approximately 1 to 3 inches of topsoil was encountered at our field explorations. This material may be stockpiled for use in green areas.

Based on the results of our borings and laboratory testing, upper on-site S1 material is unsuitable for use as fill material under structures and foundations. The fill material obtained on- or off-site should comply with the requirements contained in Section 7.4. Fill derived from onsite excavation may require moisture conditioning and must be protected from precipitation prior to placement and compaction in the work.

7.4 Fill Material

Fill material obtained on- or off-site should meet the requirements indicated in the table below. When practical, requests to use soils that do not precisely meet requirements may be evaluated by the geotechnical engineer.

Table 3: Fill Material Requirements

Fill Material Use	Recommended USCS Material Classifications	Index Property Limitations
Under Structures, Foundations, or as Backfill	GW, GP, GC, GM, SW, SP, SC, SM, CL, & ML	Less than 65% passing the No. 200 sieve & L.L. ≤ 50
General Site Grading	GW, GP, GC, GM, SW, SP, SC, SM, CL, ML, CH, & MH	None

The maximum particle size of all fill material should be less than three inches largest dimension, except in the uppermost lift of fill, where the maximum particle size should be less than two inches largest dimension. Maximum sized particles should not be in excess of 20 percent of the volume of the fill material, and such particles shall be well distributed throughout the mass. Fill material shall not contain frozen masses of soil and shall not be placed on saturated, frozen, or frost-covered subgrade. Fill material should be placed in such a way to provide positive drainage from the fill area. Fill materials should be free of organics and debris.

Soil fill below structures should be placed in a maximum of an 8-inch-thick loose lift and compacted to a minimum of 98 percent of its respective maximum dry density and within ±2 percentage points of its optimum moisture content as determined by a standard Proctor test.

7.5 Field Observation

We recommend that the foundation construction be observed by our Geotechnical Engineer or our qualified representative to observe that the required minimum soil requirements are met. For greater continuity and proper implementation of the recommendations contained herein, we recommend Draper Aden Associates be retained for construction observation services during this project.

8.0 LIMITATIONS

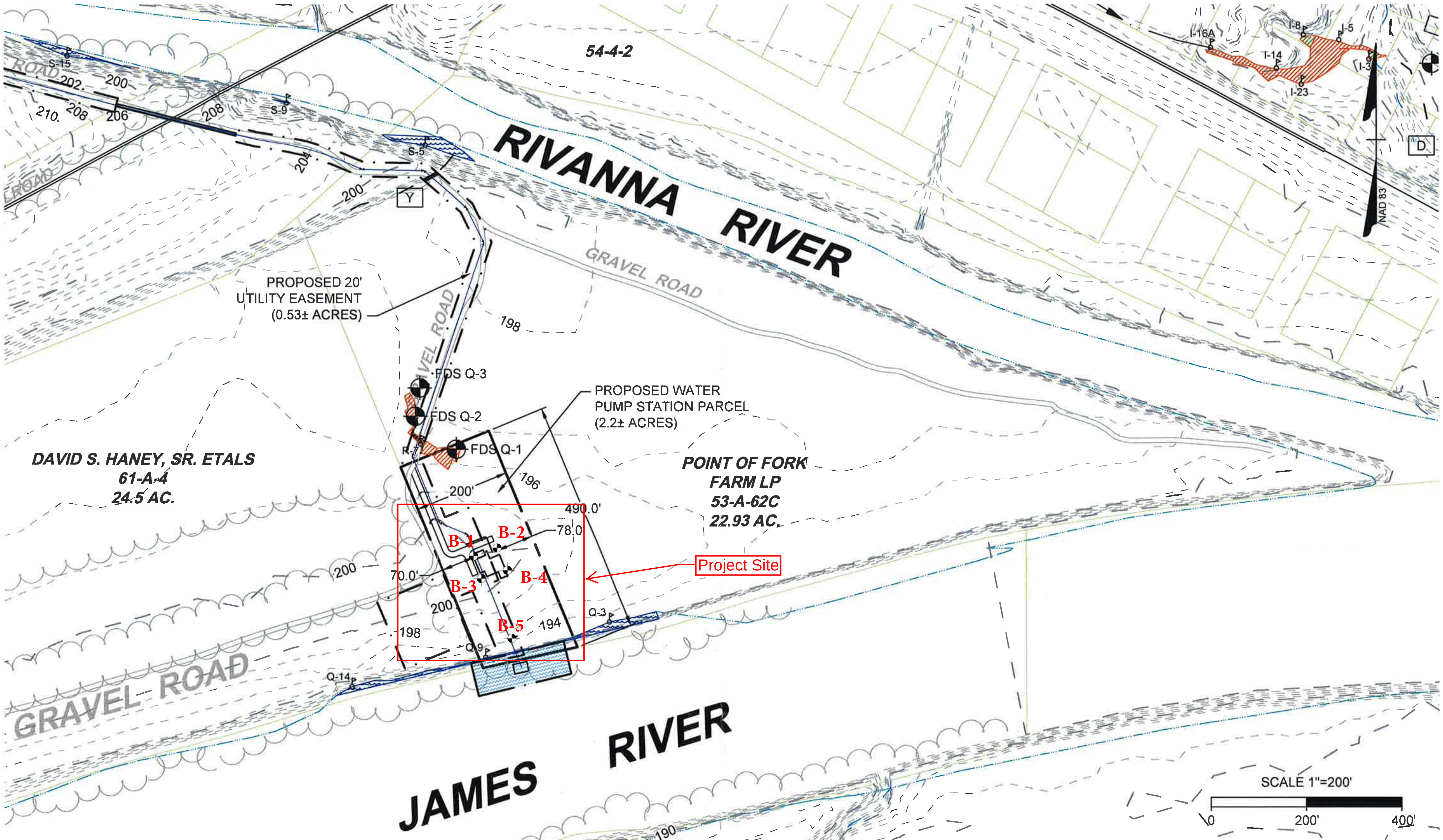
This report has been prepared for the exclusive use of Timmons Group and their designated representatives for specific application to the Pump Station and Intake at the Point of Fork Farm in Fluvanna County, Virginia. Our conclusions and recommendations have been rendered in a manner consistent with the level and skill ordinarily exercised by members of the geotechnical engineering profession in the Commonwealth of Virginia at the time of our study. We make no other warranty, express or implied.

Our conclusions and recommendations are based on design information furnished to us and our experience. They do not necessarily reflect variations in the subsurface conditions, which have potential to exist intermediate of our borings and in unexplored areas of the site due to inherent variability of the subsurface conditions in this geologic region, as well as past land use. Should such variations become apparent during construction, it will be necessary for us to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

If changes are made in the location or nature of the structure, then the recommendations presented in this report must not be considered valid unless the changes are reviewed by Draper Aden Associates, and our recommendations are modified or verified in writing. We request the opportunity to review the foundation plan, grading plan and applicable portions of the project specifications when the design is finalized. This review will allow us to check whether these documents are consistent with the intent of our recommendations. Draper Aden Associates is not responsible for the conclusions, opinions or recommendations of others based on the data in this report.

APPENDIX
Section I

Boring Location Plan



Original drawing titled "Pump Stations Notes" provided by Timmons Group and edited to include boring locaitons.

JAMES RIVER WATER AUTHORITY
POINT OF FORK FARM PROPERTY IMPACTS

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

APPENDIX
Section II

Key to Boring Logs
Boring Logs B-1 through B-5

Draper Aden Associates
Blacksburg ◆ Richmond, Virginia
Engineering ◆ Surveying ◆ Environmental Services

Key to Boring Log

Well Graded Sand * =+	Silt (ML)	Lean Clay (CL)
Poorly Graded Sand (SP)	Silt with Sand(ML)	Lean Clay with Sand (CL)
Silty Sand * ˆ+	Sandy Silt (ML)	Sandy Lean Clay (CL)
Clayey Sand * ˛+	Elastic Silt *ˆ6+	Fat Clay *˛6+
Silty-Clayey SAND * ˛5 ˆ+	Elastic Silt with Sand(MH)	Fat Clay with Sand(CH)
Topsoil	Sandy Elastic Silt *ˆ6+	Sandy Fat Clay *˛6+
	Silty-Clay (ML-CL)	Weathered Rock

Soil Description Format:
PRIMARY ˛ °˜ ˇ !"˜ # color, major modifier, minor modifiers, moisture content,.

Soil Strength

Relative Density
Coarse Grained Soil, SAND

N-Value	Relative Density
-50	Very Loose
15,-	Loose
,,5/-	Medium Dense
/,51-	Dense
A1-	Very Dense

Consistency
Fine Grained Soil, SILT or CLAY

N-Value	Relative Density
-5,	Very Soft
.50	Soft
154	Medium Stiff
C5,1	Stiff
,25.C	Very Stiff
A.C	Hard

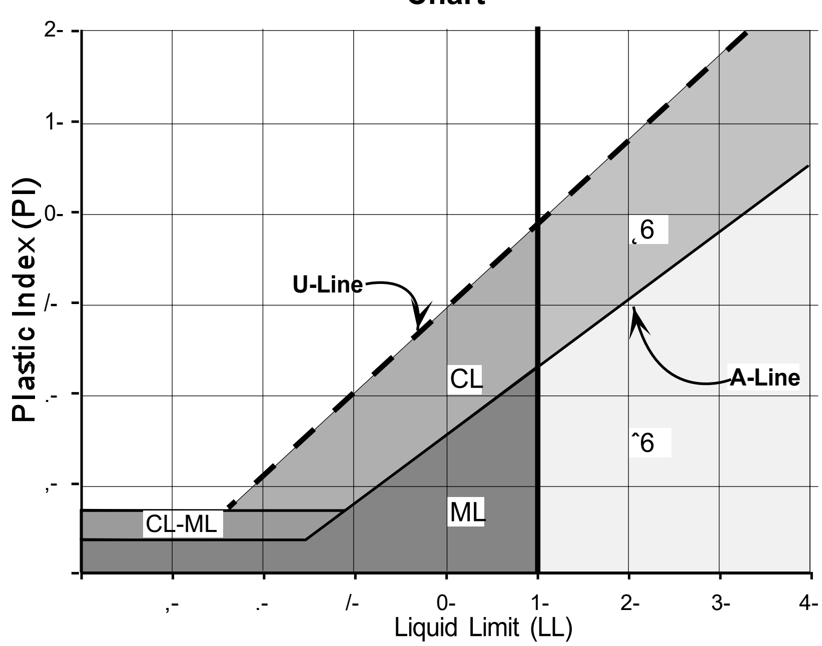
Moisture Content

Dry	No apparent moisture, dusty.
Damp	Apparent moisture, below the Plastic Limit
Moist	Significant moisture, at or above the Plastic Limit (can be rolled into a 1/8" thread).
Wet	Appears saturated, free water in voids and pores.

Further Descriptors

Mottled	Irregularly marked with patches of different colors, variegated.
Micaceous	Contains the mineral mica.
Relict Rock Structure	Distinct pattern of mineralization from parent rock.

Cassagrande's Plasticity Chart



Draper Aden Associates
Engineering • Surveying • Environmental Services
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Richmond, Virginia 23228
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Fax: (804) 264-8773

Boring Log

B - 1

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/13/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	200.0		Topsoil: Approximately 1"		WOH		Surface: Wooded Area, Grassy
-1.0			Fat CLAY: brown to red-brown, micaceous, soft to stiff, damp	CH	1 1 2	2	
-2.0	198.0				2		
-3.0					5 6 6	11	Cave-in measured @ 3' below existing grade.
-4.0	196.0				7		
-5.0					7 7 7	14	
-6.0	194.0				8		
-7.0					7 8 7	15	
-8.0	192.0				2		
-9.0					3 3 4	6	
-10.0	190.0						
-11.0							
-12.0	188.0						
-13.0			Lean CLAY with Sand: brown, fine to medium grained, micaceouos, soft, moist	CL			
-14.0	186.0				2 2 2 2	4	
-15.0							
-16.0	184.0						
-17.0							
-18.0	182.0				1		
-19.0					1 1 1	2	
-20.0	180.0		Terminated: @ 20' below existing grade.				Subsurface water not encountered.
-21.0							

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Boring Log

B - 2

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225

Project: Timmons Pump House

Date: 02/13/15

DAA No. H15102R-02G

Logged By: JW

Drill Type: 3 1/4" HSA w/ SPT

Drilled By: Fishburne Drilling

Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	200.0		Topsoil: Approximately 1"		2 1 1 2	2	Surface: Wooded Area, Grassy
-1.0			Fat CLAY: brown to red-brown, micaceous, soft to stiff, damp	CH			
-2.0	198.0				1 3 4 6	7	
-3.0							
-4.0	196.0				6 6 8 7	14	
-5.0							
-6.0	194.0				7 7 8 5	15	
-7.0							
-8.0	192.0				2 3 4 4	7	
-9.0							
-10.0	190.0						
-11.0							
-12.0	188.0						
-13.0			Lean CLAY with Sand: brown, fine to medium grained, micaceouos, soft, moist	CL	1 2 2 2	4	Cave-in measured @ 13' below existing grade.
-14.0	186.0						
-15.0							
-16.0	184.0						
-17.0							
-18.0	182.0				WOH 1 2 3	3	
-19.0							
-20.0	180.0						
-21.0							
-22.0	178.0						

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Boring Log

B - 2

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/13/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-22.0	178.0	▨					
-23.0		▨	Sandy Lean CLAY: dark gray, fine to medium grained, soft, moist	CL	1 2 2 2	4	
-24.0	176.0						
-25.0							
-26.0	174.0						
-27.0		⁘	Clayey SAND: gray, medium to coarse grained, with fine gravel, very dense, wet	SC			
-28.0	172.0				50/3 - -	SR	Subsurface water first encountered @ 28' below existing grade.
-29.0		+	Rock Core: Granodiorite: RQD= 100%, white, fresh, hard, very slight fracturing, fine-grained, 50% Quartz, 35% K-Feldspar, 15% Biotite/Hornblende				
-30.0	170.0						
-31.0							
-32.0	168.0						
-33.0							
-34.0	166.0						
-35.0							
-36.0	164.0						
-37.0							
-38.0	162.0						
-39.0			Terminated: @ 40' below existing grade.				
-40.0	160.0						

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Boring Log

B - 3

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/13/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	200.0		Topsoil: Approximately 2"		1 2 3 2	5	Surface: Wooded Area, Grassy
-1.0			Fat CLAY: brown to red-brown, micaceous, soft to stiff, damp	CH			
-2.0	198.0				4 3 3 4	6	
-3.0							Cave-in measured @ 3' below existing grade.
-4.0	196.0				5 6 5 3	11	
-5.0							
-6.0	194.0				6 4 4 4	8	
-7.0							
-8.0	192.0				2 2 2 2	4	
-9.0							
-10.0	190.0						
-11.0							
-12.0	188.0						
-13.0			Lean CLAY with Sand: brown, fine to medium grained, micaceouos, soft, moist	CL	1 1 1 2	2	
-14.0	186.0						
-15.0							
-16.0	184.0						
-17.0							
-18.0	182.0				1 1 1 1	2	
-19.0							
-20.0	180.0		Terminated: @ 20' below existing grade.				Subsurface water not encountered.
-21.0							

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Boring Log

B - 4

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/12/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	200.0		Topsoil: Approximately 2"		1 2		Surface: Wooded Area, Grassy
-1.0			Fat CLAY: brown to red-brown, micaceous, soft to stiff, damp	CH	2 2	4	
-2.0	198.0				2 5		
-3.0					4 4	9	Cave-in measured @ 3' below existing grade.
-4.0	196.0				6 4		
-5.0					4 4	8	
-6.0	194.0				3 3		
-7.0					3 4	6	
-8.0	192.0				1 1		
-9.0					2 2	3	
-10.0	190.0						
-11.0							
-12.0	188.0						
-13.0			Lean CLAY with Sand: brown, fine to medium grained, micaceouos, very soft to soft, moist	CL	WOH 1		
-14.0	186.0				1 1	2	
-15.0							
-16.0	184.0						
-17.0							
-18.0	182.0				WOH WOH		
-19.0					1 1	1	
-20.0	180.0						
-21.0							
-22.0	178.0						

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Boring Log

B - 4

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/12/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-22.0 to -28.0	178.0 to 172.0				WOH 1 1 1	2	
-28.0 to -29.3	172.0		Clayey SAND: gray, medium to coarse grained, with fine gravel, very dense, wet	SC	1 50/1 - -	SR	Subsurface water encountered @ 28' below existing grade.
-29.3 to -31.0	170.0		Rock Core: Granodiorite: RQD= 100%, white, fresh, hard, very slight fracturing, fine-grained, 50% Quartz, 35% K-Feldspar, 15%				
-31.0 to -35.0	168.0, 166.0		Rock Core: Granite Gneiss: RQD= 63%, white to gray, moderately weathered, moderately fractured, moderately close to close, fine-grained, 60% Biotite/Hornblende, 25% Quartz, 15% K-Feldspar				
-35.0 to -38.0	164.0, 162.0		Rock Core: Granodiorite: RQD= 100%, white, very slightly weathered, hard, very slight fracturing, fine-grained, 50% Quartz, 35% K-Feldspar, 15% Biotite/Hornblende				
-38.0 to -39.0			Terminated: @ 38' below existing grade.				

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Boring Log

B - 5

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/12/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	194.0	Topsoil: Approximately 3"		WOH		Surface: Grassy Area
-1.0		Fat CLAY: brown to red-brown, fine to medium grained, micaceous, soft to medium stiff, damp to moist	CH	1 1 2	2	
-2.0	192.0			2 2		
-3.0				2 3	4	
-4.0	190.0			3 3		
-5.0				3 3	6	
-6.0	188.0	Lean CLAY with Sand: brown and red-brown, medium grained, soft to medium stiff, damp to moist	CL	2 2		
-7.0				4 3	6	
-8.0	186.0			4 3		
-9.0				4 4	7	
-10.0	184.0					
-11.0						
-12.0	182.0					
-13.0				2 2		
-14.0	180.0			2 2	4	
-15.0						
-16.0	178.0					
-17.0						
-18.0	176.0			1 2		
-19.0				2 1	4	
-20.0	174.0					Cave-in measured @ 20'6" below existing grade.
-21.0						
-22.0	172.0					

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Boring Log

B - 5

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Timmons Pump House
Date: 02/12/15
DAA No. H15102R-02G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-22.0	172.0						
-23.0			Clayey SAND: gray, with organics - wood obstruction encountered - boring offset approx. 10' to east and redrilled, stiff, moist	SC	2 2 7 5	9	Subsurface water encountered @ 23' below existing grade.
-24.0	170.0						
-25.0			Fat CLAY: brown and red-brown, medium grained, stiff, moist	CH			OBSTRUCTION ENCOUNTERED AT 23' - BORING LOCATION OFFSET 10' TO EAST AND REDRILLED
-26.0	168.0						
-27.0							
-28.0	166.0						
-29.0			Rock Core: Granodiorite: RQD= 100%, white, very slightly weathered, hard, very slight fracturing, fine-grained, 50% Quartz, 35% K-				
-30.0	164.0						
-31.0			Rock Core: Granite Gneiss: RQD= 0%, dark gray, severely weathered, extremely fractured, close, fine-grained, 90% Amphibolite, 10% Quartz and K-Feldspar				
-32.0	162.0						
-33.0							
-34.0	160.0						
-35.0			Rock Core: Granodiorite: RQD= 100%, white, very slightly weathered, hard, very slight fracturing, fine-grained, 50% Quartz, 35% K-Feldspar, 15% Biotite/Hornblende				
-36.0	158.0						
-37.0							
-38.0	156.0		Terminated: @ 38' below existing grade.				
-39.0							

APPENDIX
Section III

Laboratory Test Results

Soil Classification Calculations

Timmons Group Fluvanna Pump House
H15102R-02G
Prepared By: DJA

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	B-2
Sample Depth	2'-4'
Visual Sample Description	Brown Fat CLAY

Natural Moisture Content: ASTM D 2216

Pan ID	7
Pan Wt	192.30 grams
Pan + Soil (wet)	392.64 grams
Pan + Soil (dry)	356.23 grams
Natural Moisture Content	*22.2%*

Coarse or Fine Grained: ASTM D 422

Pan + Soil retained on No. 200 sieve (dry)	198.57 grams
Percent Passing No. 200 Sieve	96.2%
Pan + Soil retained on No. 4 sieve (dry)	192.30 grams
Percent Passing No. 4 Sieve	100.0%
Soil Classifies as	*Fine-Grained Soil*

Atterberg Limits: ASTM D 4318

Liquid Limit

No of Blows	20	29	34
Pan ID	70	5	62
Pan Wt	11.05	11.12	11.01
Pan + Soil (wet)	21.13	22.17	22.03
Pan + Soil (dry)	17.66	18.60	18.60
Moisture Content	52.4%	47.7%	45.3%
Liquid Limit	51	49	47
Liquid Limit	*50*		

Plastic Limit

Pan ID	74	22
Pan Weight	4.26	4.31
Pan + Soil (wet)	12.38	12.54
Pan + Soil (dry)	10.87	11.07
Moisture Content	22.8%	21.7%
Plastic Limit	*22*	
Plastic Index	*28*	

USCS Classification: ASTM D 2487

Group Symbol	**CH**
Group Name	**Fat CLAY**

Grain Size Distribution Calculations

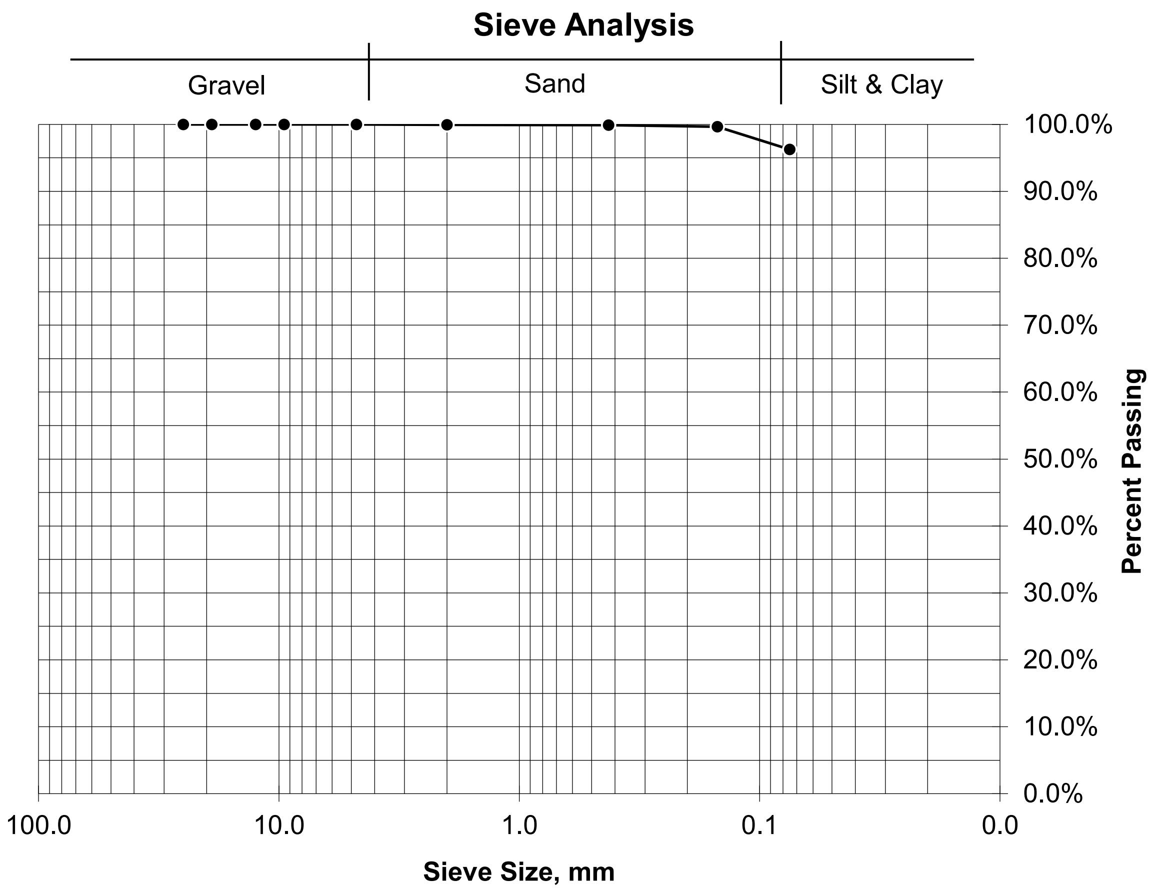
Timmons Group Fluvanna Pump House
H15102R-02G
Prepared By: DJA

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID B-2
Sample Depth 2'-4'

Mechanical Sieve Analysis: ASTM D 422

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
1"	0.00	0.0%	25.0	100.0%
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.06	0.0%	2.0	100.0%
No. 40	0.07	0.0%	0.425	99.9%
No. 100	0.42	0.3%	0.15	99.7%
No. 200	5.58	3.4%	0.075	96.3%
Pan	0.00	0.0%		
Total	6.13	3.7%		



Soil Classification Calculations

Timmons Group Fluvanna Pump House
H15102R-02G
Prepared By: DJA

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID	B-5
Sample Depth	8'-10'
Visual Sample Description	Brown Lean CLAY with Sand

Natural Moisture Content: ASTM D 2216

Pan ID	38
Pan Wt	193.66 grams
Pan + Soil (wet)	428.10 grams
Pan + Soil (dry)	381.76 grams
Natural Moisture Content	*24.6%*

Coarse or Fine Grained: ASTM D 422

Pan + Soil retained on No. 200 sieve (dry)	245.23 grams
Percent Passing No. 200 Sieve	72.6%
Pan + Soil retained on No. 4 sieve (dry)	193.66 grams
Percent Passing No. 4 Sieve	100.0%
Soil Classifies as	*Fine-Grained Soil*

Atterberg Limits: ASTM D 4318

Liquid Limit

No of Blows	15	21	33
Pan ID	105	97	91
Pan Wt	29.29	26.09	24.54
Pan + Soil (wet)	44.92	48.94	44.62
Pan + Soil (dry)	40.34	42.73	39.54
Moisture Content	41.5%	37.3%	33.8%
Liquid Limit	39	37	35
Liquid Limit	*37*		

Plastic Limit

Pan ID	4	81
Pan Weight	9.00	4.30
Pan + Soil (wet)	21.30	15.37
Pan + Soil (dry)	19.00	13.28
Moisture Content	23.0%	23.3%
Plastic Limit	*23*	
Plastic Index	*14*	

USCS Classification: ASTM D 2487

Group Symbol	**CL**
Group Name	**Lean CLAY with Sand**

Grain Size Distribution Calculations

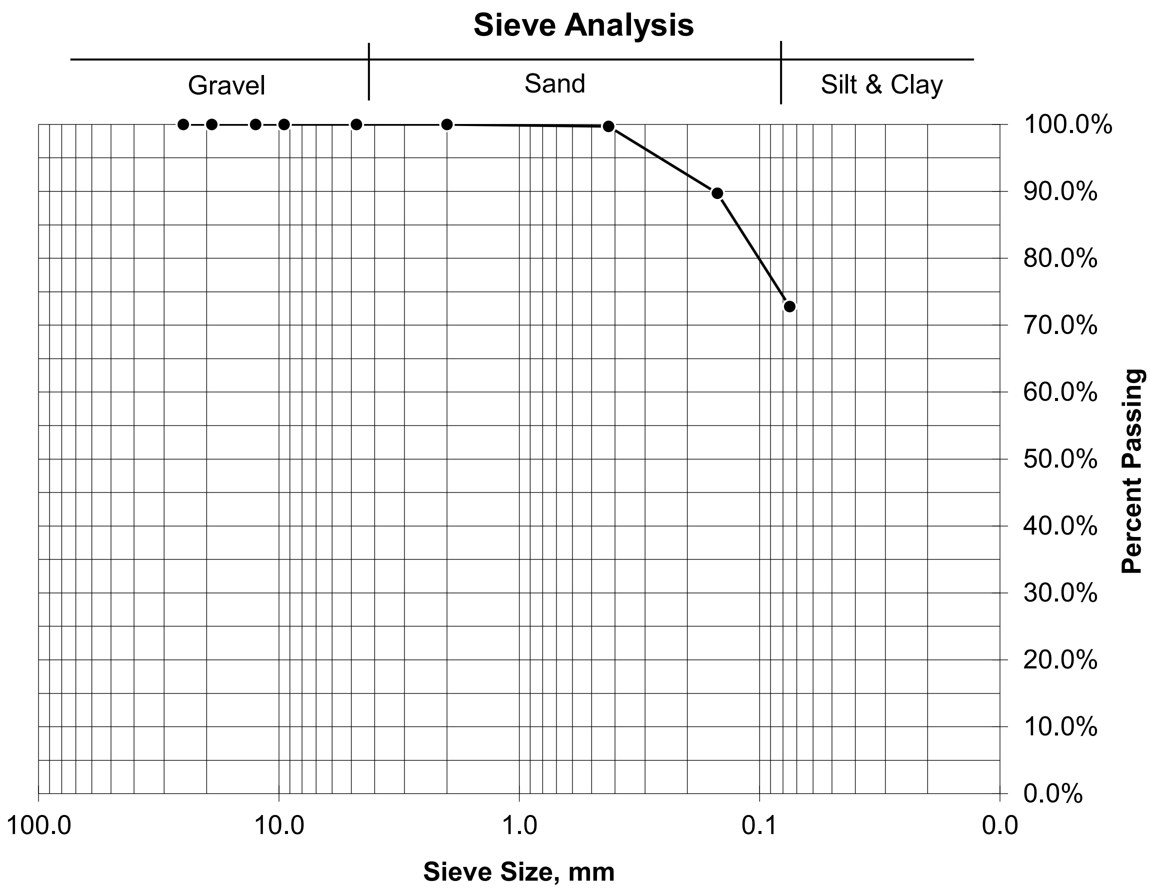
Timmons Group Fluvanna Pump House
H15102R-02G
Prepared By: ADC

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

Sample ID B-5
Sample Depth 8'-10'

Mechanical Sieve Analysis: ASTM D 422

Sieve Size	Weight Retained	Percent Retained	Sieve Size, mm	Percent Passing
1"	0.00	0.0%	25.0	100.0%
3/4"	0.00	0.0%	19.0	100.0%
1/2"	0.00	0.0%	12.5	100.0%
3/8"	0.00	0.0%	9.5	100.0%
No. 4	0.00	0.0%	4.75	100.0%
No. 10	0.00	0.0%	2.0	100.0%
No. 40	0.53	0.3%	0.425	99.7%
No. 100	18.80	10.0%	0.15	89.7%
No. 200	31.86	16.9%	0.075	72.8%
Pan	0.35	0.2%		
Total	51.54	27.2%		



APPENDIX
Section IV

Geotechnical Test Methods

Draper Aden Associates
Blacksburg • Richmond, Virginia
Engineering • Surveying • Environmental Services

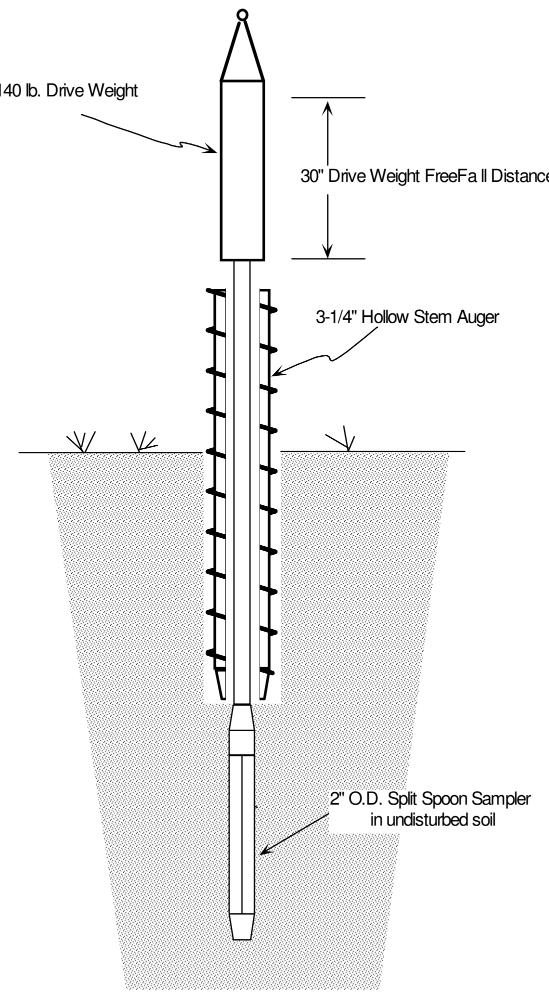
Standard Penetration Test

Split Spoon Sampling is an in-situ technique of obtaining samples of both cohesive and cohesionless soils. The sample is taken by actually driving the split spoon sampler into the “undisturbed” soil at the bottom of the bore hole. The bore hole is advanced using a hollow stem auger.

The Split Spoon Sampler is made up of a split steel barrel with a ball check valve in the head for venting and a hardened steel shoe for driving. A spring sample retainer is used between the shoe and the barrel to retain any loose or flowing materials. After the sampler is driven, the head and the shoe are removed and the barrel opens into two halves exposing the entire sample.

The use of a 140 lb. drive weight falling freely 30" to drive the 2" O.D. (1-$^{3}/_{8}$" I.D.) split spoon sampler a distance of one foot is known as the Standard Penetration Test. Once the sampler is lowered to the bottom of the borehole, the sampler is driven continuously for 18". The number of blows required by the 140 lb. weight to drive the sampler is recorded. Separate counts are made for the second 6" and the third 6" with the first 6" considered to be seating the sampler. An N-Value is obtained by adding the second and third 6" intervals and recorded. The N-Value correlation is shown below:

Standard Penetration Test Diagram



Soil Strength

Relative Density
Coarse Grained Soil, SAND

N-Value	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
>50	Very Dense

Consistency
Fine Grained Soil, SILT or CLAY

N-Value	Relative Density
0-1	Very Soft
2-4	Soft
5-8	Medium Stiff
9-15	Stiff
16-29	Very Stiff
>29	Hard

SPT performed in accordance with ASTM D1586, Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

Moisture Content

Naturally occurring soils nearly always contain water as part of their structure. The moisture content of a soil is assumed to be the amount of water within the pore space between the soil grains which is removable by oven drying at 110^{o}C, expressed as a percentage of the mass of dry soil. By 'dry' is meant the result of oven drying at that temperature to constant mass, usually for a period of about 12-14 hours. In non-cohesive granular soils, this procedure removes all water present.

There are several ways in which water is held in cohesive soils, which contain clay minerals existing as plate-like particles of less than 2□m across. The shape and very small size of these particles, and their chemical composition, enable them to combine with or hold on to water by several complex means as follows:

1) Adsorbed water is held on the surface of the particle by powerful forces of electrical attraction and virtually in a solid state. This water cannot be removed by oven drying at 110^{o}C, and may, therefore, be considered a part of the solid soil grain.

2) Water which is not so tightly held and can be removed by oven drying, but not by air drying.

3) Capillary water, held by surface tension, generally removable by air drying.

4) Gravitational water, which can move within the voids between soil grains, is removable by drainage.

5) Chemically combined water, in the form of water of hydration within the crystal structure. Except for gypsum, and some tropical clays, this water is not generally removable by oven drying.

Moisture content is usually expressed as a percentage, always on the basis of oven-*dry* mass of soil. The equation for the determination of moisture content is:

$$w(\%) = \frac{m_w}{m_d} x100$$

where ,

m_w = mass of water removed at 110^{o}C.

m_d = mass of dried soil

The following ASTM (American Society for Testing and Materials) apply to moisture content determinations:
ASTM D2216-90 Laboratory Determination of Water Content of Soil and Rock
ASTM D4959 -89 Determination of Water Content of Soil By Direct Heating Method
ASTM D4643-87 Determination of Water Content of Soil by the Microwave Oven Method
ASTM D3017-88 Water Content of Soil and Rock in Place by Nuclear Methods

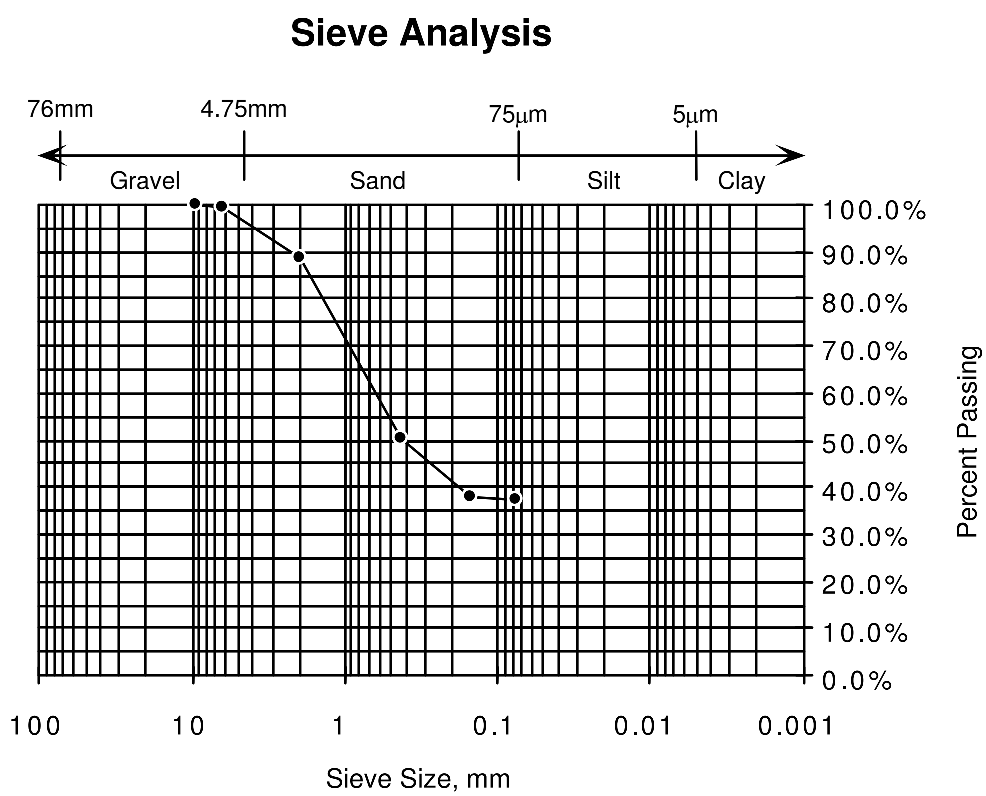
Particle Distribution

A soil consists of an assemblage of discrete particles of various shapes and sizes. The object of a particle size analysis is to group these particles into separate ranges of sizes, and so determine the relative proportions, by dry weight, of each size range.

Particle size analyses consist of two separate and quite different procedures in order to span the very wide range of particle sizes which are encountered. These are sieving and sedimentation procedures. Sieving is used for gravel and sand size (coarse) particles, which can be separated into different size ranges with a series of standard aperture openings. Sieving cannot be used for the very much smaller silt and clay size (fine) particles, so a sedimentation procedure is used instead. Measurements of the density of the suspension are made using a hydrometer.

For soils containing both coarse and fine particles, composite tests using both sieving and sedimentation methods may be used if a full particle size distribution analyses is required. Particle size testing can range from a simple sieving test on a 'clean' sand and gravel, to elaborate composite tests on clay-silt-sand-gravel mixtures.

Presentation of particle size distribution data may include a table showing the percentages, by dry weight, of particles finer than certain standard sizes and may include a graphical presentation of the percentages plotted against the particle size on a logarithmic scale. An example of the graphical presentation with respective particle sizes follows:



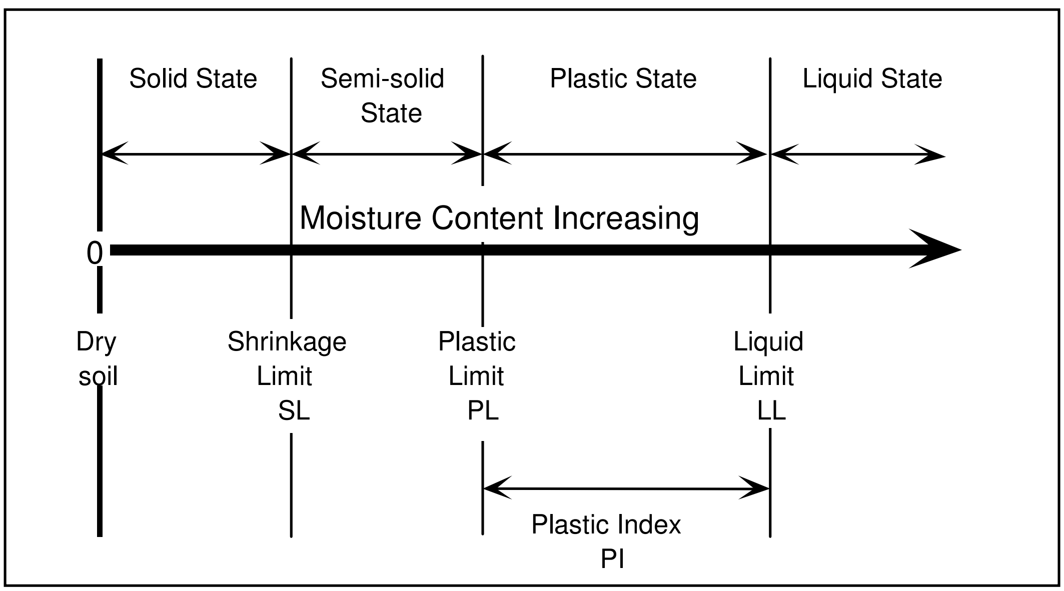
Particle size analyses are performed in accordance with ASTM D422-63, Standard Test Method for Particle-Size Analysis of Soils or ASTM C136-84, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

The condition of a clay soil can be altered by changing the moisture content; the softening of clay by the addition of water is a well known example. For every clay soil there is a range of moisture contents within which the clay is of a plastic consistency, and the Atterberg limits provide a means of measuring and describing the plasticity range in numerical terms.

If sufficient water is mixed with a clay, it can be made into a slurry, which behaves as a viscous liquid. This is known as the 'liquid' state. If the moisture content is gradually reduced by allowing it to dry out slowly, the clay eventually begins to hold together and to offer some resistance to deformation; this is the 'plastic' state. With further loss of water the clay shrinks and the stiffness increases until there is little plasticity left, and the clay becomes brittle; this is the 'semi-solid' state. As drying continues, the clay continues to shrink in proportion to the amount of water lost, until it reaches the minimum volume attainable by this process. Beyond that point further drying results in no further decrease in volume, and this is called the 'solid' state.

These four states, or phases, are shown diagrammatically below. The change from one phase to the next is not observable as a precise boundary, but takes place as a gradual transition. Nevertheless three arbitrary but specific boundaries have been established empirically, as indicated below, and are universally recognized. The moisture contents at these boundaries are known as the Liquid Limit (LL), Plastic Limit (PL) and the Shrinkage Limit (SL).

The moisture content range between the PL and the LL is known as the Plastic Index (PI), and is a measure of the plasticity of the clay. Cohesionless soils have no plasticity phase, so their PI is zero.



Atterberg limits are performed in accordance with ASTM D4318-84, Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

APPENDIX E-3-2

RIVANNA RIVER CROSSING - DRAPER ADEN ASSOCIATES BORING LOGS

Draper Aden Associates
Engineering • Surveying • Environmental Services
8090 Villa Park Drive
Richmond, Virginia 23228
Phone: (804) 264-2228
Fax: (804) 264-8773

Boring Log

B - 1

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Rivanna River Crossing
Date: 06/08/2015
DAA No. H15102R-04G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	192.0		Topsoil: Approximately 2"		1		Surface: Grassy Area
-1.0			Sandy SILT: brown, fine grained, micaceous, soft to medium stiff, damp to moist	ML	1 2 1	3	
-2.0	190.0				3		
-3.0					2 3 3	5	
-4.0	188.0				3		
-5.0					3 3 4	6	
-6.0	186.0				3		
-7.0					3 3 2	6	
-8.0	184.0				3		
-9.0					3 2 4	5	
-10.0	182.0						
-11.0							
-12.0	180.0						
-13.0					1		Subsurface water upon completion measured @ 13' below existing grade.
-14.0	178.0				1 1 1	2	
-15.0							
-16.0	176.0						
-17.0							
-18.0	174.0						

Draper Aden Associates
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8090 Villa Park Drive
Richmond, Virginia 23228
Phone: (804) 264-2228
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Boring Log

B - 1

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Rivanna River Crossing
Date: 06/08/2015
DAA No. H15102R-04G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-18.0	174.0		Silty SAND: light brown to gray, well graded, fine to very coarse grained, with trace to little fine to medium gravel, micaceous, very dense, damp to wet	SM	1 1 2 3	3	
-19.0							
-20.0	172.0						
-21.0							
-22.0	170.0						
-23.0					46 50/3 - -	SR	
-24.0	168.0						
-25.0							
-26.0	166.0						Cave-in measured @ 26' below existing grade.
-27.0							
-28.0	164.0				50/2 - - -	SR	
-29.0							
-30.0	162.0						
-31.0							
-32.0	160.0						
-33.0					50/1 - - -	SR	
-34.0	158.0						
-35.0							
-36.0	156.0						

Draper Aden Associates
Engineering • Surveying • Environmental Services
8090 Villa Park Drive
Richmond, Virginia 23228
Phone: (804) 264-2228
Fax: (804) 264-8773

Boring Log

B - 1

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Rivanna River Crossing
Date: 06/08/2015
DAA No. H15102R-04G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-36.0	156.0						
-37.0							
-38.0	154.0				50/5 - - -	SR	
-39.0							
-40.0	152.0						
-41.0							
-42.0	150.0						
-43.0			ROCK CORE: very hard, slightly weathered, gray BIOTITE GNEISS: smooth, tight fractures with rust staining, with quartzite banding, micaceous. RQD=88%				
-44.0	148.0						
-45.0							
-46.0	146.0						
-47.0							
-48.0	144.0		Terminated: @ 47.5' below existing grade.				

Draper Aden Associates
Engineering • Surveying • Environmental Services
8090 Villa Park Drive
Richmond, Virginia 23228
Phone: (804) 264-2228
Fax: (804) 264-8773

Boring Log

B - 2

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Rivanna River Crossing
Date: 06/08/2015
DAA No. H15102R-04G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Legend	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
0.0	198.0		Topsoil: Approximately 2"		2 2 5 6	7	Surface: Grassy Area
-1.0			Sandy SILT: brown, fine grained, micaceous, soft to medium stiff, damp to moist	ML			
-2.0	196.0				3 3 2 2	5	
-3.0							
-4.0	194.0				2 1 2 2	3	
-5.0							
-6.0	192.0				1 1 1 1	2	
-7.0							
-8.0	190.0				2 1 1 2	2	
-9.0							
-10.0	188.0						
-11.0							
-12.0	186.0						Cave-in measured @ 12' below existing grade.
-13.0					2 2 2 3	4	
-14.0	184.0						Subsurface water upon completion measured @ 13' below existing grade.
-15.0							
-16.0	182.0						
-17.0							
-18.0	180.0						

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Richmond, Virginia 23228
Phone: (804) 264-2228
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Boring Log

B - 2

Client: Timmons Group
1001 Boulders Parkway Ste. 300 Richmond, VA 23225
Project: Rivanna River Crossing
Date: 06/08/2015
DAA No. H15102R-04G

Logged By: JW
Drill Type: 3 1/4" HSA w/ SPT
Drilled By: Fishburne Drilling
Location: See Location Plan

Depth ft.	Elevation ft.	Description	USCS Symbol	SPT Blow Count	N-Value	Notes
-18.0 to -23.0	180.0 to 175.0			3 3 5 5	8	
-23.0 to -28.0	175.0 to 170.0	Well Graded SAND with Clay: brown, medium to coarse grained, with some fine to medium gravel, loose, wet	SW	3 3 5 5	8	
-28.0 to -35.0	170.0 to 163.0	Silty SAND: light brown to gray, well graded, fine to very coarse grained, with trace to little fine to medium weathered rock and gravel, micaceous, very dense, moist to wet	SM	46 50/2 - - 50/2 - - -	SR SR	
-35.0 to -36.0	163.0 to 162.0	Terminated: @ 36' below existing grade.				

APPENDIX E-3-3

GEOTECHNICAL ENGINEERING REPORTS JAMES RIVER WATER AUTHORITY WATER SUPPLY PROPOSED PUMP STATION

GEOTECHNICAL ENGINEERING REPORT

JAMES RIVER WATER AUTHORITY WATER SUPPLY
PROPOSED PUMP STATION
FLUVANNA COUNTY, VIRGINIA

JOB NUMBER: 36790

PREPARED FOR:

FAULCONER CONSTRUCTION COMPANY, INC.
2496 OLD IVY ROAD
P.O. BOX 7706
CHARLOTTESVILLE, VIRGINIA 22906

August 24, 2016

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

For your convenience, this report is summarized in outline form below. This brief summary should not be used for design or construction purposes without reviewing the more detailed conclusions and recommendations contained in this report.

1. The subsurface exploration included a visual site reconnaissance, performance of 5 test borings to depths of approximately 23 to 49 feet below the ground surface and quantitative laboratory testing.
2. The borings encountered approximately 1 to 3 inches of surficial topsoil. Beneath the topsoil, the borings encountered undisturbed alluvial soil deposits to depths up to 31 feet below the ground surface. These soils consisted of fine grained very soft to stiff silts and clays and very loose to dense sands. Weathered rock was encountered in all the borings at depths ranging from approximately 21 feet below the existing ground surface to boring termination depths.
3. At the time of exploration, water was encountered in several of the borings at depths ranging from 13 to 18 feet below the ground surface.
4. We recommend that site grading be conducted during the typically drier summer months.
5. Temporary shoring or sloping of excavation sidewalls will be required for the deep excavations at this site.
6. Pump station structures bearing near existing grade may be supported on shallow foundations designed using an allowable bearing pressure of 1,500 psf. The wet well foundation may be supported on rock materials.
7. Earth pressure parameters for various backfill types are present in this report. Earth pressures can be substantially reduced if off-site granular materials are used as backfill.

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

1001 Boulders Parkway
Suite 300
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P 804.200.6500
F 804.560.1016
www.timmons.com

August 24, 2016

Faulconer Construction Company, Inc.
2496 Old Ivy Road
P.O. Box 7706
Charlottesville, Virginia 22906

Attention: Mr. Ed Stelter

Re: **Geotechnical Engineering Report**
James River Water Authority Water Supply
Proposed Pump Station
Fluvanna County, Virginia
Timmons Group Project No. 36790

Mr. Stelter:

Timmons Group is pleased to submit this geotechnical engineering report for the referenced project. The objectives of our services were to explore subsurface conditions and provide our geotechnical recommendations for site grading and foundation support.

1. PROJECT INFORMATION

The site consists of partially wooded land located along the James River in Fluvanna County, Virginia. A Site Vicinity Map is shown on Figure 1.

The site currently consists of agricultural land near the intersection of the Rivanna River and James River. There are two stretches of mature woodland that run parallel with the James River on the property.

Proposed construction will consist of a new pump station with a wet well and an intake from the James River. The pump station will have a floor elevation near existing grade (approximate elevation 200 feet), and the bottom of the wet well is expected to bear on rock below approximate elevation 170 feet. Some foundations for the pump station building will bear at shallow depths below existing grade. We expect maximum column and wall loads for the pump station will be 10 kips and 2 kips per linear foot, respectively.

Site grades range from approximately elevation 200 feet near the pump station to elevation 170 at the location of the intake along the James River.

2. FIELD EXPLORATION

The field exploration included a visual site reconnaissance by a representative of Timmons Group and performance of five soil test borings (B-01 through B-05). Boring locations were selected by Timmons Group. A representative of Timmons Group established locations in the field using GPS equipment. Approximate boring locations are shown on Figure 2 in Appendix A.

Borings were performed to auger refusal with hollow stem drilling techniques. A Timmons Group representative was present on site to visually classify encountered subsurface conditions. Split-spoon samples of subsurface soils were taken within soil test borings at approximate 2-foot intervals above a depth of 10 feet and at 5 foot intervals below 10 feet. Two bulk samples of soil cuttings were also collected. Standard penetration tests were conducted in conjunction with split-spoon sampling in general accordance with ASTM D 1586-99. Within Boring B-04, materials refusing auger advancement were cored with an NQ core barrel, typically at 5-foot core intervals. Total core run was approximately 20 feet in this boring.

Water levels were measured in open boreholes at the time of drilling. Upon completion, boreholes were then backfilled up to the original ground surface with drill cuttings. Representative portions of split-spoon soil samples and the bulk samples were returned to our laboratory for quantitative testing and visual classification in general accordance with Unified Soil Classification System guidelines.

Boring logs and a generalized soil profile (Figure 3), which present specific information from the borings, are included in the Appendix. Stratification lines shown on the boring logs and profile are intended to represent approximate depths of changes in soil types. Naturally, transitional changes in soil types are often gradual and cannot be defined at particular depths. Ground surface elevations shown on these documents were interpolated from a GIS topographic plan and should be considered approximate.

3. LABORATORY TESTING

Laboratory testing was performed on representative split-spoon and bulk soil samples obtained from the borings. This testing consisted of natural moisture content, Atterberg limits, grain size analyses, and standard Proctor tests. Testing of rock core samples consisted of unconfined compression strength. Laboratory tests were performed in general accordance with applicable ASTM procedures. Individual laboratory test data sheets are provided in the Appendix. A summary of laboratory test data is provided in the tables below.

Natural Moisture and Classification Tests

Boring	Sample	Depth (Feet)	Natural Moisture Content (%)	Atterberg Limits			Grain Size Analysis		USCS Classification
				LL	PL	PI	% Sand	% Fines*	
B-01	S-5	8-10	23.1	56	18	38	13.3	86.7	CH
B-02	Bulk	0-10	21.7	53	24	29	2.2	97.8	CH
B-02	Bulk	10-20	23.5	50	24	26	28.3	71.7	CH
B-03	S-3	4-6	21.8	58	31	27	2.9	97.1	MH
B-03	S-6	13-15	27.5	51	20	31	30.6	69.4	CH
B-04	S-2	2-4	19.7	38	25	13	7.2	92.8	ML

*Material passing No. 200 sieve (clay and silt)
**Visual Classification

Standard Proctor Testing

Boring	Depth (Feet)	Natural Moisture Content (%)	Standard Proctor		USCS Classification
			Optimum Moisture Content (%)	Maximum Dry Density (pcf)	
B-02	0-10	21.7	21.4	102.2	CH
B-02	10-20	23.5	19.2	103.7	CH

Unconfined Compression Testing of Rock Core Samples

Boring	Approximate Depth (Feet)	Unconfined Compressive Strength of Rock Core (psi)
B-04	29.5-30.1	6,581
B-04	39.0-39.56	8,580

Based on the Atterberg limits testing, soils are of low to high plasticity. Based on comparison of natural moisture contents to the optimum moisture contents of the bulk samples, near-surface soils appear near to wet of optimum moisture. Drying of some near-surface soils will likely be required prior to their re-use as fill. The time of year the grading occurs will likely have a significant impact on the moisture levels of near-surface soils.

4. SITE GEOLOGY

According to the 1993 Geologic Map of Virginia, the site is located in the Piedmont Physiographic Province of Virginia. The Piedmont is characterized by low, rounded hills composed of saprolitic soils overlying folded metamorphic and igneous bedrock. Locally, the site appears to be underlain by the Columbia pluton formation. Undisturbed soils in the Piedmont were formed from the chemical weathering of parent bedrock and are termed “residual” soils.

Based on the borings performed at this site, the majority of encountered soils appear to be alluvial in nature (i.e., deposited by the James River). The alluvial soils are underlain by a thin layer of weathered rock followed by intact bedrock.

5. SUBSURFACE CONDITIONS

The following is a summary of subsurface conditions encountered during the exploration.

5.1 Ground Surface Cover

The borings encountered approximately 1 to 3 inches of surficial topsoil.

5.2 Soils

Beneath the topsoil, the borings encountered alluvial soil deposits to depths up to 31 feet below the ground surface. These soils consisted of fine-grained very soft to stiff highly plastic clay (CH), elastic silt (MH), silt (ML) and lean clay (CL). The coarse soils were sampled as very loose and dense silty sand (SM) and clayey sand (SC). SPT N-values within the soil profile ranged from 1 to 38 blows per foot (bpf).

5.3 Weathered Rock

Weathered rock was encountered in all the borings at depths ranging from approximately 21 feet below the existing ground surface to boring termination depths. Weathered rock is residual material derived from the physical and chemical weathering of underlying parent rock. Weathered rock is defined as a residual soil having Standard Penetration Test N-values of 60 blows per foot or greater. Weathered rock was sampled primarily as silty sand (SM) and clayey sand (SC).

5.4 Auger Refusal Materials

Materials refusing auger advancement were encountered in all the borings at depths of 23.6 to 31 feet below the ground surface. Based on cores taken from Boring B-04, rock materials were sampled as granite bedrock.

5.5 Groundwater

At the time of exploration, water was encountered in all the borings at depths ranging from 13 to 18 feet below the ground surface. It is important to realize that groundwater levels will fluctuate with changes in rainfall, river water levels, and evaporation rates. In addition, perched groundwater could be encountered within near-surface soils, particularly after rainfall.

6. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon our borings, laboratory testing, engineering analysis, and past experience with similar projects and subsurface conditions

6.1 Site Preparation

6.1.1 General

Site grading will be difficult during periods of extended rainfall and low temperatures that generally occur during the winter months. If grading is conducted during a wet time period, soils will tend to rut and pump under rubber-tired traffic and provide poor subgrade support for pavements. Heavy rubber-tired construction equipment should not be allowed to operate on wet or unstable subgrades at this site due to the potential for rutting and other damage to the soils. To reduce potential earthwork problems, site preparation and grading should be scheduled during the typically drier summer months, if possible. We recommend that exposed subgrades be sloped and sealed at the end of each day to promote runoff and reduce infiltration from rainfall.

Site preparation should begin with clearing and grubbing of existing trees, stripping of topsoil, and removal of any other unsuitable materials. Approximately 1 to 3 inches of topsoil was encountered in the borings. However, stripping activities often mix topsoil with underlying "clean" soils and cause stripping depths to be greater than actual topsoil depths, particularly during wet periods of the year. Topsoil should be wasted from the site or permanently stockpiled outside the proposed construction limits.

6.1.2 Subgrade Evaluation

After stripping, exposed soil subgrades in areas to receive fill, and finished subgrades, should be evaluated by the Geotechnical Engineer or his representative. To aid the engineer during this evaluation, exposed soil subgrades should be proofrolled with a loaded tandem axle dump truck or equivalent. Proofrolling will help to reveal the presence of unstable or otherwise unsuitable surface materials. The following methods are typically used to repair soil subgrades that are observed to rut, pump, or deflect excessively during proofrolling:

- Undercut the unstable soils to firm soils and replace them with suitable, well compacted fill.
- In-place repair of near-surface soils by scarifying, drying and recompacting, when weather conditions are suitable.

6.2 Excavations

We expect that deep excavations on the order 30 to 40 feet will be required to construct the wet well and intake pipe. Excavations will extend through low to high consistency soils, weathered rock, and mass rock. A temporary shoring system or sloping of excavation sidewalls will be required for excavations. Excavation considerations are presented in the following sections.

6.2.1 Excavated Materials

Soils encountered above approximate elevation 173 feet consist of low to moderate consistency soils which can likely be excavated using conventional earthwork equipment. However, blasting of rock will be required below that elevation. Care must be used to avoid over-blasting materials beneath the planned bottom elevation of structures. Any over-blasted materials must be removed beneath structures because over-blasted materials could settle if left in place. We recommend that a preblast survey of any nearby structures be performed prior to blasting.

6.2.2 Shoring

Temporary shoring will be required to support lateral earth pressures from excavation sidewalls. Otherwise, excavation sidewalls should be properly sloped in accordance with OSHA guidelines. The temporary shoring or sloped excavation sidewalls should be designed by an engineer that is licensed in the state of Virginia who specializes in temporary excavation design and has experience with similar geologic conditions.

Water was encountered in the borings at depths ranging from approximately 13 to 18 feet below existing grades. The contractor should be prepared to control and remove groundwater seepage that occurs within excavations.

6.3 Structural Fill

Structural fill placed in building area should be free of debris, contain less than 5 percent organics, have plasticity index (PI) less than 25, and have a maximum particle size of 3 inches. These requirements apply to the re-use of on-site soils or imported soils. The near-surface, low-plasticity silts (ML) should be suitable for re-use in the building area, provided the moisture content can be properly controlled. Structural fill should be placed in maximum 8 to 10-inch loose lifts and compacted to at least 95 percent of the Standard Proctor maximum dry density

(ASTM D 698). The final 12 inches of structural fill relative to finished subgrade should be compacted to at least 98 percent of the Standard Proctor maximum dry density. Structural fill should be maintained within 3 percentage points of optimum moisture during placement and compaction.

Recommended backfill materials types for the wet well retaining walls are provided later in this report.

Site preparation, including fill placement and compaction, should be observed by a qualified soils technician working under the direction of the Geotechnical Engineer. During fill placement, a sufficient amount of in-place density tests should be conducted to confirm that compaction and fill moisture is in accordance with our recommendations.

6.4 Foundations

6.4.1 Pump Station Foundations

Based on the performed borings and assumed structural loads, the light pump station loads bearing near elevation 200 feet may be supported on shallow foundations designed using an allowable bearing pressure of 1,500 psf. Individual column and wall foundations should be at least 24 inches and 18 inches wide, respectively. This recommendation is made to prevent a localized or “punching” shear failure condition which can occur with very narrow footings. Because some near-surface soils are highly plastic, we recommend that the foundations bear at least 36 inches below finished exterior grade. This embedment depth should provide adequate frost protection for foundation bearing materials.

We expect total and differential settlements of the pump station structures will be one inch and ½ inches, respectively, provided the recommendations of this report are properly implemented.

Foundation excavations should be evaluated by the Geotechnical Engineer or his representative prior to reinforcing steel and concrete placement. The evaluation should involve probing of foundation bearing surfaces, advancing shallow hand auger borings, and dynamic cone penetrometer (DCP) testing. If soft foundation bearing soils are encountered, they should be overexcavated and replaced with VDOT No. 57 stone.

If groundwater or surface water runoff collects in any excavation, it should be removed promptly. Care should be exercised during construction of foundations in order not to disturb bearing soils and reduce their bearing strength. Concrete for the foundations should be placed as soon as practical following excavation. If concrete placement is delayed, placement of a concrete “mud mat” on exposed bearing soils should be considered.

6.4.2 Wet Well

The wet well will bear on mass rock. The wet well foundation is expected to consist of a structural mat supporting cast-in-place concrete walls. As previously mentioned, all overblasted rock must be removed beneath the wet well. We recommend that any overblasted rock material below the wet well bearing elevation be backfilled with VDOT No. 57 stone up to the design bearing elevation for the wet well. Wet well foundation bearing on rock can be designed using an allowable bearing pressure of 5,000 psf. Higher bearing pressures are available for the rock but are not expected to be needed. Settlement of the wet well foundation is expected to be ½ inches or less.

6.5 Seismic Site Classification

Based on our test borings and our past experience, it is our opinion the site should be considered Seismic Site Classification D in accordance with the 2012 International Building Code (IBC). Additional field testing (i.e., shear wave velocity testing) could be performed in an attempt to obtain a more favorable seismic site classification.

6.6 Uplift Considerations for Below-Grade Structures

During normal operations, the wet well will have both internal and external fluid pressures applied to the exterior walls. Water within the structure should balance or exceed hydrostatic forces applied to the outside of the walls from groundwater. However, if this structure will be emptied for maintenance purposes, hydrostatic pressure from groundwater will create uplift forces on the structures. The structures should be designed with an adequate factor of safety against uplift. A method to reduce uplift pressures on the structures during maintenance includes construction of pressure relief valves along the mat bottom.

6.7 Below Grade Walls

Cast-in-place concrete, below-grade walls will be constructed for the wet well. These walls must be designed to resist lateral earth pressures from the backfill. In addition to these lateral pressures, the walls may be subjected to surcharge loading from adjacent traffic and stockpiled materials. If present, these surcharge stresses should be resolved into appropriate lateral stress distributions and added to the earth pressures outlined below.

Backfill soils placed behind retaining walls should be compacted to at least 95 percent of the soil's standard Proctor maximum dry density (ASTM D 698) and within 3 percent points of optimum moisture. Operating heavy compaction equipment within 5 feet behind the retaining structures can create lateral earth pressures far in excess of those recommended for design. As such, we recommend that hand-operated equipment be used within 5 feet from walls.

On-site soils may be used as backfill behind the wet well walls. However, the earth pressures can be substantially reduced by backfilling with an off-site granular material, such as relatively clean sands (less than 10 percent fines), VDOT 21B stone, or VDOT No. 57 stone. To receive the benefit of reduced lateral earth pressure, the granular backfill must be located within an imaginary line extending at a 45-degree angle from the bottom of wall (e.g., for a 30-foot tall wall, the granular backfill must extend 15 feet behind the top of wall).

At-rest equivalent fluid unit weights are provided in the table below for various backfill types described above. The lateral earth pressure parameters presented below assume no wall friction between the wall and soil backfill (δ = 0 degrees) and are based on placement of properly compacted backfill and a level backfill surface.

Backfill Type	At-Rest Equivalent Fluid Unit Weight (γ_{eq})
On-Site Soils	75 pcf
Granular Backfill	40 pcf
VDOT 21B Stone or Relatively Clean Sand	50 pcf

We expect the wet well will maintain a water pool elevation above the groundwater table. For this case, internal and external hydrostatic pressures are expected to balance each other. If the wet well walls will not experience this balance, then the potential external hydrostatic lateral pressures on the wall must be considered in design.

7. LIMITATIONS OF REPORT

The recommendations contained in this report are made on the basis of the site information made available to us and the surface and subsurface conditions that existed at the time of the exploration. While this exploration has been conducted in accordance with generally accepted geotechnical engineering practices, there remains some potential for variation of the subsurface conditions in unexplored areas of the site. If the subsurface conditions encountered during construction vary significantly from those presented in this report, we should be notified to reevaluate our recommendations. No other warranty, expressed or implied, is made as to the professional advice included in this report.

8. CLOSURE

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this study or if we can be of further assistance, please contact us at (804) 200-6500.

Respectfully submitted,
TIMMONS GROUP

Julian M. Ruffin IV, P.E.
Geotechnical Engineer

COMMONWEALTH OF VIRGINIA
JNR
8/24/16
J NATHAN REEVES
No. 049619
PROFESSIONAL ENGINEER

J. Nathan Reeves, P.E.
Geotechnical Engineer
VA Registration No. 049619

APPENDIX A

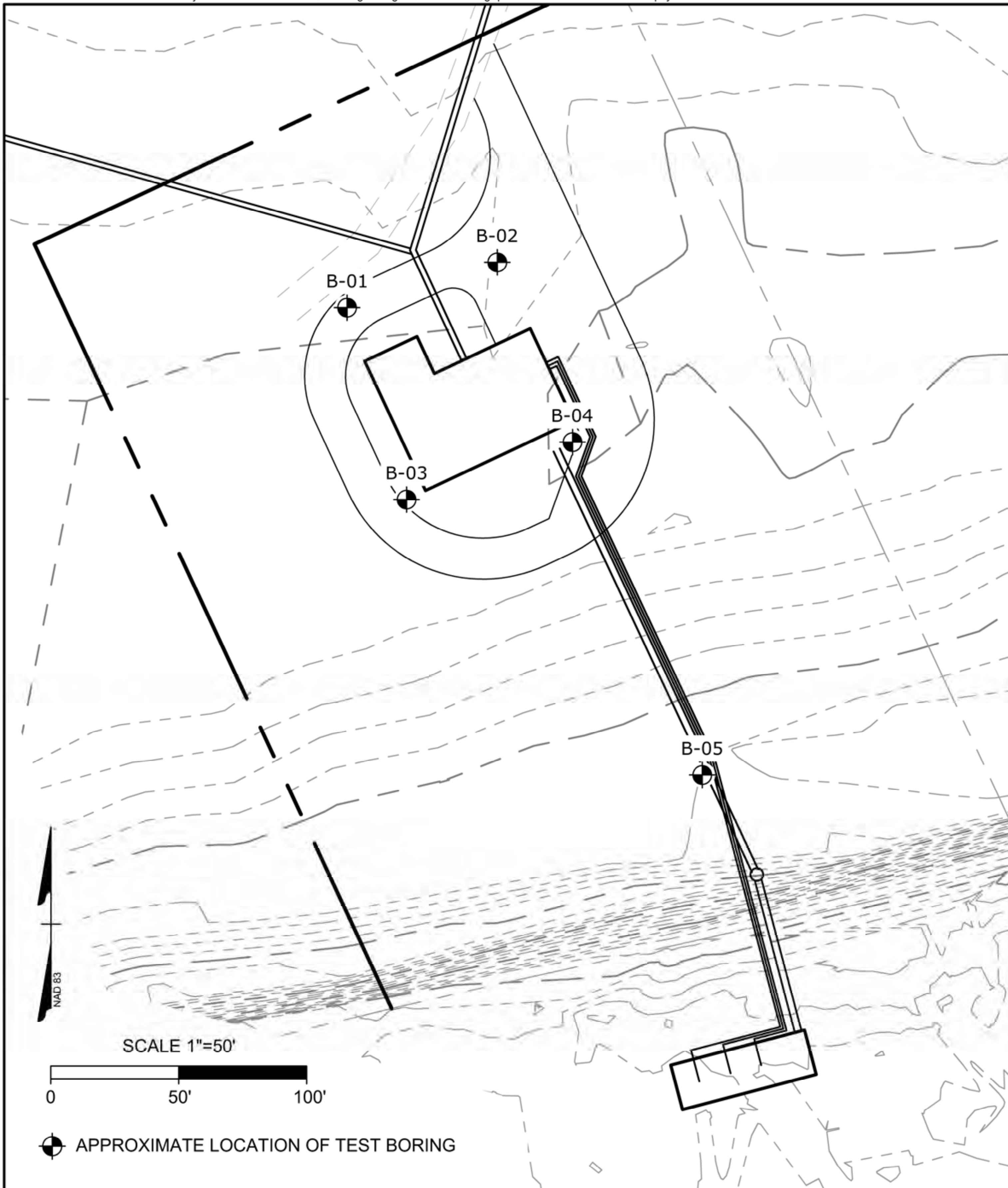
FIGURES

NORTH

Source: Bing Maps

SCALE: NTS	TIMMONS GROUP YOUR VISION ACHIEVED THROUGH OURS.	**SITE VICINITY MAP** JAMES RIVER WATER AUTHORITY WATER SUPPLY FLUVANNA COUNTY, VA	FIGURE 1
CHECKED BY: JNR			
PLOTTED BY: JMR			
DATE: 4-18-2016	PROJECT NUMBER: 36790		

K:\Geotechnical\PROJECTS\2016 Projects\36790 JRWA RWPS\Drafting\Boring Location Plan.dwg | Plotted on 4/26/2016 2:13 PM | by Julian Ruffin



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THIS DRAWING PREPARED AT THE
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1001 Boulders Parkway | Richmond, VA 23225
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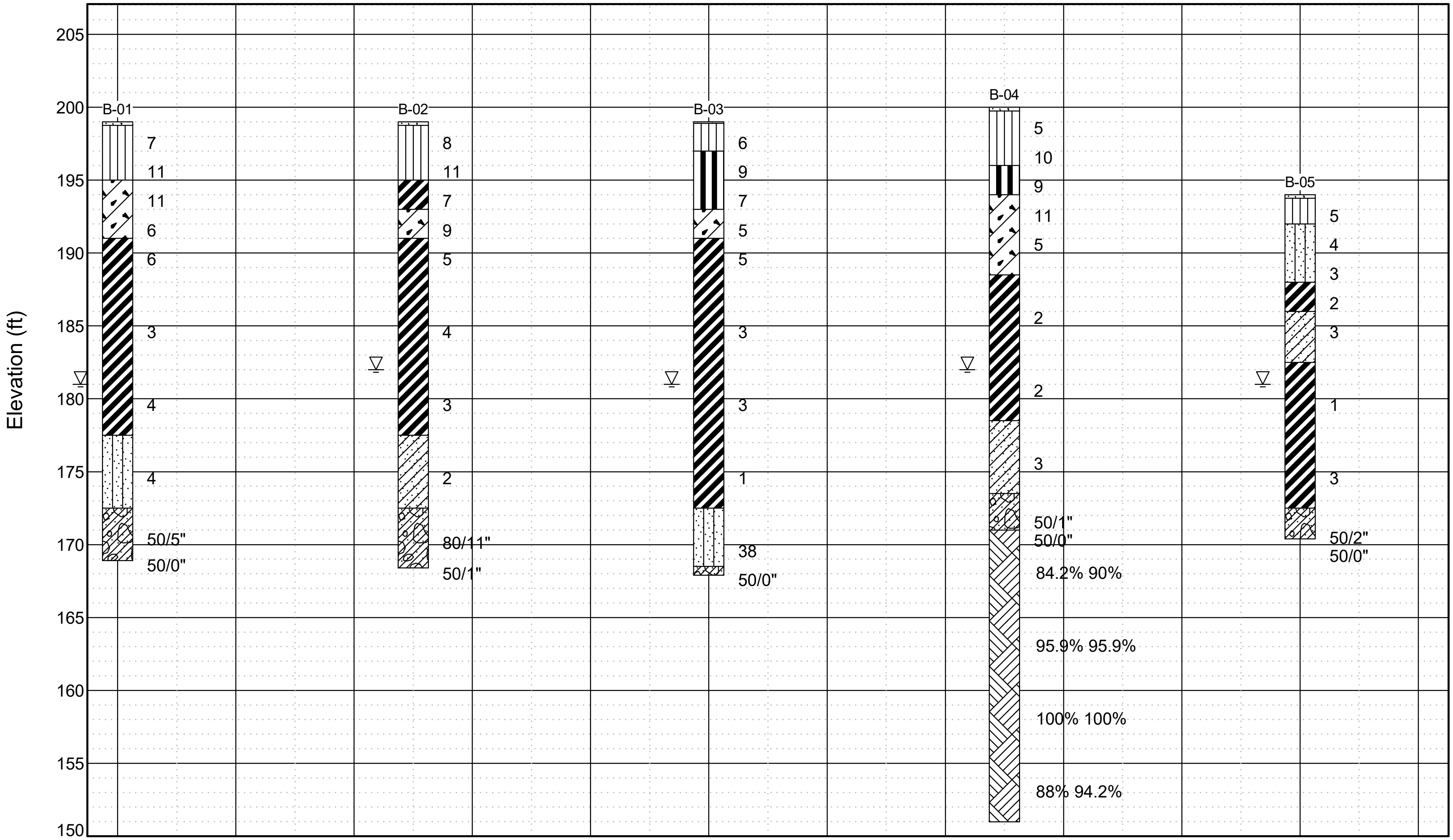
SHEET NO. 2 | JOB NO. 36790

JAMES RIVER WATER AUTHORITY WATER SUPPLY
FLUVANNA COUNTY - VIRGINIA
BORING LOCATION PLAN

SCALE: AS SHOWN | CHECKED BY: N. REEVES | DESIGNED BY: N. REEVES | DRAWN BY: J. RUFFIN | DATE: 4/25/2016

DATE	REVISION DESCRIPTION
-	-



TG SUBSURFACE PROFILE V2.0 - GINT STD US LAB.GDT - 13/6/16 13:55 - K:\GEOTECHNICAL\PROJECTS\2016 PROJECTS\36790 JRWA RWPS\LOGS\JWRA.GPJ

Lithology Symbols

- Topsoil
- Silt
- Low Plasticity Clay
- High Plasticity Clay
- Silty Sand
- Weathered Rock
- Clayey Sand
- Elastic Silt

Groundwater Symbols

- At End of Drilling
- At 24 Hours

Exploration Symbols

B-01 (Exploration ID)

13 (N-Value)

53% 98% (RQD REC)

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Fence Diagram

James River Water Authority Water Supply
Fluvanna County, Virginia

PROJECT NUMBER	DRAWN BY	DATE DRAWN
36790	JR	6/13/2016
HORIZONTAL SCALE	APPROVED BY	FIGURE
VERTICAL SCALE	NR	3

APPENDIX B

BORING LOGS

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

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KEY TO ROCK CORE TERMINOLOGY

Descriptive Sequence – Weathering, hardness, bedding (if present), color, ROCK TYPE, fracturing/joint condition, additional features observed.
Example Description – Unweathered, hard, thin foliation, slightly jointed, gray and green QUARTZ MUCOVITE SCHIST; foliation present with dip of 23 degrees, primary joint set at 72 degrees, joints typically infilled with quartz and slightly rough.

Degree of Weathering	
Unweathered	No evidence of any chemical or mechanical alteration
Slightly	Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the rock volume altered
Moderately	Discoloring evident, surface pitted and altered, weathering “halos” evident. 10-50% of the rock altered.
Highly	Entire mass discolored, alteration for nearly all of the rock, pockets of slightly weathered rock, some minerals leached.
Decomposed	Rock reduced to a soil, relict rock structure remaining. Generally molded and crumbled by hand (friable).

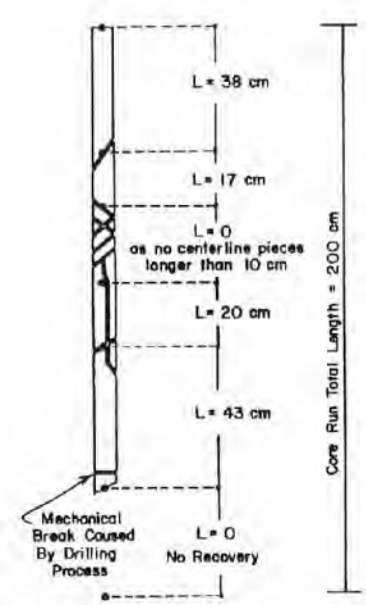
Hardness		Bedding Thickness		Color
Very soft	Deformed by hand.	Thin	< 0.3 ft	The color is to be described immediately after the core is extracted and also in the dry state using the Munsell Color Chart or simplified color terms.
Soft	Scratched with a fingernail.	Medium	0.3 ft to 1 ft	
Moderately Hard	Scratched easily with a knife.	Thick	1 ft to 3 ft	
Hard	Scratched with difficulty with a knife.	Massive	> 3 ft	
Very hard	Cannot be scratched with a knfe.			

Igneous Rocks			Sedimentary Rocks			Metamorphic Rocks		
Granite	Diorite	Diabase	Arkose	Breccia	Limestone	Gneiss	Schist	Greenstone
Basalt	Rhyolite	Pegmatite	Sandstone	Shale	Dolostone	Slate	Phyllite	Unakite
Tuff	Gabbro		Conglomerate	Coal	Siltstone	Quarzite	Marble	Soapstone
			Claystone	Mudstone				

Fracturing and Joint Conditions

Fracturing – Breaks in a core are nonparallel, nonsystematic, or cur across bedding or foliations.
Joints – Breaks in a core run are parallel or systematic.
Spacing – When possible, measure the actual spacing perpendicular to the surface. Note the mineralogy of infilling.

Spacing		Separation of Planes	Surface Condition	
				Wall Rock – Describe the condition of the parent rock on either side as Hard Wall Rock or Soft Wall Rock
Very widely	> 10 ft	No separation	Very rough	**Continuity** – Continuous/discontinuous; assume continuous if not discernable
Slightly	3 ft to 10 ft	Separation < 0.05 in	Slightly rough	
Moderately	1 ft to 3 ft	Gouge < 0.2 in	Slickensided	**Orientation** – Measure in degrees from a horizontal plane when possible. If not possible use High, Moderate, or Low-angle. Note if joints are conjugated.
Highly	2 in to 1 ft	Gouge > 0.2 in	Gouge	
Intensely	< 2 in	Joints open 0.05 to 0.2 in		
		Joints open > 0.2 in		



$$RQD = \frac{\sum \text{Length of Core Pieces} > 10\,cm\,(4\,in.)}{\text{Total Core Run Length}} \times 100\%$$

$$RQD = \frac{38+17+20+43}{200} \times 100\%$$

RQD = 59% (FAIR)

RQD (Rock Quality Designation)	Description of Rock Quality
0-25 %	Very Poor
25-50 %	Poor
50-75 %	Fair
75-90 %	Good
90-100 %	Excellent

RQD – (ASTM D6032)

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1001 Boulders Parkway, suite 300
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BORING B-01

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 30.1 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 18.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)		S-1, SPT 1-4-3-3 (7)			
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots					
		(ML): stiff		S-2, SPT 4-4-7-8 (11)			
5	195	LEAN CLAY WITH SAND, (CL): brown, moist, stiff		S-3, SPT 3-4-7-7 (11)			
		(CL): medium stiff		S-4, SPT 3-3-3-5 (6)			
10	190	FAT CLAY WITH SAND, (CH): brown, moist, medium stiff		S-5, SPT 2-2-4-4 (6)			
15	185	(CH): soft		S-6, SPT 2-1-2-1 (3)			
20	180	▽		S-7, SPT 2-2-2-1 (4)			
25	175	SILTY SAND, (SM): gray, fine to medium grained, moist, loose, contains wood fragments		S-8, SPT 1-2-2-2 (4)			
30	170	SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, very dense, weathered decomposed rock		S-9, SPT 50/5"			
				S-10, SPT 50/0"			

Refusal at 30.1 feet.
Bottom of borehole at 30.1 feet.

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BORING B-02

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/26/2016 **COMPLETED** 4/26/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 30.6 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 17.00 ft / Elev 182.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)					
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots		S-1, SPT 4-4-4-4 (8)			
		(ML): stiff		S-2, SPT 4-5-6-7 (11)			
5	195	FAT CLAY, (CH): brown, moist, medium stiff		S-3, SPT 4-3-4-7 (7)			
		LEAN CLAY WITH SAND, (CL): brown, moist, stiff		S-4, SPT 4-4-5 (9)			
10	190	FAT CLAY WITH SAND, (CH): brown, wet, medium stiff		S-5, SPT 3-2-3-3 (5)			
15	185	(CH): soft		S-6, SPT 2-2-2-2 (4)			
		▽					
20	180			S-7, SPT 2-1-2-2 (3)			
25	175	CLAYEY SAND, (SC): gray, fine to medium grained, wet, very loose, Contains wood fragments		S-8, SPT 2-1-1-1 (2)			
30	170	SILTY SAND, (SM): gray, fine to medium grained, moist, very dense, weathered decomposed rock		S-9, SPT 80/11"			
				S-10, SPT 50/1"			

Refusal at 30.6 feet.
Bottom of borehole at 30.6 feet.

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23225

BORING B-03

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 199 ft **HOLE DEPTH** 31.1 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 18.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (1 Inch)					
		SANDY SILT, (ML): brown, moist, medium stiff		S-1, SPT 3-3-3-3 (6)			
		ELASTIC SILT, (MH): brown, moist, stiff		S-2, SPT 4-4-5-7 (9)			
5	195	(MH): medium stiff		S-3, SPT 3-3-4-6 (7)			
		LEAN CLAY WITH SAND, (CL): brown, moist, medium stiff		S-4, SPT 2-2-3-3 (5)			
10	190	FAT CLAY WITH SAND, (CH): brown, moist, medium stiff		S-5, SPT 2-3-2-4 (5)			
15	185	(CH): wet, soft		S-6, SPT 0-1-2-1 (3)			
20	180	▽		S-7, SPT 1-1-2-1 (3)			
25	175	(CH): gray, very soft		S-8, SPT 1-0-1-2 (1)			
		SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, dense					
30	170			S-9, SPT 8-19-19-29 (38)			
		SILTY SAND, (SM): gray, fine to coarse grained, wet, very dense, contains rock fragments, weathered decomposed rock		S-10, SPT 50/0"			

Refusal at 31.1 feet.
Bottom of borehole at 31.1 feet.

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1001 Boulders Parkway, suite 300
23225

BORING B-04

PROJECT NUMBER 36790 **PROJECT NAME** James River Water Authority Water Supply

CLIENT Faulconer Construction Company, Inc. **PROJECT LOCATION** Fluvanna County, Virginia

DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016 **GROUND ELEVATION** 200 ft **HOLE DEPTH** 49.01 feet

DRILLING CONTRACTOR Landmark Drilling, Inc. **BOREHOLE WATER LEVELS:**

DRILLING METHOD Hollow Stem Auger ∇ **AT END OF DRILLING** 18.00 ft / Elev 182.00 ft

LOGGED BY Julian Ruffin **CHECKED BY** ▼ **AT 24 HOURS DRILLING** ---

NOTES **CAVE DEPTH**

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0	200	TOPSOIL: (3 Inches)					
		SILT, (ML): brown, moist, medium stiff, contains roots		S-1, SPT 3-3-2-3 (5)			
		(ML): stiff		S-2, SPT 6-4-6-6 (10)			
5	195	ELASTIC SILT WITH SAND, (MH): brown, moist, stiff		S-3, SPT 3-4-5-6 (9)			
		SANDY LEAN CLAY, (CL): brown, moist, stiff		S-4, SPT 5-5-6-6 (11)			
		(CL): medium stiff		S-5, SPT 2-2-3-4 (5)			
10	190						
		SANDY FAT CLAY, (CH): brown, moist, soft					
15	185			S-6, SPT 1-1-1-2 (2)			
		∇		S-7, SPT 1-1-1-0 (2)			
20	180						
		CLAYEY SAND, (SC): gray, fine to medium grained, wet, very loose		S-8, SPT 1-2-1-3 (3)			
25	175						
		SILTY SAND WITH GRAVEL, (SM): gray, fine to coarse grained, wet, very dense, weathered decomposed rock		S-9, SPT 50/1"			
		GRANITE, slightly weathered, light gray, very hard		S-10, SPT 50/0"			
30	170			1, RC RQD=84.2% Rec=90%			
35	165						

(Continued Next Page)

Timmons Group
1001 Boulders Parkway, suite 300
23225

BORING B-04

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 200 ft **HOLE DEPTH** 49.01 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 18.00 ft / Elev 182.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
35	165	GRANITE, slightly weathered, light gray, very hard *(continued)*		2, RC RQD=95.9% Rec=95.9%			
40	160			3, RC RQD=100% Rec=100%			
45	155			4, RC RQD=88% Rec=94.2%			

Refusal at 29.0 feet.
Bottom of borehole at 49.0 feet.

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23225

BORING B-05

PROJECT NUMBER 36790
PROJECT NAME James River Water Authority Water Supply
CLIENT Faulconer Construction Company, Inc.
PROJECT LOCATION Fluvanna County, Virginia
DATE STARTED 4/25/2016 **COMPLETED** 4/25/2016
GROUND ELEVATION 194 ft **HOLE DEPTH** 23.6 feet
DRILLING CONTRACTOR Landmark Drilling, Inc.
BOREHOLE WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT END OF DRILLING** 13.00 ft / Elev 181.00 ft
LOGGED BY Julian Ruffin **CHECKED BY**
▼ **AT 24 HOURS DRILLING** ---
NOTES
CAVE DEPTH

DEPTH (ft)	ELEVATION (ft)	MATERIAL DESCRIPTION	SYMBOL	SAMPLING BLOW COUNTS (N-VALUE)	POCKET PEN. (tsf)	LAB TESTS	REMARKS
0		TOPSOIL: (3 Inches)					
		SANDY SILT, (ML): brown, moist, medium stiff, contains roots		S-1, SPT 1-3-2-3 (5)			
		SILTY SAND, (SM): brown, fine to medium grained, moist, loose		S-2, SPT 2-2-2-2 (4)			
5	190	Very loose		S-3, SPT 1-1-2-1 (3)			
		SANDY FAT CLAY, (CH): brown, moist, soft		S-4, SPT 1-1-1-2 (2)			
10	185	CLAYEY SAND, (SC): brown, fine to medium grained, wet, very loose		S-5, SPT 1-1-2-1 (3)			
		SANDY FAT CLAY, (CH): gray, wet, very soft					
	▽						
15	180			S-6, SPT 1-0-1-1 (1)			
20	175	(CH): soft, trace organics		S-7, SPT 1-1-2-1 (3)			
		CLAYEY SAND, (SC): gray, fine to coarse grained, moist, very dense, weathered decomposed rock		S-8, SPT 50/2"			
				S-9, SPT 50/0"			

Refusal at 23.6 feet.
Bottom of borehole at 23.6 feet.

APPENDIX C

LABORATORY TEST RESULTS

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

Project Name: James River Water Authority Water Supply
Project Number: 36790
Report Date: 5/9/2016

Sample Information

Date Sampled: 4/25/2016
Boring: B-04
Core Run (ft): 29 to 34

Specimen Information

Date Prepared: 5/9/2016
Length (in): 3.92
Diameter (in): 1.84
L/D Ratio: 2.13
Test Depth (ft): 29.54 to 30.1
Area (in^2): 2.66
Mass (g): 478.9
Unit Weight (pcf): 174.9

Test Information

Date Tested: 5/9/2016
Max Load (lb): 17500
Failure Time (sec): 78
Compressive Strength (psi): 6581
Load Rate (lb/sec): 224

Photos

Before

After

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMENS

Project Name: James River Water Authority Water Supply **Report Date:** 5/9/2016

Project Number: 36790

Sample Information

Date Sampled: 4/25/2016 **Boring:** B-04 **Core Run (ft):** 39 to 44

Specimen Information

Date Prepared: 5/9/2016 **Test Depth (ft):** 39 to 39.56

Length (in): 3.98 **Area (in^2):** 2.68

Diameter (in): 1.85 **Mass (g):** 487.5

L/D Ratio: 2.16 **Unit Weight (pcf):** 173.9

Test Information

Date Tested: 5/9/2016 **Compressive Strength (psi):** 8580

Max Load (lb): 23000 **Load Rate (lb/sec):** 288

Failure Time (sec): 80

Photos

Before

After

TIMMONS GROUP

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GRAIN SIZE DISTRIBUTION TEST REPORT

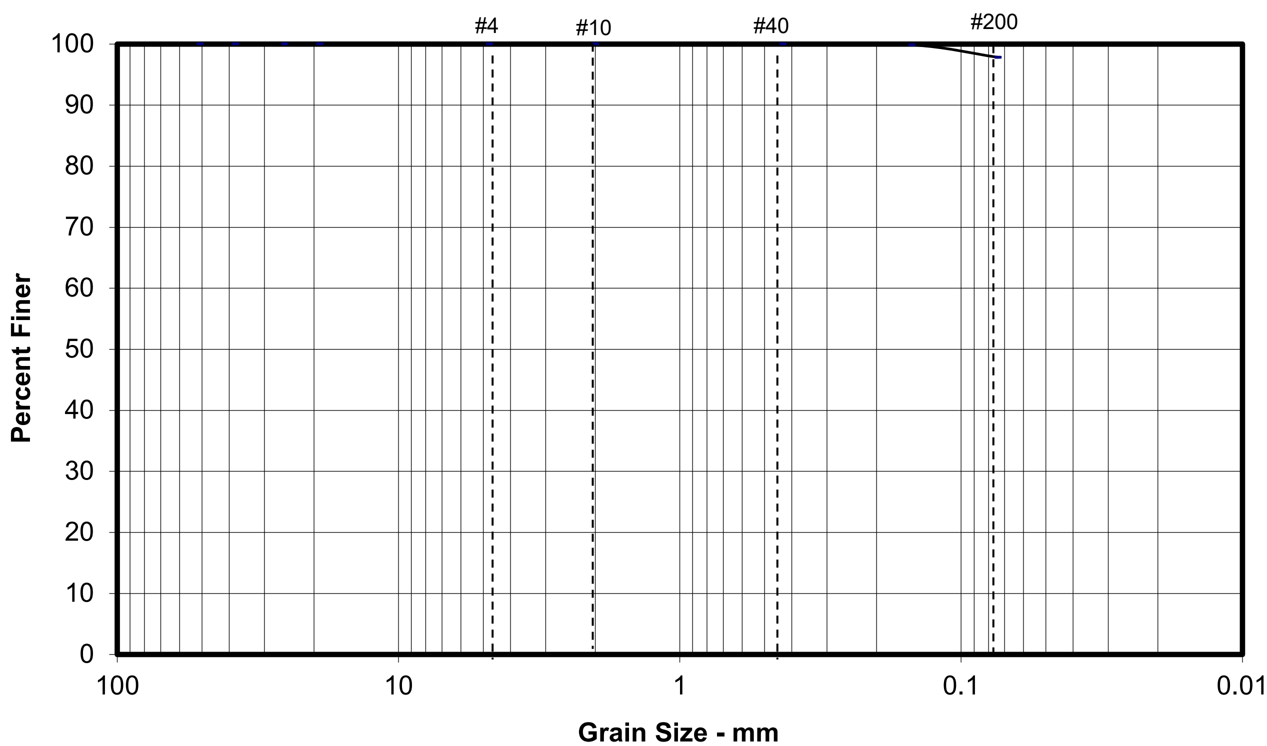
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 0-10

Liquid Limit	Plastic Index	USCS	AASHTO
53	**29**	**CH**	**A-7-6 (15.7)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**2.2%**	**97.8%**

Material Description	Fat CLAY
Natural Moisture	21.7%
SPT Blow Counts	N/A

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

PROCTOR TEST REPORT

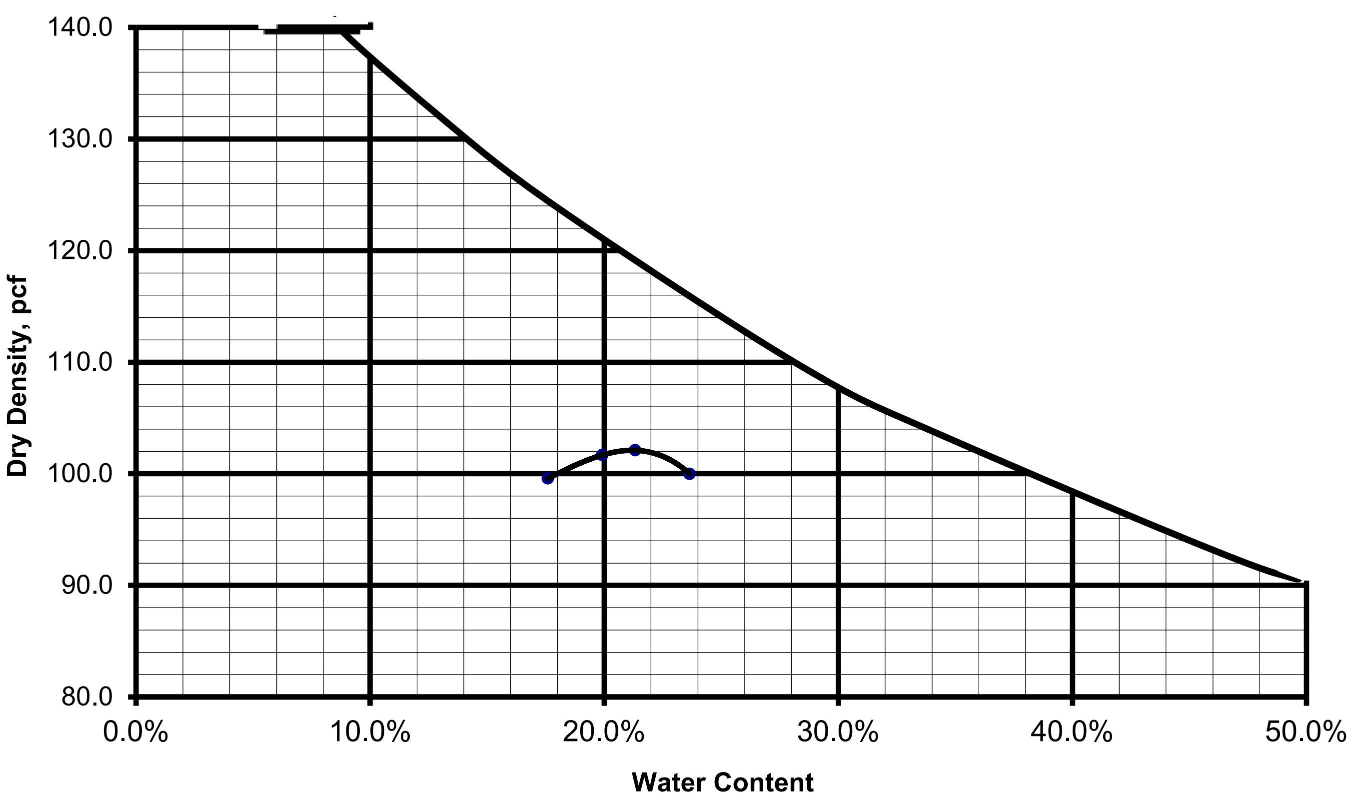
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 0-10

	Uncorrected	Rock Corrected Results
Maximum Dry Density, pcf	**102.2**	**102.2**
Optimum Moisture	**21.4**	**21.4**

Material Description	Fat CLAY

USCS	CH	AASHTO	A-7-6 (15.7)
Natural Moisture	21.7%	Percent Fines	97.8%
Liquid Limit	53	Plastic Index	29

Moisture-Density Curve



DATE 6/8/16

FIGURE NUMBER PR2

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

GRAIN SIZE DISTRIBUTION TEST REPORT

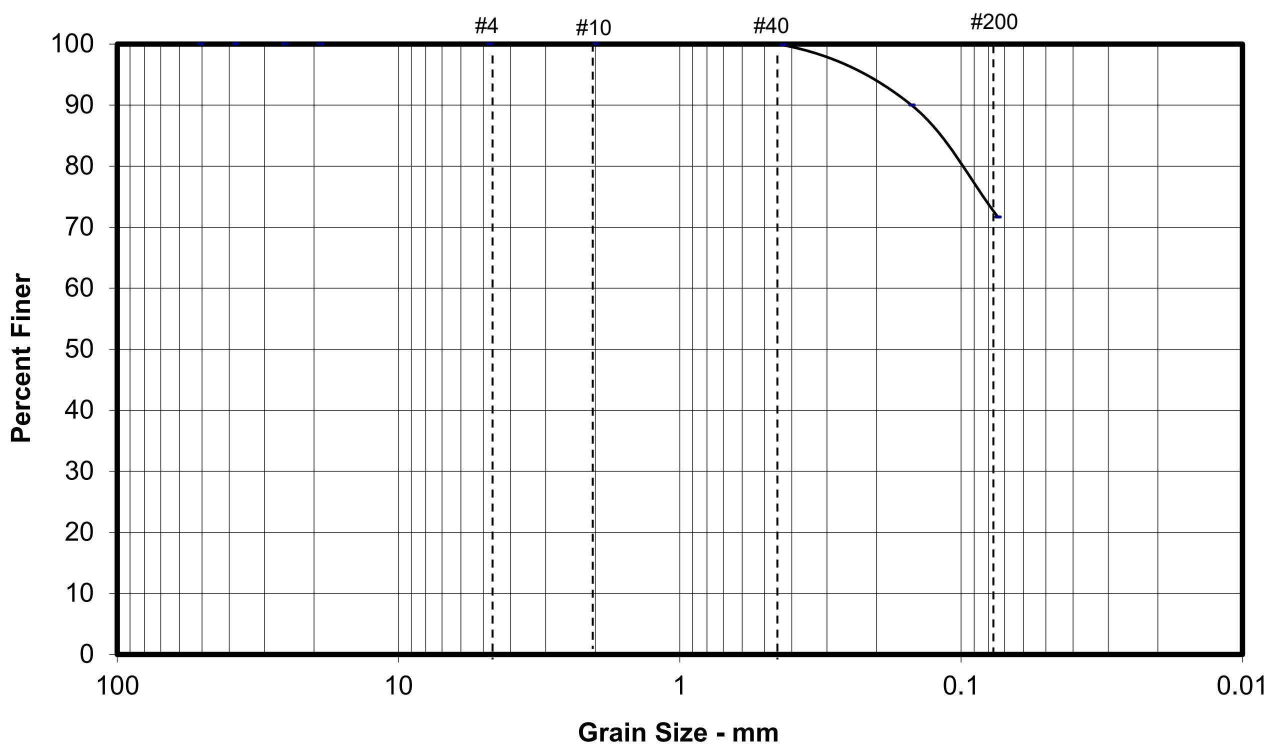
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 10-20

Liquid Limit	Plastic Index	USCS	AASHTO
50	**26**	**CH**	**A-7-6 (7.9)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**28.3%**	**71.7%**

Material Description	Fat CLAY with Sand
Natural Moisture	23.5%
SPT Blow Counts	N/A

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

PROCTOR TEST REPORT

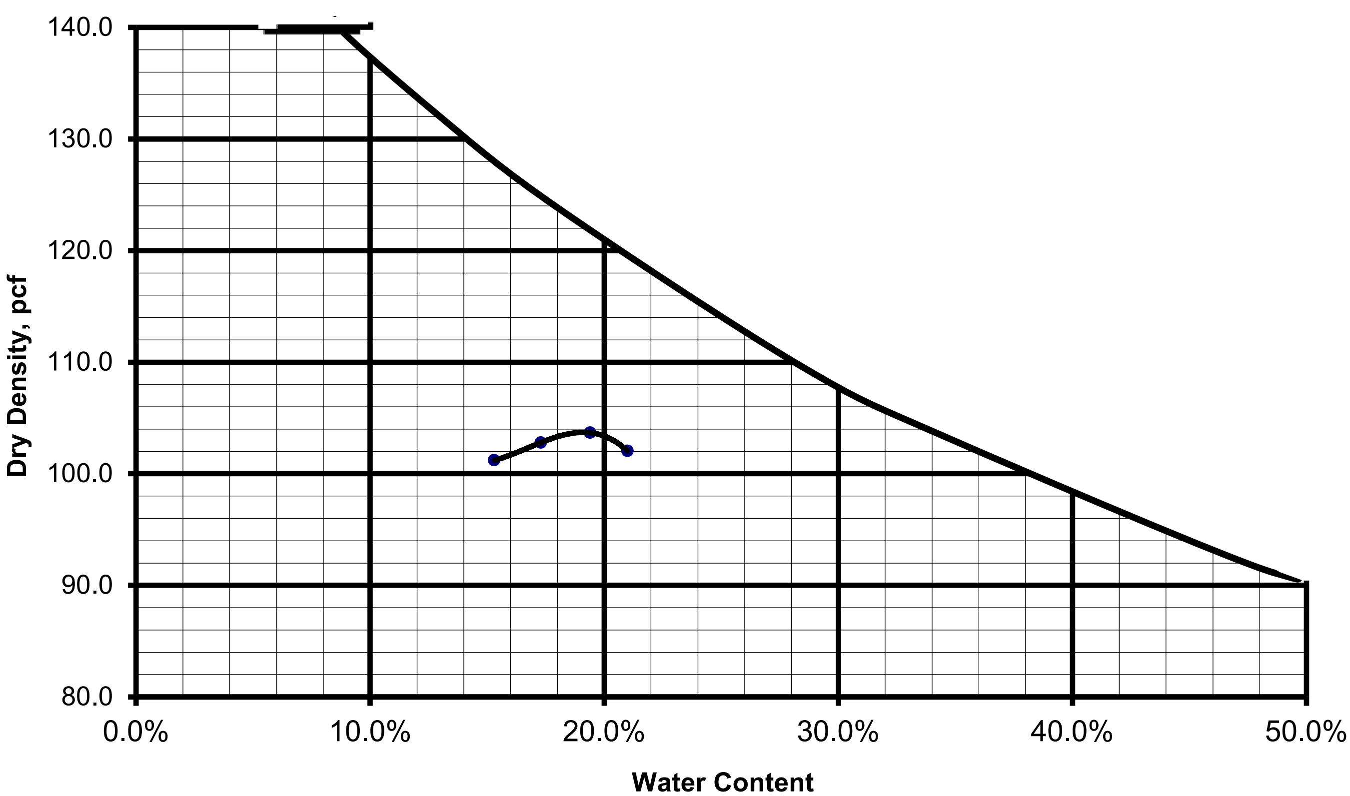
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-02 Bulk/ 10-20

	Uncorrected	Rock Corrected Results
Maximum Dry Density, pcf	**103.7**	**103.7**
Optimum Moisture	**19.2**	**19.2**

Material Description	Fat CLAY with Sand

USCS	CH	AASHTO	A-7-6 (7.9)
Natural Moisture	23.5%	Percent Fines	71.7%
Liquid Limit	50	Plastic Index	26

Moisture-Density Curve



DATE 6/8/16

FIGURE NUMBER PR2

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

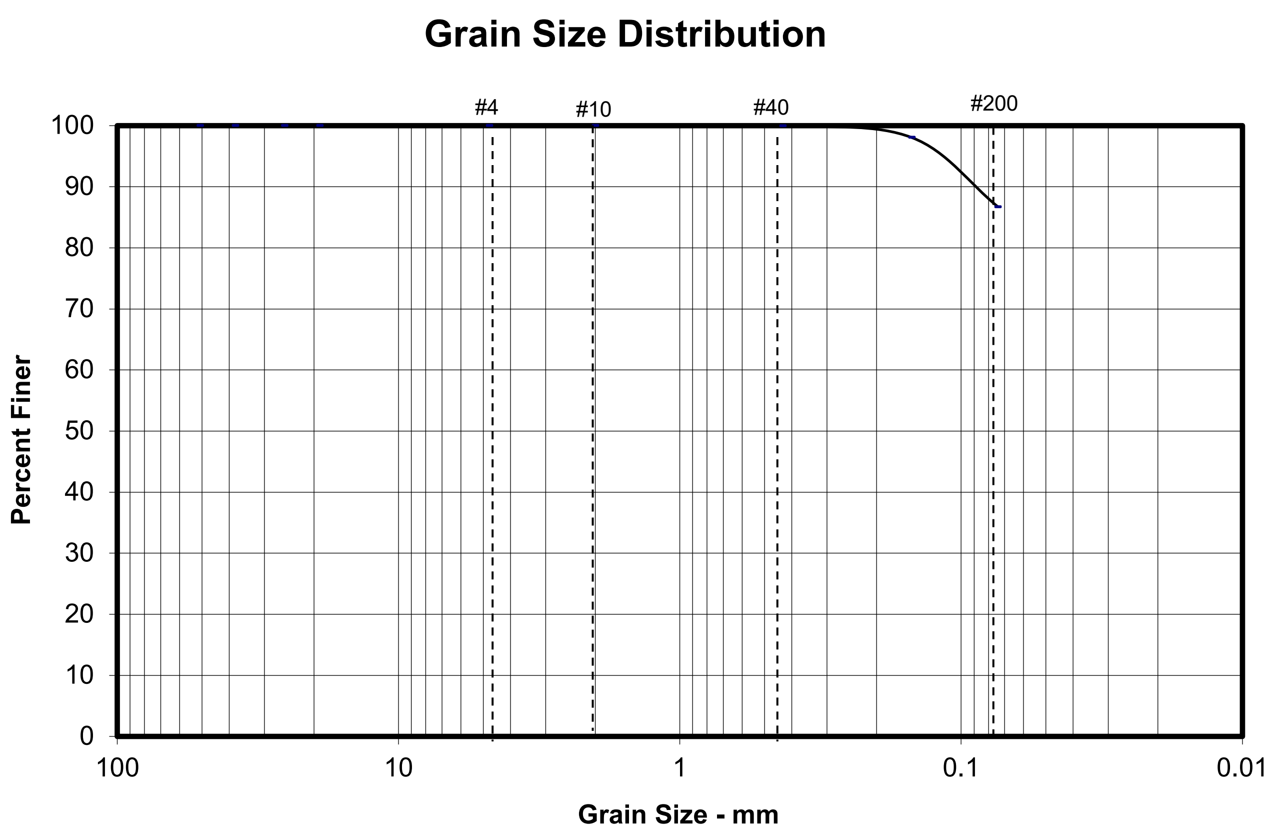
GRAIN SIZE DISTRIBUTION TEST REPORT

Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-01/ 8-10

Liquid Limit	Plastic Index	USCS	AASHTO
56	**38**	**CH**	**A-7-6 (20.1)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**13.3%**	**86.7%**

Material Description	Fat CLAY
Natural Moisture	23.1%
SPT Blow Counts	2-2-4-4



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP

YOUR VISION ACHIEVED THROUGH OURS.

GRAIN SIZE DISTRIBUTION TEST REPORT

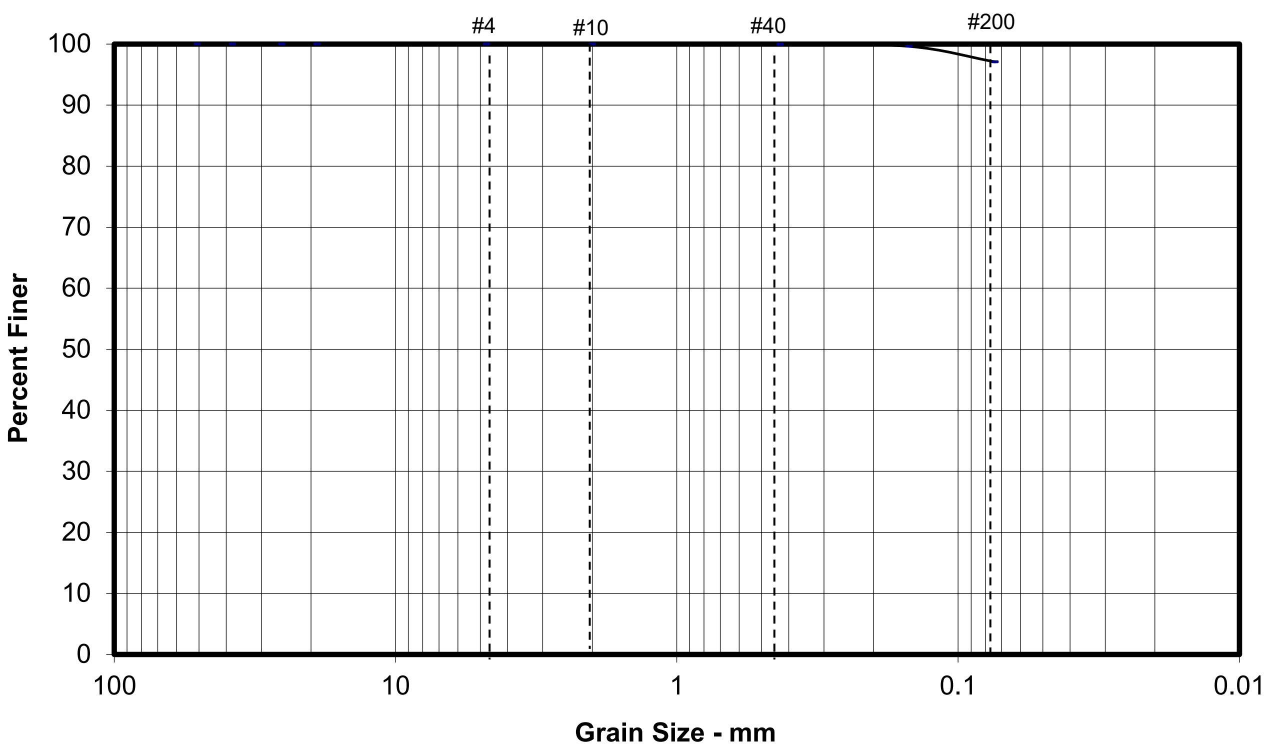
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-03/ 4-6

Liquid Limit	Plastic Index	USCS	AASHTO
58	**27**	**MH**	**A-7-5 (14.0)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**2.9%**	**97.1%**

Material Description	Elastic SILT
Natural Moisture	21.8%
SPT Blow Counts	3-3-4-6

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

GRAIN SIZE DISTRIBUTION TEST REPORT

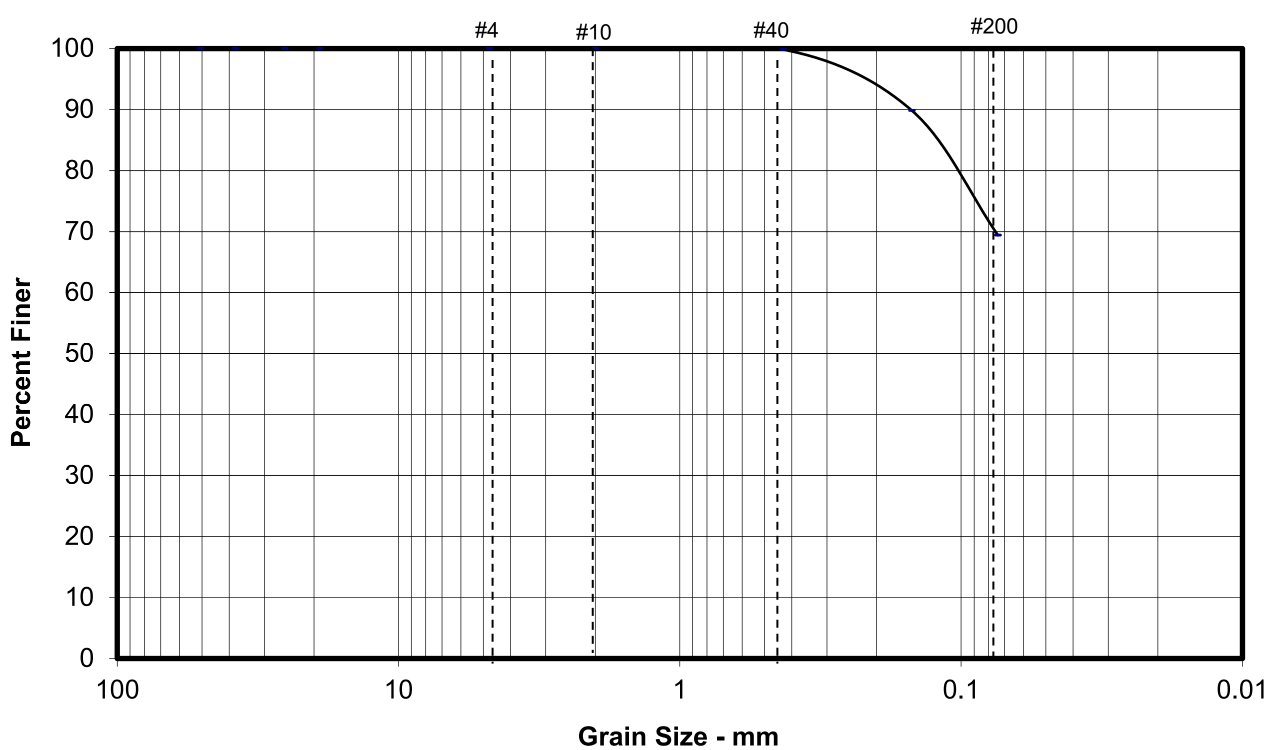
Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-03/ 13-15

Liquid Limit	Plastic Index	USCS	AASHTO
51	**31**	**CH**	**A-7-6 (11.4)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**30.6%**	**69.4%**

Material Description	Sandy Fat CLAY
Natural Moisture	27.5%
SPT Blow Counts	0-1-2-1

Grain Size Distribution



DATE 6/8/16

FIGURE NUMBER GS4

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

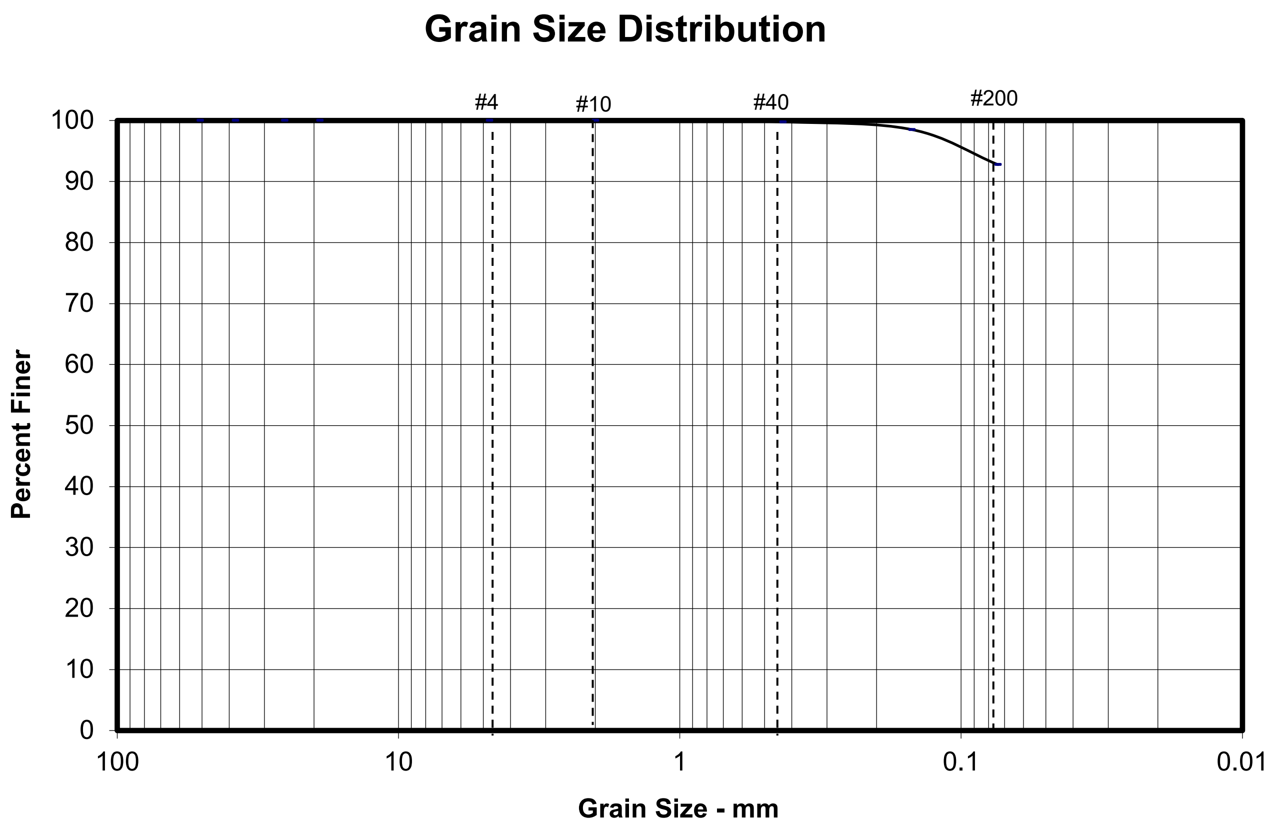
GRAIN SIZE DISTRIBUTION TEST REPORT

Project Number	36790
Project Name	James River Water Authority Water Supply
Location	B-04/ 2-4

Liquid Limit	Plastic Index	USCS	AASHTO
38	**13**	**ML**	**A-6 (2.3)**

Percent Gravel	Percent Sand	Percent Silt and Clay
0.0%	**7.2%**	**92.8%**

Material Description	Silt
Natural Moisture	19.7%
SPT Blow Counts	6-4-6-6



DATE 6/8/16

FIGURE NUMBER GS4

APPENDIX E-3-4
JAMES RIVER TOPOGRAPHIC AND BATHYMETRIC SURVEY

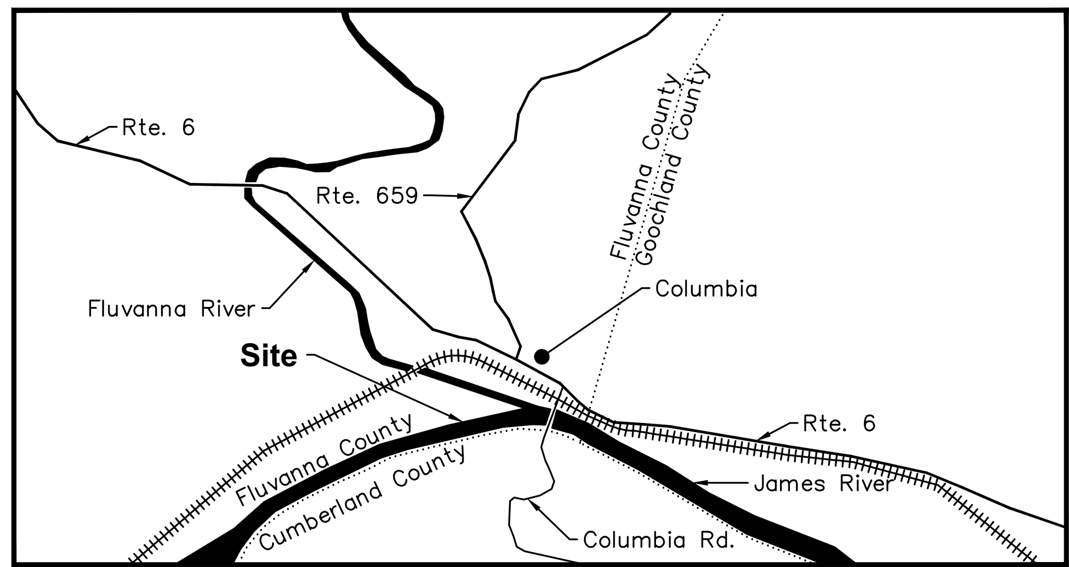
DRAPER ADEN ASSOCIATES REVIEW

THESE PLANS HAVE BEEN SUBJECTED TO TECHNICAL AND QUALITY REVIEWS BY:

NAME: Jason Dickerson DATE: 03-24-2015
SURVEY PARTY CHIEF

NAME: Michael Little DATE: 03-24-2015
PROJECT MANAGER

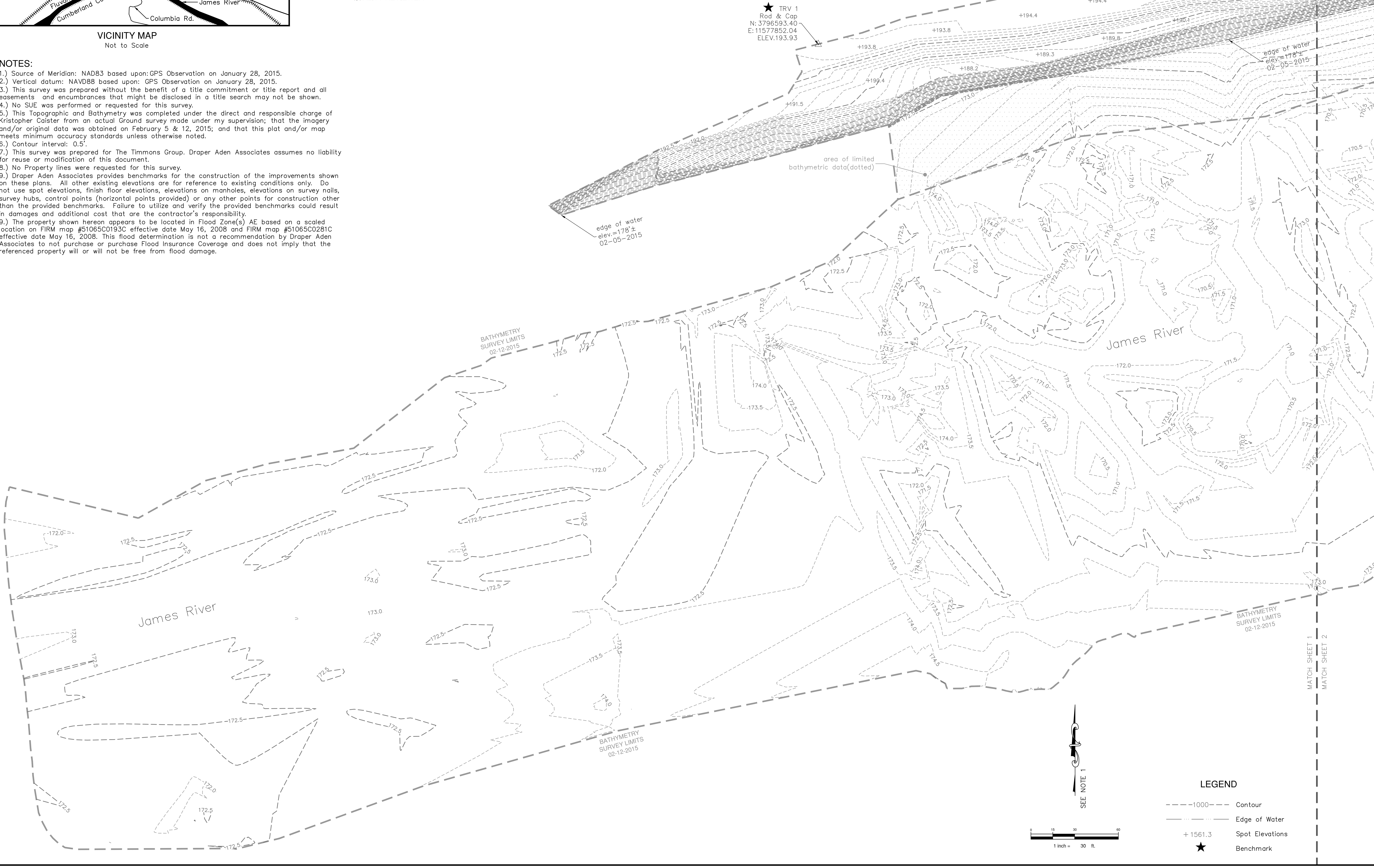
NAME: Kristopher Caister DATE: 03-24-2015
QUALITY REVIEWER



VICINITY MAP
Not to Scale

NOTES:

1.) Source of Meridian: NAD83 based upon: GPS Observation on January 28, 2015.
2.) Vertical datum: NAVD88 based upon: GPS Observation on January 28, 2015.
3.) This survey was prepared without the benefit of a title commitment or title report and all easements and encumbrances that might be disclosed in a title search may not be shown.
4.) No SUE was performed or requested for this survey.
5.) This Topographic and Bathymetry was completed under the direct and responsible charge of Kristopher Caister from an actual Ground survey made under my supervision; that the imagery and/or original data was obtained on February 5 & 12, 2015; and that this plat and/or map meets minimum accuracy standards unless otherwise noted.
6.) Contour interval: 0.5'.
7.) This survey was prepared for The Timmons Group. Draper Aden Associates assumes no liability for reuse or modification of this document.
8.) No Property lines were requested for this survey.
9.) Draper Aden Associates provides benchmarks for the construction of the improvements shown on these plans. All other existing elevations are for reference to existing conditions only. Do not use spot elevations, finish floor elevations, elevations on manholes, elevations on survey nails, survey hubs, control points (horizontal points provided) or any other points for construction other than the provided benchmarks. Failure to utilize and verify the provided benchmarks could result in damages and additional cost that are the contractor's responsibility.
9.) The property shown hereon appears to be located in Flood Zone(s) AE based on a scaled location on FIRM map #51065C0193C effective date May 16, 2008 and FIRM map #51065C0281C effective date May 16, 2008. This flood determination is not a recommendation by Draper Aden Associates to not purchase or purchase Flood Insurance Coverage and does not imply that the referenced property will or will not be free from flood damage.



COMMONWEALTH OF VIRGINIA
KRISTOPHER L. CAISTER
Lic. No. 3087
03-27-2015
LAND SURVEYOR

Draper Aden Associates
Engineering • Surveying • Environmental Services

Blacksburg, VA
Richmond, VA
Charlottesville, VA

Hampton Roads, VA
703 Thimble Shoals Boulevard, Suite C2
Newport News, VA 23606
757-599-9800 Fax: 757-599-3684
www.daa.com

TOPOGRAPHIC AND BATHYMETRY SURVEY
JAMES RIVER
FLUVANNA COUTY, COLUMBIA, VIRGINIA

REVISIONS

DESIGNED BY:	N/A
DRAWN BY:	MJL
CHECKED BY:	KLC
SCALE:	1" = 30'
DATE:	03-27-2015
PROJECT NUMBER:	H15102H-01S

SHEET
1 OF 4

COMMONWEALTH OF VIRGINIA
KRISTOPHER L. CAISTER
Lic. No. 3087
03-27-2015
LAND SURVEYOR

Draper Aden Associates
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TOPOGRAPHIC AND BATHYMETRY SURVEY

JAMES RIVER

FLUVANNA COUTY, COLUMBIA, VIRGINIA

REVISIONS

DESIGNED BY:	N/A
DRAWN BY:	MJL
CHECKED BY:	KLC
SCALE:	1" = 30'
DATE:	03-27-2015
PROJECT NUMBER:	H15102H-01S

SHEET
2 OF 4

COMMONWEALTH OF VIRGINIA
KRISTOPHER L. CAISTER
Lic. No. 3087
03-27-2015
LAND SURVEYOR

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Blacksburg, VA
Richmond, VA
Charlottesville, VA

TOPOGRAPHIC AND BATHYMETRY SURVEY

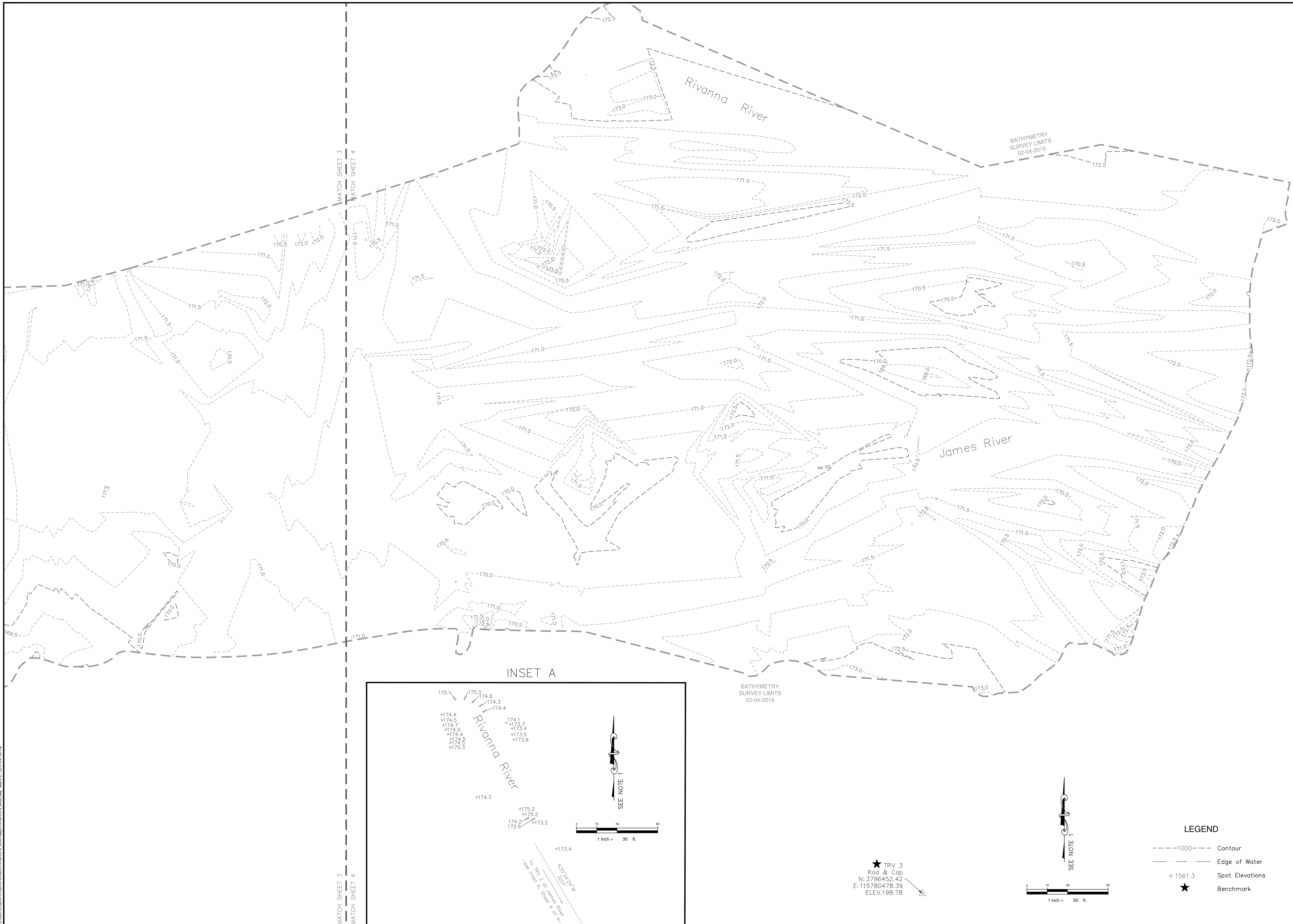
JAMES RIVER

FLUVANNA COUNTY, COLUMBIA, VIRGINIA

REVISIONS

DESIGNED BY:	N/A
DRAWN BY:	MJL
CHECKED BY:	KLC
SCALE:	1" = 30'
DATE:	03-27-2015
PROJECT NUMBER:	H15102H-01S

SHEET
3 OF 4



KRISTOPHER L. CAISTER
Lic. No. 3087
03-27-2015
COMMONWEALTH OF VIRGINIA LAND SURVEYOR

Draper Aden Associates
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Blacksburg, VA
Richmond, VA
Charlottesville, VA

TOPOGRAPHIC AND BATHYMETRY SURVEY
JAMES RIVER
FLUVANNA COUTY, COLUMBIA, VIRGINIA

REVISIONS

DESIGNED BY:	N/A
DRAWN BY:	MJL
CHECKED BY:	KLC
SCALE:	1" = 30'
DATE:	03-27-2015
PROJECT NUMBER:	H15102H-01S

SHEET
4 OF 4

APPENDIX F
PROJECT ENGINEERING DETAILS

<u>APPENDIX F-1</u>

PUMP SELECTION SUBMITTAL

<u>APPENDIX F-2</u>

RIVANNA RIVER HDD SELECT SHEETS

APPENDIX F-1
PUMP SELECTION SUBMITTAL

SUBMITTAL

Quote ID: 9007-181105-004:0:1 QTY: 1
VIT-FFFM 14RJHC, 6 Stages
TMC Municipal

PERFORMANCE ON DESIGN CURVE AT 1770 RPM

	Shut Off	Design [2]	Run Out [5]		
Flow (USGPM)	0.0	2100.0	0.0	**Best Efficiency**	87.70 % at 2262.0 USgpm
TDH-Bowl (ft)	596.0	464.0	0.0	**Design Flow % BEP**	92.84 %
TDH-Disch Flange (ft)	555.0	419.5	-	**Pump Efficiency**	85.99 %
Bowl Efficiency (%)	-	87.20	-	**Overall Efficiency**	0.00 %
Power (Hp)	-	282.0	-	**Max Power (NOL)**	301.0 Hp at 3000.0 USgpm
NPSHr (ft) [1]	-	31.0	-	**Max Power (NOL) at Max Trim**	347.0 Hp at 3000.0 USgpm
NPSH Margin (ft) [1]	-	20.4	-	**Specified NPSH Ratio**	1.1
Hydraulic Thrust(lb)	9655.2	7516.8	0.0	**Thrust Load Power Loss**	1.09949 Hp
Thrust (lb)	10313.9	8168.6	0.0	**Total Flow Derate Factor**	1.00
Pressure-Bowl (psi)	258.0	200.9	-	**Total Head Derate Factor**	1.00
Pressure-Disch Flange (psi)	240.3	181.6	-	**Total Efficiency Derate Factor**	1.00
Min Submergence (Inch) [3]	-	43.48	-	**Actual Submergence**	230.52 in
Friction Loss (ft) [4]	-	3.47	-	**Shaft Friction Power Loss**	0.74 Hp
Lineshaft Elongation (Inch)	0.09379	0.07302	-	**Min Flow (MCSF)**	566.0 USgpm
Column Elongation (Inch)	0.01575	0.01155	-	**kWh per 1000 gal**	0.00000
Lateral (Inch)	0.20804	0.19146	-	**Impeller Running Clearance**	0.13 in

[1] at 1st impeller eye [2] rated values [3] from bottom of pump [4] from bowl to disch flange [5] based on user entered TDH

OPERATING CONDITIONS

Specified Flow	2100.00 USgpm
Specified TDH	460.00 ft
Rated Speed	1770 RPM
Atmospheric Pressure	15 psi
TPL	59.21 ft
Pumping Level	40.00 ft
NPSHa at 1st Impeller	51.4 ft
NPSHa at Grade	33.9 ft

FLUID CHARACTERISTICS

Fluid	Water
Fluid Temperature	68.0 °F
Specific Gravity	1.0000
Viscosity	1.0017 cP
Vapor Pressure	0.3393 psi
Density	62 lbs/ft³

MATERIALS & DIMENSIONS

Bowl Data

Bowl Material	Cast Iron with Glass Enamel
Bowl Material Derate Factor	1.00
Impeller Material	316SS
Additional Stage Impeller Material	316SS
Impeller Matl Derate Factor	1.00
Bowl Shaft Material	416SS
Impeller Attachment	Keyed
Key Material	416SS
Discharge Bowl Material	Not Included
Suction Type	Bell
Suction Material	Cast Iron
Bowl Bolting Material	Carbon Steel
Sand Collar	Not Included
Pipe Plug	Iron
Suction Bearing	Vesconite
Discharge Bowl Bearing	Not Included
Intermediate Bowl Bearing	Vesconite
Strainer Type	Not Included
Tube Adapter Bearing Material	Not Included
Impeller Trim	9.13 in

Bowl Data

Max Impeller Trim	9.82 in
Thrust K-Factor	16.2 Lb/Ft
Bowl Pressure Limit	700 psi
Available Lateral	1.25 in
Bowl Assembly Length (BL)	80.50 in
Disch Bowl Length OLS (O1)	5.25 in
Disch Bowl Length ELS (L2)	9.00 in
Bowl Shaft Diameter	1 15/16"
Impeller Balance	Dynamic Two Plane Balance
Impeller Design	Enclosed
Bowl Wear Ring	416SS
Impeller Wear Ring	416SS
Suction Pipe Diameter	No Suction Pipe
Bowl Diameter (D)	13.63 in
Bowl Length (L3)	11.50 in
Bowl Flange Diameter (A)	5.06 in
Bowl Flange Thickness (E)	9.63 in
Floor Clearance (X)	9.50 in
Min Column Diameter	8 in
Max Column Diameter	14 in
Max Bowl Shaft Diameter	1.94 in
Bowl Shaft Length	89.25 in

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Certified By		
Project	James River Raw Water Pumps Revised 100518	
Tag	3 MGD	
PO Number		
Serial Number		

SUBMITTAL

Quote ID: 9007-181105-004:0:1 QTY: 1
VIT-FFFM 14RJHC, 6 Stages
TMC Municipal

GOULDS WATER TECHNOLOGY
a xylem brand

Bowl Data

Bowl Shaft Power Limit	448.83 Hp

Bowl Specials

Column Data

Column Type	Flanged
Column Diameter	10"
Lineshaft Diameter	1 11/16 in [42.9 mm]
Column Bolting	Carbon Steel
Column Pipe Material	Carbon Steel
Lineshaft Material	416SS
Lineshaft Bearing Material	Vesconite
Lineshaft Coupling Type	Threaded
Lineshaft Coupling Material	416SS
Column Loss	2.01 ft
Column Flange	Carbon steel
Column Shaft Sleeve	Not Included
Column Bearing Retainer	304SS
Column Bearing Options	Not Included

Column Data

Column Retainer Design	Separate
Maximum Bearing Spacing	5 ft Spacing
Max Column Section Length	120 in
Number of Bearings	10
Fabrication Welding Option	Not Included
Column Length (COL)	630.02 in
Column Wall Thickness	0.36 in
Column Load	6356.8 lb
Lubrication Method	Water (Open Lineshaft)
Lineshaft Length	630.02 in
Head Sleeve	Not Included
Lineshaft Power Limit	381 Hp

Column Specials

Head Data

Head Type	Type FF (Fabricated F-Head)
Discharge Flange Rating	150 #
Disch Flange Pressure Limit	285 psi
Head Design	One Piece Head
Discharge Head Material	Carbon steel
Headshaft Material	416SS
Headshaft Coupling Type	Type AS Adjustable Spacer
Coupling Assembly	Carbon Steel
Headshaft Diameter (BX)	1.69 in
Discharge Head Size	10"
Discharge Head BD	20"
Sealing Method	Mechanical Seal
Tension Plate	Not Included
Mechanical Seal	Chesterton 155 1DCW
Seal Provided By	Xylem
Seal Mounted By	Customer

Head Data

Stuffing Box / Seal Hsg Bolt	316SS
Stuffing Box / Seal Hsg Brg	Vesconite
Seal Housing Material	Cast iron
Steel Sub Base	Carbon Steel
Head Loss	1.46 ft
150# Disch Companion Flg	Not Included
300 # Suct Convenience Flg	No suction flange
Column Hanger Flange	Not Included
Head Sleeve	Not Included
Head Bolting	316SS
Split Gland	316SS
Motor Stand	Not included
Air Vacuum Valves	Not Included
Fabrication Welding Option	Not Included

Head Specials

155 Seal Faces are SC/SC

Motor Data

Driver Type	Vertical Solid Shaft Motor
Motor Manufacturer	US Motors
Selected Motor Power	350
Voltage	460
Phase / Frequency	3/60
Enclosure	WP1
Motor Frame	447TPA
Inverter Duty	Yes
Steady Bushing	No
Motor Coupling	Adjustable
Insulation Class	F
Service Factor	1.15 Sine
Motor Provided By	Xylem
Motor Mounted By	Customer

Motor Data

HP Rating	350 Hp
Voltage	460 V
Speed [Poles]	1800 rpm [4 pole]
Thrust Level	100% HT
BD	20.0 in
BX / U	1.69 in
Enclosure	WPI
Efficiency / Config	Premium Inverter Duty
Coupling	NRR w/o Steady Bushing
Manufacturer	US
Winding Thermal	Thermostats
Conduit Box	Standard w/ Accessory Box

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Project	James River Raw Water Pumps Revised 100518
Tag	3 MGD
PO Number	
Serial Number	

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VIT-FFFM 14RJHC, 6 Stages
TMC Municipal

Motor Data

Options 1	Space Heater & Shaft Grounding Ring & Insulated Bearing (Upper)
Mfg Catalog Number	

Motor Data

Motor Part Number	
Driver Size Criteria	Max power on design curve (NOL)

Motor Specials

Coating Data

Bowl OD	Goulds Water Technology Standard Blue Enamel
Column ID	Not Included
Column OD	Goulds Water Technology Standard Blue Enamel
Column Bearing Retainer	Not Included
Can ID	Not Included

Coating Data

Head ID	Not Included
Head OD	Goulds Water Technology Standard Blue Enamel
Enclosing Tube OD	Not Included
Steel Sub Base	Not Included

Testing Data

Performance Testing	Bowl Assembly Only Non-Witness Lab Motor
Hydrostatic Testing	Discharge Head Non-Witness

Miscellaneous Specials

Weight Data

Total Bowl Weight	1165 lbs
Unit Bowl Weight	390 lbs / 155 lbs
Total Column Weight	3180 lbs
Unit Column Weight	60 lbs
Head Weight	735 lbs

Weight Data

Motor Weight	2100 lbs
Total Weight	7180 lbs
Total Rotating Weight	628 lbs

INFO, WARNING & ERROR MESSAGES

	Invalid	is invalid

Our offer does not include specific review and incorporation of any Statutory or Regulatory Requirements and the offer is limited to the requirements of the design specifications. Should any Statutory or Regulatory requirements need to be reviewed and incorporated then the Customer is responsible to identify those and provide copies for review and revision of our offer.

Our quotation is offered in accordance with our comments and exceptions identified in our proposal and governed by our standard terms and conditions of sale – Xylem Americas attached hereafter.

For units requiring performance test, all performance tests will be conducted per ANSI/HI 14.6 standards unless otherwise noted in the selection software submittal documents. Test results meeting with grade 2B tolerances for pumps with a rated shaft power of 134HP or less and grade 1B for greater than 134HP will be considered passing.

Customer is responsible for verifying that the recommendations made and the materials selected are satisfactory for the Customer's intended environment and Customer's use of the selected pump. Customer is responsible for determining the suitability of Xylem recommendations for all operating conditions within Customer's and/or End User's control. Xylem disclaims all warranties, express or implied warranties, including, but not limited to, warranties of merchantability and fitness for a particular purpose and all express warranties other than the limited express warranty set forth in the attached standard terms and conditions of sale – Xylem Americas attached hereafter.

Xylem does not guarantee any pump intake configuration. The hydraulic and structural adequacies of these structures are the sole responsibility of the Customer or his representatives. Further, Xylem accepts no liability arising out of unsatisfactory pump intake field operating conditions. The Customer or his representatives are referred to the Hydraulic Institute Standards for recommendations on pump intake design. To optimize the hydraulic design of a field pump intake configuration, the Customer should strongly consider performing a detailed scale model pump intake study. However, the adequacies of these recommendations are the sole responsibility of the Customer.

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PO Number		
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OUTLINE DRAWING

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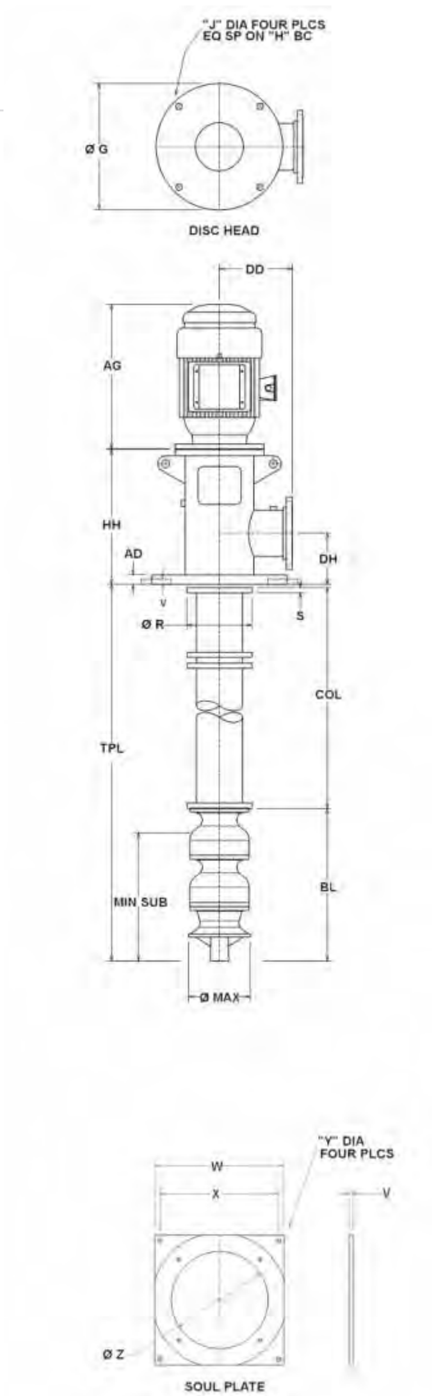
VIT-FFFM 14RJHC, 6 Stages
TMC Municipal



DIMENSIONS

G [Mounting Flange Dia]	25.00 in
J [Mounting Flange Hole Dia]	1.25 in
K [Mounting Hole Places]	12
H [Mounting Flange Bolt Circle]	22.75 in
BD Head [Discharge Head Base Dia]	20.00 in
HH [Head Height]	44.00 in
AD [Mounting Flange Thickness]	1.75 in
DD [Disch Flange Stickout]	17.50 in
DH [Disch Flange Height]	12.00 in
S [Hanger Flange Stickdown Length]	1.13 in
R [Hanger Flange OD]	14.60 in
Column Length (COL)	630.02 in
COL [Column Diameter]	10.00 in
TPL [Total Pump Length]	710.52 in
MIN SUB [Minimum Submergence]	43.48 in
MAX [Max Assembly OD]	13.63 in
BL [Bowl Assembly Length]	80.50 in
V [Sub Base Thickness]	1.00 in
W [Sub Base Overall Size]	25.00 in
X [Center Line of Holes]	22.00 in
Y [Mounting Holes Base Plate Dia]	1.00 in
Z [Base Plate Opening or Can ID]	19.00 in

PUMP DATA

Column Diameter	10"
Lineshaft Diameter	1 11/16 in
Specified Flow	2100.00 USgpm
Specified TDH	460.00 ft
Pumping Level	40.00 ft
Motor Manufacturer	US Motors
Driver Type	Vertical Solid Shaft Motor
Selected Motor Power	350
Phase / Frequency	3/60
Voltage	460

WEIGHTS

Total Bowl Weight	1165 lbs
Unit Bowl Weight	390 lbs / 155 lbs
Total Column Weight	3180 lbs
Unit Column Weight	60 lbs
Head Weight	735 lbs
Motor Weight	2100 lbs
Total Weight	7180 lbs
Total Rotating Weight	628 lbs

	NOTES
1	Total Pump Length ± 1.0 inch.
2	Tolerance on all dimensions is .12 or ± .12 inch per 5 ft, whichever is greater.
3	All dimensions shown are in inches unless otherwise specified.
4	Drawing not to scale.
5	½" NPT – Gauge Conn (plugged)
6	Driver may be rotated at 90º intervals about vertical centerline for details refer to driver dimension drawing.
7	Refer to product IOM for impeller setting requirements.
8	This assembly has been designed so that its natural frequency responses avoid the specific operating speeds by an adequate safety margin. The design has assumed the foundation to be rigid.

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CROSS SECTION DRAWING

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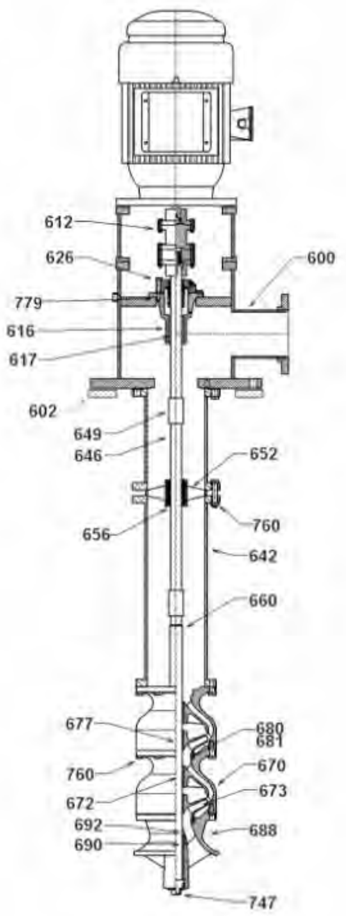
VIT-FFFM 14RJHC, 6 Stages
TMC Municipal



BILL OF MATERIALS

ITEM	PART NAME	CODE	MATERIAL	ASTM#
Head Assembly				
608	Headshaft	2227	SST 416	A582 S41600
600	Head-Discharge	9645	Carbon Steel Fab	A53
602	Sub Base	3201	Carbon Steel Gr D	A36M
604	Nut – Adjusting	2242	Carbon Steel 1018	A108
605	Motor Stand	NA	NA	NA
612	Coupling Assembly	5932	Carbon Steel 1215 Zinc	A108
616	Housing	1003	Cast Iron Cl30	A48 CLASS 30B
617	Bearing-Housing	6397	Vesconite H/L	x
618	Gland-Split	1203	SST 316	A744M
625	Tension Plate	N/A	Not Included	N/A
626	Mechanical Seal	0000	Chesterton 155 1DCW	
637	Hanger Flange	N/A	Not Included	N/A
648	Headshaft Sleeve	N/A	N/A	N/A
730	Key-Motor Gib	2242	Carbon Steel 1018	A108
760	Head Bolting	2229	SST 316	A276
779	Gasket-Housing	5136	Acrylic/Nitrile	5136 REV 4
Column Assembly				
637	Column Flange	9645	Carbon Steel Fab	A53
642	Column Pipe	6501	Black Pipe Sch 40	A 53
646	Lineshaft	2227	SST 416	A582 S41600
649	Lineshaft-Coupling	2265	SST 416	A582M
652	Retainer-Bearing	1205	SST 304	A744M
656	Lineshaft Bearing	6397	Vesconite H/L	x
Bowl Assembly				
660	Shaft - Bowl	2227	SST 416	A582 S41600
661	Discharge Bowl	NA	Not Included	Not Included
664	Bearing - Discharge Bowl	N/A	Not Included	N/A
668	Bearing Tube Adapt	N/A	Not Included	N/A
670	Bowl - Intermediate	6911	Cast Iron Cl30 Enamel	A48
672	Bearing - Intermediate Bowl	6397	Vesconite H/L	x
673	Impeller	1203	SST 316	A744M
673	Impeller	1203	SST 316	A744M
674	Key-Impeller	2217	SST 416	A582M
680	Wear Ring-Bowl	1299	SST CA15	A743M
681	Wear Ring - Impeller	2217	SST 416	A582M
688	Suction	1003	Cast Iron Cl30	A48 CLASS 30B
690	Bearing - Suction	6397	Vesconite H/L	x
692	Sandcollar	NA	Not Included	NA
747	Pipe Plug	1046	Malleable Iron	A197
760	Capscrew-Hex	2298	Steel Bolting Gr 8	J429

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PO Number	
Serial Number	

PERFORMANCE CURVE

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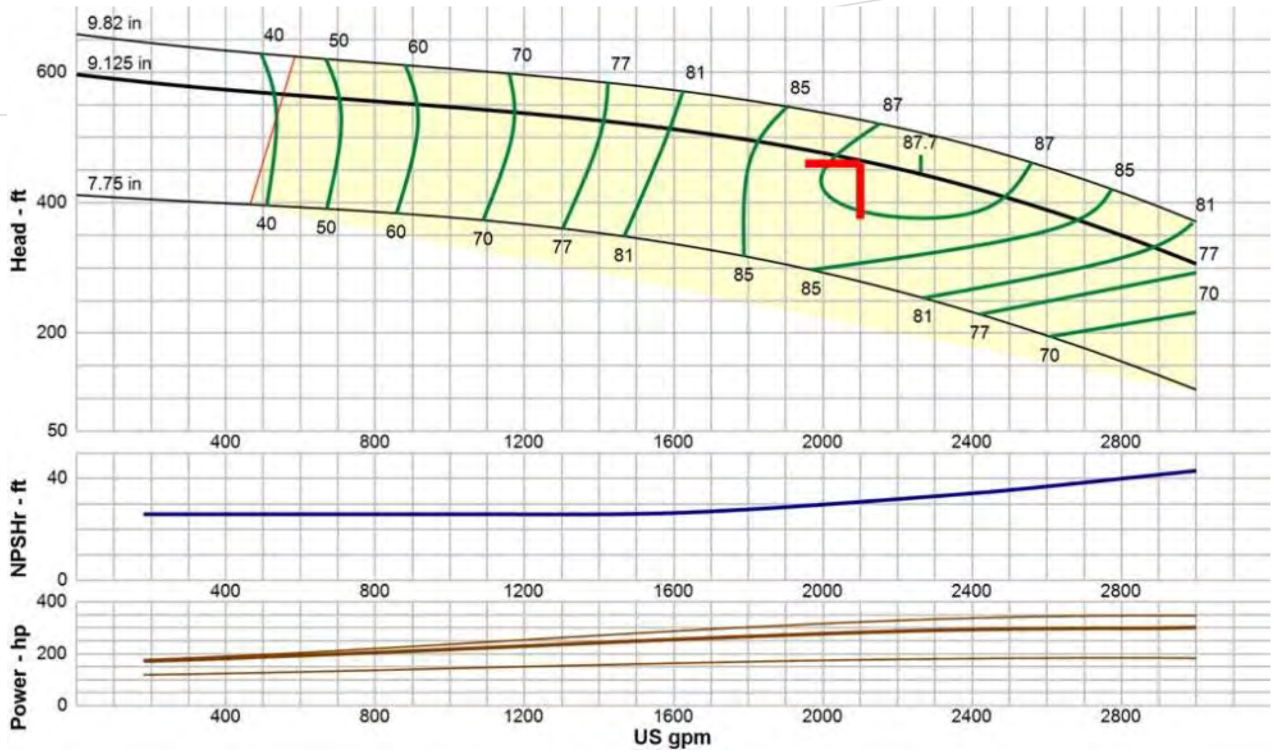
VIT-FFFM 14RJHC, 6 Stages
TMC Municipal



Specified NPSH available is insufficient for the pump.

CURVE DATA

Specified Flow	2100.00 USgpm	**Shut Off TDH (Bowl)**	596.0 ft	**Specified NPSH Ratio**	1.1
Specified TDH	460.00 ft	**Shut Off TDH (Disch Flange)**	555.0 ft	**NPSH Margin at Design**	20.4 ft
Atmospheric Pressure	15 psi	**Shut Off Pressure (Bowl)**	258.0 psi	**Min Submergence at Design**	43.48 in
TPL	59.21 ft	**Shut Off Pressure (Disch Flange)**	240.3 psi	**Actual Submergence**	230.52 in
Pumping Level	40.00 ft	**Bowl Efficiency at Design**	87.20 %	**Shaft Friction Power Loss**	0.74 Hp
NPSHa at Grade	33.9 ft	**Best Efficiency**	87.70 %	**Thrust Load Power Loss**	1.09949 Hp
NPSHa at 1st Impeller	51.4 ft	**BEP Flow**	2262.0 USgpm	**Hydraulic Thrust at Design**	7516.8 lb
Fluid	Water	**Design Flow % BEP**	92.84 %	**Thrust at Design**	8168.6 lb
Fluid Temperature	68.0 °F	**Pump Efficiency**	85.99 %	**Hydraulic Thrust at Shut Off**	9655.2 lb
Specific Gravity	1.0000	**Friction Loss at Design**	3.47 ft	**Thrust at Shut Off**	10313.9 lb
Viscosity	1.0017 cP	**Power at Design**	282.0 Hp	**Bowl Material**	Cast Iron with Glass Enamel
Vapor Pressure	0.3393 psi	**NOL Power**	301.0 Hp		
Density	62 lbs/ft³	**Max Power (NOL) Flow**	3000.0 USgpm	**Bowl Material Derate Factor**	1.00
Design Flow	2100.0 USgpm	**Max Power (NOL) at Max Trim**	347.0 Hp	**Impeller Material**	316SS
Min Flow (MCSF)	566.0 USgpm	**Max Power (NOL) Flow at Max Trim**	3000.0 USgpm	**Impeller Matl Derate Factor**	1.00
Design TDH (Bowl)	464.0 ft			**Total Flow Derate Factor**	1.00
Design TDH (Disch Flange)	419.5 ft	**Recommended Power**	350.00 Hp	**Total Head Derate Factor**	1.00
Design Pressure (Bowl)	200.9 psi	**kWh per 1000 gal**	0.00000	**Total Efficiency Derate Factor**	1.00
Design Pressure (Disch Flange)	181.6 psi	**NPSHr at Design**	31.0 ft	**Curve ID**	E6414RCPC2

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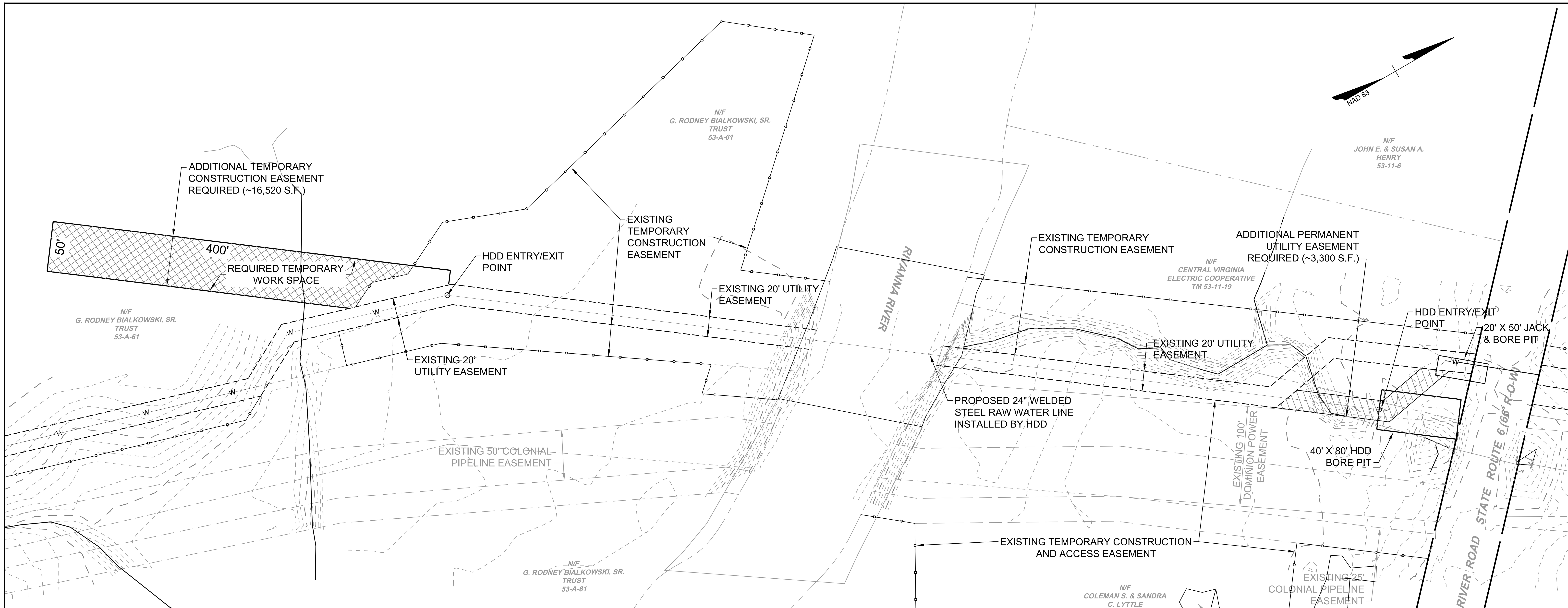
Project	James River Raw Water Pumps Revised 100518	
Tag	3 MGD	
PO Number		
Serial Number		

APPENDIX F-2

RIVANNA RIVER HDD SELECT SHEETS



CONSTRUCTION ACCESS NOTE:

ADDITIONAL TEMPORARY CONSTRUCTION ACCESS MAY BE REQUIRED DUE TO THE CHANGE IN PIPE MATERIAL.

NOTES:

TIMMONS GROUP BASED THESE CONCEPTUAL DRAWINGS ON PRELIMINARY PLANNING DRAWINGS PROVIDED BY DELTA DIRECTIONAL DRILLING (DELTA) IN 2019. THIS IS A CONCEPTUAL DRAWING ONLY TO APPROXIMATE THE LIMITS OF CONSTRUCTION AND POTENTIAL IMPACTS FOR A HYDRAULIC DIRECTIONAL DRILL (HDD) UNDER THE RIVANNA RIVER. FURTHER DETAILED ENGINEERING STUDY AND DUE DILIGENCE WOULD BE NEEDED TO DETERMINE THE ACTUAL LIMITS OF CONSTRUCTION AND FEASIBILITY PRIOR TO FINAL DESIGN SHOULD THIS BE DEEMED A VIABLE OPTION. FOLLOWING IS THE DISCLAIMER NOTE PROVIDED BY DELTA:

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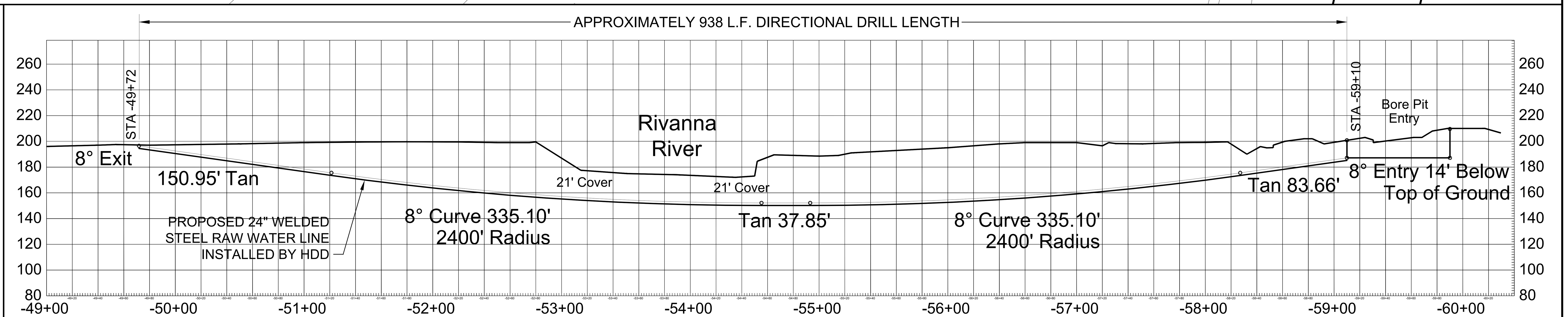

Vertical Geometry						
PVI #	PVI Sta	PVI Elev	Type	Rad / Length	Reverse	Incl
1	-59+10	187.14	Tan Point			0.00
2	-58+27	175.49	Vertical PC	2400.000	No	82.00
3	-54+93	152.14	Vertical PT			90.00
4	-54+55	152.14	Vertical PC	2400.000	No	90.00
5	-51+21	175.49	Vertical PT			98.00
6	-49+72	196.50	Tan Point			98.00

Horizontal Geometry						
From	Station	Azimuth	Dist / Arc	RP #	Radius	To
1	-49+72	217.08	938.21			2

HORIZONTAL DIRECTIONAL DRILLING (HDD)
CONCEPTUAL DRAWING FOR
THE RIVANNA RIVER CROSSING

L:\20\133927 - James River Water Project\DWG\P SUPPLEMENTAL FEB 2020\33927-201C-DD-DELTA.dwg | Plotted on 3/16/2020 10:17 AM | by James Carter

THIS DRAWING PREPARED AT THE CORPORATE OFFICE
1001 Boulders Parkway, Suite 300 | Richmond, VA 23225
TEL 804.200.6500 FAX 804.560.1016 www.timmons.com

YOUR VISION ACHIEVED THROUGH OURS.

TIMMONS GROUP

DATE	REVISION DESCRIPTION

DATE: MARCH 2020
DRAWN BY:
DESIGNED BY:
CHECKED BY:
SCALE: AS SHOWN

JAMES RIVER WATER PROJECT
JAMES RIVER WATER AUTHORITY - FLUVANNA COUNTY, VIRGINIA
HDD CONCEPTUAL LAYOUT DETAILS

JOB NO. 33927
SHEET NO. DD-1

CONSTRUCTION ACCESS NOTE:

ADDITIONAL TEMPORARY CONSTRUCTION ACCESS MAY BE REQUIRED DUE TO THE CHANGE IN PIPE MATERIAL.

NOTES:

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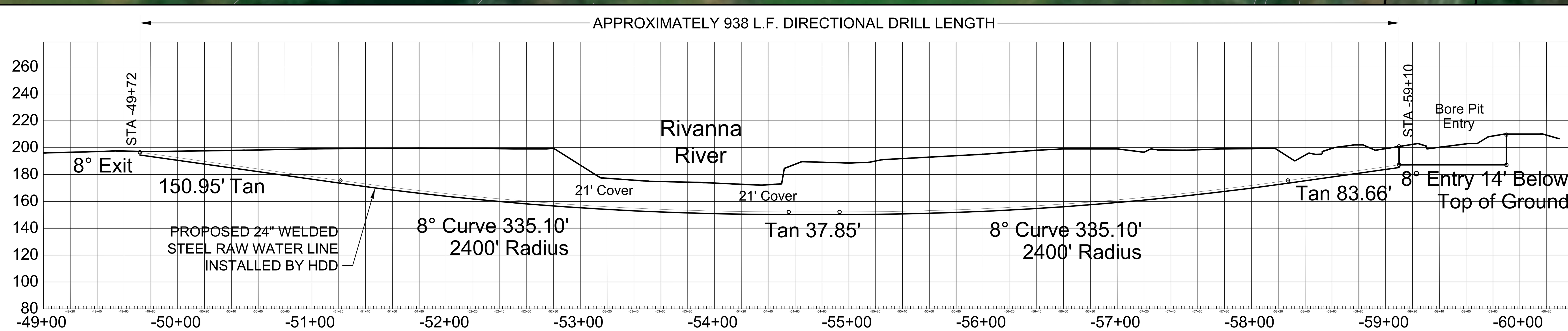
COORDINATES AND ELEVATIONS USED FOR THIS SURVEY ARE APPROXIMATE. ALL UNDERGROUND UTILITIES NEED TO BE FIELD VERIFIED.



Vertical Geometry						
PVI #	PVI Sta	PVI Elev	Type	Rad / Length	Reverse	Incl
1	-59+10	187.14	Tan Point			0.00
2	-58+27	175.49	Vertical PC	2400.000	No	82.00
3	-54+93	152.14	Vertical PT			90.00
4	-54+55	152.14	Vertical PC	2400.000	No	90.00
5	-51+21	175.49	Vertical PT			98.00
6	-49+72	196.50	Tan Point			98.00

Horizontal Geometry						
From	Station	Azimuth	Dist / Arc	RP #	Radius	To
1	-49+72	217.08	938.21			2

HORIZONTAL DIRECTIONAL DRILLING (HDD) CONCEPTUAL DRAWING FOR THE RIVANNA RIVER CROSSING

NOT FOR CONSTRUCTION

THIS DRAWING PREPARED AT THE **CORPORATE OFFICE**
1001 Boulders Parkway, Suite 300 | Richmond, VA 23225
TEL 804.200.6500 FAX 804.560.1016 www.timmons.com

YOUR VISION ACHIEVED THROUGH OURS.

DATE	REVISION DESCRIPTION

DATE: MARCH 2020
DRAWN BY
DESIGNED BY
CHECKED BY
SCALE: AS SHOWN

TIMMONS GROUP

JAMES RIVER WATER PROJECT

JAMES RIVER WATER AUTHORITY - FLUVANNA COUNTY, VIRGINIA

HDD CONCEPTUAL LAYOUT DETAILS

JOB NO. 33927

SHEET NO. DD-1

APPENDIX G
COUNTY WATER PLANS

<u>APPENDIX G-1</u>

FLUVANNA COUNTY REGIONAL WATER SUPPLY PLAN

<u>APPENDIX G-2</u>

LOUISA COUNTY LONG RANGE REGIONAL WATER SUPPLY PLAN

APPENDIX G-1

FLUVANNA COUNTY REGIONAL WATER SUPPLY PLAN

FLUVANNA COUNTY

REGIONAL WATER SUPPLY PLAN

Prepared For:

Fluvanna County
and
Town of Columbia

April 2010

Prepared By:

Draper Aden Associates
Engineering • Surveying • Environmental Services

DAA Project Number: R09163-01

TABLE OF CONTENTS

TABLES

FIGURES

APPENDIX

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Appendix 2. Engineering Description Sheets – Community Systems Using Ground Water

- Town of Columbia
- Fork Union Sanitary District
- Palmyra
- Woodslodge Cottages
- Pine Grove Mobile Home Park
- Stagecoach Hills
- Oakland School

Appendix 3. Engineering Description Sheets – Community Systems Using Ground Water

- Fluvanna Correctional Center for Women
- Lake Monticello

Appendix 4. VWP Information – Tenaska/ECTI and Bremo Bluff

Appendix 5. VWP Information – Department of Corrections, Lake Monticello, Fluvanna County

Appendix 6. VDEQ Water Withdrawal Records

Appendix 7. Engineering Description Sheets for NTNC and NC Systems

Appendix 8. Summary of Withdrawal Data Reported to VDH and Summary of Information from Sanitary Survey Reports

Appendix 9. SWAP Data

Appendix 10. VDGIF Known of Likely Species (by order of concern) for Conservation

Appendix 11. Fluvanna County Drought Ordinance

1.0 INTRODUCTION

1.1 Purpose of the Study

Fluvanna County and the Town of Columbia have prepared this Regional Water Supply Plan to evaluate the current and future water supply needs in Fluvanna County to ensure that the water needs of the people living in the County will be met now and in the future.

The water supply planning process is designed to:

- Ensure that adequate and safe drinking water is available;
- Encourage, promote and protect all other beneficial uses of water resources;
- Encourage, promote and develop incentives for alternative water sources; and
- Promote conservation.

This Water Supply Plan was developed to comply with the State Water Control Board's Local and Regional Water Supply Planning Regulation (9VAC 25-780-10 through 9VAC 25-780-190, herein after, the "Regulation") which established a comprehensive water supply planning process for the development of local, regional and state water supply plans.

1.2 General Location and Description

Fluvanna County is a predominately rural county located in central Virginia, approximately 54 miles northwest of Richmond and approximately 15 miles southeast of Charlottesville. The total area of the county is approximately 290 square miles, with the land area totaling 287 square miles. The water area is approximately 3 square miles. According to the U.S. Census Bureau, Fluvanna County's population in the year 2000 was 20,047, and had increased to approximately 26,068 in 2007. The population of the Town of Columbia was 49 in 2000 and increased to 55 in 2007.[1] See Figure 1-1 for a map of Fluvanna County relative to the surrounding counties. Figure 1-2 provides a map of Fluvanna County and includes the major features including roadways, population centers and rivers.

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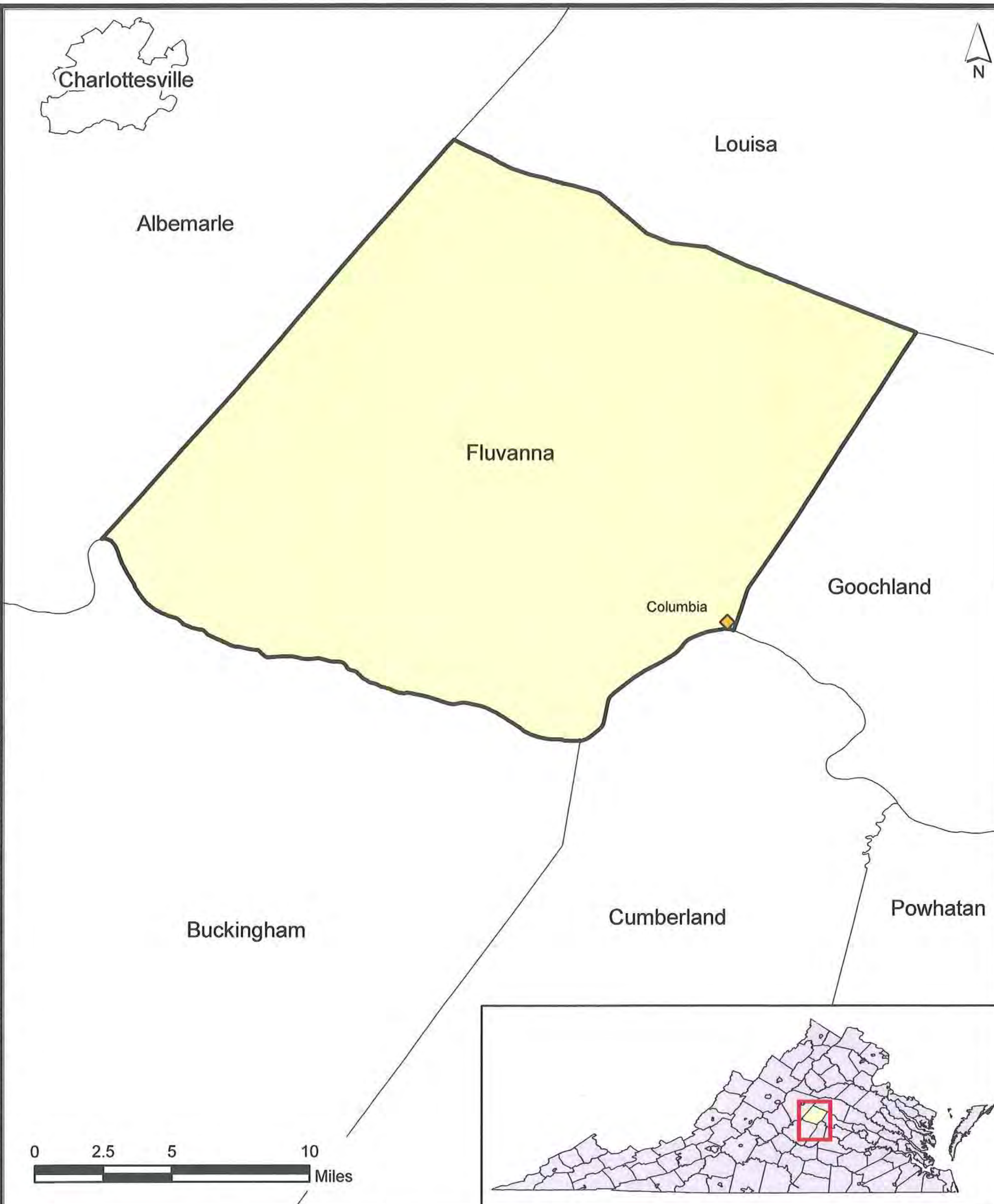
[1] Source: US Bureau of the Census; 2000 Census and 2007 Estimate.



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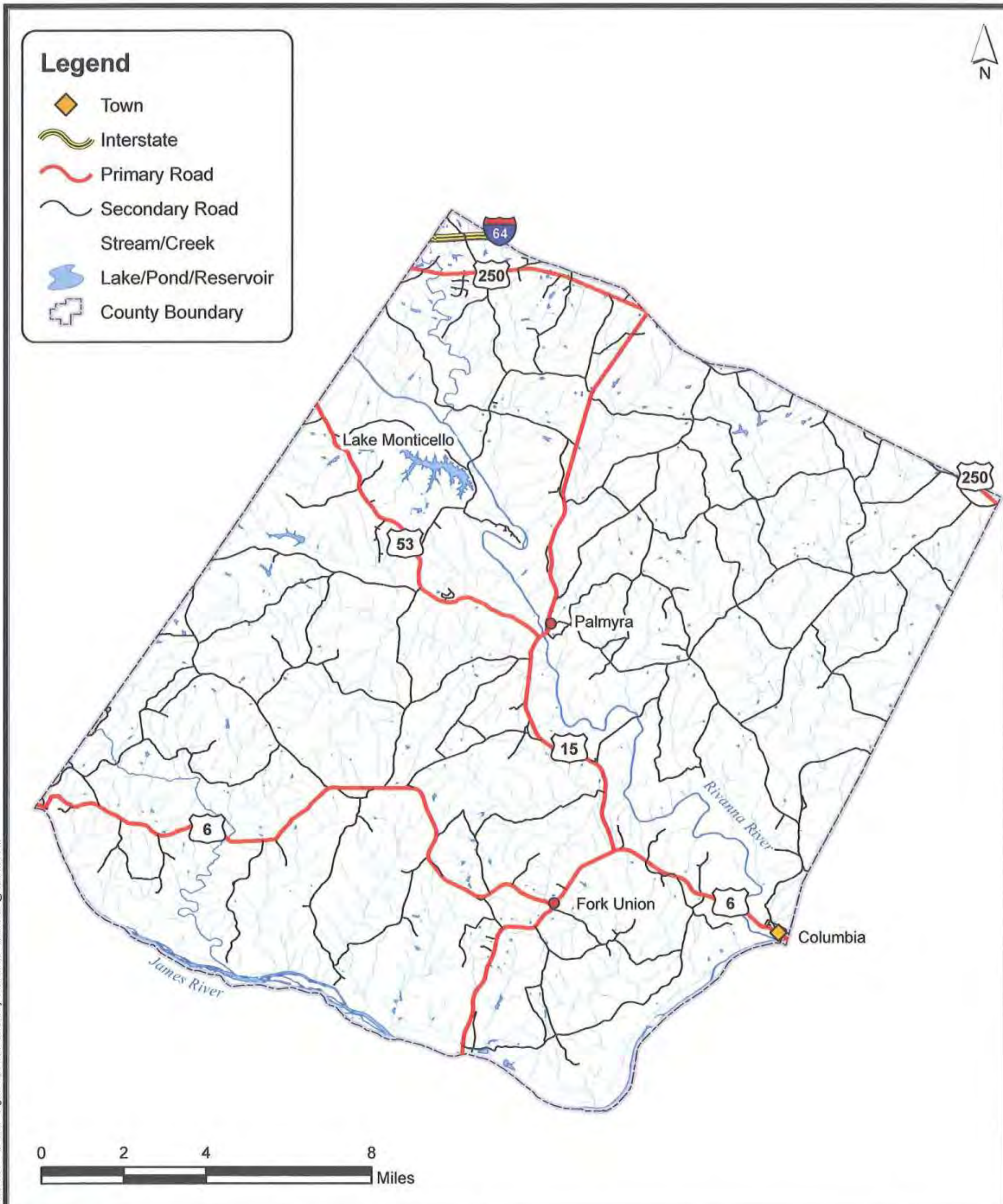
FLUVANNA COUNTY & SURROUNDING LOCALITIES
Virginia

FIGURE 1-1

\\RCH-FILES\Projects\R09100\R09163R\R09163R-01\GIS\MAP - 09 0427 - Figure 1-1 Fluvanna & Surroudning Localities - AWG.mxd - 6/15/2009 @ 12:02:46 PM



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FLUVANNA COUNTY

Virginia

FIGURE 1-2

P:\R09\100\R09163\R09163-01\GIS\MAP - 09 0427 - Figure 1-2 Fluvanna County - AWG.mxd - 4/30/2009 @ 12:34:56 PM

1.3 Abbreviations Used in This Plan

Throughout this Water Supply Plan, a number of abbreviations are used. The following table provides definitions for each.

Table 1-1: Abbreviations Used

Abbreviation	Definition
cfs	Cubic feet per second
ERC	Equivalent residential connection
GPD or gpd	Gallons per day
GPM or gpm	Gallons per minute
HUC	Hydrologic Unit Code
MG or mg	Million gallons
MGD or mgd	Million gallons per day
N/A	Not Applicable
N/I	No information, or, information not available
NOAA	National Oceanographic and Atmospheric Administration
SWCB	State Water Control Board
TJPDC	Thomas Jefferson Planning District Commission
VDCR	Virginia Department of Conservation and Recreation
VDEQ	Virginia Department of Environmental Quality
VDOF	Virginia Department of Forestry
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VDMME	Virginia Department of Mines, Mineral and Energy
VDMR	Virginia Division of Mineral Resources
VOF	Virginia Outdoor Fund
VOP	Virginia Outdoors Plan

2.0 EXISTING WATER SOURCE INFORMATION

As required by the Regulation[2], current information on existing water sources is detailed in the following sections. The residential, commercial, industrial, institutional, and agricultural sectors of Fluvanna County rely on ground water and surface water including Mechunk Creek and the Rivanna and James Rivers. Maps showing the location of the public water systems are found at the end of this chapter.

2.1 Community Systems Using Ground Water[3]

There are seven community water systems using ground water. The systems are listed below.

Table 2-1: Community Water Systems Using Ground Water[4]

PWSID	System Name	System Owner	# of Wells	# of Connections[5]
2065120	Columbia, Town of	Aqua Virginia, Inc.	1	47
2065300	Fork Union Sanitary District	Fork Union Sanitary District	6	433
2065520	Oakland School	Fluvanna Oakland Farm, Inc.	4	20
2065540	Palmyra	Aqua Virginia, Inc.	3	39
2065600	Pine Grove Mobile Home Park	Pine Grove MHP, LLC	1	31
2065781	Stagecoach Hills	Roger Crawford	1	27
2065833	Woodslodge Cottages	Management Services Corp.	1	15

Appendix 1 includes a table entitled **Community Water Systems Using Ground Water** which includes the name, identification number of the well or wells, the well depth, the casing depth, the screen depth or water zones, the well diameter, the design capacity for the average daily withdrawal and maximum daily withdrawal, and the system capacity permitted by VDH. The information included in this table was taken from the VDH Engineering Description Sheets. **Appendix 2** includes Engineering Description sheets from VDH for each of the community systems using ground water.

[2] 9 VAC 25-780-70.
[3] 9 VAC 25-780-70 B.
[4] Source: VDH Records.
[5] Number of connections based on 2008 Ground Water System Sanitary Survey Reports, includes both residential and non-residential connections.

2.2 Ground Water Management Area

Fluvanna County is not located in a ground water management area, therefore ground water withdrawal permits are not required by VDEQ.

2.3 Community Systems Using Surface Water Reservoirs[6]

VDH and VDEQ records do not indicate the presence of any community water systems in Fluvanna County using surface water reservoirs. Further, the VDH and VDEQ records do not indicate the existence of any interconnected reservoirs.

2.4 Community Systems Using Stream Intakes[7]

There are two community water systems in Fluvanna County using stream intakes.

Table 2-2: Community Water Systems Using Stream Intakes[8]

PWSID	VDEQ Withdrawal Permit Number	System Name	System Owner	Source	# of Connections
2065250	VWP 95-0176	Fluvanna Correctional Center for Women	VA Department of Corrections	Mechunk Creek	5
2065480	VWP 95-0957	Lake Monticello	AquaSource, Inc.	Rivanna River	4,238

Appendix 1 includes a table entitled **Community Water Systems Using Stream Intakes** which includes the name of the system, the name of the stream or river, the drainage area of the intake, the sub-basin in which the intake is located, the design capacity for the average daily and designed maximum daily withdrawal from the stream, the safe yield, the lowest daily flow of record, the design capacity of the pump station, the design of the water treatment plant, the capacity of the system as permitted by VDH, and any limitations on withdrawals established by permits issued by the SWCB. Much of the information included in this table was taken from the VDH Engineering Description Sheets. **Appendix 3** includes Engineering Description sheets from VDH for each of the community systems using surface water.

[6] 9 VAC 25-780-70 C.
[7] 9 VAC 25-780-70 D.
[8] Source: VDH Records.

2.5 James River Water Authority

The James River Water Authority was created by action of the Boards of Supervisors of Louisa and Fluvanna Counties in 2009. The purpose of the joint regional authority is to provide treated water to both counties. Fluvanna County holds a withdrawal permit that allows for withdrawal from the James River for municipal water supply. The permit limits the daily water withdrawal to 5.7 million gallons; the maximum annual withdrawal is limited to 1.1 billion gallons. It is anticipated that Fluvanna County will transfer the withdrawal permit to the James River Water Authority.

The Authority plans to withdraw water from the James River, pump raw water to the Pleasant Grove site, treat the water at a treatment plant to be constructed at Pleasant Grove, and deliver treated water to Fork Union, to the Zion Crossroads area in Fluvanna and to Louisa County where Louisa County Water Authority will distribute water to current and future customers in Louisa.

The James River Water Authority regional project is discussed in greater detail in later sections of this report.

2.6 Non-Agricultural, Self-Supplied Users of More than 300,000 Gallons per Month of Surface Water[9]

There are two non-agricultural self-supplied users of more than 300,000 gallons per month of surface water. Both facilities withdraw water from the James River and both use water for cooling. It is important to note that much of the water withdrawn from the James River by these industrial users is "non-consumptive" use.[10] However, the withdrawal records provided by VDEQ do not provide data concerning the amount of water that is returned to the river.

[9] 9 VAC 25-780-70 E.

[10] Uses of fresh water can be categorized as consumptive and non-consumptive (sometimes called "renewable"). A use of water is consumptive if that water is not immediately available for another use. Losses to sub-surface seepage and evaporation are considered consumptive, as is water incorporated into a product (such as farm produce). Water that is returned as surface water, is generally considered non-consumptive if that water can be put to additional use.

2.6.1 Dominion Generation/Bremo Bluff

Bremo Bluff is a coal-fired power station owned and operated by Dominion Generation. The facility withdraws water from the James River. The design capacity of the water intake structure is not available (based on review of VDEQ data sources). The Bremo Bluff facility was constructed before 1989 and is a "grandfathered system"; therefore, there is no VDEQ-issued water withdrawal permit.

2.6.2 Tenaska Generating Station

The Tenaska Virginia Generating Station is a natural gas-fueled, combined-cycle electric generating facility.

The Tenaska intake station is located in Buckingham County. The water is piped across the James River and used at the Tenaska facility which is located in Fluvanna. (See Figure 2-1 for the general location of the Tenaska facility). The Tenaska operation also includes a surface water reservoir where water is stored prior to usage at the facility. Since the intake is in Buckingham County, based upon VDEQ's recommendation, usage data for the Tenaska facility is not detailed in this plan.

The VWP controls the withdrawals through a formula that includes the time of year, the stream flow at Scottsville and the allowable pumping rate (see Schedules A and B of the VWP, Appendix 4).

The Tenaska facility pumps water into a reservoir on an un-named tributary of the James River. As outlined on page 7 of the July 2006 "Extension of Virginia Water Protection Permit No. 01-1849 (see Appendix 4) the maximum daily withdrawal from the reservoir "shall not exceed 16.65 million gallons."

Research of VDEQ and VDH records did not reveal any information on the following:

- Design capacity for average daily and maximum daily withdrawal for the Bremo Bluff Power Plant; and,

- Design capacity for average daily and maximum daily withdrawal for the Tenaska facility.

The following table summarizes key data about each facility.

Table 2-3: Non-Agricultural Users of more than 300,000 Gallons per Month of Surface Water

VWP Permit Number	System Name	System Owner	Source	Category
WP2-08-1862	Bremo Bluff Power Plant	Dominion Generation	James River	Power – Fossil
01-1281	Tenaska Virginia Generating Station	Tenaska	James River	Power – Fossil

2.6.3 Lake Monticello Golf Course

VDEQ records include the Lake Monticello Golf Course as a surface-water user of more than 300,000 gallons per month. As shown in the table in Appendix 6, the Golf Course reported usage ranging from 0 MG per month to 6 MG per month during 2005 and 2006. There was no data reported for 2007 or 2008, but the golf course is still active.

2.6.4 Laurel Ridge Golf / Rivanna Resort

The Rivanna Resort Golf Course (formerly known as Laurel Ridge) does not report withdrawals to VDEQ.

2.6.5 Non-Agricultural, Self-Supplied Users of More than 300,000 Gallons per Month of Ground Water[11]

VDEQ records do not include any additional non-agricultural self-supplied users of more than 300,000 gallons per month of ground water.

2.6.6 Amount of Ground Water or Surface Water Purchased from Water Supply Systems outside the Geographic Boundaries of the County[12]

There is no ground water or surface water purchased from water supply systems outside the geographic boundaries of Fluvanna County.

[11] 9 VAC 25-780-70 F.
[12] 9 VAC 25-780-70 G.

As noted earlier, the Tenaska facility withdraws water from the Buckingham County shore of the James River and pipes the water across the James to a pipeline which delivers the water to the Tenaska power plant.

2.7 Amount of Water Available to be Purchased from Outside the County from any Source with the Capacity to Withdraw more than 300,000 Gallons per Month of Surface and Ground Water[13]

There are no existing contracts to purchase water from outside of the Fluvanna County boundaries. Louisa County Service Authority operates a community water system in the Zion Crossroads area that relies on ground water. However, the availability of the ground water in that area is not adequate to meet the projected demands of the Zion Crossroads area.[14]

The James River Water Authority was created by the Boards of Supervisors of Louisa and Fluvanna Counties to provide water to both Louisa and Fluvanna counties and will serve the Zion Crossroads area of Louisa.

2.8 Agricultural Users Who Utilize More than 300,000 Gallons per Month, Estimate of Total Agricultural Usage by Source, Irrigation vs. Non-Irrigation and Source[15]

Records from VDEQ do not include any agricultural users in Fluvanna County who withdraw more than 300,000 gallons of water per month. The following information concerning livestock and crops was made available by the 2007 Census of Agriculture. The following table shows the estimated annual usage of water for agricultural purposes. Based on the information available, it is not known if any one user exceeds 300,000 gallons per month. Further, it is not know if the water used is from ground water or surface water sources.

[13] 9 VAC 25-780-70 H.
[14] See page 3-1 of Water Resources Study for the Zion Crossroads Area, Dated 1996, prepared by Timmons Group.
[15] 9 VAC 25-780-70 I.

Table 2-4: Fluvanna County Livestock Information[16]

Type of Livestock	# in 2007	Gallons of Water Needed per Day per Animal[17]	Estimated Monthly Usage (Gallons)	Estimated Annual Usage (Gallons)
Cattle and Calves	6,730	12	201,900	2,422,800
Horses and Ponies	732	12	21,960	263,520
Poultry – Layers	636	0.06	19,080	228,960
Sheep and Lambs	258	2	7,740	92,880
			Total Estimated Usage	**3,008,160 or 3.0 MG**

Table 2-5: Fluvanna County Crop Information[18]

Type of Crop	Acres in 2007	Acres Irrigated (Estimated)	Approximate Irrigation[19] (inches/acre/year)	Estimated Total Annual Irrigation (Gallons)
Forage-Land Used for All Hay and Haylage, Grass Silage, and Greenchop	11,026	1,102[20]	10 – 15	374,250,005
Corn for Grain	935	0	0	0
Wheat for Grain	869	0	0	0
Soybeans	762	0	0	0
Nursery Stock	Information Not Available	100%	Information Not Available	Information Not Available
			Total Estimated Usage	**374,250,005 or 374.2 MG**

2.9 2000 Census Data and Average Household Size

The 2000 Census data includes the following information about population and household size in Fluvanna in 2000.

[16] 2007 Census of Agriculture.
[17] Source: USGS Livestock Water Use.
[18] Source: 2007 Census of Agriculture.
[19] Handbook for Extension Agents, NC State University, 1982.
[20] 10% of all crops used for silage are irrigated and the crop is irrigated only 5 months (April – September) as per Handbook for Extension Agents; NC State University, 1982.

Table 2-6: 2000 Census Data and Household Size[21]

District	Population in 2000	# of Households in 2000	Population in Households	Average Household Size
Columbia District	3,255	1,221	3,253	2.66
Cunningham District	3,262	1,227	3,262	2.66
Fork Union District	2,906	1,064	2,847	2.68
Palmyra District	3,467	1,007	2,597	2.58
Rivanna District	7,157	2,868	7,157	2.50
Fluvanna County	**20,047**	**7,387**	**19,116**	**2.59**

2.10 Residences and Businesses that are Self-Supplied and Individual Wells Withdrawing less than 300,000 Gallons per Month[22]

The U.S. Census Bureau estimates the Fluvanna County population at 26,068.[23] Approximately 1,200 are in group quarters.[24] The estimated number of households[25] is 9,612. Approximately 4,692 households are provided water through one of the community water systems (see below). The remainders of the homes, approximately 4,920 households, are self-supplied by individual wells.

[21] Source: Bureau of the Census, 2000.
[22] 9 VAC 25-780-70 J.
[23] Source: 2007 Census Bureau Estimate.
[24] Source: As per DOC's Environmental Science Unit in October 2009.
[25] Source: 2000 Census reported 2.59 persons per household.

Table 2-7: Residences Served by Community Water Systems

System	Connections	Estimated Residential Connections[26]	Estimated Population Served by Community Systems[27]
Columbia, Town of	47	40	104
Fork Union S.D.	433	394	1,020
Lake Monticello	4,238	4,175	10,813
Palmyra	38	10	26
Pine Grove Mobile Home Park	31	31	62
Stagecoach Hills	27	27	70
Woodslodge Cottages	15	15	30
Total	**4,829**	**4,692**	**12,125**
Estimated 2008 County Population			26,068
Estimated Institutionalized Population			1,200
Estimated Population Served by Community Systems			12,125
Estimated Population that is Self-Supplied			12,743
Estimated Number of Self-Supplied Homes			4,920

There are twelve VDH-permitted non-community systems. All rely on ground water. The systems and population for each, as reported on the Engineering Description Sheets are shown below. The Engineering Description Sheets for these permitted systems are included in **Appendix 7**.

[26] The number of connections is estimated based on VDH records and Engineering Description Sheets; estimates made by the system owners; and GIS data was reviewed to estimate the number of homes and non-residential users served.

[27] Calculated using 2.59 persons per household, except for Pine Grove and Woodslodge, where estimate is 2 persons per household.

Table 2-8: Self-Supplied Businesses / Non-Residential Uses

Name	Population
Camp Friendship	495
Fluvanna Co. High School	2,466
Columbia School District	135
Cunningham School District	228
MacSteel Service Centers	28[28]
Fluvanna Co. Courthouse	60
Laurel Ridge Golf Club	300
Open Door School	175
Inn 1831 and Restaurant	50
Fluvanna Co. School Board	48
Tenaska Generating Station	25
Fork Union Shopping Center	300

2.11 Source Water Assessment Plans or Wellhead Protection Programs

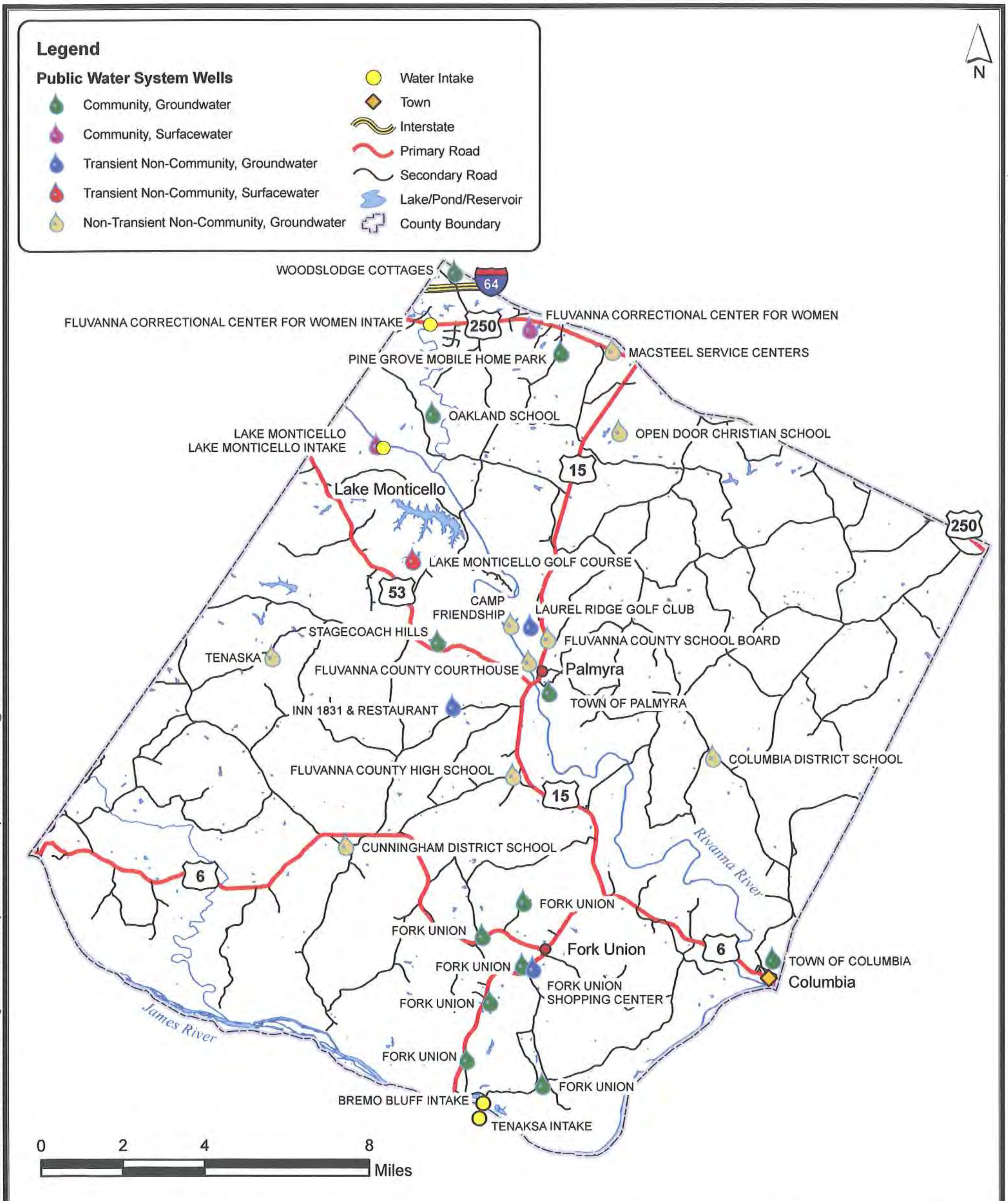
Discussions with the VDH Lexington Field office reveal that source water assessments have been completed for most areas in the Commonwealth. The VDH Source Water Assessment results for wells in Fluvanna County are included in **Appendix 9.** As shown on the table in **Appendix 9**, the Source Water Assessment completed in 2002 indicated that all the ground water systems in Fluvanna have "High Susceptibility" to water quality degradation.

All areas of the Commonwealth are vulnerable to ground water quality degradation. Common land use activities that threaten ground water quality include on-site sewage systems, fuel storage systems, pastures, crop and fodder production, roadways, parking lots, gasoline stations and service centers, solid waste collection and transfer sites, wastewater pumping stations and underground storage tanks.

The Lexington VDH field office confirmed that there are no wellhead protection plans or source water protection programs in effect in Fluvanna.

The following figures show the location of the public water systems.

[28] VDH Engineering Description Sheet lists population of 44; actual 2009 employment is 28.



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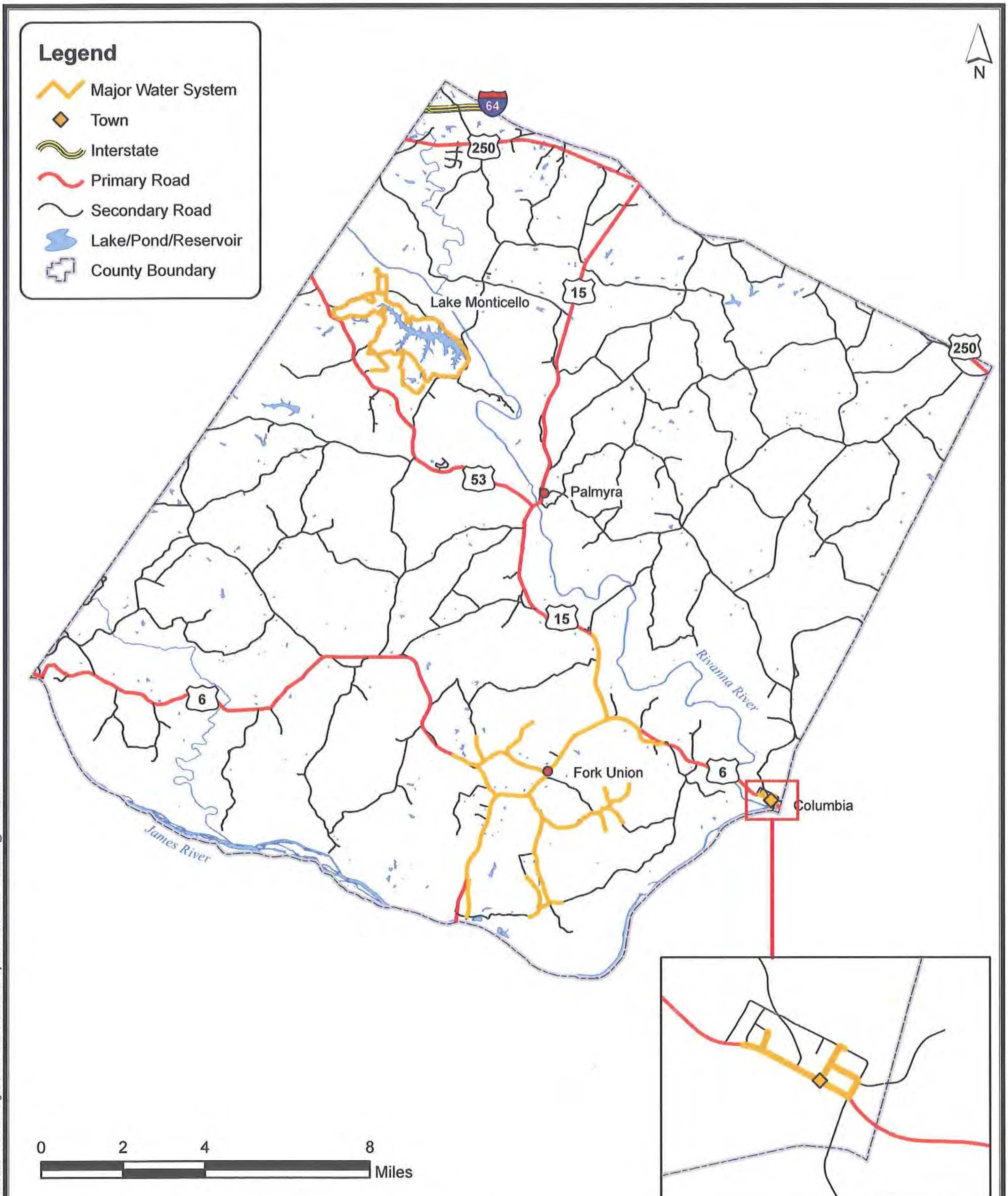
PUBLIC WATER SYSTEM FACILITIES

Fluvanna County, Virginia

FIGURE 2-1



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MAJOR PUBLIC
WATER SYSTEMS

Fluvanna County, Virginia

FIGURE

2-2

3.0 EXISTING WATER USE INFORMATION

The following section of the Fluvanna County Water Supply Plan summarizes water use information as required by 9 VAC 25-78-80.

3.1 Community Water Systems

There are nine community water systems in Fluvanna County. The information required by Section 9 VAC 25-780-80B is summarized below for each of the nine community water systems. The community water systems are:

- Fluvanna Correctional Center for Women
- Lake Monticello
- Town of Columbia
- Fork Union Sanitary District
- Oakland School
- Palmyra
- Pine Grove Mobile Home Park
- Stagecoach Hills
- Woodslodge Cottages

In the following section, two sources of data have been used where available:

- 2008 VDH Monthly Operation Reports were used for average daily withdrawal, maximum daily withdrawal and month of maximum withdrawal (see **Appendix 8** for detailed summaries of the VDH reports).
- VDEQ records were used for the annual withdrawal and monthly average withdrawal. Data is provided for 2002 – 2008, where available (**Appendix 6**).
- 2008 VDH data was used for the peak water withdrawal by month (**Appendix 8**).

3.2 Fluvanna Correctional Center for Women

3.2.1 Fluvanna Correctional Center – Population and Connections

The Correctional Center serves approximately 1,700 persons through 5 connections. In October 2009, DOC reported 1,200 inmates at the facility and approximately 500 employees.[29]

3.2.2 Fluvanna Correctional Center - Average and Maximum Daily Withdrawals

Correctional Center withdrawals are reported to VDH and to VDEQ. The following table summarizes the withdrawals for 2008[30] and more detailed information for the years from 2007 through 2008 are provided in Appendix 6. Summarized VDH records are provided in Appendix 8.

Table 3-1: Fluvanna Correctional Center – Average and Maximum Daily Withdrawal - 2008[31]

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.114	.147	January

3.2.3 Fluvanna Correctional Center – Annual and Monthly Average Withdrawals

Withdrawal reports submitted to VDEQ provide the following withdrawals for 2007 and 2008. The VDEQ records do not provide information for the years from 2002 – 2006.

Table 3-2: Fluvanna Correctional Center – Annual and Monthly Average Withdrawal[32]

Year	Annual Withdrawal (MG)	Monthly Average Withdrawal (MG)[33]
2007	34.95	2.91
2008	37.44	3.12
Average	**36.20**	**3.02**

[29] Source: Conversation with DOC, Environmental Services Unit, October 2009.
[30] Source: VDH Records.
[31] Source: VDH Records.
[32] Source: DEQ Water Withdrawal Records. Reflects the volume of water pumped from Mechunk Creek. See **Appendix 6**. Data for previous years not available from VDEQ.
[33] The withdrawal for November 7 was recorded as .820. This withdrawal is nearly 8 times the average daily withdrawal. See detailed table in **Appendix 8.**

3.2.4 Fluvanna Correctional Center – Peak Withdrawal by Month – 2008

The following table provides the peak water withdrawal each month in 2008.

Table 3-3: Fluvanna Correctional Center – Peak Withdrawal - 2008[34]

Month	Maximum Daily Withdrawal (MG)
Jan	.147
Feb	.131
Mar	.143
Apr	.131
May	.134
Jun	.142
Jul	.140
Aug	.132
Sep	.139
Oct	.141
Nov	.141
Dec	.144

The ratio of the peak day to the average day ranged from 1.16 to 1.32 in 2008. The median figure is 1.20. This ratio will be used in the demand projection section of this report.

3.2.5 Fluvanna Correctional Center – Estimated Usage of Self-Supplied Non-Agricultural Users of Greater Than 300,000 Gallons per Month (Within the Service Area)

The Fluvanna Correctional Center's water system provides the water needs of the prison and there are no self-supplied non-agricultural users within the service area.

3.2.6 Fluvanna Correctional Center – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

The Fluvanna Correctional Center's water system provides the water needs of the prison and there are no self-supplied agricultural users within the service area.

3.2.7 Fluvanna Correctional Center – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

The Fluvanna Correctional Center's water system provides the water needs of the prison and there are no self-supplied users within the service area.

[34] Source: VDH Records.

3.2.8 Fluvanna Correctional Center – Estimated Disaggregated Use

The water usage at the Fluvanna Correctional Center is considered institutional. Based on withdrawal and production records from 2008, the amount of water used in the water treatment process is approximately 2.3% of the total withdrawal. The system does not sell water to any other community water system.

3.3 Lake Monticello

3.3.1 Lake Monticello – Population and Connections

The population served by the Lake Monticello water system is approximately 10,813; there are 4,238 connections, approximately 4,175 of which are residential.[35]

3.3.2 Lake Monticello - Average and Maximum Daily Withdrawals

The Lake Monticello withdrawals are reported to VDH. The following table summarizes the withdrawal data available from VDH and additional information is provided in Appendix 8.

Table 3-4: Lake Monticello – Average and Maximum Daily Withdrawal – 2008[36]

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.6337	.9590	July

3.3.3 Lake Monticello – Annual and Monthly Average Withdrawals

Withdrawal reports submitted to VDEQ provide the following annual and monthly withdrawals.

[35] Source: VDH records; 2008.
[36] Source: VDH Records.

Table 3-5: Lake Monticello – Annual and Average Monthly Withdrawal – 2002 - 2008[37]

Year	Annual Withdrawal (MG)	Average Monthly Withdrawal (MG)	Max Day (MG)	Max Month
2002	204.77	17.06	1.007	August
2003	208.42	17.37	Not Provided in VDEQ Data	
2004	Not Provided in VDEQ Data			
2005	Not Provided in VDEQ Data			
2006	Not Provided in VDEQ Data			
2007	238.97	19.91	1.035	November
2008	229.98	19.17	0.959	July

3.3.4 Lake Monticello – Peak Day Withdrawal by Month

The following data was obtained from VDH records; more detailed information is included in Appendix 8.

Table 3-6: Lake Monticello – Peak Withdrawal - 2008

Month	Maximum Daily Withdrawal (MG)
Jan	.8940
Feb	.8653
Mar	.7766
Apr	.7737
May	.8870
Jun	.9390
Jul	.9590
Aug	.9358
Sep	.7717
Oct	.7757
Nov	.8174
Dec	.8105

The ratio of the peak day to the average day ranges from 1.21 to 1.46 in 2008. The median figure is 1.35. This ratio will be used in the demand projection section of this report.

3.3.5 Lake Monticello – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000Gallons per Month (Within the Service Area)

The only self-supplied non-agricultural user within the Lake Monticello service area is the Lake Monticello golf course. The golf course uses ponds on the property for irrigation. The following table summarizes the data provided by VDEQ for the golf course:

[37] Source: DEQ Water Withdrawal Records.

Table 3-7: Lake Monticello Golf – Annual and Monthly Average Withdrawal – 2002 - 2008[38]

Year	Annual Usage (MG)	Monthly Average Withdrawal (MG)
2002	Not Provided in VDEQ Data	
2003	Not Provided in VDEQ Data	
2004	Not Provided in VDEQ Data	
2005	13.00	1.08
2006	25.00	2.08
2007	Not Provided in VDEQ Data	
2008	Not Provided in VDEQ Data	

3.3.6 Lake Monticello – Estimated Usage of Self-Supplied Agricultural Users of More than 300,000 gallons per Month (Within the Service Area)

Review of VDEQ and VDH records and GIS data do not indicate the presence of any self-supplied agricultural users within the Lake Monticello community.

3.3.7 Lake Monticello – Estimated Number of Self-Supplied Non-agricultural Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

All of the homes and businesses within the Lake Monticello community are provided water by the Lake Monticello community system. As new development occurs outside of the existing service area, the development plan and related rezoning generally provides that the Lake Monticello system will provide water. As a result, there are no known self-supplied users within the service area of the Lake Monticello system.

3.3.8 Lake Monticello – Estimated Disaggregated Use

The estimated disaggregated uses in the Lake Monticello system are as follows:

[38] VDEQ Records. See **Appendix 6.**

Table 3-8: Disaggregated Uses – Lake Monticello – Based on 2008 Withdrawals[39]

Category	Annual Use (MG)	%
Residential	203.1	87.8%
Non-residential[40]	11.6	5.0%
Unaccounted for losses	11.6	Less than 5.0%
Water Used in Production Process	5.1	2.2%
Total	**231.3**	**100%**

The Lake Monticello system does not sell water to any other community water system.

3.4 Town of Columbia

3.4.1 Town of Columbia – Population and Connections

The population served by the Town of Columbia water system is approximately 104 persons through 40 connections.[41]

3.4.2 Town of Columbia - Average and Maximum Daily Withdrawals

The Town of Columbia ground water withdrawals are reported to VDH on a monthly basis. The following table summarizes the withdrawals for 2008. Detailed information is provided in Appendix 8.

Table 3-9: Town of Columbia – Average and Maximum Daily Withdrawal - 2008[42]

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.004	Not Available[43]	Maximum months were May and July with the total withdrawal being .145 MG each month.

[39] The annual withdrawal in 2008 (231.3 MG) is as per VDEQ withdrawal records.
[40] Source: Estimate for non-residential use provided by AquaVirginia, the company does not maintain billing records in a way that the residential and non-residential billings can be separated, but the company estimates at approximately 5% of the water billed is for commercial/business use.
[41] Source: Information provided by AquaVirginia concerning the percentage of the connections that are residential vs. non-residential.
[42] Source: VDH Records. See **Appendix 8.**
[43] The meters are not read on a daily basis; therefore maximum daily withdrawal information is not available.

3.4.3 Town of Columbia – Annual and Monthly Average Withdrawals

The total withdrawal in 2008 was 1.432 MG; the monthly average withdrawal was .119 MG, average daily withdrawal was .004 MG.

Table 3-10: Town of Columbia – Annual and Monthly Average Withdrawal – 2008[44]

Year	Annual Withdrawal (MG)	Monthly Average Withdrawal (MG)
2008	1.432	.119

3.4.4 Town of Columbia – Peak Day Water Use by Month

The Town of Columbia does not take daily meter readings; therefore peak day water use by month is not available.

3.4.5 Town of Columbia – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

All the homes and small non-residential uses in the service area of the system are served by the system.[45] Further, review of VDEQ records does not reveal the existence of any non-agricultural users of more than 300,000 gallons per month within the service area or the general vicinity of the Town of Columbia.

3.4.6 Town of Columbia – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

Review of VDEQ records and GIS data does not indicate the existence of any self-supplied agricultural users within the service area of the Town of Columbia system.

3.4.7 Town of Columbia – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

All the homes and the non-residential uses in the service area of the system are served by the system. Therefore, there is no evidence of any self-supplied user within the service area of the system.

[44] Source: VDH Records.

[45] The owner of the system is replacing the entire distribution system, the few homes, businesses and a church that were not previously served by the system, will be served at the completion of the project, which will be complete in the early part of 2010.

3.4.8 *Town of Columbia – Estimated Disaggregated Use*

The disaggregated uses in the Town of Columbia system are as follows:

Table 3-11: Disaggregated Uses – Town of Columbia - 2008[46]

Category	Amount Usage (MG)	%
Residential	1.1	80%
Non-residential	.1	5%
Unaccounted for losses[47]	.2	15%
Water Used in Production	Not Known	
Total	**1.4**	**100%**

The Town of Columbia system does not sell water to any other community water system.

3.5 Fork Union Sanitary District

3.5.1 *Fork Union – Population and Connections*

The Fork Union water system serves 433 connections[48]. There are approximately 394 residential connections and the balance are non-residential connections.[49] The residential population served is approximately 1,020.

In addition, the system serves the Fork Union Military Academy. The school estimates that approximately 50 people (faculty and their families) live on school grounds. There are approximately 435 cadets.[50] [51]

[46] Source: AquaVirginia does not disaggregate customer use by type. However, AquaVirginia estimates that no more than 5% of the usage in Columbia is non-residential.

[47] The distribution system in Columbia is being replaced. In the near future, the "Unaccounted for losses" should decrease to 5% or less.

[48] Source: VDH Ground Water System Sanitary Survey Report, 2008.

[49] Source: Fork Union customer records, as per Fluvanna County.

[50] Based on the Census Bureau definitions, students who board at a school and who are NOT in college are included in the Census counts where the parents live. Therefore the students who live at Fork Union are not included in the 2000 Census count for Fluvanna County.

[51] The students are not at school during the summer and have about five weeks off during the academic year. The equivalent year-round residency is approximately 290, as per Fork Union Military Academy.

3.5.2 Fork Union - Average and Maximum Daily Withdrawals

The Fork Union withdrawals are reported to VDH.[52] The following table summarizes the withdrawals for 2008 and more detailed information for the years from 2002 through 2007 is provided in Appendix 6.

Table 3-12: Fork Union – Average and Maximum Daily Withdrawal - 2008[53]

Well	Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
Morris Well #1	.0790	0.080	September
Morris Well #2	.0082	0.035	November
Omohundro Well	.0533	0.000	September
Owens Well	.0126	0.030	January
Melton Well	.0138	0.041	March
Bremo Well	.0129	0.046	May
West Bottom Well	.0101	0.000	Data not available.

3.5.3 Fork Union – Annual and Monthly Average Withdrawals

The annual average and monthly average withdrawals for the Fork Union system are as follows:

Table 3-13: Fork Union – Annual and Average Monthly Withdrawal – 2007 - 2008[54] [55]

Year	Annual Withdrawal (MG)	Monthly Average Withdrawal (MG)
2002	51.76	4.31
2003	66.57	5.55
2004	70.34	5.86
2005	65.96	5.50
2006	67.22	5.60
2007	67.94	5.66
2008	69.29	5.77
Average	**65.58**	**5.46**

[52] See **Appendix 8.**
[53] Source: VDEQ Records.
[54] Source: VDEQ Records.
[55] In order to determine the max day, it would be necessary to add the daily withdrawals for each of the seven wells. That data is not available in the VDH or VDEQ records.

3.5.4 Fork Union – Peak Day Water Use by Month

The Fork Union system uses seven wells. The system keeps daily water withdrawal records for only the Omohundro Well and Morris Well #1; the withdrawals for these wells are reported to VDH. The peak days in 2008 are as follows.

Table 3-14: Fork Union – Peak Withdrawal – 2008[56]

Month	Maximum Daily Withdrawal (MG)
Jan	0.143
Feb	0.145
Mar	0.152
Apr	0.136
May	0.151
Jun	0.158
Jul	0.150
Aug	0.090
Sep	0.189
Oct	0.170
Nov	0.166
Dec	0.183

The ratio of the peak day to the average day ranges from 1.05 to 1.28 in 2008. The median figure is 1.11. This ratio will be used in the demand projection section of this report.

3.5.5 Fork Union – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

Review of VDEQ data and GIS data does not indicate the presence of any self-supplied non-agricultural users within the service area of the Fork Union system that use 300,000 gallons or more of water per month.

3.5.6 Fork Union – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

Review of VDEQ data and GIS data does not indicate the presence of any self-supplied agricultural users within the service area of the Fork Union system.

[56] Based on combined withdrawals from the Morris #1 and Omohundro wells.

3.5.7 Fork Union – Estimated Number of Self-Supplied Users of Less than 300,000 Gallons per Month of Ground Water (Within the Service Area)

The Fork Union Shopping Center is in the proximity of the Fork Union system. The estimated usage of that shopping center is not known, as the source is not metered.[57] The Bremo Bluff Power Plant owns a well in the general vicinity of Fork Union. The annual usage of the well was 1.08 MG in 2007 and .77 MG in 2008.[58]

3.5.8 Fork Union – Estimated Disaggregated Use

The disaggregated uses in the Fork Union system are as follows:

Table 3-15: Fork Union – Estimated Disaggregated Uses – 2008[59]

Category	**Amount (MG)**	**%**[60]
Residential	20.79	30%
Commercial/Light Industrial	13.86	20%
Institutional	24.25	35%
Water Used in Production	3.46	5%
Unaccounted for losses	6.93	10%
Total	**69.29**	**100%**

The Fork Union system does not sell water to any other community water system.

3.6 Oakland School

3.6.1 Oakland School - Population and Connections

The Oakland School is a boarding and day school with approximately 30-50 students who live at the school during the school year and 30-50 commuting students. The staff totals 45-55. The school hosts summer camps which have up to 135 children and similar numbers of staff. According to the 2008 Sanitary Survey Reports, the Oakland School water system serves 20 connections and a population of 125.[61] [62]

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[57] Source: VDH Ground Water System Sanitary Survey Reports, 2008.
[58] Source: VDEQ Water Withdrawal Records.
[59] Based on 2008 water withdrawal.
[60] Source: Percentages provided by Fluvanna County; amounts calculated.
[61] Source: VDH Ground Water System Sanitary Survey Report, 2008.
[62] Based on the Census Bureau definitions, students who board at a school and who are NOT in college are included in the Census counts where the parents live. Therefore the students who live at Oakland School are not included in the 2000 Census count for Fluvanna County.

3.6.2 *Oakland School - Average and Maximum Daily Withdrawals*

The Oakland School withdrawals are reported to VDH.[63] The following table summarizes the withdrawals for eleven months ending in March 2008.

Table 3-16: Oakland School – Average and Maximum Daily Withdrawal – 2007-2008[64]

Well	Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
Well #1	.0103	Not known, the withdrawal meters are not read on a regular basis.	
Well #3	.0035		
Total	**.0139**		

3.6.3 *Oakland School – Annual and Monthly Average Withdrawals*

The annual average and monthly average withdrawals for the Oakland School system are as follows:

Table 3-17: Oakland School – Annual and Average Monthly Withdrawal – 2007 - 2008[65]

Year	Annual Withdrawal (MG)	Monthly Average Withdrawal (MG)
2007 - 2008	5.08	.423

3.6.4 *Oakland School – Peak Day Water Use by Month*

The Oakland School does not record withdrawals on a daily basis; therefore peak day usage is not available.

3.6.5 *Oakland School – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)*

The owner of the Oakland system indicates that there are no self-supplied users within the service area of the school system. Further, review of VDEQ data and GIS data does not indicate the presence of any self-supplied non-agricultural users within the service area of the system that use 300,000 gallons or more of water per month.

[63] See **Appendix 8**.
[64] Source: VDH Records for the 11-month period from May 2007 – March 2008.
[65] Source: VDH Records, the 11-month period was annualized to represent a 12-month period.

3.6.6 Oakland School – Estimated Usage of Self-Supplied Agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

The water system operator confirmed that there are no self-supplied agricultural users within the service area of the school system.

3.6.7 Oakland School – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

There are no self-supplied users within the Oakland School service area, as per the water system operator.

3.6.8 Oakland School – Estimated Disaggregated Use

The usage at the Oakland School is considered institutional. The well records do not provide adequate information to calculate "water used in production processes" and the unaccounted water is unknown.

The Oakland School system does not sell water to any other community water system.

3.7 Palmyra

3.7.1 Palmyra – Population and Connections

The Palmyra water system serves 38 connections, the population served is approximately 52, as per the Sanitary Survey Report. However, the residential population is estimated at 10 households and approximately 26 persons.[66]

3.7.2 Palmyra - Average and Maximum Daily Withdrawals

The Palmyra withdrawals are reported to VDH. The following table summarizes the withdrawals for 2008. Additional information is found in Appendix 8.

[66] Source: VDH Ground Water System Sanitary Survey Report, 2008. The SSR estimated 85 for the population, including the persons who work at the businesses served. The resident population is approximately 26, based on 2.59 persons per household. AquaVirginia's estimate of the number of homes served is approximately 10.

Table 3-18: Palmyra – Average and Maximum Daily Withdrawal - 2008[67]

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.004	Not available, daily readings are not recorded.	

3.7.3 Palmyra – Annual and Monthly Average Withdrawals

The annual average and monthly average withdrawals for the Palmyra system are as follows:

Table 3-19: Palmyra – Annual and Monthly Average Withdrawal - 2008[68]

Year	Annual Withdrawal (MG)	Monthly Average Withdrawal (MG)
2008	1.51	.126

3.7.4 Palmyra – Peak Day Water Use by Month

The Palmyra system is not metered on a daily basis, so the peak day information in not available.

3.7.5 Palmyra – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

There are existing structures throughout the Palmyra service area that are not served by the community water system. Neither the system owner nor Fluvanna County has analyzed the number of self-supplied users. The number of self-supplied users is estimated in the demand projections section of this report.

3.7.6 Palmyra – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

Review of VDEQ records and GIS data did not reveal the presence of any self-supplied agricultural users within the Palmyra service area.

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[67] Source: VDH Records.

[68] Source VDH Records. Data for December was not available. Total for the year is based on the average usage over 11 months, annualized to 12 months.

3.7.7 Palmyra – Estimated Number of Self-Supplied Users of Less than 300,000 Gallons per month of Ground Water (Within the Service Area)

There is no indication of any single significant self-supplied ground water users in the Palmyra service area. The usage of the businesses and homes in the area is estimated in the demand projection section of this report.

3.7.8 Palmyra – Estimated Disaggregated Use

The disaggregated uses in the Palmyra system are as follows:[69]

Table 3-20: Palmyra - Disaggregated Uses

Category	**Annual Usage (MG)**	**%**
Residential	0.30	20% or less
Commercial	1.13	75%
Water Used in Production	Not Known	Not Known
Unaccounted for losses	0.08	5% or less
Total	**1.51**	**100%**

The Palmyra system does not sell water to any other community water system.

3.8 Woodslodge Cottages

3.8.1 Woodslodge Cottages – Population and Connections

The Woodslodge Cottages water system serves 15 connections, the population served is approximately 30.[70]

3.8.2 Woodslodge Cottages - Average and Maximum Daily Withdrawals

The withdrawals for the Woodslodge Cottages are reported to VDH.[71] The following table summarizes the withdrawals for 2008. The system does not report withdrawals to VDEQ and readings are not taken on a daily basis, so maximum day information is not available.

[69] Source: AquaVirginia estimates. Based on 2008 VDH reports.
[70] Source: VDH Ground Water System Sanitary Survey Report, 2008. The SSR reports 60 persons served, but based on 2 persons per household, the total is estimated to be 30.
[71] See **Appendix 8** for more detail.

Table 3-21: Woodslodge Cottages – Average and Maximum Daily Withdrawal - 2008[72]

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.001	Not Available. Daily readings are not recorded.	

3.8.3 Woodslodge Cottages – Annual and Monthly Average Withdrawals

In 2008, the water withdrawal for Woodslodge was as follows:

Table 3-22: Woodslodge Cottages – Annual and Monthly Average Withdrawal - 2008[73]

Year	Aunual Withdrawal (MG)	Monthly Average Withdrawal (MG)
2008	.354	.030

3.8.4 Woodslodge Cottages – Peak Day Water Use by Month

Woodslodge does not take meter readings on a daily basis; as a result, maximum day data is not available.

3.8.5 Woodslodge Cottages – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

Review of VDH and VDEQ records does not indicate the presence of any self-supplied non-agricultural in the immediate vicinity of the Woodslodge community system. Further, the owner of the system confirmed that there are no self-supplied water users of any type within the system service area.

3.8.6 Woodslodge Cottages – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

Review of VDEQ records and GIS information does not reveal the presence of any self-supplied agricultural users within the service area of the Woodslodge system. The system owner confirmed that there are no self-supplied agricultural users within the service area.

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[72] Source: VDH records.
[73] Source: VDH records.

3.8.7 Woodslodge Cottages – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

As per the system owner, there are no self-supplied users of less than 300,000 gallons per month of ground water within the service area of the Woodslodge system.

3.8.8 Woodslodge Cottages – Estimated Disaggregated Use

The disaggregated uses in the Woodslodge Cottages system are as follows:

Table 3-23: Woodslodge Cottages - Disaggregated Uses

Category	Annual Usage (MG)	%
Residential	.354	100%
Commercial/Light Industrial	0	0%
Institutional	0	0%
Water Used in Production	Not Known	0%
Unaccounted for losses	Not Known	0%
Total	**.354**	**100%**

The Woodslodge Cottages system does not sell water to any other community water system.

3.9 Stagecoach Hills

3.9.1 Stagecoach Hills – Population and Connections

The Stagecoach Hills water system serves 27 connections, the population served is approximately 72.[74]

3.9.2 Stagecoach Hills - Average and Maximum Daily Withdrawals

The Stagecoach Hills should report withdrawals to VDH, but the meter has been inoperative since 2007. As a result, average and maximum daily withdrawal data is not available.

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[74] Source: VDH Ground Water System Sanitary Survey Report, 2008.

3.9.3 Stagecoach Hills – Annual and Monthly Average Withdrawals

The meter for this community water system is not operational; annual and monthly withdrawal data is not available.

3.9.4 Stagecoach Hills – Peak Day Water Use by Month

Peak day water use data is not available because the meter for this waterworks is not operational.

3.9.5 Stagecoach Hills – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

Review of VDH and VDEQ records does not indicate the presence of any self-supplied non-agricultural users within this community water system. Further, the owner of the system confirmed that there are no self-supplied users of any type within the system service area.

3.9.6 Stagecoach Hills – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

Review of VDEQ records and GIS data does not indicate the presence of any self-supplied agricultural users within this community water system. The system owner confirmed that there are no self-supplied agricultural users within the service area of the system.

3.9.7 Stagecoach Hills – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

There is no indication of any self-supplied users within the service area of this community water system; this was confirmed by the system owner.

3.9.8 Stagecoach Hills – Estimated Disaggregated Use

The Stagecoach Hills community system is 100% residential. The volume of any water loss is not known.

The Stagecoach Hills system does not sell water to any other community water system.

3.10 Pine Grove Mobile Home Park

3.10.1 Pine Grove Mobile Home Park – Population and Connections

The Pine Grove Mobile Home Park water system serves 31 connections, the Sanitary Survey Report estimates that the population served is approximately 63.[75]

3.10.2 Pine Grove Mobile Home Park - Average and Maximum Daily Withdrawals

The Pine Grove Mobile Home Park provides withdrawal information to VDH on an annual basis. The following table shows the average daily withdrawal for 2008.[76]

Table 3-24: Pine Grove Mobile Home Park – Average Daily Withdrawal - 2008

Average Daily Withdrawal (MG)	Maximum Daily Withdrawal (MG)	Month of Maximum Withdrawal
.004	Not Available. Meter readings are not recorded on a daily basis.	

3.10.3 Pine Grove Mobile Home Park – Annual and Monthly Average Withdrawals

The following table summarizes the annual average and monthly average withdrawals for the Pine Grove Mobile Home Park system.

Table 3-25: Pine Grove Mobile Home Park – Average Daily, Monthly and Annual Withdrawal – 2007 - 2008[77]

Year	Avg. Gallons Per Day	Avg. Gallons Per Day (MG)	Avg. Gallons per Month (MG)	Total for Year (MG)
2007	4,201	0.0042	.1260	1.5334
2008	4,331	0.0043	.1299	1.5808
Average	**4,266**	**.0043**	**.1280**	**1.5571**

3.10.4 Pine Grove Mobile Home Park – Peak Day Water Use by Month

The Pine Grove system does not record water withdrawal on a daily basis; As a result, it is not possible to provide peak day usage.

[75] Source: VDH Ground Water System Sanitary Survey Report, 2008. The SSR lists 63 as the population served.
[76] Source: VDH records.
[77] Source: VDH records provided the average gallons per day; the average gallons per month and per year are calculated based on the VDH records.

3.10.5 Pine Grove Mobile Home Park – Estimated Usage of Self-Supplied Non-agricultural Users of Greater than 300,000 Gallons per Month (Within the Service Area)

There are no self-supplied users in the service area of the water system.

3.10.6 Pine Grove Mobile Home Park – Estimated Usage of Self-Supplied Agricultural Users (Within the Service Area)

There is no evidence of any self-supplied agricultural user within the service area of the Pine Grove system.

3.10.7 Pine Grove Mobile Home Park – Estimated Number of Self-Supplied Users of Less than 300,000 gallons per month of Ground Water (Within the Service Area)

There are no self-supplied users within the service area of this system, as per a conversation with VDH.

3.10.8 Pine Grove Mobile Home Park – Estimated Disaggregated Use

The disaggregated uses in the Pine Grove Mobile Home Park system are as follows:[78]

Table 3-26: Pine Grove Mobile Home Park - Disaggregated Uses

Category	Amount (MG per year)	%
Residential	1.5808	100%
Unaccounted for losses	Unknown	Unknown
Total	**1.5808**	**100%**

The Pine Grove Mobile Home Park system does not sell water to any other community water system.

3.11 Summary of Disaggregated Uses for the Community Systems

The following table summarizes the disaggregated uses for the community systems in Fluvanna County.

[78] Source: Billing data, Fork Union S.D.

Table 3-27: Summary of Disaggregated Uses for Community Systems

Water System Name	Total Withdrawal 2008 (MG)	Total Withdrawal 2008 (MGD)	Residential		Commercial, Institutional, Light Industrial		Water Lost in Production Process		Unaccounted for Losses		TOTAL	
			%	MGD	%	MGD	%	MGD	%	MGD	%	MGD
Fluvanna Correctional Center	41.440	0.114	0.0%	-	97.7%	0.111	2.3%	.003	0.0%	-	100.0%	0.114
Lake Monticello	231.297	0.634	87.8%	0.556	5.0%	0.032	2.2%	0.014	5.0%	0.032	100.0%	0.634
Columbia	1.432	0.004	80.0%	0.003	5.0%	0.000	0.0%	-	15.0%	0.001	100.0%	0.004
Fork Union SD	69.290	0.190	30.0%	0.057	55.0%	0.104	5.0%	0.009	10.0%	0.019	100.0%	0.190
Oakland School	4.653	0.013	100.0%	0.013	0.0%	-	0.0%	-	0.0%	-	100.0%	0.013
Palmyra	1.506	0.004	20.0%	0.001	75.0%	0.003	0.0%	-	5.0%	0.000	100.0%	0.004
Woodslodge Cottages	0.354	0.001	100.0%	0.001	0.0%	-	0.0%	-	0.0%	-	100.0%	0.001
Stagecoach Hills	Not Known - Not Metered										0.0%	-
Pine Grove MHP	1.581	0.004	100.0%	0.004	0.0%	-	0.0%	-	0.0%	-	100.0%	0.004
												-
Total	**351.553**	**0.963**	**66%**	**0.635**	**26%**	**0.250**	**3%**	**0.026**	**5%**	**0.051**	**100%**	**0.963**

3.12 In-Stream Beneficial Uses

3.12.1 Lake Monticello System

The Lake Monticello community water system withdraws water from the Rivanna River. As outlined in the Existing Resources section of this report, the Rivanna has a number of in-stream beneficial uses including:

- Fish and wildlife habitat;
- There are numerous point source discharges in the Rivanna Basin (both within Fluvanna and upstream from Fluvanna and the Lake Monticello intake), the river is important for the assimilation of waste from point source discharges;
- The Rivanna is also important to the assimilation of non-point sources of pollution;
- The entire length of the Rivanna within the Fluvanna County is designated as a scenic river;
- The recreational uses of the Rivanna include fishing, boating and swimming;
- The Rivanna is used by some farmers for irrigation; and
- There are historic resources along the Rivanna, including dams and other structures designed by Thomas Jefferson, and there are both archeological and architectural sites in close proximity to the river.

3.12.2 Fluvanna Correctional Center

The Fluvanna Correctional Facility withdraws from the Mechunk Creek which is a tributary of the Rivanna River. The in-stream beneficial uses listed above could be affected by the point of stream withdrawal.

3.12.3 The JRWA System

The JRWA system will withdraw water from the James. As outlined in the Existing Resources section of this report, the James has a number of in-stream beneficial uses including:

- Fish and wildlife habitat;
- There are numerous point source discharges in the James Basin (both within Fluvanna and upstream and downstream from the proposed intake site), the river is important for the assimilation of waste from point source discharges;
- The James is also important to the assimilation of non-point sources of pollution;
- The James River has a number of historic canals and other structures;
- The James, from Wingina to Maidens, has been evaluated by VDCR and has been found to have components that may qualify it for designation as a scenic river;
- There are numerous community water systems, both upriver and downstream of Fluvanna that rely on the James for source water;
- The James is the source of water for several electric generation plants, two of which are in Fluvanna;
- The recreational uses of the James include fishing, boating and swimming;
- The James is used by some farmers for irrigation; and
- There are historic resources along the James including both archeological and architectural sites in close proximity to the river.

3.13 Self-Supplied Non-Agricultural Users of More than 300,000 Gallons per Month of Surface and Ground Water (Outside the Service Areas of the Community Water Systems)

There are two self-supplied non-agricultural users of more than 300,000 gallons of water; they are as follows:

Table 3-28: Self-Supplied Non-Agricultural Users

Name	Source	Type
Bremo Bluff / Dominion Generation	Surface Water / Reservoir /James River	Power - Fossil
East Coast Transport / Pump Station	Surface Water / James River	Power - Fossil

Based on VDEQ water withdrawal records, the water withdrawn by these users is as follows:

Table 3-29: Self-Supplied Non-Agricultural Users[79]

Name	Annual Withdrawal 2005 (MG)	Annual Withdrawal 2006 (MG)	Annual Withdrawal 2007 (MG)	Annual Withdrawal 2008 (MG)
Bremo Bluff	47,635.88	48,890.44	47,267.00	54,147.00
East Coast Transport[80]	522.99	476.27	815.40	616.70
Total	**48,158.87**	**49,366.71**	**48,082.40**	**54,763.70**

3.14 Self-Supplied Agricultural Users of More than 300,000 Gallons per Month of Surface and Ground Water (Outside the Service Areas of the Community Water Systems)

Records from VDEQ do not include any agricultural users in Fluvanna County who utilize more than 300,000 gallons of water per month. The following information concerning livestock and crops was made available by the 2007 Census of Agriculture. The following table shows the estimated annual usage of water for agricultural purposes. Based on the information available, it is not known if any one user exceeds 300,000 gallons per month. Further, it is not known if the water used is from ground water or surface water sources.

Table 3-30: Fluvanna County Livestock Information[81]

Type of Livestock	# in 2007	Gallons of Water Needed per Day per Animal[82]	Estimated Monthly Usage (Gallons)	Estimated Annual Usage (Gallons)
Cattle and Calves	6,730	12	201,900	2,422,800
Horses and Ponies	732	12	21,960	263,520
Poultry – Layers	636	0.06	19,080	228,960
Sheep and Lambs	258	2	7,740	92,880
			Total Estimated Usage	**3,008,160**
			Total Estimated Usage (MG)	**3.01**

[79] See **Appendix 6** for more details.
[80] As noted earlier, the East Cost Transport withdrawal is on the Buckingham County side of the James River, but the water withdrawn is used in Fluvanna. As per VDEQ's recommendation, the ECTI usage is not included in the Fluvanna usage in subsequent sections of this report.
[81] 2007 Census of Agriculture.
[82] Source: USGS Livestock Water Use.

Table 3-31: Fluvanna County Crop Information[83]

Type of Crop	Acres in 2007	Acres Irrigated (Estimated)	Approximate Irrigation (inches/acre/year)	Estimated Total Annual Irrigation (Gallons)
Forage-Land Used for All Hay and Haylage, Grass Silage, and Greenchop	11,026	1,102[84]	10 – 15	374,250,005
Corn for Grain	935	0	0	0
Wheat for Grain	869	0	0	0
Soybeans	762	0	0	0
Nursery Stock	Not Available	100%	Not Available	Not Available
			Total Estimated Usage	**374,250,005**
			Total Estimated Usage (MG)	**374.25**

3.15 Estimate of Number of Self-Supplied Users and Annual Usage (Outside of the Service Areas of the Community Systems)

3.15.1 Bremo Bluff

The Bremo Bluff Power Plant Facility reports to VDEQ the withdrawal of ground water as shown below.

Table 3-32: Bremo Bluff – Ground Water Usage

Year	Annual Withdrawal (MG)	Average per Month (MG)	Average Daily Withdrawal (MG)
2002	1.26	0.11	.0035
2003	0.70	0.06	.0019
2004	0.72	0.06	.0020
2005	1.16	0.10	.0032
2006	1.03	0.09	.0028
2007	1.08	0.09	.0030
2008	0.77	0.06	.0021

3.15.2 Lake Monticello Golf Course / Owners Association

The Lake Monticello Owners Association reports the withdrawal of surface water from a pond. The reported usage is shown in the table below.

[83] 2007 Census of Agriculture.
[84] Assume 10% of all crops used for silage are irrigated and the crop is irrigated only 5 months (April – September). Source: Handbook for Extension Agents; NC State University, 1982.

Table 3-33: Lake Monticello – Ground Water Usage[85]

Name	Annual Withdrawal 2005 (MG)	Annual Withdrawal 2006 (MG)	Annual Withdrawal 2007 / 2008 (MG)	Average Annual Withdrawal (MG)
Lake Monticello Golf Course	13.0	25.00	No data reported	19.0 (average for two years)

3.15.3 Laurel Ridge / Rivanna Resort Golf Course

The Rivanna Ridge Golf Resort (formerly known Laurel Ridge) as does not report withdrawals to VDEQ.

3.15.4 Non-transient Non-community Systems

There are ten NTNC systems; most provide monthly water withdrawal reports to VDH. The information is summarized below. Additional data compiled from the VDH Sanitary Survey Reports is found in Appendix 8.

Table 3-34: Self-Supplied Non-Agricultural Users[86]

Name	Average Daily Withdrawal 2008 (MG)	Estimated Annual Withdrawal (MG)[87]
Camp Friendship	0.016	5.942
Columbia School District	0.001	0.200
Cunningham District School	0.001	0.242
Fluvanna County Courthouse	0.001	0.500
Fluvanna County High School	0.007	2.597
Fluvanna County School Board	0.001	0.423
MacSteel Service Centers USA	0.000	0.069
Open Door Christian School	0.001	0.229
Palmyra Elementary	0.000	0.119
Tenaska Virginia Generating Station	0.000	0.137
Total	**0.028**	**10.458**

3.15.5 Transient Non-community Systems

There are three TNC systems; none of the three systems meter the water withdrawal. The three systems are as follows:

[85] VDEQ records do not include any usage for 2002 – 2005 and do not include usage for 2008.
[86] Source: VDH Ground Water System Sanitary Survey Reports, 2008 and VDH Records. See **Appendix 8.**
[87] Calculated based on Average Daily Withdrawals.

- Fork Union Shopping Center
- Laurel Ridge Golf Club (now called Rivanna Resort)
- Inn 1831 & Restaurant

There is limited information concerning these systems. See Appendix 7.

3.15.6 Other Self-Supplied Non-residential Uses

Analysis of the county's 911 GIS data indicates there are approximately 200 parcels with structures that are zoned commercial/business or industrial. Approximately 130 of these businesses are served by one of the community water systems. Therefore, it is estimated that there are approximately 70 self-supplied businesses in Fluvanna.

3.15.7 Self-Supplied Residential Users

The 2000 Census reported 7,387 households in Fluvanna County; the population was 20,047; the average household size was 2.59 persons. The estimated number of households in Fluvanna in 2008, based on the population of 26,068, is 9,602.[88] [89]

The following table outlines the estimated number of persons and homes provided water by community systems and those that are self-supplied.

[88] 2008 Population Estimates by Age and Sex (July 1, 2008); Demographics and Workforce Section, Weldon Cooper Center for Public Service, University of Virginia, Released July 2009.
[89] Assumes 1,200 are institutionalized.

Table 3-35: Residences Served by Community Water Systems

System	Connections	Estimated Residential Connections[90]	Estimated Population Served by Community Systems[91]
Columbia, Town of	47	40	104
Fork Union S.D.	433	394	1,020
Lake Monticello	4,238	4,175	10,813
Palmyra	38	10	26
Pine Grove Mobile Home Park	31	31	62
Stagecoach Hills	27	27	70
Woodslodge Cottages	15	15	30
Total	**4,829**	**4,692**	**12,125**
Estimated 2008 County Population			26,068
Estimated Institutionalized Population			1,200
Estimated Population Served by Community Systems			12,125
Estimated Population that is Self-Supplied			12,743
Estimated Number of Self-Supplied Homes			4,920

The following table shows the estimated annual usage of water by self-supplied individuals.

Table 3-36: Estimated Withdrawal for Self-Supplied Residences

Self-Supplied Population	Gallons per Person per Day	Estimated Annual Withdrawal for Self-Supplied Individuals (MG)
12,743	101[92]	469.77

3.16 Summary of All Uses in Fluvanna County

The following table summarizes the estimated water withdrawal for the residential and non-residential uses in Fluvanna County.

[90] The number of connections is estimated based on VDH records and Engineering Description Sheets; estimates made by the system owners; and GIS data was reviewed to estimate the number of homes and non-residential users served.
[91] Calculated using 2.59 persons per household, except for Pine Grove and Woodslodge, where estimate is 2 persons per household.
[92] Average indoor and outdoor water use is 101 gallons per capita per day in the United States with 69.3 gpcpd for indoor use and 31.7 gpcpd for outdoor use. Source: Handbook of Water Use and Conservation, Amy Vickers, Water Plow Press, 2001, page 12.

Table 3-37: Summary of All Withdrawals

	Population	Annual Withdrawal (MG)
Community Systems		
Columbia, Town of	104	1.43
Fork Union S.D.	1,020	69.29
Lake Monticello	10,813	231.30
Palmyra	26	1.51
Pine Grove Mobile Home Park	62	1.58
Stagecoach Hills (estimated)	70	2.58
Woodslodge Cottages	30	0.354
Oakland School	0	5.08
Fluvanna Correctional Center	1,200	41.44
Subtotal	**13,325**	**354.56**
Self-Supplied Residential	12,743	469.77
NTNC Systems		10.46
TNC Systems (estimated .5 MG per business per year)		1.50
Self-Supplied Businesses (70 estimated, 250,000 gallons per year)		17.50
Agricultural – Livestock		3.01
Agricultural – Crops		374.25
Dominion (Ground Water)		0.77
Dominion Generation (Surface Water)		54,147.00
Lake Monticello Golf		19.00
Laurel Ridge Golf / Rivanna Resort (estimated)		19.00
Total	**26,068**	**55,416.82 MG**
		151.82 MGD

4.0 EXISTING RESOURCE INFORMATION

When planning future water supply options, the existing historic and environmental resources must be taken into consideration. As required by the Regulation[93], the following sections detail the existing geologic, hydrologic, historic, and environmental conditions in Fluvanna County.

4.1 Geologic, Hydrologic and Meteorological Conditions[94]

4.1.1 Geologic Conditions

Fluvanna County is wholly located within the Piedmont Physiographic Province of Virginia, or more specifically the Outer Piedmont which is characterized by rolling to hilly topography. The Piedmont lies between the Blue Ridge Province to the west and the Coastal Plain Province to the east and is underlain by igneous and metamorphic bedrock that ranges from PreCambrian (>570 million years) to Triassic (181-230 million years) in geologic age. A geological map of Fluvanna County follows.

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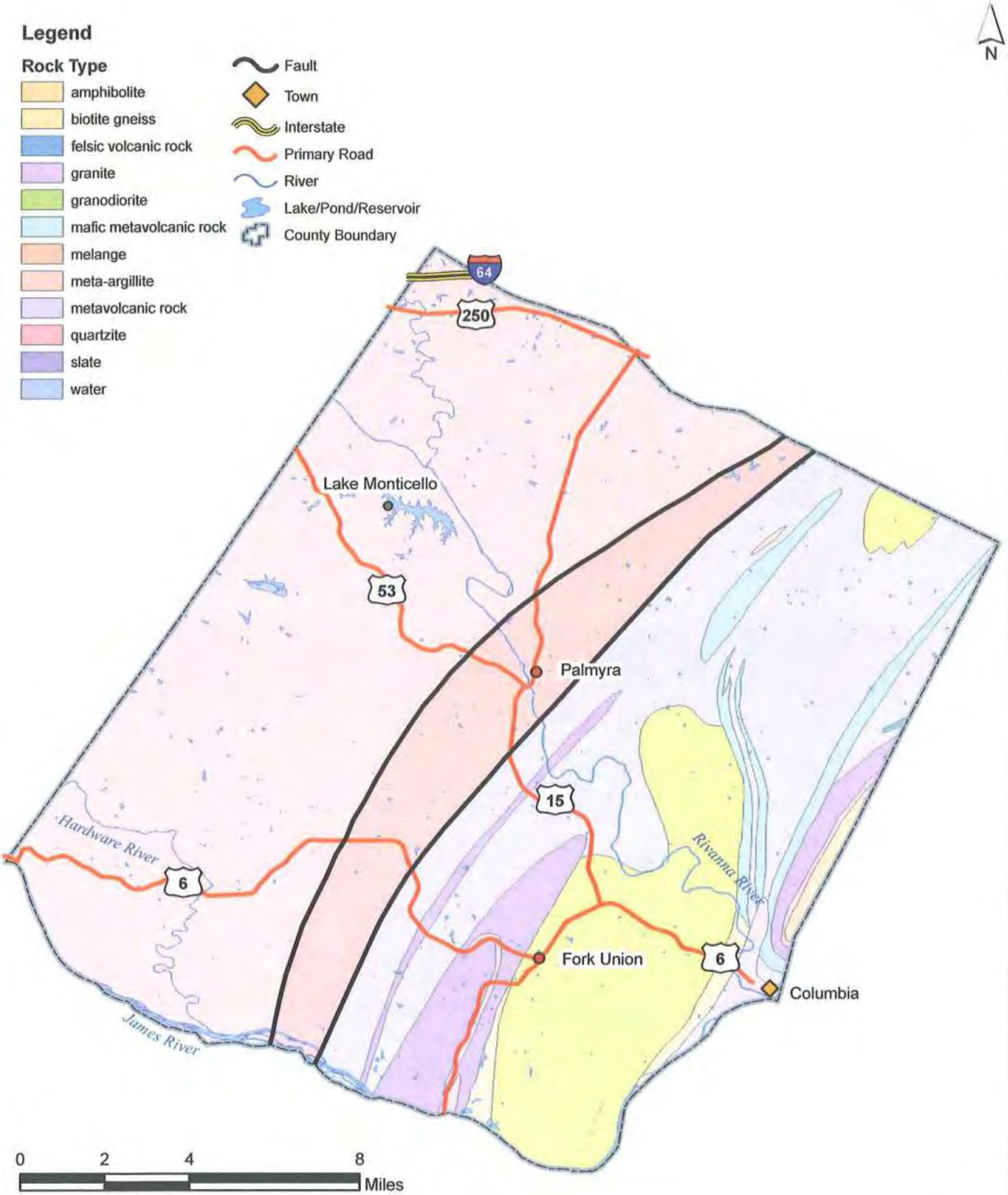
[93] 9 VAC25-780-90.
[94] 9 VAC 25-780-90 A.



Source: Fluvanna County 2009; USGS; VDMME

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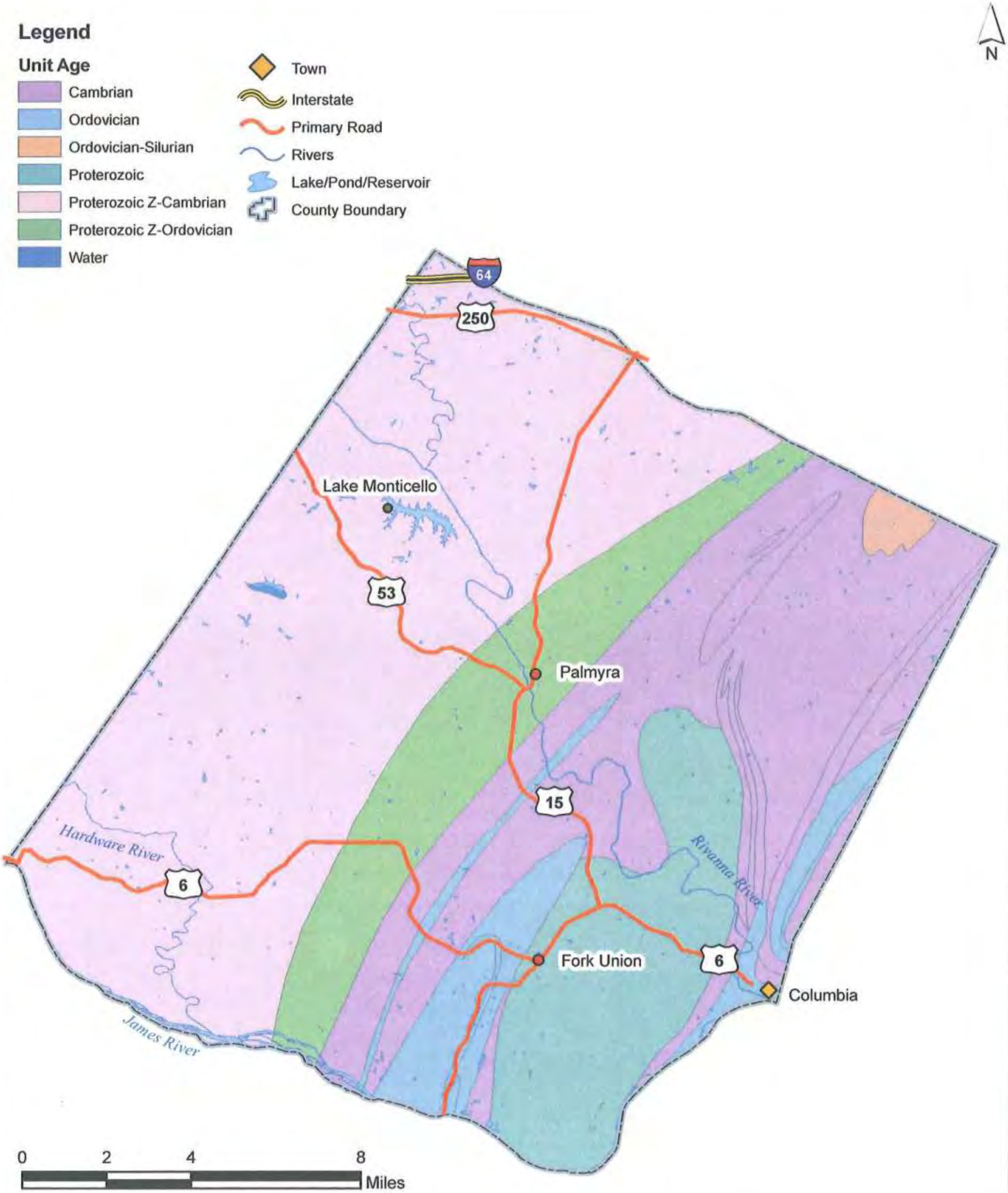
GEOLOGIC CONDITIONS

Fluvanna County, Virginia

FIGURE 4-1



Source: Fluvanna County 2009; USGS; VDMME

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GEOLOGIC CONDITIONS BY UNIT AGE

Fluvanna County, Virginia

FIGURE 4-2

The Piedmont is characterized by deeply weathered bedrock and a relative paucity of solid rock outcrop, which most often occur in and along streams. Most of the Piedmont rocks have weathered to saprolitic soil up to one hundred foot or more in thickness in some areas. A thin veneer of colluvium or alluvium is present in some areas, and alluvium fills the larger stream valleys.[95].

The surface features of the county are those typical of a moderately high plateau dissected by numerous streams. Areas between the streams are moderately wide, and the relief is gently rolling to rolling. Land surface is of three general types:

- Gently rolling to rolling, moderately wide, weakly dissected divides of upland;
- Narrow to moderately wide flood plains along the larger streams; and
- Hilly to steep areas along the major streams where the streams have cut deeply into the upland plateau.

Entrenchment has been rapid along the James River and its major tributaries, and steep slopes commonly rise abruptly from the floodplain.

The highest elevation is around 550 feet above sea level and the lowest elevation is 200 – 275 feet above sea level.[96] Floodplains along the James and Rivanna rivers range from 200 to 275 feet above sea level.[97]

Thirty-three different soil series have been identified in Fluvanna County. Nineteen soil series are formed from weathered products of the underlying rocks, four series are considered to be colluvial, six series make up the elevated terraces near tributaries and/or are remnants of old floodplains, and the remaining four soil series make up the bottomlands along the banks of river and creek beds.[98]

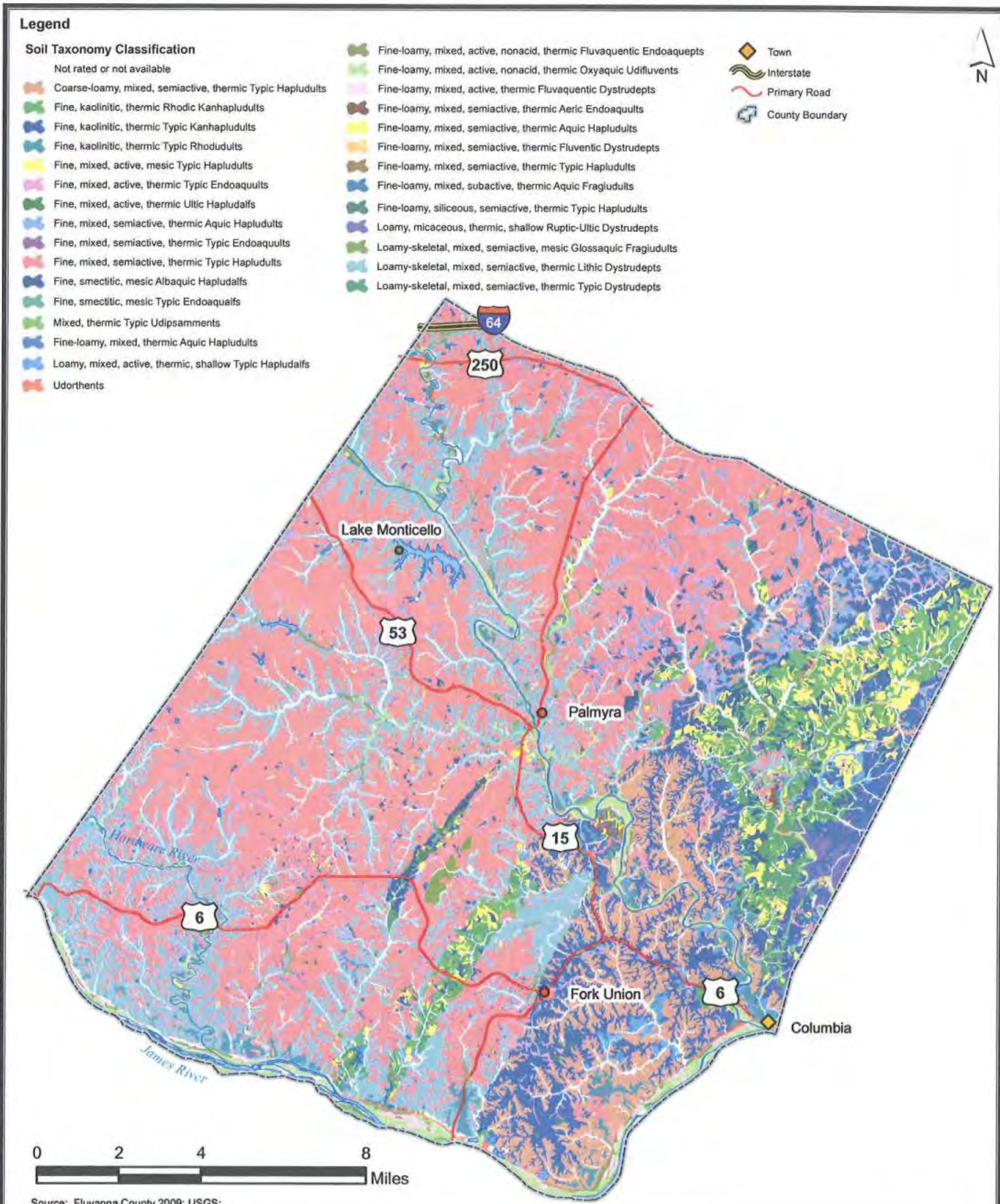
The soils of Fluvanna County are predominantly silt loam and contain high clay content. The majority comprise Tatum silt loam, Nason silt loam, and Manteo silt

[95] Smith, J. W., Milici, R.C., and Greenberg S.S. 1964, Geology and Mineral Resources of Fluvanna County: Virginia Division of Mineral Resources Bulletin 79, pp 4-5.
[96] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us
[97] 1958. Soil Survey Fluvanna County Virginia, No. 5. pg 6.
[98] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

loam. Manteo soils are shallow and somewhat excessively drained, typically occurring in gently sloping to very steep uplands. They form in material weathered from very strongly acid sericite schist and are typically found in woodlands. Tatum soils are well drained and have a parent material with residuum from sericite schist, phyllite, or other fine-grained metamorphic rocks. They are also typically found in woodlands. Nason soils are deep and well drained. They occur on uplands formed in material weathered from schist and other fine grained metamorphic rocks. About seventy-five percent of this soil occurs in woodland of oaks, hickory, Virginia pine, and shortleaf pine.[99]

The following figure depicts the soils present within Fluvanna County:

[99] http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.



Source: Fluvanna County 2009; USGS;

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SOILS
TAXONOMY CLASSIFICATION
Fluvanna County, Virginia

FIGURE
4-3

4.1.2 Hydrology

4.1.2.1. Ground Water Hydrology

Throughout the Piedmont Physiographic Province of Virginia, ground water occurs within two basic horizons, in the soils or "overburden materials" overlaying the bedrock and also within fractures present within bedrock. These two water bearing horizons are typically called the Water Table Aquifer and the Bedrock Aquifer. In many instances the Water Table Aquifer and the shallow fractures in the Bedrock Aquifer are hydraulically interconnected, and behave as a single aquifer. With increasing fracture depths in the Bedrock Aquifer, the likelihood of hydraulic interconnection with the Water Table Aquifer decreases.

Ground water flow in the Water Table Aquifer usually conforms to the slope of the ground surface, but in a subdued manner. Ground water gradients are typically much less than those of the ground surface. Flow in bedrock is controlled by the frequency and orientation of the bedrock fractures, which provide permeability to the bedrock. Since ground water is essentially confined to the fractures, it is possible to drill dry wells as the result of not penetrating any water bearing fractures.

Recharge of the Water Table Aquifer is by infiltration of precipitation and runoff through the overlying soils. The underlying Bedrock Aquifer is recharged slowly by the vertical migration of infiltrating waters through the overburden and into the bedrock fractures. More rapid recharge occurs where fractured bedrock is exposed in stream beds, drainage ways, or surface water bodies such as ponds and lakes.

4.1.2.2. Hydrogeology

The hydrologic setting is a function of the underlying geology and the County's ground water system is dependent on bedrock fractures for ground water production, yield and recharge. Since the hydrogeologic setting of an area is a function of the underlying features, it is necessary to understand the underlying geology of Fluvanna County. Fluvanna County is underlain predominantly by deformed and metamorphosed formations. A thick mantle of soil and weathered rock comprised of saprolite, regolith, or residuum, a characteristic feature of the province, overlies the fractured crystalline bedrock.[100]

The bedrock underlying Fluvanna County is crystalline rock that contains virtually no pore space between individual mineral grains. There are eighteen different bedrock mapping units that can be grouped into six rock families.[101]

Table 4-1: Bed Rock Mapping Units – Rock Families

Rock Family	Average Depth to Bedrock (feet)
Granitic gneiss	54.6
Mafic igneous rocks	53.0
Metamorphosed volcanic rocks	51.1
Phyllite and metagraywacke	48.1
Quartz-mica schist and gneiss	58.4
Slate and quartzite	53.3

Upland areas within the county have at least fifty feet of saprolite with variable depths at other locations depending on the type of rock present. Most ground water storage and flows occur within the saprolite layer and along fractures and joints in the bedrock. The type of saprolite present is important to distinguish since it affects ground water recharge potential as well as the ability of the material to cleanse drainfield effluents.[102]

Throughout Fluvanna County, many of the boundaries between individual rock formations are faults or abrupt discontinuities between blocks of bedrock. In addition, there are three major folds where the rocks have been compressed by regional tectonic forces in the county. Folds and faults are indicative of ground water productivity. Favorable quantities of ground water occur primarily within the fractures in the rock. As a result of the underlying geology and variable

[100] Nelms, D. L., Harlow, G.E Jr., Plummer, L.N, and Busenberg, E. 2003. Aquifer Susceptibility in Virginia, 1998-2000. Water-Resources Investigations Report 03-4278: USGS and Virginia Dept. of Health. pp. 8-9.

[101] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

[102] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

bedrock fracturing, the quantity and depth of water bearing zones are difficult to predict.

According to the 2009 Comprehensive Plan for Fluvanna County, ground water resources have been decreasing since 2004 due to a lack of significant precipitation. Ground water recharge typically occurs between October and March, but during the past ten years precipitation totals have been approximately twenty percent below normal. It is also important to note that young water is present throughout most of the Piedmont regional aquifer system, therefore water in this system is considered to be susceptible to contamination from near-surface sources.[103]

Based on analysis of 1,342 records [104]from wells drilled in Fluvanna County prior to 1999 the following generalizations can be made:

- Average yields for domestic wells drilled in the six Fluvanna rock families are a general indication of relative ground water potential in different parts of the county.
- The largest percentage of high-yield wells are within slate, quartzite, granitic gneiss, and metavolcanic rocks.
- Twenty-two of the wells report initial yields of 50 gallons per minute or greater indicating that substantial ground water resources occur throughout the county.
- Well depths range from 65 to 1,101 feet with high yield zones producing at depths ranging from 105 to 505 feet below ground surface.[105]

[103] Nelms, D. L., Harlow, G.E Jr., Plummer, L.N, and Busenberg, E. 2003. Aquifer Susceptibility in Virginia, 1998-2000. Water-Resources Investigations Report 03-4278: USGS and Virginia Dept. of Health. pg 16.
[104] These well records include 1,326 domestic wells and 16 community water supply wells.
[105] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

4.1.2.3. Surface Hydrology

Three main rivers flow through Fluvanna County. The James River flows eastward and forms the southern boundary of the county, the Rivanna River also flows eastward through the central portion of the county, and the Hardware River flows southeastward across the southwest corner of the county. The Mechum, Ballinger, Cunningham, and Raccoon Creek tributaries flow into the Rivanna River. The James River tributaries include Bremo, Rockfish, North, and Byrd creeks.

During the late eighteenth century the Rivanna and James Rivers were made navigable through the creation of long stretches of canals and locks that serviced farmsteads and industrial facilities. The James, Rivanna, and Hardware rivers were critical to the history and success of the county and today development and preservation techniques are being implemented to protect and enhance these natural resources.

Dam restoration projects allow migratory fish to spawn and inhabit upstream reaches that were once blocked. Conservation of riparian buffers along stream corridors has prevented sediments and other pollutants from entering waterways and provides contiguous habitat use by the fauna that inhabit them. Groups such as StreamWatch and the Rivanna River Basin Commission provide volunteers for monitoring water quality as well as guidance for the stewardship and enhancement of the county's water and natural resources.

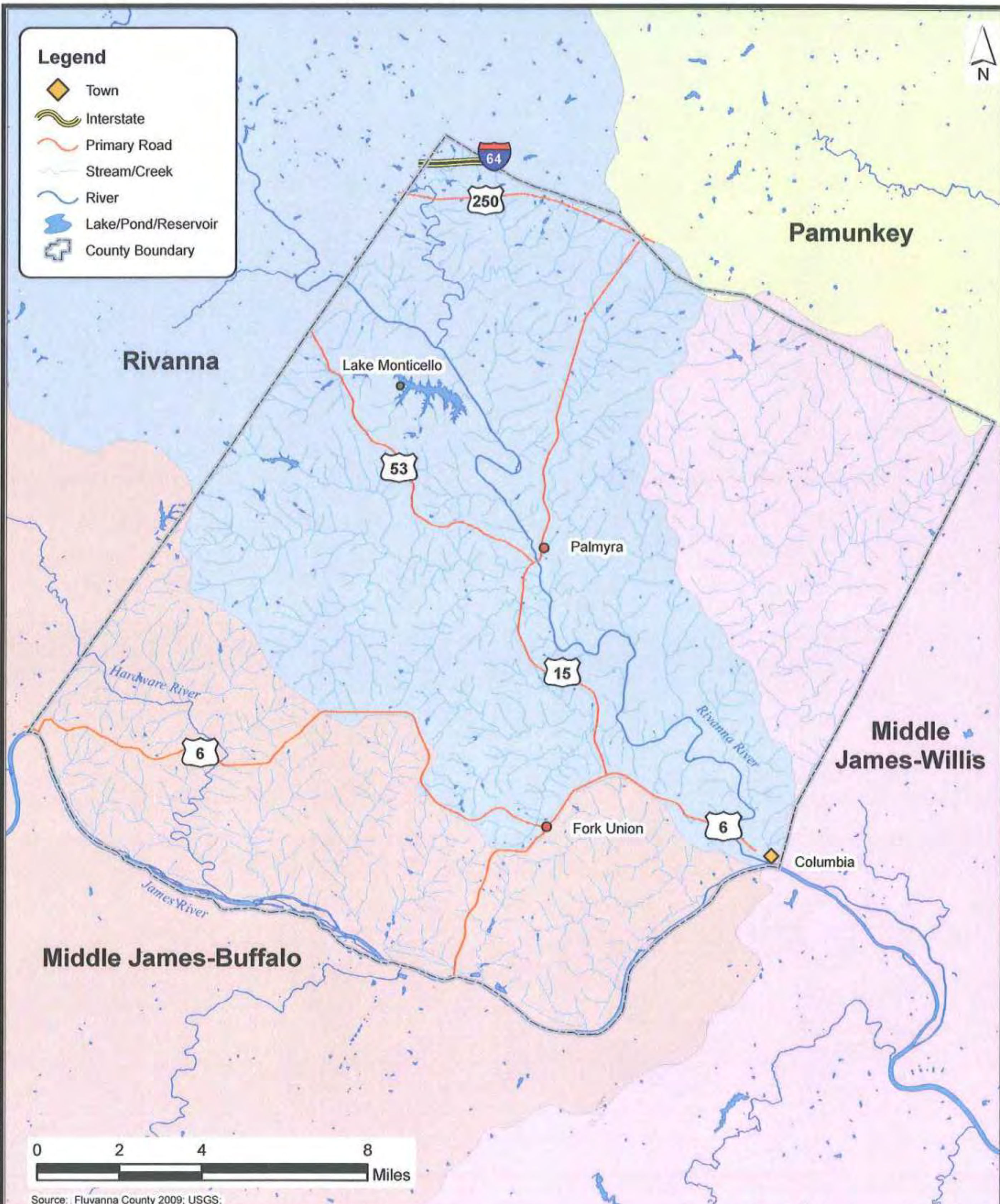
There are two USGS stream gages in Fluvanna County. The following table depicts the location and general statistics of the gages. [106]

[106] http://wdr.water.usgs.gov/nwisgmap/

Table 4-2: USGS Stream Gages

Agency	Site Number	Location	Period of Record	Minimum mean flow on Record (cfs)	Peak Stream Flow on Record (cfs)	Mean Annual Discharge (cfs)
USGS	02030000	Hardware River below Briery Run Near Scottsville, VA	Oct. 1938 – Sept. 2009	50	52,000	128
USGS	02034000	Rivanna River at Palmyra, VA	Oct. 1934 – Sept. 2009	245	86,000	720

Except for some upland flats, some smaller, narrower flood plains, and some areas on the larger flood plains near the uplands, the surface drainage in the county is generally good. The drainage pattern is generally dendritic and irregularly branched. Rectangular drainage patterns occur locally when influenced by prominent fractures or faults in the underlying bedrock. The following figure depicts the surface hydrology of Fluvanna County.



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MAJOR WATERSHEDS

Fluvanna County, Virginia

FIGURE 4-4

4.1.2.4. *Ground Water Recharge Potential*

The recharge potential, also known as the available ground water supply, can be estimated based on several known variables. These variables are the county's total surface area, average rainfall infiltration (approximately 6 inches of the annual precipitation recharges into the ground water system), and percentage of undeveloped area. The Comprehensive Plan states that in 2007 there were 121,366 acres or about 66.1 % of the County in land assessment status; 25.6% farmland, 74.2% forested and 0.4% open space.

The equation for recharge potential does not take into account the geology or hydrogeologic characteristics of the area. This is a theoretical method of calculating the amount that is potentially available for extraction.

The equation and parameters are shown in the following table. Assuming that 25% of the total recharge potential can be extracted through wells, approximately 13.5 mgd of ground water is potentially available for use. However, the cost and feasibility of withdrawing this water will require further study if it is to be used as a significant source to meet future demands in concentrated areas of development.

Table 4-3: Fluvanna County Ground Water Recharge Potential

Equation:
Recharge Potential = Total Surface Area X 43,560 ft^2 per acre X Estimated Recharge X Estimated Percentage of Undeveloped Area X 7.48 gallons per cubic foot
Known Variables:
Total County Surface Area = 183,680 acres or 287 square miles
Estimated Ground Water Recharge Area = 121,366 acres
Estimated Annual Precipitation = 40.66 inches[107]
Estimated Variables:
0.5 feet = Estimated Recharge from Annual Precipitation
66.1 % = Estimated Percentage of Undeveloped Area (Agriculture, Forested, Open)
Recharge Potential =183,680 X 43,560 X 0.5 X .661 X 7.48 = 19,779,841,320 gallons per year
Assume 25% can be developed through the use of wells, then:
Recharge Potential = 4,944,960,330 gallons per year, or,
Recharge Potential = 13,547,837 gallons per day

[107] Southeast Regional Climate Center Website.

4.1.3 Watersheds

Fluvanna County crosses four watersheds: the Pamunkey (02080106), Middle James – Buffalo (02080203), Rivanna (02080204), and the Middle James – Willis (02080205), all of which are part of the James River and Chesapeake Bay watersheds.[108] The water resources in Fluvanna County include rivers, creeks, impoundments, and ground water supplies. The majority of the county, 99.8%, drains to the James River or one of its tributaries.[109]

Slightly more than half (51.2%) of the county is in the 766 square mile Rivanna River watershed. The Lower Rivanna River/Buck Island Creek watershed is the largest watershed in the Rivanna basin covering approximately 32% of the county. The Rivanna River Basin is home to over 100,000 people as it enters the county in the northwest and passes through Palmyra in the center of the county before winding its ways to Columbia in the southeast corner.[110]

The James River, Virginia's largest river, forms the southern boundary of Fluvanna County. At 340 miles long, it is one of the longest rivers in the United States that begins and ends in the same state. It encompasses twenty-five percent of the state, therefore touching the lives of more Virginians than any other feature on the landscape.

Thirty percent (30%) of the county drains directly into the Hardware River, the James River, or the minor tributaries of the James.[111] The remaining nineteen percent (19%) of Fluvanna County drains to Byrd Creek, which joins the James River in Goochland County and covers most of the northeast corner of Fluvanna (See Figure 4-4).

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[108] http://cfpub.epa.gov/surf/county.cfm?fips_code=51065.

[109] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

[110] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

[111] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

4.1.4 *Water Supply*

4.1.4.1. *Ground Water*

The bedrock beneath Fluvanna County is complex and contains relatively few open spaces or extensive fracture networks to conduct ground water. The wide variety of mineralogy and rock chemistry also results in variations in ground water chemistry that lead to elevated iron and manganese concentrations in some areas.

The Thomas Jefferson Planning District Commission (TJPDC) and the Virginia Division of Mineral Resources (VDMR) completed a study of present conditions and recommendations for preservation and restoration of water resources in Fluvanna County in January 1999. Their research produced several conclusions:

The western portion of Fluvanna County was found to be less favorable to ground water productivity with the areas of Bremo Bluff, Fork Union, Columbia, and northeast of Palmyra having a high potential yield for ground water at depths of one-thousand feet or more.

The presence and abundance of saprolite throughout the county was found to be optimal for ground water storage and sanitary drain field siting, although individual areas will still need to be looked at discretely.

It was also determined that mature forest land cover is the best protection for ground water recharge areas.[112]

A Fluvanna County hydrogeologic database was developed as part of the 1999 TJPDC and VDMR study. The database currently contains hydrologic data from 1,326 domestic and 16 public water supply wells. The average yields from the domestic wells are presented below and provide a general indication of relative

[112] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

ground water potential in different parts of the county depending on the type of geology present.[113]

Table 4-4: Average Yields – Domestic Wells

Rock Family	Average Yield, Domestic Drilled Wells (gpm)
Granitic gneiss	14.1
Mafic igneous rocks	10.0
Metamorphosed volcanic rocks	12.3
Phyllite and metagraywacke	8.0
Quartz-mica schist and gneiss	12.0
Slate and quartzite	17.0

Twenty-two of the wells report initial yields of fifty gallons per minute or greater and occur in slate and quartzite, granitic gneiss, and metavolcanic rocks indicating that substantial ground water resources are present throughout the county.

Three of the high yield wells are operated by the Fork Union Sanitary District. These wells have larger diameters, which are known to enhance productivity, than most domestic wells although there has been a reported decline in productivity in recent years likely due to pumping in excess of recharge rates.

According to the Fork Union Area Water and Sewer Improvements, Preliminary Engineering Report prepared by Dewberry and Davis in 1993, two public wells in the Fork Union Sanitary District have historic problems with iron and manganese levels. The Water and Wastewater Preliminary Engineering Report and Facilities Master Plan prepared by Timmons in 1998 revealed that two wells were removed from service due to contamination, although one was rehabilitated.[114]

4.1.5 Water Quality – Self Supplied Users

Virginia Tech conducted a study in 1997, *Evaluation of Household Water Quality in Fluvanna County, Virginia,* in which fifty self-supplied households were given a

[113] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.
[114] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

water sampling kit. Thirty eight raw water samples and fifty tap water samples were tested. It was discovered that sixty-eight percent of the households had very low pH values and ninety percent had a low saturation index likely due to corroded pipes. Coliforms were also present in about half of the households with twenty percent representing the E. coli strain. No households exceeded the standards for sulfate, chloride, fluoride, high pH, high saturation index, or copper. Fewer than ten percent exceeded the standards for hardness, total dissolved solids, sodium, and nitrate, and less than twenty percent exceeded the standards for iron and manganese.[115]

The 2009 Fluvanna County Comprehensive Plan emphasizes the importance of managing and protecting water and ground water resources, so that they are preserved for future use.

4.1.6 Impoundments

There are no community water systems in Fluvanna that use impoundments or reservoirs for the water source.

4.1.7 Meteorological Conditions

Fluvanna County contains approximately 287 square miles of rolling Piedmont land. The highest elevation is around 550 feet above sea level and the lowest elevation is around 200-275 feet above sea level[116]. Average annual temperatures vary slightly from one year to another but average between a minimum of 44°F to a maximum of 68°F. Temperatures above 95° are infrequent, and temperatures above 100° or below 0° are rare[117].

Monthly average precipitation ranges from 4.2 inches in July to approximately 3.0 inches November through February. The average annual snow fall is approximately 17.9 inches with an average of 5.0 - 6.0 inches occurring during January and February. The average annual precipitation in Fluvanna County is approximately

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[115] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.
[116] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[117] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

40.66 inches.[118] The growing season is 166 days, beginning around April 27 and ending around October 10.[119]

For the past five years, ground water resources have declined. This is primarily because winter precipitation has been approximately twelve percent lower than normal. Primary ground water recharge occurs between the months of October and March so adequate precipitation during these months is crucial to maintaining adequate water for future usage.[120]

4.2 Existing Environmental Conditions that Pertain to or May Affect In-Stream Flow, In-Stream Uses, and Sources that Provide the Current Supply[121]

4.2.1 State or Federal Listed Threatened or Endangered Species or Habitats of Concern

The Virginia Department of Game and Inland Fisheries (VDGIF) and the Department of Conservation and Recreation (DCR) list nine threatened or endangered species as "known or likely to occur" within Fluvanna County:[122]

Table 4-5: Threatened and Endangered Species[123]

Status	Common Name	Scientific Name
Federal Endangered and State Endangered	James spinymussel	*Pleurobema collina*
State Endangered	Bewick's wren	*Thryomanes bewickii*
State Endangered	brook floater	*Alasmidonta varicosa*
State Threatened	upland sandpiper	*Bartramia longicauda*
State Threatened	loggerhead shrike	*Lanius ludovicianus*
State Threatened	migrant loggerhead shrike	*Lanius ludovicianus migrans*
State Threatened	green floater	*Lasmigona subviridis*
State Threatened and Federal Species of Concern	bald eagle	*Haliaeetus leucocephalus*
State Threatened and Federal Species of Concern	Atlantic pigtoe	*Fusconaia masoni*

In 2005, the VDGIF created a comprehensive wildlife conservation strategy that included wildlife species in Virginia and prioritized each major taxonomic group (Bird, Fish, Herpetofauna, Mammal, Mussel, and Invertebrate) into four tiers based on their conservation concern. The tiers are defined as follows:

---

118 http://www.sercc.com/cgi-bin/sercc/cliRECtM.pl?va6491.
119 http://www.sercc.com/cgi-bin/sercc/cliRECtM.pl?va6491.
120 Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
121 9 VAC25-780-90 B.
122 http://vafwis.org/fwis/
123 See **Appendix 10** for VDGIF listing of Known or Likely Species (by order of concern) for Conservation.

Tier I. Critical conservation need. Faces and extremely high risk of extinction or extirpation. Populations of these species are at critically low levels, face immediate threat(s), or occur within an extremely limited range. Intense and immediate management action is needed.

Tier II. Very high conservation need. Has a high risk of extinction or extirpation. Populations of these species are at very low levels, face real threat(s), or occur within a very limited distribution. Immediate management is needed for stabilization and recovery.

Tier III. High conservation need. Extinction or extirpation is possible. Populations of these species are in decline, have declined to low levels, or are restricted in range. Management action is needed to stabilize or increase populations.

Tier IV. Moderate conservation need. The species may be rare in parts of its range, particularly on the periphery. Populations of these species have demonstrated a declining trend or a declining trend is suspected which, if continued, is likely to qualify this species for a higher tier in the foreseeable future. Long-term planning is necessary to stabilize or increase populations.

The upland sandpiper, Bewick's wren, loggerhead shrike, and James spinymussel, are listed as Tier I species and the bald eagle, brook floater, green floater, and the Atlantic pigtoe are listed as Tier Il species under Virginia's comprehensive wildlife conservation strategy.

The DCR Natural Heritage Program lists three species as State threatened:

- the Atlantic pigtoe (*Fusconaia masoni*),
- green floater (*Lasmigona subviridis*), and the
- Virginia Piedmont water boatman (*Sigara depressa*).

The DCR Natural Heritage Program lists one species as Federally and State Endangered:

- the James spinymussel (Pleurobema *collina*).

The DCR Natural Heritage Program lists the following as Federal and State species of concern:

- The yellow lance mussel (*Elliptio lanceolata*) and the
- Virginia pigtoe (*Lexingtonia subplana*).[124]

Fluvanna County is advised to consult with the DCR and VDGIF to ensure compliance with protected species legislation. To minimize adverse impacts to the aquatic ecosystem as a result of any proposed activities, it is also recommended that implementation and strict adherence to erosion and sediment control measures be observed during all land disturbing activities.

4.2.2 Anadromous, Trout and other Significant Fisheries

The Virginia Fish and Wildlife Information Service database maintained by the VDGIF does not indicate the presence of trout within Fluvanna County. However, the database revealed the presence of several reaches as potential anadromous fish reaches including sections of the Rivanna River, North Fork of the Rivanna River, James River, and the Hardware River.[125]

The database also designates seven reaches located within Fluvanna County as threatened and endangered waters. These include sections of the Hardware River, James River, and Rivanna River. In addition, the database revealed eighteen impediments to fish passage located within the county, mostly relating to dams, which would impede the migration of aquatic species upstream. No other significant fisheries were reported in the VDGIF database.[126]

4.2.3 River Segments that have Recreational Significance including Scenic River Status

The Virginia Scenic Rivers program began in 1970 with passage by the General Assembly of the Virginia State Scenic River Act.[127] Since 1970, 24 river segments totaling approximately 529 miles have been designated state scenic rivers.[128] The intent of the Virginia Scenic Rivers program is to identify, designate and help protect

[124] http://webdat.dcr.virginia.gov/cfprog/dnh/naturalheritage/select_counties.cfm.
[125] http://vafwis.org/fwis/.
[126] http://vafwis.org/fwis/.
[127] *Code of Virginia:* Title 10.1, Chapter 4 Sections 10.1-400 through 10.1-418.
[128] http://www.dcr.virginia.gov/recreational-planningdocuments/srlist.pdf.

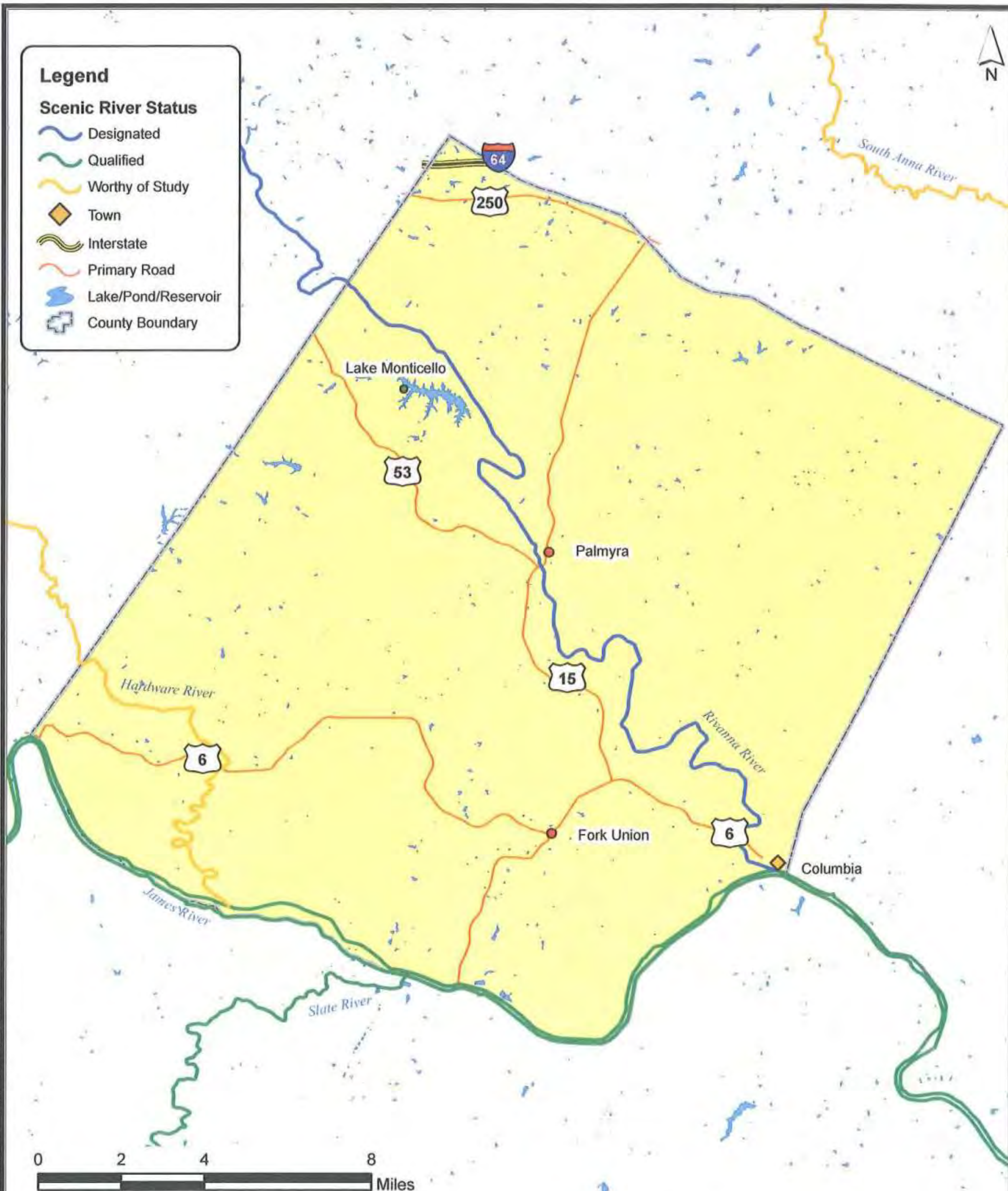
rivers and streams that possess outstanding scenic, recreational, historic and natural characteristics of statewide significance for future generations.

According to the VDCR, the Rivanna River from Woolen Mills to the confluence with the James River is a designated scenic river. The James River from Wingina to Maidens has been evaluated and found to have desirable components worthy of qualifications for designation. The Hardware River from Route 708 to the confluence with the James River has potential components that are worthy of future study.

In addition, the National Park Service lists several reaches within Fluvanna County as having outstanding remarkable values. These include the James River from above Bosher Dam near Richmond to Bremo Bluff. This reach has historical and recreational significance which includes the Bremo Bluff Plantation and the Hardware Aqueduct. Numerous state fishery programs are also located within this corridor since the James is noted for its smallmouth bass fishing. The James River from Big Island to the Gladstone railroad yard has scenic, geologic, hydrologic, historic, and botanic values. Bremo and Midway Mill are on the National Historic Register. This area also possesses cliff like valley walls over 300' high and numerous islands. This site also has a rare population of Arbor vitae. The Rivanna River from its confluence with the James River to near the University of Virginia Airport is an excellent example of a Piedmont upland.[129] The scenic rivers for Fluvanna County are depicted in the following figure.

According to the *2007 Virginia Outdoors Plan (VOP)*, set forth by the VDCR, several natural areas in Virginia have been recommended for outdoor recreation and land conservation. The *VOP* also recommends that the localities adopt planning tools that will afford special recognition and protection to Virginia's scenic rivers including the James River from Wingina to Maidens and the Hardware River.[130]

[129] http://www.nps.gov/ncrc/programs/rtca/nri/states/va.html.
[130] *2007 Virginia Outdoors Plan*, prepared by the Virginia Department of Conservation and Recreation.



Source: Fluvanna County 2009; USGS;

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SCENIC RIVERS

Fluvanna County, Virginia

FIGURE
4-5

4.2.4 *Sites of Historical Significance*

On June 19, 1777 Fluvanna County was officially declared a separate county from Albemarle County. Fluvanna County has many historic and cultural resources as well as a County Historical Society that operates as a non-profit community organization with over 600 members whose mission is to preserve Fluvanna County's heritage. The Society has ownership and responsibility for four historic properties including the lock and mill site on the Rivanna River at Palmyra, Triangle Park, the Holland Page Log House, and Maggie's House, all of which are available for public use and education.[131]

The Old Stone Jail, completed in 1829, was the first public building erected in Fluvanna County. One of Fluvanna's most notable historic resources includes four early 20th century African-American schools that were constructed as a result of contributions provided by Julius Rosenwald who donated money to bring educational opportunities to all African-American children throughout the south. There are also many landmarks and historic districts that were recommended for designation in a 1999 report by the Historic Preservation Task Force including the Palmyra, Wilmington, Columbia, Fork Union, and Bremo Bluff historic districts. In addition, the Rivanna River has a system of dams, locks, and canals designed by Thomas Jefferson and seen by him as one of his greatest accomplishments. The dams, locks, and canals are at seven locations (Union Mills, Crofton, Broken Island, Palmyra, Carysbrook, Rivanna Mills, and Columbia). The locks are also known to be the best preserved in the state.[132]

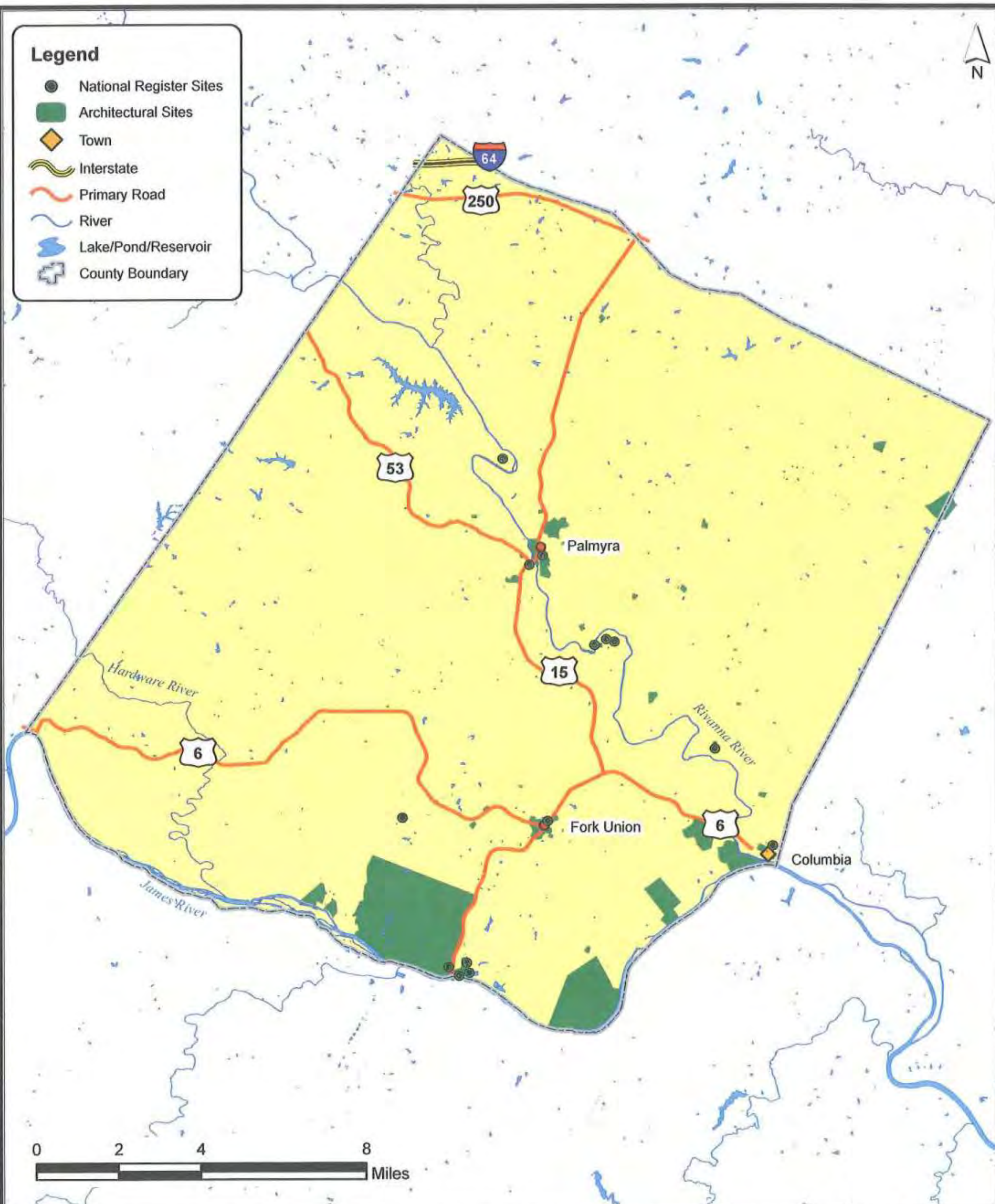
The Virginia Department of Historic Resources lists approximately 389 historic architectural sites in Fluvanna County; 14 are on the National Register of Historic Places:

- VDHR ID 032–0007 is known as Carysbrook, Columbia quadrangle;
- VDHR ID 032-0074 is known as the Spring Grove, Jackson House, or John Ashlin House, Columbia quadrangle;

[131] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[132] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

- VDHR ID 032-0186 is the John H. Cocke Memorial Bridge #1987 that spans the James River; Arvonia quadrangle;
- VDHR ID 032–0045 is known as the Cocke-Morris House, Arvonia quadrangle;
- VDHR ID 032-0290 is known as the Dunbar School, Fork Church School, or Rosenwald Schoolhouse, Palmyra quadrangle;
- VDHR ID 032-0106 is known as the Bachelor's Quarters, Arvonia quadrangle;
- VDHR ID 032-0038 is known as Solitude Mill, Palmyra quadrangle;
- VDHR ID 032–5011 is the Broken Island Canal and Lock, Boyd Tavern quadrangle;
- VDHR ID 200-0021 is the Columbia Historic District, Columbia quadrangle;
- VDHR ID 032-0036 is the Rivanna Canal Navigation Historic District, Palmyra/Columbia quadrangle;
- VHDR ID 032-5019 is the Bremo Bluff Village Historic District, Arvonia quadrangle;
- VDHR ID 032-5018 is the Palmyra Lock and Mill Site, Palmyra quadrangle;
- VDHR ID 032-5020 is the Fork Union Historic District, including the Fork Union Military Academy, Palmyra quadrangle;
- VDHR ID 032-0036-0001 is the Oak Hill Lock or Carysbrook Lock, Columbia quadrangle.

The following figure shows the location of these historic architectural sites.



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HISTORIC/ARCHITECTURAL SITES

Fluvanna County, Virginia

FIGURE
4-6

\\RCH-FILES\Projects\R09100\R09163R\R09163R-01\GIS\MAP - 09 1123 - Figure 4-6 -Historic-Architechural Sites - AWG.mxd - 11/24/2009 @ 4:09:27 PM

4.2.5 Sites of Archaeological Significance

The Virginia Department of Historic Resources lists approximately 243 historic archaeological sites in Fluvanna County; one is listed on the National Register of Historic Places:

- VDHR ID 44FV-0114 is the nineteenth century Broken Island Canal and Lock, Boyd Tavern quadrangle.

According to the Fluvanna County 2009 Comprehensive Plan, the preservation of historic properties can benefit the county in several ways and continues to be part of their implementation strategy for future economic growth as well as provide incentives for improving property maintenance. Tax credits, potential employment opportunities created by the rehabilitation of historic properties, and tourism opportunities are all opportunities for the county to benefit from their history.

The recognized archeological sites located in Fluvanna County are shown on the following figure.

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ARCHAEOLOGICAL SITES

Fluvanna County, Virginia

FIGURE

4-7

4.2.6 Unusual Geologic Formations or Special Soil Types

Fluvanna County lies within the Piedmont province. Chemical weathering is very active as a result of the warm, moist climate. This is evident with the presence of thirty-three different soil series in the county. Most of the soils within Fluvanna County are suitable for construction purposes; however, there are about 8,500 acres of shrink-swell soils that require further evaluation prior to construction of structures.[133]

The geology of the county has provided many natural resources of economic value. Part of eastern Fluvanna County occurs within the gold-pyrite belt.[134] There are eleven abandoned gold mines in the county, several pits, and seven mines. Gold was first discovered in the county around 1830 and mining remained active until the early 1900's. Since most of the mining is restricted to weathered rock and does not go deeper than fifty feet, gold mining is not economically viable under present market conditions.

Schists, gneiss, and soapstone have been quarried for use in the construction of canals, small dams, railroad foundations, and buildings throughout the county and the state. Talc was once mined near Palmyra at the Solitude Plantation. Several places in the county have been prospected for slate. Two miles east of Bybee, asbestos was discovered and 0.7 miles north-northeast of Stage Junction anthophyllite was identified. Quarries producing crushed stone have operated at several locations in the County including Scottsville and north of Nahor. Garnet has been mined near the eastern border of the county in the Columbia syncline and north of Bremo Bluff in the Arvonia syncline. Gemstones have been extracted from a rhodonite-quartz vein extending across the South Fork of Cunningham Creek. Amethyst crystals have been reported one mile east-northeast of Yancey's Store, and clear quartz crystals have been found one mile east of Palmyra and along the east bank of Byrd Creek just north of State road 630. Iron-bearing minerals have also been discovered at several locations throughout Fluvanna. A garnet-amphibole-chlorite schist extends northward from Bremo Bluff for about two miles; ferruginous quartzites exist at several

[133] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[134] http://www.dmme.virginia.gov/DMR3/dmrpdfs/gOLD.pdf.

locations as well as massive magnetite, magnetite-quartz rock and limonite. Vermiculite is present as a minor constituent in many of the rocks in the eastern part of Fluvanna County. The Rivanna, James River, and their tributaries have provided sand and gravel. Clay of residual and alluvial origin is also present in Fluvanna County.[135]

Fluvanna County has unique natural resources that have had economic benefit in the past. Many of these resources continue to provide economic value today and will likely do so into the future. The 2009 Comprehensive Plan seeks to protect and manage these resources for the county's best interests in the future.

4.2.7 Wetlands

Fluvanna County is predominantly forested. Thus, the majority of the county's wetlands are freshwater forested and shrub wetlands that occur along the riparian zone of existing tributaries. Freshwater emergent wetlands are also present but they are not as numerous.[136]

These wetland areas are highly protected from disturbance as Section 404 of the Clean Water Act empowers the U.S. Environmental Protection Agency to regulate the placement of fill or dredged material into the waters of the United States, including wetlands.

The wetlands in Fluvanna County are presented in the following figure.

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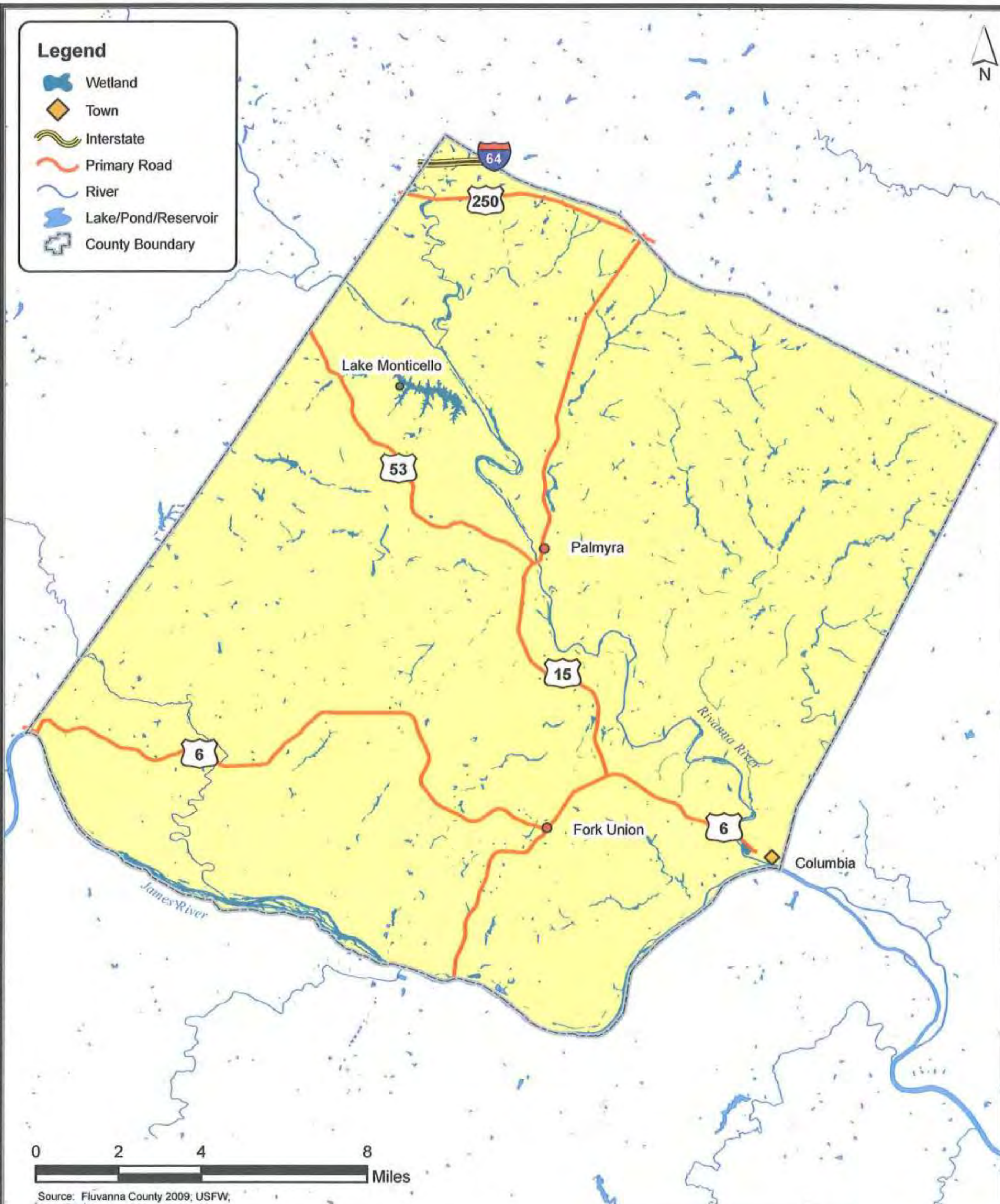
[135] Smith, J. W., Milici, R.C., and Greenberg S.S. 1964, Geology and Mineral Resources of Fluvanna County: Virginia Division of Mineral Resources Bulletin 79, pp 32-45.
[136] http://www.fws.gov/wetlands/Data/Mapper.html.



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WETLANDS

Fluvanna County, Virginia

FIGURE
4-8

4.2.8 *Riparian Buffers*

There have been many riparian buffer projects implemented throughout Fluvanna County. However, according to the 2009 Fluvanna County Comprehensive Plan, many are inadequate at less than one-hundred feet. To ensure that the buffers remain intact, county legislation is necessary. Part of the 2009 Fluvanna County Comprehensive Plan is to ensure that riparian buffers of adequate width are required adjacent to waterways to protect local and regional water resources such as perennial streams, floodplains, wetlands, steep slopes, and highly erodible soils. In addition, educating the public on the values and benefits of preserving stream corridors is important to gaining support.[137]

The Thomas Jefferson Planning District Commission and the VDMR, offer a different perspective regarding the quality of riparian buffers in the county. Utilizing Virginia Gap Analysis data, they determined that the majority of watersheds in Fluvanna County appear to have adequate forest cover with very little disturbed land. Lake Monticello was found to have the most developed land causing the area surrounding it to be at risk for lowered water quality if protective measures are not implemented.[138]

The Virginia Department of Forestry has compiled GIS data regarding riparian buffers; see the following map.[139] The VDOF map shows where buffers of 100 feet or greater exist on one or both sides of the streams and where no riparian buffer exists.

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[137] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

[138] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

[139] The map of Riparian Buffers features the 2003 Riparian Buffer GIS layer generated by Penn State Land Analysis Laboratory. Buffers were mapped using a GIS automated buffer inventory algorithm that compared the USGS National Land Cover Dataset and USGS 1:100k National Hydrography Dataset. The algorithm determined where buffers exist by sampling at regular intervals along an axis orthogonal to the stream segment. This method, therefore, produces a layer that describes whether buffers exist on one, both or no sides of a waterway. These data are useful at the watershed and county scale, however are not suitable to be used at the site-level owing to the nature of the analysis method.

Not to Scale
Source: Virginia Department of Forestry, 2003;

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RIPARIAN FOREST BUFFERS

Fluvanna County, Virginia

FIGURE 4-9

4.2.9 Land Conservation Efforts

Fluvanna County has implemented a land-use taxation program, has created agricultural and forestal districts, holds and protects conservation easements, and has encouraged cluster development. All of these activities have been undertaken to conserve land in the county.

4.2.10 Land-Use Taxation

In Virginia, localities may elect to reduce the real estate tax burden on land used for agriculture, horticulture, sylviculture, viticulture, aquaculture, improved pasturage, and open space. Properties are removed from land-use taxation when the landowner changes the use of the property or elects to develop the property. Although land-use taxation programs do not guarantee long-term conservation, they do remove some of the financial pressure related to sale or development of land because the land is taxed at a lower value, thus reducing the annual real estate taxes assessed to the land.

In 2006, there were 2,068 parcels and 115,001 acres of land, or approximately 63 percent of the land in the county, in the land-use program in Fluvanna County. In 2007, 66 percent, or 121,366 acres were in land-use. However, in 2003, approximately 71 percent of the total acreage in the county was in land-use.

Table 4-6: 2006 Property in Land Use Taxation – By Magisterial District[140]

Magisterial District	Number of Parcels	Agricultural Acres	Forestal Acres	Open Space Acres	Total Land Use
Palmyra	469	6,093	16,762	0	22,855
Columbia	499	6,409	22,850	21	29,280
Cunningham	398	6,949	19,383	402	26,734
Fork Union	702	9,396	26,696	40	36,132
Total	**2,068**	**28,847**	**85,691**	**463**	**115,001**
% of Total Land Use		**25%**	**75%**	**0%**	**100%**

4.2.11 Agricultural and Forestal Districts

The purpose of this program is to "conserve and protect and to encourage the development and improvement of agricultural and forestal lands for the production of food and other agricultural and forestal products …, and to conserve and protect

[140] Source: Fluvanna County Office of the Commissioner of Revenue, Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.

agricultural and forestal lands as valued natural and ecological resources which provide essential open space for clean air sheds, watershed protection, wildlife habitat, as well as for aesthetic purposes."[141]

The benefit to the community is that the rural areas, including agricultural land and forest lands, are protected. Additionally, water supply and other natural and scenic resources are protected. The Agricultural and Forestal Districts provide the landowner with certain tax benefits and provide restrictions on public utilities and government actions. These restrictions serve to protect the agricultural and forestal land and also delay development of the land. In exchange, the landowner voluntarily agrees to conditions which limit development of the property during the specified number of years the district is in effect. Districts of this type can be initiated only by the landowners. See Appendix 13 for more information. The following table provides information about the properties currently in Agricultural and Forestal Districts.

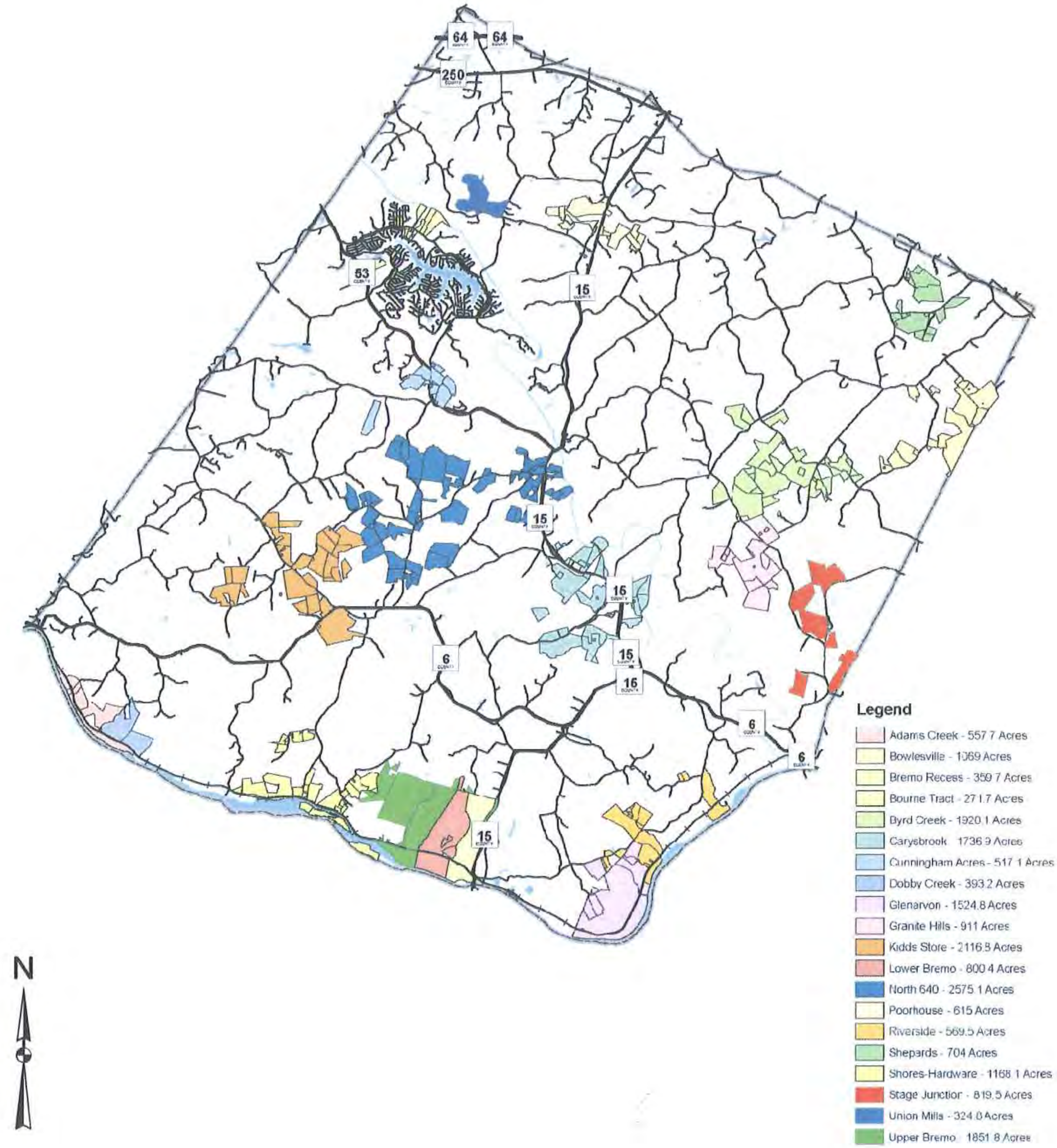
[141] *Code of Virginia.*

Table 4-5: 2008 Fluvanna County Agricultural and Forestal Districts[142]

District Name	Planning Areas	Approval Date	Review Period	Review Date	Total Acreage
Riverside	Rural Preservation	8/7/2002	10 years	08/2012	600.53
Union Mills	Rural Preservation	5/15/2002	10 years	05/2012	324.752
Adams Creek	Rural Residential	5/16/2001	10 years	05/2011	557.674
Bremo Recess	Rural Preservation	1/17/2001	10 years	01/2011	359.67
Lower Bremo	Rural Preservation	1/17/2001	10 years	01/2011	800.377
Shores-Hardware	Rural Preservation	1/17/2001	10 years	01/2011	1,239.81
Dobby Creek	Rural Residential	1/17/2001	10 years	01/2011	369.16
Sheperds	Rural Preservation	11/15/2000	10 years	11/2010	703.99
Upper Bremo	Rural Preservation	9/20/2000	10 years	09/2010	1,851.78
Stage Junction	Rural Preservation	6/7/2000	10 years	06/2010	819.454
Poorhouse	Rural Residential	1/19/2000	10 years	01/2010	615.315
Kidds Store	Rural Preservation and Route 6/Anitoch Primary Residential	12/15/1999	10 years	12/2009	2,116.75
North 640	Rural Preservation	11/17/1999	10 years	11/2009	2,575.13
Cunningham Acres	Rural Residential and Lake Monticello Primary Residential	11/17/1999	10 years	11/2009	517.068
Glenarvon Farm	Rural Preservation	11/17/1999	10 years	11/2009	1,524.78
Bourne Tract	Rural Preservation	8/4/1999	8 years	08/2015	271.657
Granite Hills	Rural Preservation	8/4/1999	10 years	08/2009	911.035
Byrd Creek	Rural Preservation	7/21/1999	10 years	07/2009	1,920.10
Carysbrook	Rural Preservation	7/21/1999	10 years	07/2009	1,736.95
Bowlesville	Rural Preservation	3/17/1999	8 years	05/2015	1,069.01
Total Acreage					**20,806.30**
Percent of Fluvanna County acreage in agricultural or forestal districts					**11.4%**

The following figure depicts the Agricultural and Forestal Districts in Fluvanna.

[142] Source: Fluvanna County Office of the Commissioner of Revenue, Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.



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AGRICULTURAL & FORESTAL DISTRICTS

Fluvanna County, Virginia

FIGURE 4-10

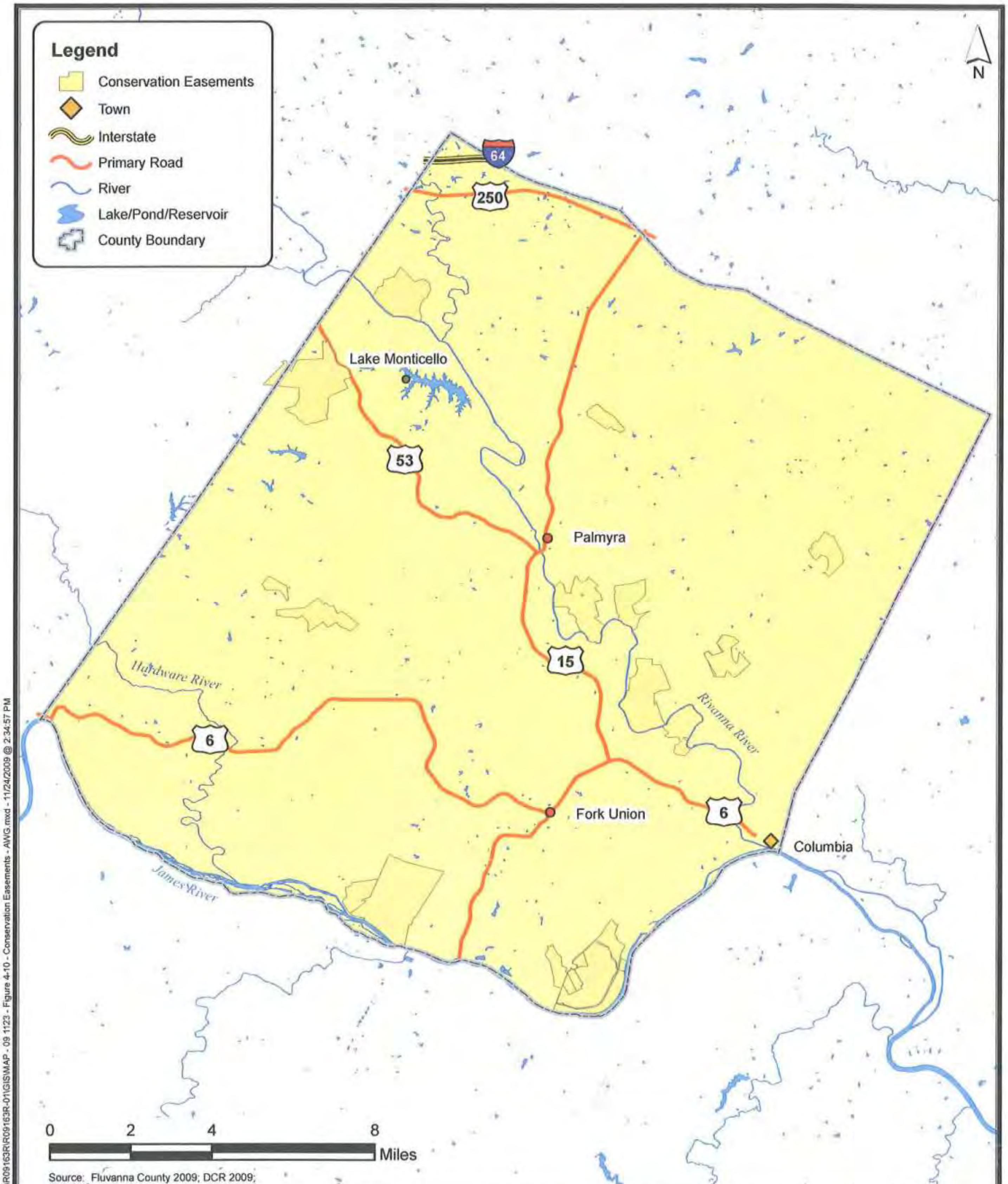
4.2.12 Conservation Easements

Fluvanna County has taken a proactive position on conservation easements. The county's easement program allows the county to hold and protect easements. As shown below, the county holds two conservation easements that total more than 200 acres. In addition, there are many conservation, historic, and open-space easements that protect properties in perpetuity from development. As of 2008, 9,738 acres had been placed under conservation, historic or open-space easements, many of which are held by the Virginia Outdoors Foundation or the Department of Historic Resources[143].

Table 4-7: Conservation, Historic, and Open-Space Easements[144]

Property Name	Easement Holder	Acreage
Barber, William T. and Lynn M.	Fluvanna County	100.6
Bremo Recess (Road Frontage)	Virginia Department of Historic Resources	44.8
Chatham Plantation	Virginia Outdoors Foundation	887.5
Cumber Farm	Virginia Outdoors Foundation	698.2
Glenarvon	Virginia Outdoors Foundation	1,371.9
Glen Burnie	Virginia Department of Historic Resources	1,86.3
Granite Hills	Virginia Outdoors Foundation	358.2
Lakeview	Virginia Outdoors Foundation	1,236.5
Lower Bremo	Virginia Department of Historic Resources	653
Little Byrd Creek	Virginia Outdoors Foundation	301.1
Lowfields Farm	Virginia Outdoors Foundation	249.8
Maranatha Farm	Virginia Outdoors Foundation	441.1
Melrose	Virginia Department of Historic Resources	100.0
Palmyra Mill and Lock Site	Virginia Department of Historic Resources	5.0
Red Bank Farm	Virginia Outdoors Foundation	424.3
Oak Hill Farm	Virginia Outdoors Foundation	676.1
Scheier Natural Area	Virginia Outdoors Foundation	100.5
Seven Islands Historic District	Virginia Department of Historic Resources	23.0
Upper Bremo	Virginia Department of Historic Resources	1,534.10
Upper Yewers Farm	Virginia Outdoors Foundation	239.2
Zehler, John C. & Kathryne K.	Fluvanna County	107.6
TOTAL		**9,738.8**
Percentage of Total County Acreage in Easements		**5%**

[143] Source: Fluvanna County Office of the Commissioner of Revenue, Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[144] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.



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CONSERVATION, OPEN SPACE, & HISTORIC EASEMENTS

Fluvanna County, Virginia

FIGURE
4-11

4.2.13 *Land Use and Land Coverage*

Part of the county's vision is to maintain the rural appearance of the county so that natural resources remain protected while directing residential and commercial growth to community planning areas. Cluster development zoning was adopted in 2004 to conserve open space, reduce the impacts of erosion, sedimentation, and quantity of stormwater runoff.[145]

Fluvanna County contains 287 square miles; 73% of the land area is forested. Most of the forests are pioneer or transitional systems that have developed over the last century as marginal farmland was abandoned[146]. Approximately fifteen percent of the watershed is comprised of highly impervious land[147]. As the county grows and develops the rural character of the county is increasingly threatened as pressure to develop agricultural and forested lands increases.

4.2.14 *Presence of Impaired Streams and Type of Impairment*

There are six Virginia Department of Environmental Quality (VDEQ) stations within Fluvanna County. Station locations are shown below. [148]

Table 4-8: VDEQ Stations

Station	Watershed
Rivanna River upstream of Rt. 15 bridge	H31 – Lower Rivanna River/Ballinger Creek
Rivanna River upstream of Rt. 6 bridge at Columbia	H31 – Lower Rivanna River/ Ballinger Creek
Mechunk Creek at Rt. 616 bridge	H30 – Mechunk Creek
Cunningham Creek at Rt. 660 bridge	H32 – Cunningham Creek
Hardware River at Rt. 637 bridge	H19 – Hardware River
James River at 0.2 miles downstream of Rt. 20 bridge	H17 – James River/Totier Creek/Rock Island Creek
Byrd Creek at Rt. 603 bridge (Goochland Co.)	H34 – Byrd Creek

VDEQ has compiled a list of streams in Fluvanna County that are impaired for failure to meet water quality standards for designated water uses. There are six designated uses for surface waters: aquatic life, fish consumption, shellfish consumption,

[145] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[146] Fluvanna County 2009 Comprehensive Plan www.co.fluvanna.va.us.
[147] http://www.tjpdc.org/environment/rivBasin.asp.
[148] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.

swimming, public water supplies, and wildlife. The *2008 305(b)/303(d) Water Quality Assessment Integrated Report* is a summary of the water quality conditions in Virginia from January 1, 2001, to December 31, 2006. The VDEQ lists the following Fluvanna County bodies of water as "impaired":

Table 4-9: Impaired Waters of Fluvanna County[149]

Waterbody Name	Size (miles)	Impairment
James, Hardware, Slate Rivers	59.7	PCB in Fish Tissue
James River	20.4	Escherichia coli
North Creek	3.25	Benthic-Macroinvertebrate Bioassessments
Rivanna River	15.17	Benthic-Macroinvertebrate Bioassessments
Fluvanna Ruritan Lake	51.13	pH
Middle Fork Cunningham Creek	3.73	Benthic-Macroinvertebrate Bioassessments
Middle Fork Cunningham Creek	6.81	Escherichia coli
Middle Fork Cunningham Creek X-trib	3.6	Escherichia coli
Byrd Creek	18.83	Escherichia coli
Venable Creek	7.11	Escherichia coli
Phils Creek	6.38	Escherichia coli

VDEQ has a separate designation for "waters of concern" where indicators show an apparent decline in water quality. These waters are *not* impaired and are included only for informational purposes. The VDEQ lists the following Fluvanna County bodies of water as "waters of concern".

Table 4-10: 2008 "Waters of Concern" in Fluvanna County[150]

Waterbody	Size	City/County	Concern	Source
Hardware River	23.03	Fluvanna	Sediments-DDT-Threatened	Unknown
Rivanna River	13.42	Albemarle, Fluvanna	Total Phosphorus	NPS-Urban 1998, Unknown
Rivanna River	13.38	Albemarle, Fluvanna	Total Phosphorus	Unknown

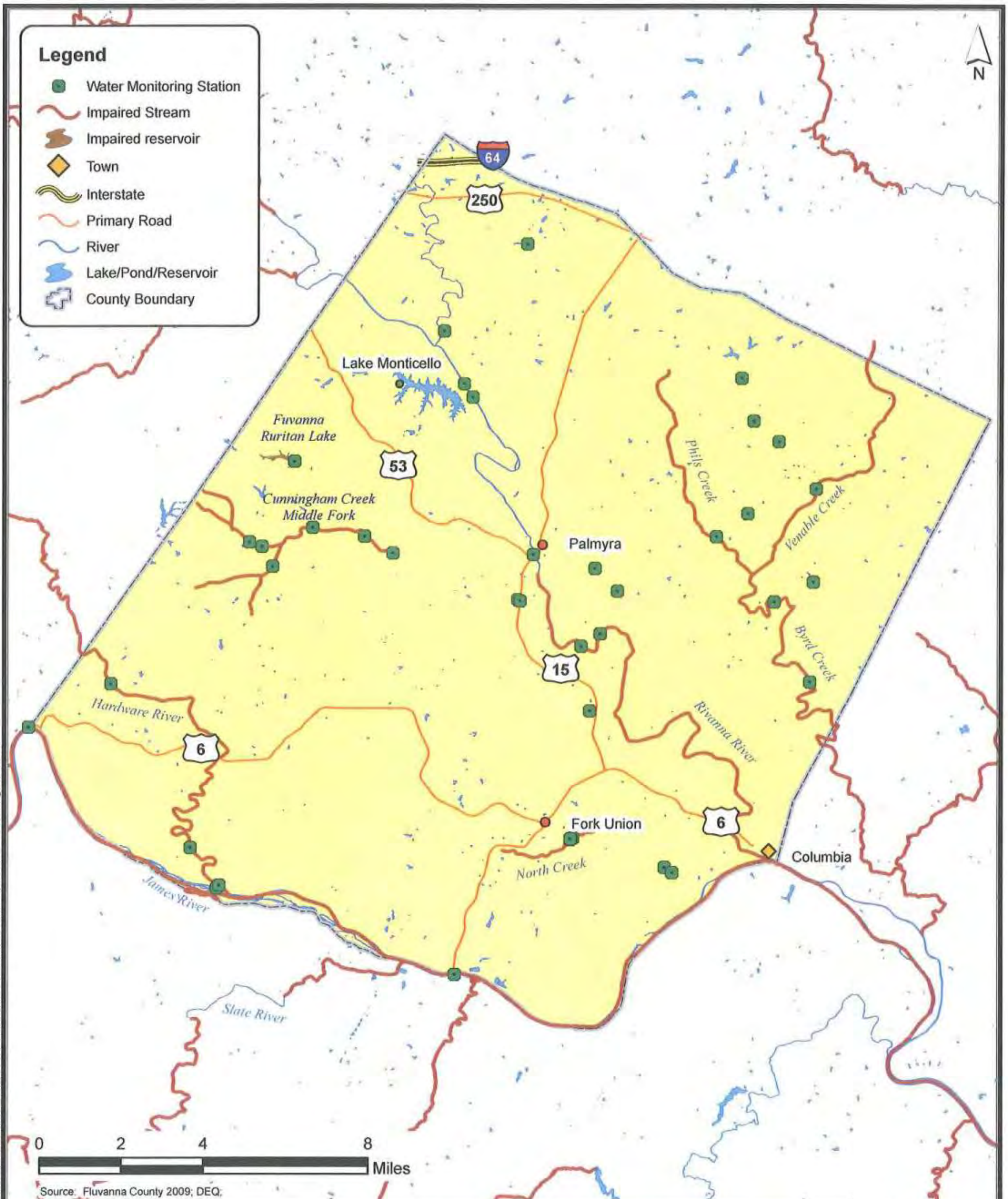
The water quality of Fluvanna County is relatively good during good weather, however during high stormflows the levels of phosphorus, total suspended solids, and fecal coliforms increase which results in poorer water quality. During a 2008 study conducted by the TJPDC and the VDMME, all stations exceeded the maximum fecal coliform level during stormflows, although the exact source remains unknown. Total

149 Final 2008 305(b)/303(d) Water Quality Assessment Integrated Report, Virginia Department of Environmental Quality.

150 Final 2008 305(b)/303(d) Water Quality Assessment Integrated Report, Virginia Department of Environmental Quality.

suspended solid limits were also exceeded at all stations for limits recommended for shad and three stations exceeded the limits for all fish. Elevated phosphorus concentrations are a concern because of eutrophication. High levels are likely attributed to agricultural and urban land use as well as sewage treatment discharge. In addition, several stations along the Rivanna River had pH readings lower than the 6.5-8.5 range for drinking water. The Hardware River on the other hand had readings well above this range which could be attributed to contamination or corrosion from metals from plumbing pipes. Nitrate, nitrite, dissolved oxygen, ammonia, and ammonium concentrations were within acceptable ranges. It is recommended that several abandoned mining sites within the county be monitored since they could potentially cause water quality problems in the future.[151] The following figure depicts the impaired streams for Fluvanna County.

[151] Water Resources in Fluvanna County: Present Conditions and Recommendations for Preservation and Restoration. Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999.



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IMPAIRED WATERS

Fluvanna County, Virginia

FIGURE 4-12

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4.2.15 Location of Point Source Discharges

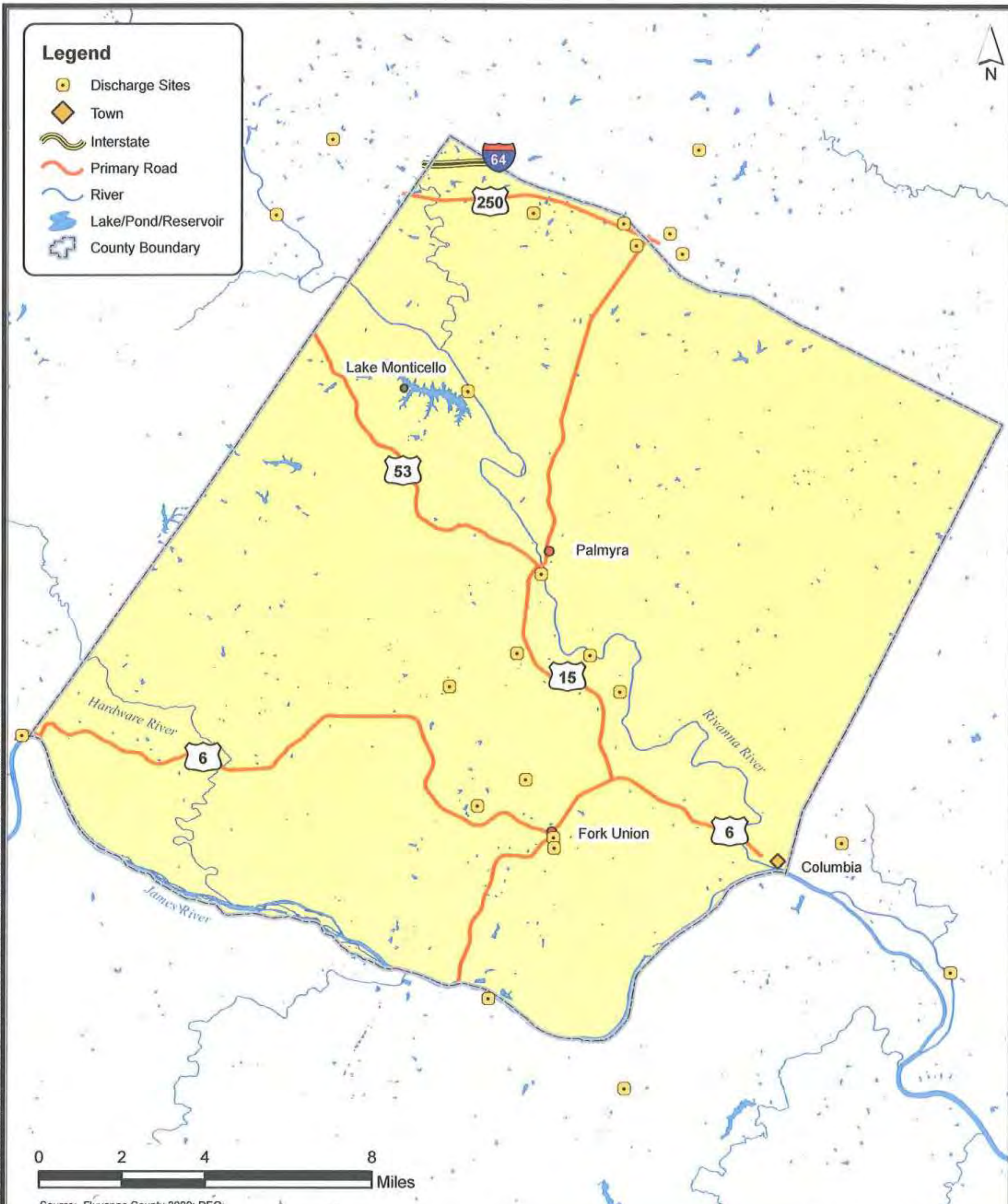
Point sources are fixed locations from which pollutants are discharged into a water source. A point source can be any single source of pollution, such as a pipe from a sewage treatment plant or a ditch.

The Envirofacts database, maintained by The United States Environmental Protection Agency, indicates several point source discharge sites which are shown below.[152]

Table 4-11: Point Source Discharge Sites

Facility Name	NPDES ID	Address	Facility Information
Bio-Cat, Inc.	VAU001587	Troy, VA	Industrial Organic Chemicals
DOC-Fluvanna Correctional Center for Women	VA0023418	144 Prison Lane, Troy, VA	Correctional Institutions
Dominion/Bremo Power Station	VA0004138	1038 Bremo Road, Bremo Bluff, VA	Electric Services
EDGCOMB Metals Company	VAU001590	Rte 250 and 689, Troy, VA	
Fluvanna County High School	VA0030767	Rte 15, 2 miles south of Palmyra, VA	Sewerage Systems
Fluvanna Middle School	VA0082228	Rte 649, Palmyra, VA	Sewerage Systems
Fork Union Military Academy	VA0024147	State Route 652, Fork Union, VA	Elementary and Secondary Schools
Kingsbridge STP	VA0091936	Rte 649, .5 miles west of Rte 648, Palmyra, VA	Sewerage Systems
Lake Monticello STP	VA0024945	3086 South Boston Road, Palmyra, VA	Sewerage Systems
Morris Well WTP	VA0089559	42 Emerald Lane, Fork Union, VA	Water Supply
Omohundro Well WTP	VA0057606	14353 West River Rd Fork Union Palmyra, VA	Water Supply
Palmyra Area WWTP	VA0091146	12964 James Madison Highway, Palmyra, VA	Sewerage Systems
Ruxton Health at the Villages	VA0081639	4238 James Madison Highway, Fork Union, VA	Nursing Care Facilities
Thomasville Home Furnishings[153]	VA0071692	Route 15 and 615, Fork Union, VA	Sewerage Systems

[152] U.S. Environmental Protection Agency. *Water Discharge Permits*. Compiled from the EPA Envirofacts Warehouse Database.
[153] The Thomasville Home Furnishings facility is not currently operational.



\\RCH-FILES\Projects\R09\100\R09163R\R09163R-01\GIS\MAP - 09 1123 - Figure 4-12 - Point Source Discharge Sites - AWG.mxd - 11/24/2009 @ 3:04:24 PM

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POINT SOURCE DISCHARGE SITES

Fluvanna County, Virginia

FIGURE

4-13

4.2.16 Other Potential Threats to the Existing Water Quantity and Quality

The rapid population growth in the county, increases in agricultural and forestal land values, the aging of agricultural land owners, along with the high suitability of many agricultural and forestal lands for development can all be cited as potential threats that may contribute to the loss of the county's agricultural, forestal and open space resources.

As identified in the 2009 Fluvanna County Comprehensive Plan, a river protection program needs to be implemented that protects the county's water sources and waterways. Since the majority of Fluvanna's rivers lie outside of the county, it is also important that the county continue to work with the local governments that are upstream and continue to work with groups such as the Rivanna River Basin Commission to protect these resources.

Fluvanna County may also want to consider implementation of a ground water management policy that protects and preserves the quantity and quality of well water throughout the county. Generally, a ground water management policy provides recommendations for the development of new wells; provides a plan for protecting existing wells from contamination and from negative impacts on yields; and makes recommendations for protection of the aquifer recharge areas. A ground water management policy also enables the county to manage the groundwater resources so that adequate supplies are available to meet the needs of new users without disrupting supplies for existing users.

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5.0 WATER DEMAND MANAGEMENT INFORMATION

This section of the Water Supply Plan addresses water demand management practices that are in place in Fluvanna County and includes efforts made by the County, the community water systems, and the Department of Corrections.[154]

5.1 Adoption of Virginia USBC

Fluvanna County adopted the Virginia Uniform Statewide Building Code in 1974. The County's Building Inspector is responsible for the enforcement of the USBC provisions.

5.2 Other Local Water-Use Ordinances or Plans

Fluvanna County has not adopted other water use ordinances or plans. However, with the adoption of this Water Supply Plan, the County will adopt the Drought Assessment and Response Plan (see Section 7) and the related ordinance that enacts the Drought Assessment and Response Plan (see **Appendix 11** for the ordinance).

5.3 Homeowners' Associations

The Lake Monticello Homeowners' Association is the largest homeowner's group in Fluvanna; the association has not adopted any landscaping plans or other plans to increase water efficiency or reduce water use. The association has discussed water use issues with AquaVirginia and the association has asked AquaVirginia to hold seminars to provide conservation information to residents.

5.4 WaterSense Partners

EPA, through the WaterSense program, is partnering with manufacturers, retailers and distributors, utilities, state and local governments, nongovernmental organizations, trade associations, irrigation professionals, and professional certifying organizations to bring water-efficient products to market and spread the word about the need for smart water use. EPA's website lists organizations that have agreed to partner with EPA to promote water conservation.

---

[154] 9 VAC 25-780-110.

5.4.1 *Water Providers*

None of the community water systems in Fluvanna County appear on EPA's list of WaterSense Partners.[155]

5.4.2 *Landscape Irrigation Professionals*

EPA's WaterSense website includes 55 landscape and irrigation partners in Virginia who have been certified through WaterSense programs for their expertise in water-efficient irrigation technology and techniques. Of these, 19 provide services statewide, 16 provide services in the areas in and around Richmond and Charlottesville, and 20 provide services in other areas of Virginia. None specifically list Fluvanna County.

5.5 Water Conservation Efforts

The following section of the plan outlines the efforts made by the community water systems to reduce water consumption.

5.5.1 *Town of Columbia*

The system serving the Town of Columbia is owned and operated by AquaVirginia. An AquaVirginia representative notes that the Columbia system has historically had high water loss, but the entire distribution system is currently being replaced. As a result, there will be less "unaccounted for" water in that system. The improvements will be completed in the early part of 2010.

AquaVirginia has not implemented any customer-based water conservation plans in the service area; there are no incentive programs to encourage customers to replace older fixtures or appliances.

In the Columbia system, both the source and the customers are metered. The customers are billed on a monthly basis and the existing tariff is as follows: [156]

- Base bill is $22.85 and includes consumption of 4,000 gallons

[155] October 2009.
[156] Source: Phone conservation with AquaVirginia, February 2010.

- Usage in excess of 4,000 gallons per month is billed at $5.71 per 1,000 gallons.

AquaVirginia has a policy that requires customers to repair leaks and the system operator examines the water production reports on a weekly basis to identify any increased demand that may indicate a leak.

The capital project that is underway, which includes the development of a new well and the replacement of the entire water distribution system, will reduce water loss within the system. Further, customers are being encouraged to replace the laterals from the meters to the homes, to further reduce leaks.

5.5.2 Fork Union Sanitary District

The Fork Union Sanitary District is the only community water system operated by Fluvanna County. The existing ordinance[157] related to the Sanitary District includes several sections that relate to encouraging conservation.

The water rates[158] are as follows:

- $15.44 for the first 2,000 gallons (minimum charge);
- $7.72 for each 1,000 gallons up to 300,000 gallons;
- $3.97 for each 1,000 gallons above 300,000 gallons.

Even though the water rates amount to a uniform rate for most users, the relatively high cost per 1,000 gallons is a financial deterrent to excessive use. See section 9-2-2 of the ordinance.

Further, when a "water emergency" is declared, the water rates increase by 10% for the duration of the emergency. See sections 9-2-2 and 9-2-12 of the ordinance.

The Sanitary District has undertaken several measures that have reduced water consumption.

[157] Dated December 31, 2008, see **Appendix 12**.
[158] Water is billed on a monthly basis.

- Fork Union Military Academy is one of the largest users of the Fork Union system. In an effort to reduce water consumption, the school has provided water conservation education to the cadets. In an effort to reduce water usage in 2002, the school added timers to showers to reduce water use and during the height of the drought, the school resorted to turning off the hot water heaters during the evening to reduce use. Both efforts results in a reduction in use. Because of the success of these efforts, the school has continued to keep some of the policies and practices in place on a continuous basis.
- Water conservation information has been provided to all users in Fork Union to encourage reduction in use.
- The system operators are flushing the fire hydrants on a limited basis, and only as needed, to conserve water.
- The operators are increasing the run time as much as possible before backwashing the filters to reduce the water usage related to backwashing.
- The Fork Union wells are metered and all customers are metered.
- The District's policy is that customers are notified when it appears that there is a leak on the "customer side" of the meter. If the leak is not addressed, the water will be cut off.
- The operators monitor the storage tanks. If they see a dramatic drop in the level of a tank, they look for a leak.

5.5.3 Palmyra

AquaVirginia owns and operates the Palmyra system. The system does not have significant water loss problems. The owner has not undertaken any plans or programs in the service area to encourage water use reduction.

Both the source and the customers are metered. The existing tariff is as follows:[159]

[159] Source: Phone conservation with AquaVirginia in February 2010.

- The base fee is $21.00 per month.
- The consumption charge is $5.40 per 1.000 gallons.

AquaVirginia requires customers to repair leaks. The company monitors the water production in several ways. The water production is compared to the water billings on a bi-monthly basis. The pump station records are reviewed on a weekly basis. This monitoring allows AquaVirginia to identify potential leaks.

There are no planned capital projects that are intended to reduce water use.

5.5.4 Woodslodge Cottages

The owner of the Woodslodge system reports that many of the showerheads were changed during the 2002 drought in order to reduce water consumption. There has not been any effort to change out other fixtures or appliances.

The water source at Woodslodge is metered, but the customers are not. The customers pay a flat fee that covers water, wastewater and trash removal services. The owner reviews the water production records on a weekly basis and is able to monitor any increase in production that is attributed to leaks.

5.5.5 Pine Grove Mobile Home Park

No information was available regarding conservation efforts in the service area of the Pine Grove Mobile Home Park.

5.5.6 Stagecoach Hills

The owner of the Stagecoach Hills system reports that no measures have been undertaken to encourage water conservation in the community. The customers are metered, but the meters are not read. The monthly bill is $30, regardless of usage. The source has a meter, but the meter is not operational. The owner repairs leaks, and is able to monitor leaks by monitoring the electricity bill or by observing water on the ground.

5.5.7 *Oakland School*

The Oakland School has provided educational information to faculty and students to encourage water conservation. The school has not undertaken an effort to replace fixtures or appliances to reduce water use. The source and the various building are metered. It is generally easy it identify a leak by reviewing production records.

5.5.8 *Department of Corrections*

DOC has a water conservation plan that impacts water usage at all DOC facilities, regardless of the source of water for the facility. A copy of the DOC plan is included in Appendix 13.

The DOC Water Conservation and Management Plan encourages daily conservation practices and does not rely on droughts or emergencies to trigger conservation activities.

The DOC Water Conservation and Management Plan is written in three distinct parts:

- The first part addresses conservation during normal daily situations and includes areas of water conservation that can be achieved through design of water and plumbing systems, retrofitting of existing fixtures and systems and commonplace conservation practices.
- The second part of the plan covers water conservation during prolonged drought conditions. The section discusses the water conservation levels which are distinguished by color codes.
- The third part of the plan covers emergency situations where the emergency requires the highest level of water conservation. Generally, a water emergency is declared when a complete water outage occurs for whatever reason.

Discussions with the Environmental Services Unit (ESU) of DOC provided the following information:

- Because of a Governor's Executive Order, all DOC facilities have undergone energy audits and a directive to conserve water is a direct result of the audits.

- In all DOC facilities, showerheads, toilets, other fixtures have been replaced where necessary in order to reduce water use.
- The operators and the ESU monitor the average gallons per inmate/staff per day and always try to remain below 120 gallons per person per day.
- Under normal conditions (or "Code Blue"), 120 gallons per person per day is acceptable, but when water restrictions are in place, the average is reduced to 110 gallons per person per day ("Code Yellow") and the usage is restricted to 100 gallons per person per day under emergency situations ("Code Red").
- In Fluvanna, the inmate population is 1,100 – 1,200 and the staff is approximately 500.
- In 2009, the Fluvanna facility averaged 91 – 92 gallons per capita per day. The facility has maintained a low water usage 80 – 95 gallons per capita per day since 2006.
- In Fluvanna, the operators monitor precipitation and stream flow and compare current conditions to trends and call for conservation, when warranted.
- The source is metered. The ESU is not sure if all buildings are metered. The daily monitoring provided by the water plant operator will indicate any leaks within the facility.

5.5.9 Lake Monticello

The Lake Monticello system is owned and operated by AquaVirginia. The owner has not undertaken any recent educational activities to reduce water use or to encourage conservation, but due to homeowner requests and interest of the Homeowner's Association, the water provider plans to hold some public meetings and distribute conservation materials.

AquaVirginia has not undertaken any changes in operating practices, has not offered any customer incentives, and has not adopted any water conservation plans in the service area.

The customers are metered and the source is metered. The customers are billed on a monthly basis and the existing tariff is as follows:

- A monthly service charge of $12.00 payable by all customers connected to the system, plus
- A usage charge of $4.07 for each 1,000 gallons.

If the meter reading for any customer is extremely high, indicating a leak, a door tag will be left to notify the customer of a possible leak. If necessary, the water service will be turned off to conserve water.

The system operators monitor production and storage on a daily basis and are able to monitor leaks. Additionally, in 2003, the system was audited and repairs were made to reduce leaks. AquaVirgina has leak detection equipment that can be brought to any system, including the Lake Monticello community, to trace leaks. In many cases, leaks are obvious as the water appears on the ground.

5.6 Use of State Revolving Funds (SRF)

VDH records show that planning grants of $25,000 and $22,040 were made to Fork Union and to Camp Friendship. It does not appear that either planning grant was used for water conservation projects. There has been no use of VDEQ SRF funds in Fluvanna for water conservation projects.

5.7 Water Reuse

VDEQ confirmed that there are no existing or pending water reuse projects located in Fluvanna County.

5.8 Public Education Programs

Fluvanna County has not developed a public education program that addresses water conservation through water use reduction.

But, as outlined earlier, with the creation of the James River Water Authority, and with the anticipation of the County becoming more involved in the operation and maintenance of retail water systems in the community, it is recommended that the County begin to develop a program for public education related to water conservation including information on the County website, and links to EPA websites and other websites that promote water conservation. County efforts should provide conservation information that is useful to both citizens and businesses and should address those who are self-supplied as well as those who are served by community water systems.

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6.0 DROUGHT ASSESSMENT AND RESPONSE PLAN

6.1 Introduction

As required by the Regulation[160], a program that includes community water systems and self-supplied users who withdraw more than an average of 300,000 gallons per month of surface and ground water shall contain Drought Assessment and Response Plan.

The Regional Drought Assessment and Response Plan for Fluvanna County and the Town of Columbia has been prepared in accordance with the requirements of 9 VAC 25-780-120. The plan recognizes the unique characteristics of each water source within Fluvanna, as well as the beneficial uses of the water. Fluvanna County will take the lead on monitoring drought conditions and the Town of Columbia will declare drought stages following the County's declaration of any stage.

The Regulation requires at least three graduated stages of responses to the onset of drought conditions:

- *Drought watch* stage responses are generally responses that are intended to increase awareness in the public and private sector to climatic conditions that are likely to preclude the occurrence of a significant drought event. During this stage, public outreach activities are identified to inform the population served by community water systems of the potential for drought conditions to intensify and potential water conservation activities that may be utilized. Further, this stage alerts self-supplied users of the potential for drought conditions that may impact water supply.

- *Drought warning* stage responses are generally responses that are required when the onset of a significant drought event is imminent. *Voluntary* water conservation activities are identified with the goal of reducing water use by 10 – 15%.

- *Drought emergency* stage responses are generally responses that are required during the height of a significant drought event. *Mandatory* water conservation activities are identified with the goal of reducing water use by 10 – 15%.

[160] 9 VAC 25-780-120.

This Drought Assessment and Response Plan acknowledges the role of the Commonwealth in monitoring and responding to drought conditions as outlined in the Virginia Drought Assessment and Response Plan, dated March 28, 2003, while reserving the right to respond to those conditions and enforce the actions presented in this plan based on local conditions and local procedures.

The following section of this report details the proposed plan for Fluvanna County.

6.2 Purpose

The purpose of this Drought Assessment and Response Plan is to establish actions and procedures for managing water demand and evaluating supply options during periods of drought or other water supply emergency.

6.3 Sources of Public Water in Fluvanna County

There are several community water systems throughout Fluvanna County using either ground water or stream intakes.[161] The water systems using ground water include the Town of Columbia, Fork Union Sanitary District, Oakland School, Palmyra, Pine Grove Mobile Home Park, Stagecoach Hills, and Woodslodge Cottages. Community water systems using stream intakes include the Fluvanna Correctional Center for Women and Lake Monticello. The Fluvanna Correctional Center withdraws water from the Mechunk Creek and Lake Monticello withdraws from the Rivanna River.

There are also two non-agricultural self-supplied users of more than 300,000 gallons per month of surface water, both withdraw water from the James River; these users are Dominion Generation/Bremo Bluff and the Tenaska Generating Station. The following section describes the water systems in Fluvanna County that have obtained Virginia Water Protection (VWP) Permits from Virginia Department of Environmental Quality to withdraw and use water from a stream (either the James River, the Rivanna River, or Mechunk Creek).

[161] Source: VDH Records.

6.3.1 Lake Monticello

The VWP Individual Permit for Lake Monticello (Permit Number 95-0176) requires that, in the event of a drought emergency declared by the Governor or the Virginia Drought Coordinator, users supplied by Lake Monticello shall comply with the mandatory conservation measures outlined in Attachment A of the permit (refer to Appendix 5 for the VWP Permits). However, if a drought watch or warning is declared by Fluvanna County officials, users of water from the Lake Monticello system should voluntarily comply with the water conservations measures and restrictions detailed in this Plan. If Fluvanna County officials declare an emergency, residents in Lake Monticello should comply with the emergency restrictions. If at any time AquaVirginia declares an emergency, even if the County has not, residents should comply with the emergency measures of the VWP Permit.

6.3.2 Women's Correctional Center

The Fluvanna Women's Correction Center obtained a VWP Permit (Permit Number 95-0957) for withdrawal from the Mechunk Creek (see Appendix 5 for permit). This permit places some limitations on withdrawal from the creek. Further, the Department of Corrections has a drought response and conservation plan that governs water use at the facility (see Appendix 13).

This Drought Assessment and Response Plan recognizes DOC's Plan and recommends that DOC continue to operate under its Plan. If at any time that the County declares a drought emergency, and the DOC facility is not operating under "Code Red", DOC will be asked to declare "Code Red", if warranted. It is recommended that this process remain in place even after the DOC facility begins to receive water from Fluvanna County through the James River Water Authority.

6.3.3 James River Water Authority

As noted in other sections of this Plan, Fluvanna County now holds a VWP Individual Permit (Permit Number 04-0805) which authorizes the construction and operation of a municipal water supply intake which will withdraw water from the James River (see Appendix 5).

The James River Water Authority is a joint regional water authority that was formed by Fluvanna County and Louisa County in 2009. The Authority will own and operate a regional water supply system that will provide treated water to various systems in both Fluvanna County and Louisa County. Attachment A of the permit outlines the water uses that are prohibited when the Governor or the Virginia Drought Coordinator declares a drought.

This Plan anticipates that whenever Fluvanna County declares a drought stage, the retail users of the JRWA, whether located in Louisa or Fluvanna County, will be expected to comply with the Fluvanna restrictions.

6.3.4 East Coast Transport, Inc.

The VWP Individual Permit for East Coast Transport, Inc. (Permit Number 01-1282) places certain limitations on withdrawal from the James River. See pages 3-8 of the permit in Appendix 4. It is not anticipated that the Fluvanna County Drought Response and Contingency Plan will govern East Coast Transport, Inc.'s withdrawals from the James River.

6.3.5 Dominion Virginia Power

The Dominion Power Bremo Bluff Facility began withdrawals prior to July 1, 1989. As a result, there is no VWP for the facility, but the withdrawal is regulated by VDEQ. If any activity is proposed at this location that will increase the withdrawal amount, or will involve fill or excavation in surface waters (for example, intakes, upgrades, etc.) then the exclusion from VDEQ permitting may no longer apply and a VWP may be required, and, other state or federal permits may be required.[162]

It is not anticipated that the Fluvanna County Drought Response and Contingency Plan will govern Dominion Virginia Power's withdrawals from the James River.

[162] Source: As per VDEQ in an email in November 2009.

6.4 Drought Declaration and Notice – Fluvanna County

In the event of the onset of drought conditions, Fluvanna County and the Town of Columbia are given the authority to declare the appropriate drought response stage. There are two sections of the Code of Virginia that give governing bodies the authority to restrict the use of water: Section § 15.2-923 pertains to the nonessential use of ground water and Section § 15.2-924 provides the authority to restrict the use of water during a water supply emergency. The sections of the Code are as follows:

> § 15.2-923. Local water-saving ordinances:
> Notwithstanding any contrary provision of law, as shall be necessary to protect the public health, safety and welfare, any locality may by ordinance (i) require the installation of water conservation devices in the case of the retrofitting of buildings constructed prior to July 1, 1978, and <u>(ii) restrict the nonessential use of ground water during declared water shortages or water emergencies.</u>
>
> For purposes of this section "nonessential use" shall not include agricultural use.
>
> § 15.2-924. Water supply emergency ordinances.
> A. Whenever the governing body of any locality finds that a water supply emergency exists or is reasonably likely to occur if water conservation measures are not taken, it may adopt an ordinance restricting the use of water by the citizens of such locality for the duration of such emergency or for a period of time necessary to prevent the occurrence of a water supply emergency. However, such ordinance shall apply only to water supplied by a locality, authority, or company distributing water for a fee or charge. Such ordinance may include appropriate penalties designed to prevent excessive use of water, including, but not limited to, a surcharge on excessive amounts used.

6.5 Drought Planning in Fluvanna County and in the Commonwealth

The annual average precipitation in Fluvanna is approximately 41 inches. In most years, rainfall is adequate to maintain and replenish the ground and surface water supplies. However, the occurrence of droughts is a normal part of the weather cycle and should be expected. During droughts, water available from streams, rivers, springs, and wells can be severely diminished. In addition, water use can increase drastically during drought conditions.

Severe drought throughout the Commonwealth from 1999-2002 prompted the state government to establish a Drought Response Technical Advisory Committee. This committee was tasked with the development of a Drought Assessment and Response Plan for the Commonwealth. The Virginia Drought Assessment and Response Plan was used as a framework for this Drought Assessment and Response Plan for Fluvanna County. The Virginia Drought Assessment and Response Plan was used as a model in order to provide consistency with the Virginia Plan and to utilize the expertise and effort that went into the development of the Virginia Plan.

Important differences between the Virginia Drought Assessment and Response Plan and this regional plan include:

- Drought onset and stage declarations shall be made by the County Board of Supervisors after review of the drought indicators discussed herein. Further, the Town of Columbia will make drought declarations in accordance with County declarations.
- In order to monitor drought severity, the County will use three indicators, all of which are based on the amount of precipitation and the effect of the precipitation (or lack of precipitation) on the hydrologic system. These indicators are precipitation, ground water levels and stream flow.

The extent to which rural residents' and communities' drinking water supplies are impacted by drought depends on many factors. Obviously, the more severe and long-lasting the drought is, the greater the impact will be. Responding proactively to a developing water shortage can greatly reduce the risk that residents will face serious drinking water shortages during drought. The County website will be used to provide local officials and citizens with information regarding current drought conditions, recommended or required responses, and where to get additional information. Further, the County website will provide information to encourage water conservation at all times, not just during periods of low supply.

6.6 Overall Water Use Policy

This Drought Assessment and Response Plan is part of an overall water use policy that emphasizes the efficient use of water at all times, not just during drought. Overall water conservation efforts include:

- **Water Loss Reduction:** Fluvanna County will continue to reduce unaccounted for water by reducing water leaks in the water systems owned and operated by the County.

- **Water Efficiency:** Fluvanna County will encourage ongoing water demand management, water use efficiency and water conservation activities throughout the County by increasing public education efforts. The County website will be used for public education efforts.

- **Public Education and Outreach:** Improve the effectiveness of drought awareness by increasing public education efforts. The County website will be used to provide information about drought awareness and other forms of media (newspaper, radio and local television) may be used as well.

- The education and public awareness efforts made by Fluvanna County will be directed at all persons living in Fluvanna County, including the citizens of Columbia.

6.7 Drought Monitoring

This plan includes a monitoring framework that relies upon the monitoring of drought indicators to determine drought stages and resulting actions in the County. At the State level, during periods of normal moisture conditions, the Virginia Department of Environmental Quality monitors the National Oceanic and Atmospheric Administration (NOAA) U.S. Drought Monitor, and produces information from those reports specific to Virginia on a monthly basis.

The Virginia drought map is produced concurrent with the release of NOAA monthly and seasonal outlooks, which usually are released on the Thursday closest to the middle of the month.

County staff will monitor the Drought Map and the advance of drought conditions in the Commonwealth using the drought indicators described herein in order to determine when conditions warrant a drought stage declaration.

Other indicators such as the Standardized Precipitation Index, Palmer Drought Severity Index, Crop Moisture Index, Keetch-Byrum Drought Index, and NOAA monthly and seasonal precipitation outlooks will be monitored and will be used as necessary to enhance decision-making regarding drought declaration.

6.8 Local Drought Indicators

In order to monitor potential drought conditions Fluvanna County staff will use three indicators to evaluate drought severity. These indicators include precipitation, ground water levels, and stream flow. All three indicators are discussed below.

6.8.1 Precipitation Deficits

Precipitation deficits will be monitored by comparing current precipitation amounts with historical precipitation values as a percent of normal long-term average values.

Comparisons will be made using data compiled by the Office of the State Climatologist. Normal long-term average precipitation is defined as the mean precipitation for a thirty-year period of record for the area and time period being evaluated. Precipitation amounts will be evaluated based on the water year (beginning October 1).[163] If a precipitation deficit outside of the normal range exists at the end of a water year, the precipitation records will carry forward until a normal condition is reached (i.e. if a precipitation deficit exists on October 1, precipitation records for the previous twelve months will be evaluated until the twelve month deficit is eliminated).

Because the significance of a precipitation deficit changes as the water year progresses, drought response stages will be declared at different percentages of normal depending on the date of evaluation. The criteria for the three drought response stages for precipitation levels are as follows:

[163] Water years are a natural dividing point for water supply drought, as precipitation that falls in the first six months of a water year is analogous to putting money in the bank. Precipitation that occurs during this six-month period has the potential to recharge ground water, which will sustain stream flows and support withdrawals from wells during the following six-month period when moisture deficits naturally develop as evaporation and plant transpiration generally exceed precipitation.

Table 6-1: Fluvanna County - Drought Stages Based on Precipitation Levels[164]

Months Analyzed	Normal (% of Normal Precipitation)	Watch (% of Normal Precipitation)	Warning (% of Normal Precipitation)	Emergency (% of Normal Precipitation)
October – December	>75.0	<75.0	<65.0	<55.0
October – January	>80.0	<80.0	<70.0	<60.0
October – February	>80.0	<80.0	<70.0	<60.0
October – March	>80.0	<80.0	<70.0	<60.0
October – April	>81.5	<81.5	<71.5	<61.5
October – May	>82.5	<82.5	<72.5	<62.5
October – June	>83.5	<83.5	<73.5	<63.5
October – July	>85.0	<85.0	<75.0	<65.0
October – August	>85.0	<85.0	<75.0	<65.0
October – September (and previous 12 months)	>85.0	<85.0	<75.0	<65.0

6.8.2 Ground Water Levels

There are no observation wells in Fluvanna County and very few in adjacent counties.[165] The closest wells to Fluvanna County are:[166]

Table 6-2: Observation Wells Near Fluvanna County

Locality	Site ID	Site Name	National Aquifer	Local Aquifer	Depth of Well
Louisa Co.	380043078111301	45N 4	Piedmont and Blue Ridge Crystalline-Rock Aquifer	Metamorphosed Volcanic and Sedimentary Rocks	200 ft.
Louisa Co.	380131078001001	46N 1 SOW 056	Piedmont and Blue Ridge Crystalline-Rock Aquifer	Metamorphosed Volcanic and Sedimentary Rocks	132 ft.
Albemarle Co.	380333078264801	43N 1 SOW 028	Piedmont and Blue Ridge Crystalline-Rock Aquifer	Lynchburg Formation	409 ft.
Cumberland Co.	373146078161201	44J 1 SOW 227	Piedmont and Blue Ridge Crystalline-Rock Aquifer	No information available.	202 ft.

[164] Percentages based on data from the Virginia Drought Assessment and Response Plan.
[165] The USGS Ground Water Climate Response Network lists two wells in Louisa, one in Albemarle, and one in Cumberland. There is one observation well in Buckingham County, but it is in the southern part of the county and is much further away from Fluvanna than the wells in Louisa, Albemarle, and Cumberland. There are no observation wells located in Goochland County.
[166] Information from the USGS website is included in **Appendix 14.**

Two wells will be used as drought indicators for Fluvanna County. The westernmost well in Louisa County (Site 45N 4) will be used as an indicator because of its vicinity to Fluvanna County, and the well in Albemarle County (43N 1 SOW 028) will also be monitored because it lies within the same drainage system as Fluvanna. Ground water levels in these two wells may provide an indication of ground water conditions in Fluvanna. Measured ground water levels will be compared with historic level statistics for the period of record.

Table 6-3: Fluvanna County - Drought Stages Based on Ground Water Levels

Drought Stage	Criteria
Watch	Measured ground water level between the 25^{th} and 50^{th} percentile for all historic levels.
Warning	Measured ground water level between the 10^{th} and 25^{th} percentile for all historic levels
Emergency	Measured ground water level less than the 10^{th} percentile for all historic levels.

Measured ground water level above the 50th percentile for all historic levels will be defined as normal conditions. Measured ground water level between the 25th and 50th percentiles for all historic levels will be defined as drought watch conditions. Measured ground water level between the 10th and 25th percentile for all historic levels will be defined as drought warning conditions. Measured ground water level below the 10th percentile for all historic levels will be defined as drought emergency conditions.

6.8.3 Stream Flow

The following stream flow gages will be used to monitor stream flow responses to drought conditions. These stream flow gages represent the Middle James Drought Evaluation Region, which includes Fluvanna County. Representative daily flow values will be compared with historic flow statistics for the period of record. Representative daily stream flows above the 25th percentile for return flow frequency will be defined as normal conditions. A stream flow that represents the 25th percentile of return flow frequency indicates that, for the period of record, 75% of stream flows have exceeded the current flow.

Table 6-4: Fluvanna County – USGS Stream Flow Gages

Gage	Stream / Location
USGS 02034000	Rivanna River at Palmyra, VA
USGS 02035000	James River at Cartersville, VA
USGS 02030500	Slate River Near Arvonia, VA

The following table summarizes the drought stage criteria.

Table 6-5: Fluvanna County - Drought Stages Based on Stream Flow

Drought Stage	Criteria	Description (USGS Site)
Watch	Representative daily stream flows between the 10^{th} and 24^{th} percentile for return flow frequencies.	Below Normal
Warning	Representative daily stream flows less than 10^{th} percentile	Much Below Normal
Emergency	Representative stream flows below the 5^{th} percentile for return flow frequencies	Low

6.8.4 Other Indicators

Fluvanna County will evaluate other available drought information during deliberations related to the development of drought stage recommendations. Other drought indicators that may be considered include the Standardized Precipitation Index, Palmer Drought Severity Index, Crop Moisture Index, NOAA monthly and seasonal precipitation outlooks. Also, antecedent effective ground-water recharge rates, as estimated from hydrograph separation techniques, will be considered.

6.9 Declaration of Drought

The County Administrator will use the following general descriptions of three drought stages when advising the Board of Supervisors concerning drought declarations. These descriptions should not be viewed as absolute requirements for drought designation, but as a mechanism to be used to reach the appropriate drought advisement. The specific response activities that are delineated below for the three drought stages should be viewed as activities that should be initiated in response to a drought stage declaration.

When the Board of Supervisors declares a drought condition, the County Administrator will notify the Town of Columbia of the Board's action. The Town of Columbia will declare the same drought stage and provide notice to the citizens of the Town.

6.10 Declaration of Drought by Governor or Virginia Drought Coordinator

In the event that the Governor or the Virginia Drought Coordinator declares a drought emergency in a region that includes Fluvanna County, the mandatory conservation measures detailed below will be implemented upon the drought declaration, unless the governor's restrictions are more restrictive, or unless local conditions differ.

6.11 Drought Stages

In Fluvanna County, there are three drought stages that are governed by precipitation levels, stream flow and ground water levels. These drought stages include drought watch, drought warning, and drought emergency. If the indicators meet the criteria for a drought stage to be declared, the County Administrator will recommend that the Board of Supervisors declare the stage.

6.11.1 Drought Watch

The drought watch stage is intended to increase public awareness of climatic conditions that are likely to precede the occurrence of a significant drought event. When a drought watch is warranted, the County Administrator will advise the Board of Supervisors to declare a drought watch. The County will call upon the general population to employ prudent restraint in water usage, and to conserve water voluntarily. A list of suggested voluntary conservation efforts is included below.

It is unlikely that significant water use reductions will occur at this stage although it is possible that the increased public awareness of water conservation activities may reduce water use up to 5%.

6.11.2 Drought Warning

When a drought warning is declared in accordance with the Drought Assessment and Response Plan, the County Administrator shall advise the public to curtail non-essential usages of water. See below for a list of nonessential uses that should be curtailed during a drought warning.

Water conservation activities at this stage would be voluntary. Voluntary water conservation activities generally result in reductions in water use of 5-10%.

6.11.3 Drought Emergency

When a drought emergency is declared in accordance with the Drought Assessment and Response Plan, the Board of Supervisors shall restrict the use of water to purposes which are absolutely essential to life, health and safety. All nonessential uses of water should be eliminated. During these times, it is likely that some water supplies will not provide the quantity of water needed by all users.

Mandatory water conservation activities usually result in water use reductions of 10-15%.

See below for a list of prohibited uses during a drought emergency.

6.12 Enforcement

Enforcement of this plan will be in accordance with the County's Drought Ordinance included in **Appendix 11**.

6.13 Governmental Actions in Response to Drought Stages

In Fluvanna County, the County Administrator (or his designee) will be responsible for monitoring precipitation, stream flow, and ground water levels and making periodic reports to the Board of Supervisors. At any time that any of the indicators warrant the declaration of a drought watch, warning or emergency, the County Administrator will advise the Board of Supervisors. Further, the declaration and the related water use restrictions, if any, shall be posted on the County's website and shall be published in local newspapers.

6.13.1 Normal Conditions - Indications

None of the indicators are outside of the normal range.

- Precipitation exceeds the percent of normal precipitation for the time period in precipitation table.
- Ground water levels are above the 50th percentile for all historic levels.
- Stream flows are above the 25% percentile for return flow frequencies.

6.13.2 Normal Conditions – Action to be Taken

None.

6.13.3 Drought Watch - Indications

At least one of the three indicators meets the following conditions:

- Precipitation levels are at or below the percent of normal precipitation for the time period in precipitation table.
- Ground water levels fall between the 25th and 50th percentile for all historic levels.
- Stream flows are between the 10th and 25th percentile for return flow frequencies.

6.13.4 Drought Watch - Action to be Taken

- County Administrator will advise the Board of Supervisors regarding the declaration of a Drought Watch.
- The Board will issue a press release indicating the reasons for the declaration.
- Citizens will be asked to begin voluntary water conservation.
- County Administrator will continue to monitor regional moisture conditions and provide periodic reports of drought conditions to the Board.
- The Board will make periodic reports of drought conditions available to media outlets.
- County Administrator, under advisement from the Board will encourage all community waterworks, non-transient non community waterworks, and self supplied water users to begin voluntary conservation as outlined in this document.
- The County will include water conservation information on its website and will distribute water conservation information as broadly as possible.
- The County will monitor problems incurred by the public and by any water supplier.

6.13.5 Drought Warning - Indications

Two of the indicators meet the following conditions:

- Precipitation levels are at or below the percent of normal precipitation for the time period in precipitation table
- Measured ground water levels fall below the 25th percentile for all historic levels.
- Stream flow levels are between the 5th and 10th percentile for return flow frequencies.

6.13.6 Drought Warning - Action to be Taken

When there is a drought warning, the following actions are recommended:

- County Administrator will advise the Board of Supervisors regarding the declaration of a Drought Warning.
- The Board will issue a press release indicating the reasons for the declaration.
- County Administrator will continue to monitor regional moisture conditions and provide periodic reports of drought conditions to the Board.
- The Board will make regular reports of drought conditions available to media outlets.
- All community waterworks, non-transient non community waterworks, and self supplied water users will be asked to voluntarily observe the water conservation restrictions outlined in this document.[167]
- The County will include water conservation information on its website and will distribute water conservation information as broadly as possible.
- County will continue monitoring problems incurred by the public and by any water supplier.
- All local government offices and institutions will initiate the reduction or elimination of nonessential uses of water with the goal of reducing total water usage by 5-10%.

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[167] A list of all the community water systems and contact information in included in **Appendix 15.**

6.13.7 Drought Emergency - Indications

All three indicators meet the following conditions:

- Precipitation levels are at or below the percent of normal precipitation for the time period in the precipitation table.
- Measured ground water levels fall to or below the 10th percentile for all historic levels.
- Representative daily stream flows fall below the 5th percentile.

6.13.8 Drought Emergency - Action to be Taken

- The County Administrator will advise the Board of Supervisors regarding the declaration of a Drought Emergency.
- The Board will issue a press release indicating the reasons for the declaration.
- County Administrator will continue to monitor regional moisture conditions, stream flow and ground water levels and will provide periodic reports of drought conditions to the Board.
- The Board will encourage media outlets to publicize updates of drought conditions.
- The Board will require all community waterworks, non-transient non-community waterworks to initiate mandatory water conservation requirements. Further, the Board will encourage self-supplied users to eliminate any non-essential use of water and to conserve by whatever means possible.
- The County will include water conservation information on its website and will distribute water conservation information as broadly as possible.
- Staff will continue monitoring problems incurred by the public and by any water supplier.

6.14 Response to Drought – Drought Watch Stage

During a drought watch stage, responses to drought are voluntary. The following actions are those that are recommended during a drought watch.

Table 6-6: Fluvanna County Voluntary Water Conservation Measures – Drought Watch

Category	Conservation Measure
Established Landscape and Gardens	Restrict watering with hose or in-ground irrigation systems; Water no more often than 3 times per week, maximum of 1-inch per watering. Watering with a bucket permitted at any time
New Landscape	Unrestricted watering for the first 10 days after planting, then follow "Established Landscape and Gardens" measures.
Vegetable Gardens	Reduce watering to hours between 8 p.m. -10 a.m.; Unrestricted watering may continue on any two days per week at the discretion of the owner (Watering by bucket is unrestricted).
Paved Areas (Streets, Drives, Patios, Walks, etc.)	Reduce washing to four days per week and for immediate health and safety.
Vehicle Washing (Commercial Businesses Exempt)	Reduce washing of mobile equipment to any hours during any four days in a week using a handheld hose with an automatic shutoff nozzle.
Swimming Pools and Hot Tubs	Reduce filling and replenish to levels required to maintain health and safety.
Golf Courses (Greens Exempt)	Water between 8 p.m. - 10 a.m.
Businesses	Reduce non-essential water use.
Restaurants	No restrictions.
Fountains	Reduce hours of operation – at owners' discretion.
All Other Uses, Including Indoor Residential Use	Encourage conservation by any means.

6.15 Response to Drought - Drought Warning Stage

During a drought warning stage, responses to drought are voluntary; the following actions are recommended.

Table 6-7: Fluvanna County Voluntary Water Conservation Measures – Drought Warning

Category	Conservation Measure
Lawns, Established Landscape and Gardens	Monday - No Watering; Odd property addresses water Tuesdays, Thursdays, and Saturdays; Even property addresses water Wednesdays, Fridays, and Sunday; and Bucket Watering (five-gallon maximum) permitted anytime.
New Landscape	Unrestricted watering for the first 10 days after planting, then follow "Established Landscape and Gardens" measures.
Vegetable Gardens	Reduce watering to hours between 8 p.m. -10 a.m.; Unrestricted watering may continue on any two days per week at the discretion of the owner. (Watering by bucket is unrestricted).
Paved Areas (Streets, Drives, Patios, Walks, etc.)	Reduce washing to two days per week and for immediate health and safety.
Vehicle Washing (Commercial Businesses Exempt)	Reduce washing of mobile equipment to any hours during any two days in a week using a handheld hose with an automatic shutoff nozzle.
Swimming Pools, Hot Tubs	Reduce filling and replenish to levels required to maintain health and safety.
Golf Courses (Greens Exempt)	Water between 8 p.m. - 10 a.m.
Businesses	Reduce non-essential water use.
Restaurants	Serve water by request only.
Fountains	Limit filling and replenishing to 2 days per week, from 8p.m. – 10 a.m. Unrestricted operation may continue on any two days a week at the discretion of the owner.
All Other Uses, Including Indoor Residential Use	Encourage conservation by any means.

6.16 Response to Drought - Drought Emergency Stage

During a Drought Emergency, the following 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 so long as best management practices are applied to assure the minimum amount of water is utilized.

Table 6-8: Fluvanna County Mandatory Water Restrictions

Category	Mandatory Conservation Measures
Established Lawns	Watering is prohibited. Bucket watering (five-gallon maximum) is permitted any time.
New Lawns	Watering is permitted for the first 30 days after sodding or seeding. Thereafter, the restriction for established lawns shall apply. New lawns do not include refurbishment of established lawns by means of aeration and seeding, dethatching and seeding, or power overseeding.
New Landscaping	Watering is permitted for the first 30 days after planting. Thereafter, the restriction for established landscaping shall apply.
Established Landscaping	Watering is limited to three days per week by address. Addresses ending with an odd number may water only on Tuesday, Thursday, and Saturday. Addresses ending with an even number, or with no number, may water only on Wednesday, Friday, and Sunday. No watering is allowed on Mondays. Bucket watering is permitted any time.
Fountains	Water use is prohibited.
Paved Areas	Washing is prohibited except for health and safety requirements.
Swimming Pools, Hot Tubs	Filling and replenishing to maintain health and safety is permitted. New or repaired pools may be filled as needed to maintain their structural integrity. All other uses are prohibited.
Vehicle Washing	Non-commercial washing of cars is prohibited, except that construction, emergency or public transportation vehicles, may be washed as needed to preserve their proper functioning and safe operation. Commercial vehicle washing businesses are permitted to operate under normal conditions.
Restaurants	Water shall be served to customers only upon request.
Golf Courses	Watering is prohibited from 10:00 a.m. to 8:00 p.m., except for the watering of greens or watering by hand held hoses that are one inch or smaller in diameter.
All Other Businesses	Water use is limited to uses essential for business use and human hygiene.
Athletic Fields	Athletic fields may be watered only between 8:00 p.m. and 10:00 a.m. and only at a rate not exceeding a total of one inch during any ten-day period.
All other consumption	Conservation by any means is required.

6.17 Enforcement of Mandatory Restrictions

Any person, firm or corporation, whether as principal, agent, employee, or otherwise who violates or fails to comply with the mandatory conservation restrictions after a public notice has been issued shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not less than $10.00 nor more than $1,000.00. Such person, firm or corporation shall be deemed to be guilty of a separate offense for each violation of said restriction that is committed, continued, or permitted by such persons, firm or corporation.

In addition, the County Administrator or his designee shall have all necessary authority on behalf of the governing body to administer and enforce the mandatory drought restrictions as detailed in the drought ordinance, including the ordering in writing of the remedying of any condition found in violation of the ordinance, and the bringing of legal action to insure compliance with the ordinance, including injunction, abatement or other appropriate action or proceeding.

6.18 State of Emergency

In some cases, the mandatory nonessential water use restrictions may not be sufficient to protect the supplies of an individual public waterworks. When water sources are so depleted as to threaten public health and safety, it may become necessary to ration water within that system in order to assure that water is available to support essential uses. Rationing water is a more severe measure than merely banning nonessential uses of water. Under rationing, each water user is allotted a given amount of water, based on a method of allotment developed by the local government. Generally, it will be based on a percentage of previous usage or on a specific daily quantity per household. Rationing is more likely to have some effect on welfare than mandatory nonessential use restrictions, because industrial and commercial water uses may be curtailed or eliminated to assure an adequate supply is available for human consumptive uses.

The decision to ration water will typically be made by the Board of Supervisors. Staff will work closely with any entity where water rationing is required to assure that all available State resources are effectively used to support these highly stressed water supply systems. The Virginia Department of Emergency Management (VDEM) is the first point of contact for waterworks or local governments who decide to ration water. VDEM will coordinate the Commonwealth's response and assistance to such entities.

7.0 PROJECTED WATER DEMANDS

VDEQ's Water Supply Planning Regulations require projections of future water demand for a period of 30 – 50 years. The projections need to be disaggregated into categories of use, such as residential, commercial, industrial, etc. The future demands for each community water system, all self-supplied users[168], agricultural users and non-agricultural users must be included in the Plan.

The existing water sources are summarized below. As shown, the water withdrawn from all sources is approximately 55,416 million gallons per year, or 151.83 million gallons per day. Of that amount, approximately 99% of the current withdrawal is from surface water sources.[169] Further, the community systems and self-supplied homes and businesses total less than 2% of the usage.

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[168] As per the VDEQ regulation: "Self-Supplied" means any person making a withdrawal of surface or ground water from an original source (for example, a river, stream, lake, aquifer or reservoir fed by any such water body) for their own use. Self-supplied users do not receive water from a community water system.

[169] The Tenaska intake station is located in Buckingham County. The water is piped across the James River and used at the Tenaska facility which is located in Fluvanna. (See Figure 2-1 for the general location of the Tenaska facility). The Tenaska operation also includes a surface water reservoir where water is stored prior to usage at the facility. Since the intake is in Buckingham County, based upon VDEQ's recommendation, usage data for the Tenaska facility is not detailed in this plan.

Table 7-1: Summary of All Withdrawals[170]

	Annual Withdrawal (MG)	Source (Surface Water, Ground Water or Not Known)	% of Overall Withdrawal
Community Systems			
Columbia, Town of	1.43	Ground Water	
Fork Union S.D.	69.29	Ground Water	
Lake Monticello	231.30	Surface Water	
Palmyra	1.51	Ground Water	
Pine Grove Mobile Home Park	1.58	Ground Water	
Stagecoach Hills (estimated)	2.58	Ground Water	
Woodslodge Cottages	0.354	Ground Water	
Oakland School	5.08	Ground Water	
Fluvanna Correctional Center	41.44	Surface Water	
Subtotal	**354.56**		**<1%**
Self-Supplied Residential	469.77	Ground Water	<1%
NTNC Systems	10.46	Ground Water	0%
TNC Systems (estimated .5 MG per business/year)	1.50	Ground Water	0%
Self-Supplied Businesses (70 estimated, 250,000 gallons/year)	17.50	Ground Water	0%
Agricultural – Livestock	3.01	Not Known, likely a combination of ground water and surface water.	<1%
Agricultural – Crops	374.25		
Dominion (Ground Water)	0.77	Ground Water	0%
Lake Monticello Golf	19.00	Surface Water	0%
Laurel Ridge Golf / Rivanna Resort (estimated)	19.00	Surface Water	0%
Dominion Generation (Surface Water)	54,147.00	Surface Water	97.7%
Total (per year)	**55,416.82 MG**		
Million Gallons per Day	**151.83 MGD**		

7.1 Historic Population Counts and Current Population Estimates

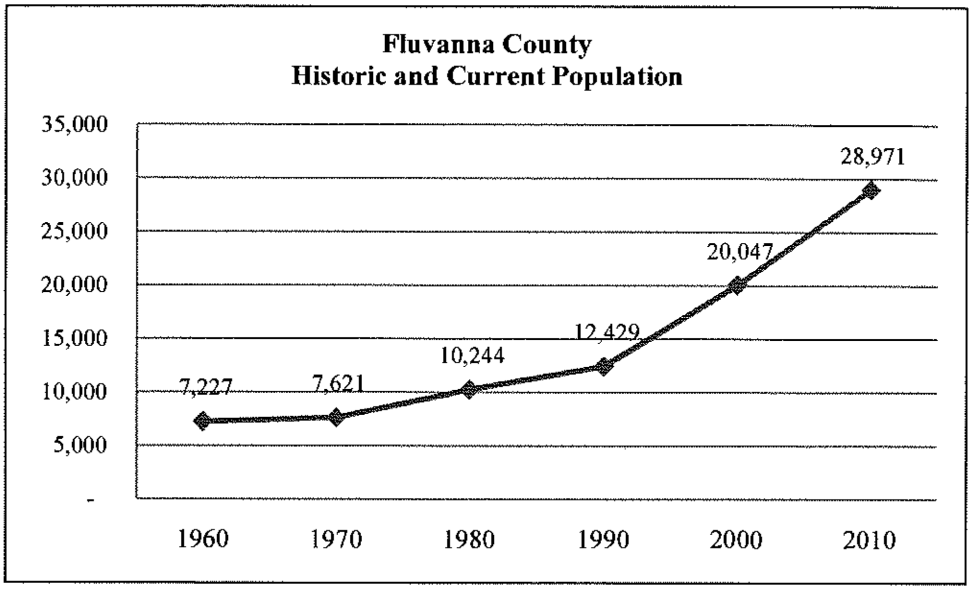
The following table shows the historic and current population of Fluvanna County.

Table 7-2: Historic Population Counts and Current Estimated Population

Year	Population	Change Over Decade (#)	Change Over Decade (%)
1960 Census	7,227	-	-
1970 Census	7,621	394	5%
1980 Census	10,244	2,623	34%
1990 Census	12,429	2,185	21%
2000 Census	20,047	7,618	61%
2010 (VEC Estimate)	28,971	8,924	45%

170 2008 Data.

Figure 7-1: Historic and Current Population



7.2 Projected Population

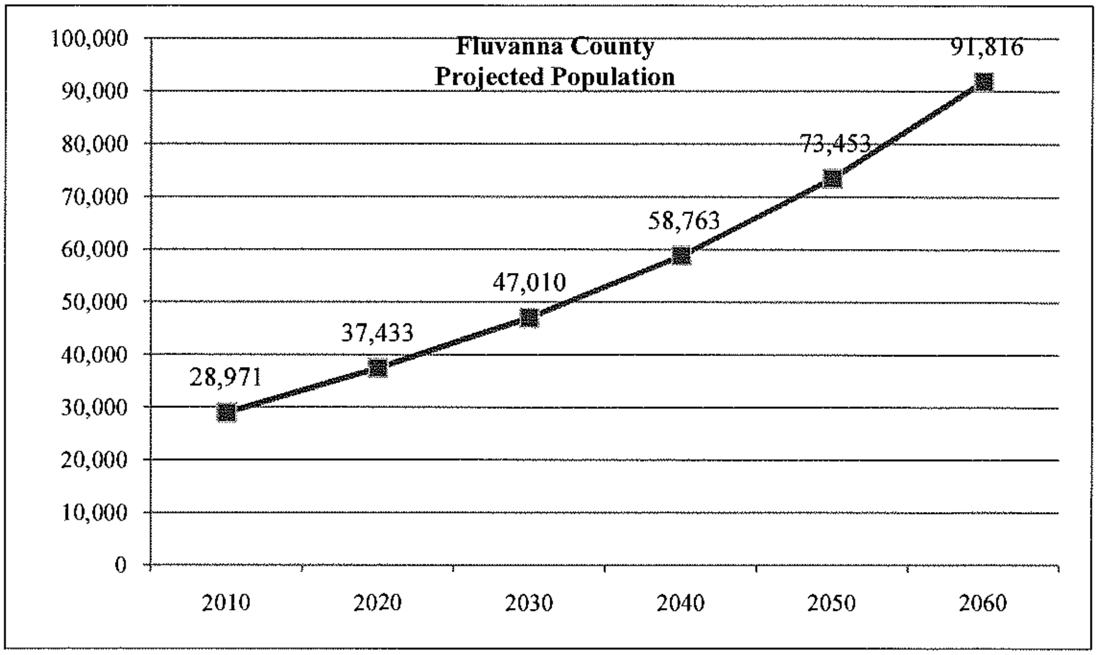
The Virginia Employment Commission provides the following projected population for Fluvanna County for 2020 and 2030. The following table and chart assume that the growth rate remains constant for the three decades following 2030 (or, through 2060). It is possible that the current growth rate will not continue for 50 years, therefore, it is recommended that Fluvanna County review this section of the Water Supply Plan on a regular basis and adjust the demand projections as necessary. It is important to recognize that projections beyond 10 or 20 years are much less reliable and will need to be adjusted as development occurs to reflect actual development patterns in the county.

Table 7-3: Projected Population, 2010 - 2060[171]

Year	Projected Population	Change Over Decade (#)	Change Over Decade (%)
2010 (estimate)	28,971	-	-
2020	37,433	8,462	29%
2030	47,010	9,577	26%
2040	58,763	11,753	25%
2050	73,453	14,691	25%
2060	91,816	18,363	25%

[171] Source of population projections for 2010 – 2030: State Data Center, VEC.

Figure 7-2: Projected Population, 2010 - 2060



7.3 Projecting Future Water Demands

The 2009 Comprehensive Plan and the 2029 Future Land Use Map have been utilized as the basis for projecting future water demands. The 2029 Future Land Use Map (from the 2009 Comprehensive Plan) and a map showing the election districts follow.

Fluvanna County

2029 Future Land Use Map

Not to Scale

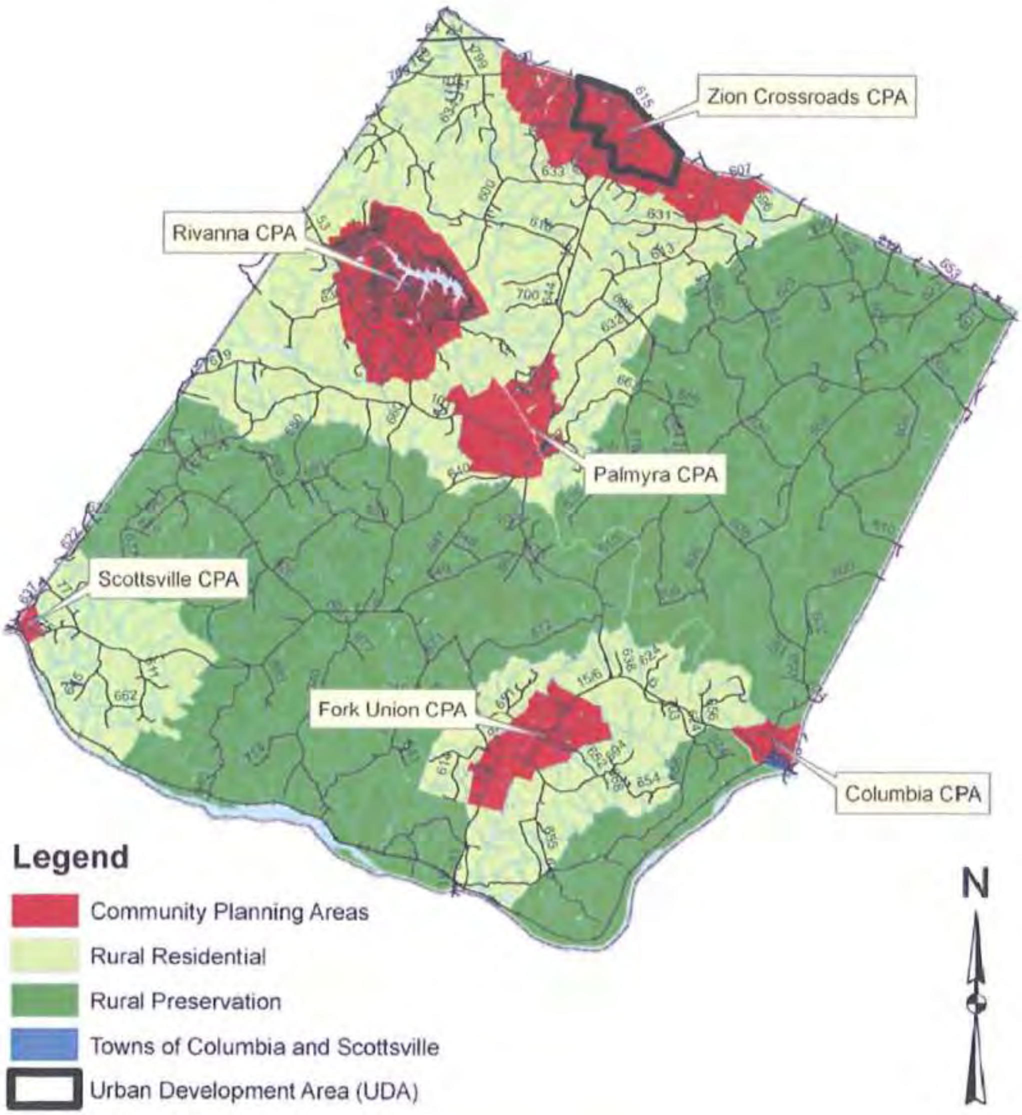


Figure LU-23, 2029 Future Land Use Map

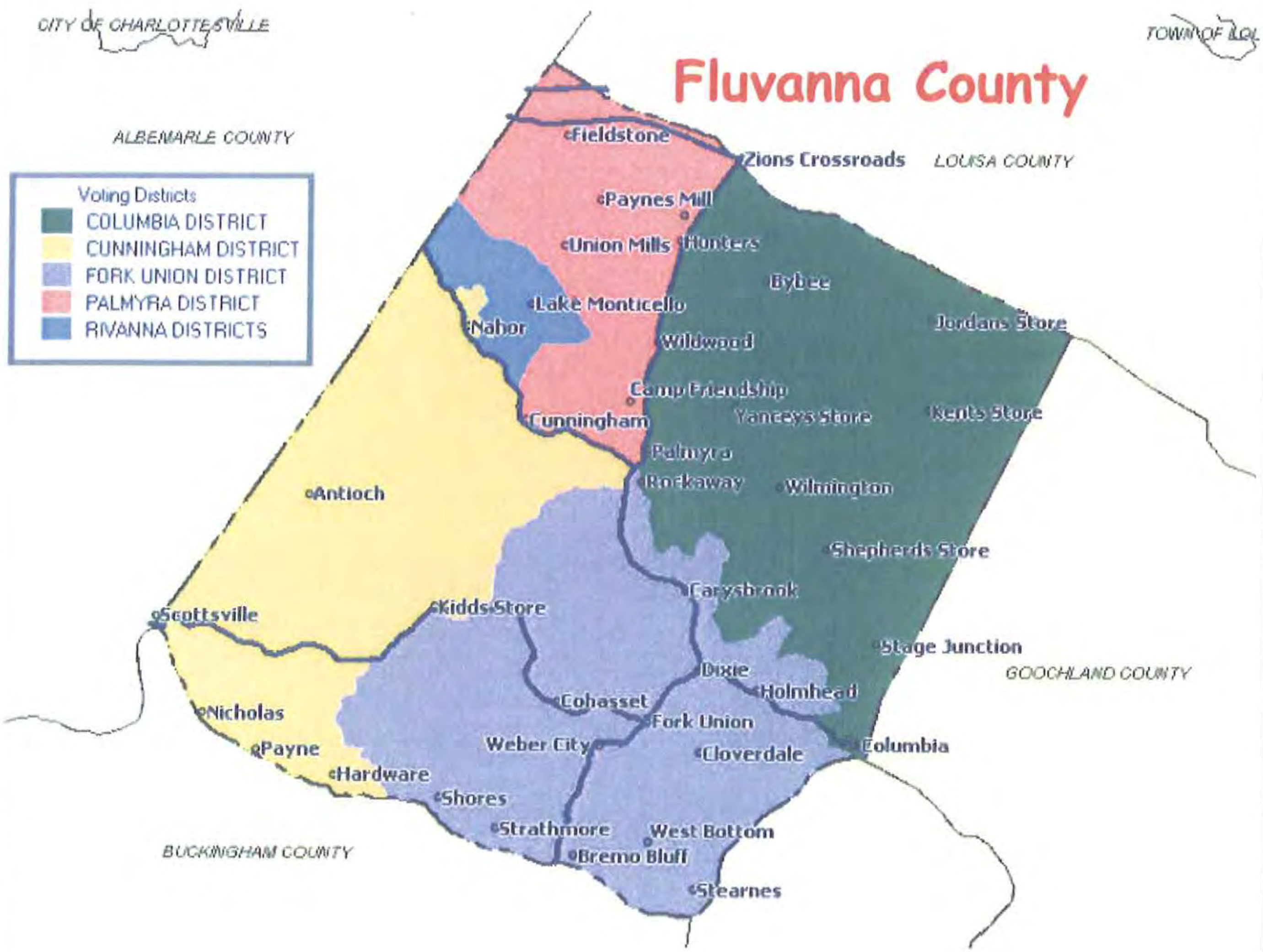
Not to Scale
Source: Fluvanna County Comprehensive Plan

Draper Aden Associates
Engineering • Surveying • Environmental Services
8090 Villa Park Drive
Richmond, VA 23228
804-264-2228 Fax: 804-264-8773
Blacksburg, VA
Charlottesville, VA
Hampton Roads, VA

FUTURE LAND USE

Fluvanna County, Virginia

FIGURE 7-3



Not to Scale
Source: Fluvanna County

Draper Aden Associates
Engineering • Surveying • Environmental Services
8090 Villa Park Drive
Richmond, VA 23228
804-264-2228 Fax: 804-264-8773
Blacksburg, VA
Charlottesville, VA
Hampton Roads, VA

VOTING DISTRICTS

Fluvanna County, Virginia

FIGURE 7-4

P:\R09100\R09163R\R09163R-01\GIS\MAP - 10 0416 - Figure 7-4 - Voting Districts - AWG.mxd - 4/16/2010 @ 12:29:55 PM

The Fluvanna County Comprehensive Plan, adopted March 2009, provides information about the existing conditions in various areas of the county and outlines the vision for the community over the next twenty years. The major land-use designations include:

- Community Planning Areas,
- Rural Residential, and
- Rural Preservation.

The preference for dispersion of new development within these land use classifications is:

- 70% in community planning areas,
- 20% in rural residential areas, and
- 10% in rural preservation areas.

7.4 The Community Planning Areas

The Land Use Plan identifies six community planning areas (CPAs).

- Zion Crossroads CPA
- Rivanna CPA
- Palmyra CPA
- Fork Union CPA
- Columbia CPA
- Scottsville CPA

The community planning areas are the areas where more dense development is encouraged. The following section is taken from the 2009 Comprehensive Plan[172] and describes the vision for these CPAs.

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[172] See pages 54 – 60 of the 2009 Comprehensive Plan.

7.4.1 *Zion Crossroads CPA*

This area is the county's primary regional economic development area and is targeted as a regional employment center and for primarily mixed-use, mixed-income development that will diversify the county's tax base and provide housing.

Large, medium, and small commercial businesses, along with office, civic, and multi-family residential uses, combine to form a neotraditional development or series of interconnected developments. Commercial and office structures will not exceed six stories, and residential density is up to 10 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.4.2 *Zion Crossroads Urban Development Area*[173]

The Comprehensive Plan designates the Zion Crossroads area as an Urban Development Area (UDA) in compliance with *Virginia Code* section 15.2-2223.1 which mandates that all high-growth counties create urban development areas of sufficient size and density to accommodate residential, commercial and industrial growth. The UDA is located in an area where high-density development is appropriate due to proximity to transportation and proximity to public water and sewer. As a result, the County will need to provide water and sewer to this area in order to comply with the mandate of the *Code of Virginia.*

7.4.3 *Rivanna CPA*

The Rivanna CPA is home to approximately half of the county's residents in the Lake Monticello community. The area is traditionally neighborhood residential, with primarily single-family detached dwellings. Surrounding growth should be a mixture of uses and residential dwelling types that serve a variety of incomes. Neighborhood mixed-use is needed to offset the single-family development already in this community. Additional services and infrastructure are needed to accommodate more growth.

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[173] See page 52 of the Comprehensive Plan.

Medium and small commercial businesses, along with office, civic, and residential uses, combine to form a series of neotraditional developments that are interconnected with surrounding development. Commercial and office structures will not exceed four stories, and residential density is up to 6 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.4.4 Palmyra CPA

The historic Palmyra village area is the county seat, and has a regional park, the future county high school campus, a library, a public safety center, and other municipal services. The area should remain a village, and surrounding growth should be a mixture of uses and residential types that serve a variety of incomes.

A mixture of medium and small commercial businesses, along with office, civic, and residential uses, will form a village-like neotraditional development or series of interconnected developments. Commercial and office structures will not exceed three stories, and residential density is up to 4 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.4.5 Fork Union CPA

This historic village is home to the Fork Union Military Academy. The area should remain a village, and surrounding growth should be a mixture of uses and residential dwelling types that serve a variety of incomes.

A mixture of smaller-scale commercial businesses, along with office, civic, and residential uses, will form a village-like neotraditional development or series of interconnected developments. Commercial and office structures will not exceed three stories, and residential density is up to 4 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.4.6 Columbia CPA

The Columbia CPA lies mostly within a floodplain and needs to be comprehensively revitalized either as a village or neighborhood mixed-use project. There are potentially beautiful views of the Rivanna and James Rivers, but development within the floodplain would have to be either elevated or carefully placed and constructed. In the future, the rail line could be used for commuter transportation to Richmond as well as increased freight. This historic town relied heavily on the rivers for commerce, but now they would make it an excellent heritage and eco-tourism destination, with the rail line serving as a commerce and commuter lifeline.

A mixture of smaller-scale commercial businesses combined with office and residential uses form a village-like neotraditional development or series of interconnected developments. Commercial and office structures will not exceed four stories, and residential density is up to 6 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.4.7 Scottsville CPA

The county's newest community planning area, Scottsville is also an historic town that lends itself to well-planned neighborhood mixed-use development with some limited neighborhood residential on the periphery. All development should enhance the character of the area and reinforce the village-like atmosphere of the town.

A mixture of smaller-scale commercial businesses combined with office and residential uses form a village-like neotraditional development or series of interconnected developments. Commercial and office structures will not exceed two stories, and residential density is up to 4 dwelling units per acre. Density may be increased with incentives such as open space, affordable housing, or transfer of development rights, depending on the zoning district standards.

7.5 Rural Areas

The Comprehensive Plan emphasizes the goal of maintaining the rural character of the county and there are two land use designations that seek to preserve the rural nature of Fluvanna.[174] The following describes these two designations.

7.5.1 Rural Residential

The rural residential areas generally surround the CPAs. Rural residential areas are intended to conserve open space by clustering development or by developing on larger lots. Regardless of the type of development, the project should achieve the goal of preserving as much open space, and thus, the rural character as possible.

7.5.2 Rural Preservation

The rural preservation areas are intended to be the least developed areas of the county. Large parks, agricultural and forestall districts, working farms and passive open spaces should comprise most of the land use, with very low-density residential development (i.e. less than one unit every five acres).

7.6 Demand Projections Based on Population Growth

The following methodology was used to project population and related water demands in Fluvanna County through 2060.

- The number of dwelling units and non-residential structures in each land use type was estimated using GIS information.
- Using current water withdrawal, water use and billing data from the community water systems, the number of homes and population served by each system was calculated. (See **Appendix 17**. The first page shows the detailed number of dwelling units, estimated population and disaggregated uses for all water use in the county and is based on 2008 water usage, 2008 population and projected population for 2010.)

[174] See pages 60 and 61 of the Comprehensive Plan.

- Using the Planning Department's Development Activity Report, the number of approved subdivision lots was examined and was used to project the growth within each of the Community Planning Areas, the Rural Preservation areas and the Rural Residential areas.[175]
- The population projections are based on the projections shown in Figure 7-2.
- These projections assume that an adequate quantity of water is available from a community water system to allow the Urban Development Area to develop as envisioned in the Comprehensive Plan.
- It is assumed that the Lake Monticello system continues to provide water service to the Rivanna CPA.
- The water demands at the Department of Corrections facility are not projected to change.

Table 7-4 summarizes the projected water demands over the next 50 years by planning area. **Appendix 17** provides the estimated population and water demands for the planning areas for each decade, includes disaggregated use, and includes the projected peak demands. The projections in the Zion Crossroads and Fork Union areas are consistent with both the population projections and the water demands presented in the Preliminary Engineering Report for the James River Water System prepared by Timmons in March 2009.

The projection of future water demands based on population growth is used in the Statement of Needs and Alternatives Section of this Plan.

7.7 Projected Demands Based on Buildout

Another method of projecting demands is based on calculating total demands based on 100 percent buildout. As shown in Table 7-5, this method uses the following factors:

[175] The Fluvanna County Department of Planning and Community Development prepares a report each year, called the Development Activity Report which categorizes, summarizes and analyses the building permits issued in the County over the last year, the subdivisions that were approved, the site development plans, special use permits, variances, and similar land use planning data. Reports for each year since 2000 are available on the County's website. The reports from 2000 - 2008 were used to model the actual and projected growth patterns. The 2008 Development Activity Report is included in **Appendix 18**.

- Land use designations and the acreage of each area;
- An estimate of the percentage of land within each planning area that is developable;
- An estimate of the water demands based on the type of development that is anticipated (unit flows, or gallons per day per acre);
- The average demand is calculated using the factors listed above; and
- An estimate is made as to the percentage of the development that will be served by community water systems vs. self-served.

In a county like Fluvanna, where the county is rural, but the county anticipates continued development in certain areas, the projected demands at 100% buildout may not be very valuable for short term planning purposes, because buildout is likely to be many decades into the future.

Both methods are presented here (See Tables 7-4 and 7-5).

It is interesting to note that the daily demands in 2060, based on population projections indicate an average daily demand of approximately 7.0 MGD supplied by community water systems and 4.8 MGD provided by self-supplied sources or individual wells. (See Table 7-4). The projections based on full buildout of the County indicate an average daily demand of 10.2 MGD supplied by community water systems and 10.1 MGD provided by self-supplied sources or individual wells. Comparing the results from the two methods of projecting future water demands indicates that even with the growth rates of approximately 25% per decade over the next 50 years; 100% build out and 100% of the projected water demands will not occur until after 2060.

Figure 7-5: Comparison of Demands Based on Population Projections and 100% Buildout

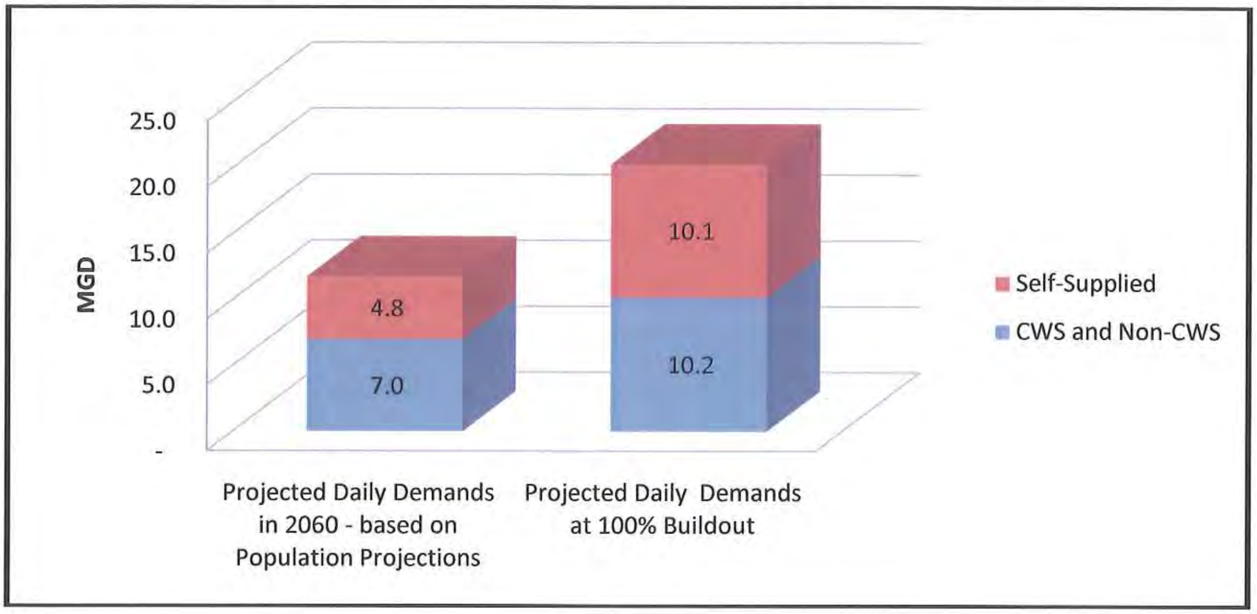

Table 7-4: Projected Water Demands - Using Population Projections

District / Land Use Designation	2010 Population	2010 Water Demand (GPD)	2010 Peak Demand (GPD)	2020 Population	2020 Water Demand (GPD)	2020 Peak Demand (GPD)	2030 Population	2030 Water Demand (GPD)	2030 Peak Demand (GPD)	2040 Population	2040 Water Demand (GPD)	2040 Peak Demand (GPD)	2050 Population	2050 Water Demand (GPD)	2050 Peak Demand (GPD)	2060 Population	2060 Water Demand (GPD)	2060 Peak Demand (GPD)
Columbia CPA																		
Columbia CWS	104	3,836	5,753	130	4,315	6,473	155	5,158	7,736	194	6,473	9,709	272	9,062	13,592	354	11,780	17,670
Self-Supplied	49	4,970	7,455	62	6,213	9,319	74	7,766	11,649	92	9,707	14,561	129	12,134	18,201	168	15,168	22,752
Fork Union CPA																		
Fork Union CWS	1,020	189,836	208,819	1,071	196,116	294,175	1,393	226,020	339,030	1,741	282,525	423,787	2,438	395,535	593,302	3,169	514,195	771,293
Self-Supplied	210	21,210	31,815	263	26,513	39,769	341	34,466	51,699	427	43,083	64,624	597	60,316	90,474	776	60,316	90,474
Palmyra CPA																		
Palmyra CWS	26	4,137	6,205	166	25,720	38,580	456	70,730	106,094	661	102,558	153,837	958	148,709	223,063	1,246	193,322	289,982
NTNC Systems	-	16,327	24,491	-	1,327	1,991	-	2,327	3,491	-	2,327	3,491	-	2,327	3,491	-	2,327	3,491
Self-Supplied	363	36,773	55,159	635	64,352	96,528	857	86,875	130,313	1,242	125,969	188,954	1,801	182,655	273,983	2,341	239,570	359,355
Rivanna CPA																		
Lake Monticello CWS	10,647	634,000	855,900	13,309	792,500	1,109,500	15,971	951,000	1,331,400	19,165	1,141,200	1,597,680	22,999	1,369,440	1,917,216	27,598	1,643,328	2,300,659
Stagecoach Hills CWS	70	7,063	10,594	70	7,063	10,594	70	7,063	10,594	70	7,063	10,594	70	7,063	10,594	70	7,063	10,594
Self-Supplied	111	11,248	16,873	139	14,060	21,091	167	16,873	25,309	200	20,247	30,371	241	24,296	36,445	289	29,156	43,734
Scottsville																		
Self-supplied	145	15,545	23,318	189	20,209	30,313	245	26,271	39,407	343	36,779	55,169	480	51,491	77,237	672	72,088	108,132
Zion Crossroads																		
Proposed Fluvanna CWS	-	-	-	606	324,315	486,472	3,639	1,070,541	1,605,812	4,912	1,403,336	2,105,003	7,368	2,045,153	3,067,730	11,052	3,007,880	4,511,820
Fluvanna Correctional CWS	1,200	117,000	140,400	1,200	-	-	1,200	-	-	1,200	-	-	1,200	-	-	1,200	-	-
Oakland School CWS	-	13,000	19,500		13,000	19,500	13,000	13,000	19,500	-	13,000	19,500	-	13,000	19,500	-	13,000	19,500
Water Sold to Louisa Co.	-	-	-	-	485,459	728,189	-	1,274,391	1,911,587	-	1,366,784	2,050,177	-	1,469,293	2,203,940	-	1,579,490	2,369,235
Pine Grove MHP CWS	62	4,000	6,000	62	4,000	6,000	62	4,000	6,000	62	4,000	6,000	62	4,000	6,000	62	4,000	6,000
County Schools	-	-	-	-	28,717	43,076	-	35,006	52,509	-	35,006	52,509	-	35,006	52,509	-	35,006	52,509
NTNC Systems	-	1,189	1,784	-	1,000	1,500	-	1,000	1,500	-	1,000	1,500	-	1,000	1,500	-	1,000	1,500
Self-Supplied	1,308	142,303	213,454	1,635	165,129	247,693	2,207	222,924	334,386	2,980	300,947	451,421	4,470	451,421	677,131	6,034	609,418	914,127
Self-Supplied Users in Rural Areas.																		
Columbia Rural Preservation	2,758	287,258	430,886	4,274	431,687	647,530	4,915	496,440	744,659	5,997	605,656	908,485	7,016	708,618	1,062,927	8,419	850,341	1,275,512
Cunningham Rural Preservation	2,715	282,685	424,028	3,258	329,058	493,587	3,747	378,417	567,625	4,571	461,668	692,503	5,548	540,152	810,228	6,418	648,182	972,274
Fork Union Rural Preservation	1,508	156,948	235,421	1,915	193,367	290,051	2,202	222,372	333,558	2,686	271,294	406,941	3,143	317,414	476,121	3,771	380,897	571,345
County Schools	-	18,000	27,000	-	9,000	13,500	-	9,000	13,500	-	9,000	13,500	-	9,000	13,500	-	9,000	13,500
Columbia Rural Residential	1,285	133,845	200,786	1,606	162,231	243,347	1,767	178,454	267,682	2,332	235,560	353,340	2,845	287,383	431,074	3,557	359,229	538,843
Cunningham Rural Residential	1,750	182,210	273,315	2,188	220,938	331,406	2,406	243,031	364,547	3,176	320,801	481,202	3,875	391,378	587,066	4,844	489,222	733,833
Fork Union Rural Residential	1,240	129,090	193,635	1,426	144,026	216,039	1,569	158,429	237,643	2,071	209,126	313,689	2,526	255,133	382,700	3,158	318,917	478,375
Palmyra Rural Residential	2,073	216,883	325,324	2,694	272,119	408,179	2,964	299,331	448,997	3,912	395,117	592,676	4,773	482,043	723,064	5,966	602,554	903,830
Rivanna Rural Residential	313	37,023	55,534	428	43,241	64,861	471	47,565	71,347	622	62,785	94,178	758	76,598	114,897	30	95,748	143,622
Woodslodge CWS	30	973	1,459	30	973	1,459	30	973	1,459	30	973	1,459	30	976	1,460	948	973	1,460
Subtotal	**28,987**	**2,667,352**	**3,794,908**	**37,356**	**3,986,648**	**5,900,722**	**59,908**	**6,089,423**	**9,039,033**	**58,686**	**7,473,984**	**11,096,860**	**73,399**	**9,350,596**	**13,888,945**	**92,142**	**11,793,170**	**17,525,421**
Agricultural Uses	-	1,033,584	1,033,584	-	1,033,584	1,033,584	-	1,033,584	1,033,584	-	1,033,584	1,033,584	-	1,033,584	1,033,584	-	1,033,584	1,033,584
Dominion Generation - Surface Water	-	148,347,945	148,347,945	-	148,347,945	148,347,945	-	148,347,945	148,347,945	-	148,347,945	148,347,945	-	148,347,945	148,347,945	-	148,347,945	148,347,945
Bremo Bluff - Ground Water	-	2,500	2,500	-	2,500	2,500	-	2,500	2,500	-	2,500	2,500	-	2,500	2,500	-	2,500	2,500
Irrigation - Golf Courses	-	104,110	104,110	-	104,110	104,110	-	104,110	104,110	-	104,110	104,110	-	104,110	104,110	-	104,110	104,110
Total	**28,987**	**152,155,491**	**153,283,047**	**37,356**	**153,474,787**	**155,388,861**	**59,908**	**155,577,562**	**158,527,172**	**58,686**	**156,962,123**	**160,584,999**	**73,399**	**158,838,735**	**163,377,084**	**92,142**	**161,281,309**	**167,013,560**

Summary Information:

GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD	GPD
Water Supplied by CWS	973,845	1,254,630	1,882,178	2,744,018	3,657,882	5,391,721	4,362,918	6,430,255	5,497,237	8,108,906	7,010,037	10,350,722
Water Supplied by NCWS Water Systems	35,516	53,275	11,327	16,991	12,327	18,491	12,327	18,491	12,327	18,491	12,327	18,491
Self-Supplied	1,657,991	2,487,003	2,093,143	3,139,713	2,419,214	3,628,821	3,098,739	4,648,114	3,841,032	5,761,548	4,770,806	7,156,208
Total	2,667,352	3,794,908	3,986,648	5,900,722	6,089,423	9,039,033	7,473,984	11,096,860	9,350,596	13,888,945	11,793,170	17,525,421

	MGD	MGD	MGD	MGD	MGD	MGD	MGD	MGD	MGD	MGD	MGD	MGD
Water Supplied by CWS	1.0	1.3	1.9	2.7	3.7	5.4	4.4	6.4	5.5	8.1	7.0	10.4
Water Supplied by NTNC Water Systems	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Self-Supplied	1.7	2.5	2.1	3.1	2.4	3.6	3.1	4.6	3.8	5.8	4.8	7.2
Total	2.7	3.8	4.0	5.9	6.1	9.0	7.5	11.1	9.4	13.9	11.8	17.5

CWS - Community Water System
NTNC - Non-transient Non-community Water System
CPA - Community Planning Area
These are minor differences in the totals presented on this page, when compared to Appendix 17 due to rounding.

Table 7-5: Water Demand Projections - 100% Buildout

District	Land Use Designation	Estimated Land Use and Targeted Residential Density as per Comprehensive Plan	Acres	Percentage Developable	Buildout %	Acres Developed	Unit Flows (gpd/acre)	Average Demand (gpd)	% Supplied by Community Water Systems	Supplied by Community Water System (gpd)	Self-Supplied (gpd)	Peaking Factor Community Systems (peaking factors are based on existing system withdrawal where available - shaded figures are estimated)	Peaking Factor Self-Supplied	Peak Demands (gpd)
	Columbia CPA	Village Mixed Use / 6 du/acre	803	50%	100%	402	750	301,125	50%	150,563	150,563	1.50	1.50	451,688
	Fork Union CPA	Village Mixed Use / 4 du/acre	3,014	70%	100%	2,110	800	1,687,840	85%	1,434,664	253,176	1.10	1.50	1,957,894
	Palmyra CPA	Village Mixed Use / 4 du/acre	3,091	60%	100%	1,855	800	1,483,680	100%	1,483,680	-	1.50		2,225,520
	Rivanna CPA	Village Mixed Use / 6 du/acre	6,562	55%	100%	3,609	750	2,706,825	85%	2,300,801	406,024	1.35	1.50	3,715,117
	Scottsville CPA	Village Mixed Use / 4 du/acre	255	50%	100%	128	800	102,000	85%	86,700	15,300	1.50	1.50	153,000
	Zion Crossroads CPA	UDA / 10 du/acre	6,091	65%	100%	3,959	1,200	4,750,980	100%	4,750,980	-	1.50		7,126,470
										-	-			
Columbia	Rural Preservation	Less than .2 du/acre	44,794	60%	100%	26,876	60	1,612,584	0%	-	1,612,584		1.50	2,418,876
Cunningham	Rural Preservation	Less than .2 du/acre	30,120	60%	100%	18,072	60	1,084,320	0%	-	1,084,320		1.50	1,626,480
Fork Union	Rural Preservation	Less than .2 du/acre	29,527	60%	100%	17,716	60	1,062,972	0%	-	1,062,972		1.50	1,594,458
Columbia	Rural Residential	.5 du/acre	10,504	60%	100%	6,302	150	945,360	0%	-	945,360		1.50	1,418,040
Cunningham	Rural Residential	.5 du/acre	14,016	60%	100%	8,410	150	1,261,440	0%	-	1,261,440		1.50	1,892,160
Fork Union	Rural Residential	.5 du/acre	14,633	60%	100%	8,780	150	1,316,970	0%	-	1,316,970		1.50	1,975,455
Palmyra	Rural Residential	.5 du/acre	16,901	60%	100%	10,141	150	1,521,090	0%	-	1,521,090		1.50	2,281,635
Rivanna	Rural Residential	.5 du/acre	5,262	60%	100%	3,157	150	473,580	0%	-	473,580		1.50	710,370
Subtotal								**20,310,766** **20.3 MGD**		**10,207,388** **10.2 MGD**	**10,103,378** **10.1 MGD**			**29,547,163** **29.5 MGD**
Fluvanna Correctional Center								115,000	100%	115,000	-	1.20		138,000
Agricultural Uses - Livestock and Crops								1,033,589	0%	-	1,033,589		Unknown	1,033,589
Dominion Generation								148,347,945	0%	-	148,347,945		Unknown	148,347,945
Irrigation - Golf Courses								104,110	0%	-	104,110		Unknown	104,110
Total (gallons per Day)			**185,573**			**111,516**		**169,911,410**		**10,322,388**	**159,589,022**			**179,170,807**
Total (MGD)								**169.91 MGD**		**10.32 MGD**	**159.59 MGD**			**179.17 MGD**

7.8 Total Projected Demands in 2060

As shown on the previous table, the total projected demands for the County are as follows:

Table 7-6: Summary of Projected Water Demands

	Population-Based Projection						100% Buildout
	2010	2020	2030	2040	2050	2060	
Business and Residential Uses	2.7 mgd	3.9 mgd	6.1 mgd	7.5 mgd	9.4 mgd	11.8 mgd	20.5 mgd
Agricultural Uses	1.0 mgd	1.0 mgd	1.0 mgd	1.0 mgd	1.0 mgd	1.0 mgd	1. 0 mgd
Dominion Generation (surface and ground water)	148.3 mgd	148.3 mgd	148.3 mgd	148.3 mgd	148.3mgd	148.3 mgd	148.3 mgd
Irrigation – Golf Courses	.1 mgd	.1 mgd	.1 mgd	.1 mgd	.1 mgd	.1 mgd	.1 mgd
Total	152.1 mgd	153.5 mgd	155.5 mgd	156.9 mgd	158.8 mgd	161.2 mgd	169.9 mgd

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8.0 STATEMENT OF NEED AND ALTERNATIVES

The Water Supply Planning Regulation (9 VAC 25-780-130) states that "A water plan shall determine the adequacy of existing water sources to meet current and projected demand by preparing a clear statement of need .....and a determination of whether the existing sources are adequate to meet current and projected demands."

8.1 Community Water Systems

The following table provides a comparison of the existing community water systems, the current capacity of each system, and the projected demands in 2020 and 2030.[176]

Table 8-1: Adequacy of Existing Community Water Systems

System	Permitted Capacity (gpd)	Existing Demand (gpd)	Projected 2020 Demand (gpd)	Projected 2030 Demand (gpd)
Columbia CWS	Limited to the existing 44 connections	3,836	4,315	5,158
Fork Union CWS	419,520	189,836	196,116	226,020
Palmyra CWS	Limited to the existing 38 connections.	4,000	25,442	69,965
Lake Monticello CWS	1,380,000	634,000	792,500	951,000
Stagecoach Hills CWS	14,400	7,063	7,063	7,063
Dept. of Corrections CWS	250,000	117,000	117,000	117,000
Pine Grove MHP CWS	Capacity is limited to the existing 31 mobile homes	4,000	4,000	4,000
Woodslodge CWS	Limited to existing 15 connections.	< 1,000	< 1,000	< 1,000
Oakland School CWS	200 persons	13,900	13,900	13,900
Proposed Fluvanna County CWS	Withdrawal permit is for 5.7 mgd; anticipated that the initial water treatment plant will be 3.0 mgd; 50% of capacity of the water treatment plant belong to Louisa County.	No CWS	324,315 (includes DOC, does not include the water transferred to Louisa, does not include the water provided to Fork Union)	1,070,541 includes DOC, does not include the water transferred to Louisa, does not include the water provided to Fork Union)

The projected future demands and alternatives to meet future demands of each system are discussed below. In most cases, the alternatives listed below are not currently planned

[176] Appendix 17 includes the projected water demands through 2060. However, the focus in this section of the Plan is the demands for 2020 and 2030. It is expected that in the timeframe from 2010 – 2020, Fluvanna County and Louisa County will initiate the development of the regional water treatment facility, or, will delay the development of that facility and Fluvanna will make critical decisions as to how to serve the northern area of the County. Those decisions will influence the sources and uses of water for the various growth and development areas through the remainder of the planning period.

and will need additional analysis to determine the technical, financial, political and regulatory feasibility of the alternatives listed.

Further, the Regulation requires a map showing the proposed boundaries of any proposed or expanded community water systems. At this time, there are no concrete plans to expand any of the existing community water systems. It is assumed that expansions of community water systems will occur within the boundaries of the Community Planning Areas. The one exception is the proposed James River Water Authority System and the proposed water distribution system that Fluvanna County would develop in the

During 2009, a Preliminary Engineering Report (PER) for the James River Water System was developed for Fluvanna and Louisa Counties. That report provides specific recommendations for the development of a regional water system that relies on water from the James River to serve the growth areas in the central and northern areas of Fluvanna, Fork Union, and the Zion Crossroads area in Louisa County. Some of the alternatives below are those found in the 2009 PER. Some of the alternatives listed below are those that could be implemented if the plan for the regional water system <u>is not</u> executed. The proposed James River Water System project is described below in section 8.1.10 of this report.

8.1.1 Columbia Community Water System

The Columbia system is limited to the existing connections.[177] The water system is owned and operated by AquaVirginia, Inc.

The area is one of the County's Community Planning Areas, and, as noted in the 2009 Fluvanna County Comprehensive Plan, "needs to be comprehensively revitalized either as a village or a neighborhood mixed-use project."[178]

As outlined above, the demands in the Columbia area are projected to show at least a moderate increase over the next 10 – 20 years. The existing system may need additional improvements or additional well(s) to serve increased demands, but it is likely that the groundwater system can serve Columbia for at least the next 20 years.

[177] Permitted capacity is limited to 44 existing connections.
[178] Page 59 of the 2009 Comprehensive Plan.

If the growth in this planning area is greater than expected, or, when the demands exceed the capacity of the groundwater, other options for future supply include:

- Extension of the Fork Union Community Water System to Columbia. This option is viable only if the Fork Union system is receiving water from a surface source (i.e., the James River, the Rivanna River, an off-stream reservoir, or the proposed James River Water System project).

- Development of a surface water source to serve Columbia. Options include: an intake on the James River or a tributary of the James River, or, development of an off-stream water storage reservoir.

- Utilize water from a source developed in Goochland County or Cumberland County, to include any system that uses groundwater or surface water as a source.

8.1.2 Fork Union Community Water System

The Fork Union Sanitary District Community Water System is operated by Fluvanna County. The projected demands for the Fork Union Community Water System over the next twenty years do not exceed the permitted capacity for the system. However, the system struggles with limited quantities of water and poor quality water. Due to the underlying geology of the area, continued reliance on groundwater is not desirable. Prior planning studies have recommended that the Fork Union system use a surface water source, when one is available. Options include:

- As noted earlier in this Plan, Fluvanna County has a water withdrawal permit which allows withdrawal from the James River (this permit was transferred to the James River Water Authority in 2009/2010). When the permit is utilized and a water treatment plant is developed, it is recommended that the location of the water plant consider proximity to Fork Union so that delivering treated water to Fork Union is feasible.

- If additional withdrawals from the Rivanna River are permitted by VDEQ, the Rivanna is a potential source of surface water for Fork Union.

- If an off-stream reservoir that withdraws water from the Rivanna River during periods of high-flow is developed, the reservoir may enhance the ability of the Rivanna to provide source water for the Fork Union system.

- If an off-stream reservoir that withdraws water from the James River during periods of high-flow is developed, the reservoir may be utilized to provide source water for the Fork Union system.

- If no options are available within Fluvanna County, it is recommended that the County consider water from sources developed outside of Fluvanna, including Albemarle County or Louisa County.

8.1.3 Palmyra Community Water System

The Palmyra system is owned and operated by AquaVirginia and currently relies on three drilled wells. The three wells are adequate to meet the current demands; the permitted capacity is limited by the system storage. The area is expected to continue to develop and will include a variety of municipal uses, commercial and office structures, and a variety of residential dwelling types.

As the village grows, water demands will exceed the permitted capacity of the existing community water system. Alternatives for meeting future demands include:

- Additional use of groundwater to meet the needs of the existing community water system, as well as other improvements to the Palmyra system to increase capacity.

- Development of additional community water system(s) using groundwater.

- Surface water sources include the Rivanna River, if the Lake Monticello system is expanded to meet the needs of growth areas in the central portion of the County.

- If a reservoir is permitted in the proximity of the Rivanna River, Lake Monticello's ability to serve the Palmyra area may be enhanced.

- Surface water sources also include the James River if the existing water withdrawal permit is utilized to provide water to the central and northern parts of the County.

8.1.4 Lake Monticello Community Water System

The Lake Monticello Community Water System is owned and operated by AquaVirginia. The Rivanna River is the source for this system. The system is permitted for a design capacity of 1.38 MGD due to treatment plant capacity. The VDEQ withdrawal permit allows for a maximum instantaneous withdrawal of 2,683 gallons per minute and a maximum day withdrawal of 2.576 MGD. The current demands are approximately 634,000 gallons per day.

- If the service area of the Lake Monticello facility does not expand beyond the Rivanna Election District, the currently permitted withdrawal from the Rivanna will be adequate to meet the projected demands through 2030 and possibly through 2050.

- Preliminary studies prepared by AquaVirginia estimate demands in the immediate Lake Monticello area in 2020 to be 757,600 gpd and 796,300 gpd in 2030. Based on the permitted capacity of the Lake Monticello facility and the existing withdrawal permit, the study suggests that the Lake Monticello facility could meet the demands in the Fork Union area as well as the Zion Crossroads area until 2030.

- The AquaVirginia study notes that a reservoir in the vicinity of Mechunk Creek may be required to provide an additional source of surface water to the Lake Monticello facility.

- An additional source of water for the Lake Monticello facility, assuming that the facility ultimately serves the Zion Crossroads area and the Fork Union area, would potentially be the James River. Raw water could be pumped from the James River to the Lake Monticello facility for treatment and distribution. Alternatively, the Lake Monticello facility could potentially receive treated water from the proposed James River Water Authority system (the source would be the James River).

8.1.5 Stagecoach Hills

The Stagecoach Hills system has daily demands of approximately 7,000 gallons per day. The existing permitted capacity is 14,400 gpd. The system appears to have adequate capacity to serve the existing connections and the subdivision is built-out. In the event that the existing wells fail, or the system needs an additional source of water, options include:

- Develop additional well(s),
- Obtain water from the Lake Monticello system, or,
- If the proposed James River Water Authority system is developed, and Fluvanna County develops a water system that is in reasonable proximity to Stagecoach Hills, the community could be provided water from the County system.

8.1.6 Department of Corrections

The Department of Corrections system has a permitted capacity of 250,000 gallons per day. The current demand is 117,000 gallons per day. At this time, there is no expectation that the prison population will change significantly in the near future. Should additional capacity be needed, or if an alternative source is desired, options include:

- Request increased withdrawal from Mechunk Creek;
- Lake Monticello CWS could provide source water;
- Louisa County Water Authority could potentially provide source water, if the Authority has sufficient quantities; and

- The Fluvanna County utility system could provide water, if the proposed James River Water Authority system develops utilizing the James River as a source.

8.1.7 Pine Grove Mobile Home Park Community Water System

The permitted capacity of the Pine Grove Mobile Home Park system is limited to the existing 31 mobile homes. There is only one well and VDH notes that the average daily usage is approaching the permitted capacity. VDH has also recommended that the system owners encourage the users to conserve water where possible and that system leaks must be repaired.

Future sources of water could include:

- Develop additional well(s); or
- Water could be provided by a community water system with greater capacity; the source could be either surface water or ground water.

8.1.8 Woodslodge Community Water System

The permitted capacity of the Woodslodge system is limited to the existing 15 homes. There is only one well. In the event the well fails, it is likely that an additional well could be developed in reasonable proximity to the system. Future sources of water include:

- Develop additional well(s), if necessary;
- When the Zion Crossroads CPA is served by a community water system, it is possible that the Woodslodge area could be served as well.

8.1.9 Oakland School Community Water System

Oakland School is served by four wells. In the event that any of the wells fail, it is likely that an additional well could be developed in reasonable proximity to the system. If the school's demands exceed the capacity of the existing system, it is likely that improvements to storage or pumping, or the development of additional wells would provide adequate water to meet the demands. In addition, future sources of water include:

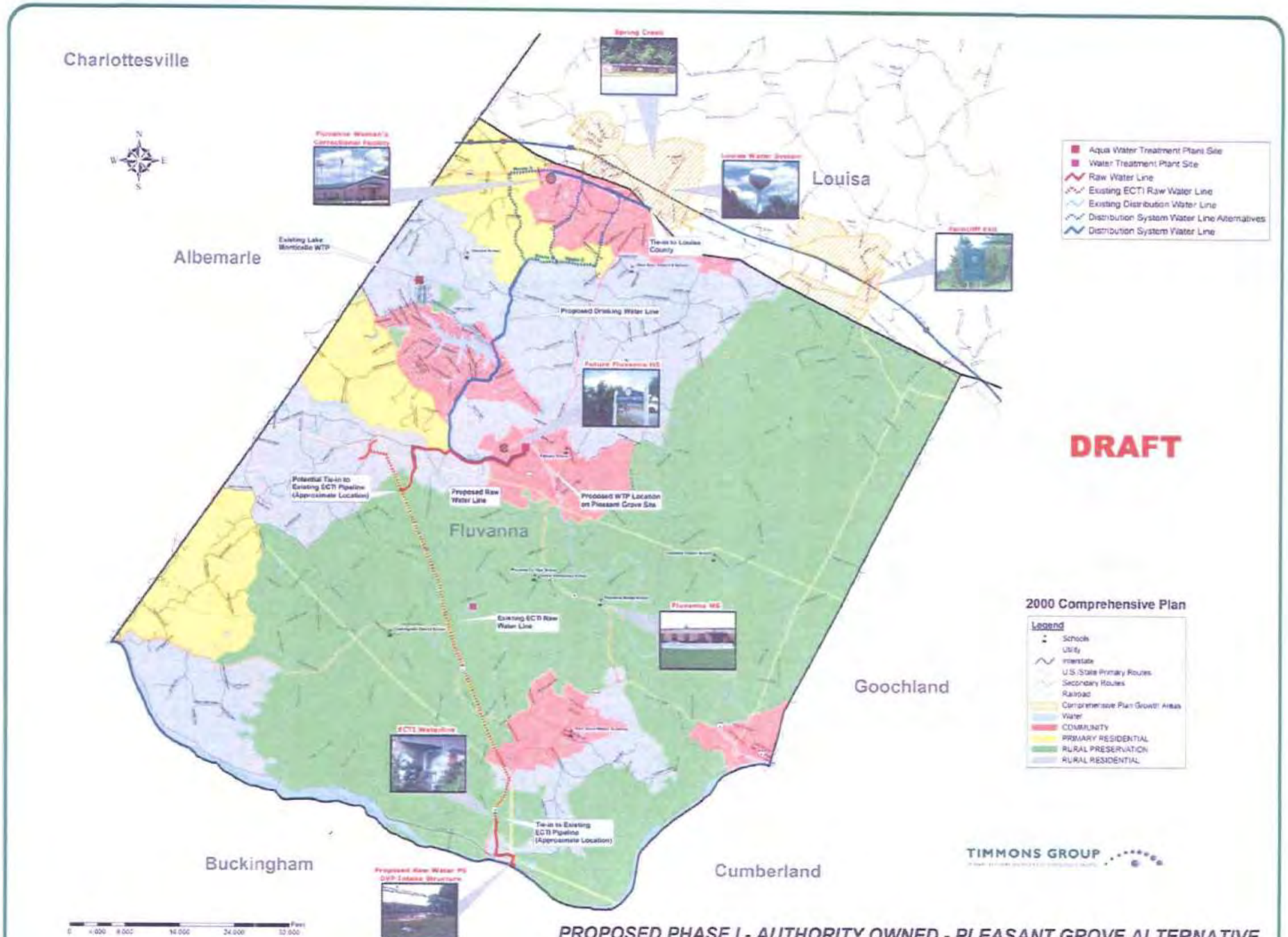
- Develop additional well(s), if necessary;
- Utilize the community water system serving the Zion Crossroads CPA or the Lake Monticello CPA, whichever is most feasible.

8.1.10 Proposed Fluvanna County Community Water System / Regional Water System

Fluvanna County, Louisa County and the James River Water Authority have considered a plan to develop a regional water system that would withdraw water from the James River and pump the water to the Pleasant Grove site where a 3.0 MGD water treatment plant would be constructed. From that facility, treated water could be provided to the following locations:

- The Fork Union Community Water System;
- The Zion Crossroads area in Louisa;
- The northern portion of Fluvanna to include the Zion Crossroads CPA, the Urban Development Area, and the Department of Corrections;
- The Palmyra and Pleasant Grove areas;
- Lake Monticello area, if needed for additional source water or for a emergency water source;
- The Ferncliff area in Louisa County; and
- When demands in the Columbia CPA can no longer be met by groundwater, water from the regional treatment plant could potentially meet the needs of Columbia.

Figure 8-1 shows the proposed location of the James River Water Authority infrastructure.



PROPOSED PHASE I - AUTHORITY OWNED - PLEASANT GROVE ALTERNATIVE
JAMES RIVER WATER PROJECT

FIGURE
8-1

8.2 Self-Supplied Ground Water Users

Even though the Comprehensive Plan seeks to direct development to the Community Planning Areas, the County has approved a number of subdivisions in the rural areas of the county. These developments and existing residents in the rural areas of the county rely on groundwater. As discussed in Section 4 of this Water Supply Plan, favorable quantities of water occur throughout the county, but the quantity and depth of water bearing zones are difficult to predict.

In the Rural Residential and Rural Preservation areas, the groundwater should normally be adequate due to the low density of development that is envisioned for the area. However, during extremely dry periods, shallower wells may have a significant decrease in yield. Therefore, it is recommended that deeper drilled wells be installed in lieu of bored wells to better meet the needs of water users during periods of extended drought.

Currently, more than 50% of the Fluvanna residents are self-supplied, or are served by private wells.[179] It is projected that the majority of the residents in the Rural Residential and Rural Preservation areas will continue to be self-supplied. In addition, many users in the CPAs are projected to continue to be self-supplied. As a result, the availability of ground water to meet the demands of the self-supplied population is important.

It is recommended that Fluvanna County consider the following policies to protect the quality and quantity of groundwater:

8.2.1 Ground Water Protection Policy

It is recommended that Fluvanna County consider the implementation of a ground water management policy to manage the ground water resources so that adequate supplies are available to meet the needs of new users without disrupting supplies for existing users. A groundwater policy would enable Fluvanna County to gather and evaluate data to promote the long-term sustainability of its ground water resources.

[179] Self-supplied user means any person making a withdrawal of surface water or ground water from an original source (for example a river, stream, lake, aquifer, reservoir, etc.) for their own use. In Fluvanna, most self-supplied users rely on ground water.

A ground water protection policy could require hydrogeologic study and testing requirements prior to the development or subdivision of property that will rely on groundwater. In order to provide evidence of sufficient ground water supply, the developer could be required to complete a hydrogeologic study and report, an aquifer test plan and related testing, and a prepare a aquifer test report.

The hydrogeologic study and report would assimilate readily available information regarding the on-site hydrology, groundwater quality and ground water use; would indentify hydrogeologically unfavorable sites, and would determine whether the site hydrogeologic conditions are sufficiently favorable or if the conditions require additional investigation.

In certain cases, the County might also require a developer to develop and submit an aquifer test plan. The plan would propose an aquifer testing program that would establish the adequacy of ground water supply to support the planned development. The aquifer test might include the drilling of a number of test wells; a yield test would be performed on each test well to provide assurance that the proposed wells will be capable of providing sustained long-term use.

The aquifer test report would summarize will provide a detailed description of geologic conditions, detailed pump test results, and information concerning groundwater balance and recharge estimates for the site.

The County would review the submittals outlined above to assess the suitability of the site for the proposed development or subdivision. In most cases, a County requiring this type of hydrogeologic study would make the results of the study available to the public for review and comment.

8.2.2 Wellhead Protection Policy

"Wellhead protection" describes the process of assessing potential threats to ground water in areas near public supply wells, for managing nearby land uses, and for planning to prevent water problems. A wellhead protection area consists of land in the vicinity of a public water supply well chosen for special protection to prevent groundwater pollution from nearby surface and subsurface activities. The size and shape of the protection area is a function of factors such as the hydrogeology in the vicinity of the well, daily withdrawal rate, surface topography, surrounding land use activities, and assessment of replacement or other options if the well were to become polluted. The wellhead protection area could range from a few acres to several square miles, or more. The types of special protection measures that could be applied to a wellhead protection area include: zoning limitations on the types of land uses allowed, performance standards to contain and manage pollutants, and contingency plans for accidents.

Fluvanna County would be an essential participant in wellhead protection because the county has authority over land use regulations. The Code of Virginia (Planning, Subdivision of Land and Zoning – Article 4: The Comprehensive Plan, 15.2-2240) gives localities clear authority to use their planning and zoning powers to protect groundwater and public water supplies.

Although individual wells for self-supplied users are not classified as public wells, the protection of yields and water quality for individual wells is important. A wellhead protection plan would encourage well owners to identify potential sources of contamination and develop contingencies for alternate sources of water in the event that their well becomes contaminated.

Developing a wellhead protection program is a multi-step process that the county would need to customize in order to achieve the County's goals and provide protection to specific wells. Some key steps could be as follows:

- Develop and maintain an inventory of wells in the County. This could include only public supply wells, or could also include individual residential wells. As noted in earlier sections of this plan, a fairly comprehensive database of over 1,300 wells, both public and private, was developed in 1999.

- Map existing wells in County GIS; add new wells as they are permitted.

- Identify potential contamination sources and locate sources on a map or in the GIS system.

- Prioritize wells for protection. Consider overlay zoning and consider applying special precautions in the vicinity of all public wells to reduce the risk of contamination. Priority should be based on the number of users and types of users.

- Delineate protection areas based on topographic conditions, local hydrology and current land uses in the area. Alternatively, the County could establish a specific radius from the well that restricts land uses that pose potential pollution or contamination risks.

VDEQ has developed a handbook entitled "Wellhead Protection – a Handbook for Local Governments in Virginia" which provides guidance in establishing a wellhead protection program.

8.2.3 Aquifer Recharge Policies

Fluvanna County lies within the Piedmont Physiographic Province, where groundwater occurs in two basic horizons; in the soils or "overburden materials" overlaying the bedrock and also within fractures present in the bedrock. These two water-bearing horizons are often referred to as the Water Table Aquifer and the Bedrock Aquifer. In many cases, the Water Table Aquifer and the shallow fractures in the Bedrock Aquifer are hydraulically interconnected and behave as a single aquifer.

Groundwater flow in the Water Table Aquifer usually conforms to the slope of the ground surface, but in a subdued manner. Groundwater gradients are typically much less than those of the ground surface. Flow in bedrock is controlled by the frequency and orientation of the bedrock fractures, which provide permeability to the bedrock.

Water infiltrating or seeping into an aquifer is known as recharge. Recharge occurs during and after periods of precipitation (rainfall and snow-melt). The most rapid rate of recharge occurs in areas underlain by permeable soils, fractured rock or karst formations. Recharge is also more rapid in flat to slightly sloping land surface areas versus moderate to steeply sloping areas where runoff is more rapid.

Recharge of the Water Table Aquifer is by infiltration of precipitation and runoff through the overlying soils. The underlying Bedrock Aquifer is recharged slowly by the vertical migration of infiltrating waters through the overburden and into the bedrock fractures. More rapid recharge occurs where fractured bedrock is exposed in stream beds, drainage ways, or surface water bodies such as ponds and lakes.

Undeveloped lands provide the most favorable groundwater recharge areas. Land development reduces groundwater recharge potential due to the addition of impermeable features such as pavement (roads, parking lots, sidewalks, etc.) and buildings. As development density increases, groundwater recharge potential decreases proportionally.

The type of development allowed in a groundwater recharge area can also impact aquifer sustainability with respect to water quality. As is the case with wellhead protection, it is important to consider types of development proposed in a groundwater recharge area in order to prevent detrimental groundwater quality impacts.

Essentially all undeveloped areas in the county are aquifer recharge areas and protection of the areas is important. Protection does not mean "no development", but instead refers to carefully planned development that considers type and density of development. Important considerations include, but are not necessarily limited to:

- Development of pavement and buildings that do not exceed twenty percent (20%) of the surface area on the subject property;
- Use of permeable pavements that allow infiltration of runoff into the subsurface; and
- Strict adherence to federal, state and local requirements applicable to land development pertaining to land disturbance, stormwater management, the

operation and maintenance of environmental operations including waste and wastewater treatment, storage and disposal, handling and storage of chemical and petroleum products, and the use and storage of pesticides and herbicides.

It is recommended that Fluvanna County consider policies such as the ones outlined above to continue to protect the quality and quantity of groundwater that is available to meet the needs of self-supplied users.

8.3 Potential Water Savings from Demand Management Actions

It is anticipated that the County-led efforts to encourage conservation on an ongoing basis may result in reductions in use of 5% - 10%. It is recommended that County-led efforts include information on the County's website that provides educational information about conservation, use of the media to promote conservation, and on-going dialog with AquaVirginia and the smaller community water systems to encourage conservation, leak detection and other water saving efforts the owners of the systems can undertake. Further, it is recommended that the County encourage the owners of all community water systems to strive to maintain accurate metering of usage within the systems to encourage conservation.

As noted earlier, Fork Union, Lake Monticello and the Department of Corrections have undertaken a number of steps to reduce water use and to educate water users. The efforts have been successful. Currently, these three community water systems represent over 40% of the business and residential use in the county.

It is also important to note that utilities across Virginia are reporting a noticeable decline in usage as newer appliances and fixtures that require less water are installed in both new and older construction. Even though the savings as a result of these changes is not quantifiable, it is important to recognize that many people are voluntarily reducing daily water use.

8.4 Identified Sources to Meet Projected Demands

8.4.1 Regional Water System

As noted in other sections of the Plan, Fluvanna County has been granted a water withdrawal permit that allows for the withdrawal of 5.7 mgd of water from the James River (the Fluvanna County Board of Supervisors authorized the transfer of the permit to the James River Water Authority in September 2009.) The proposed project to bring water to the Zion Crossroads is fully detailed in a Preliminary Engineering Report (PER) prepared by the Timmons Group in March 2009 (See Figure 8-1). Briefly, the proposed project is as follows:

- The pipeline would begin at the James River, drawing water through an existing Dominion Virginia Power Intake Structure. Untreated water would flow through an existing East Coast Transport, Inc. waterline to a proposed water treatment plant that will be located at the County's Pleasant Grove site. From there, waterlines would transport finished water toward Zion Crossroads. The line would provide water to Louisa County Water Authority near the intersection of Routes 250 and 15. Additionally, a waterline would be routed south towards Fork Union and a waterline would be routed to DOC to provide water to the prison.

- The PER for this project discusses options for the development of a reservoir for raw water storage and the option of constructing a second pipeline that would be parallel to the ECTI pipeline. The ultimate design, location and capacity of the proposed facility are factors that would be considered in deciding if an additional pipeline or reservoir would better meet the water supply needs of the County.

- Page 10 of the 2009 PER recommends location of a reservoir at the Pleasant Grove site. The recommended site offers a location central to the geographic service area and to the ECTI pipeline, the impoundment is more than adequate for a 60-day demand, the acreage requirement is moderate, the acreage of private property that is required is moderate, access from the existing park property is reasonable, and the excavation and hauling quantities of earthen material for the dam is minimized.

- While there many financial and political decisions that are yet to be finalized, it is anticipated that James River Water Authority will operate as a wholesale Authority, will operate the regional facility and will sell water to Fluvanna and Louisa Counties on a wholesale basis.

8.5 Reservoirs

As outlined above, alternatives for the development of a reservoir to increase water supply have been discussed in relation to both the Rivanna River and the James River. Opportunities to develop an off-stream reservoir in the vicinity of the Rivanna has been proposed and a reservoir in the vicinity of Pleasant Grove has been proposed.

The purpose of this Plan is not to determine the specific site of future reservoirs, but rather to identify where the development of a reservoir is critical to meeting the demands of the community. Further study of the following factors will be required to preliminarily identify sites of future reservoirs:

- Type of reservoir (terminal vs. pumped-storage reservoir);
- Usable volume and usable reserve capacity of the reservoir;
- Acreage required for the impoundment and dam;
- Number of private property-owners affected by the impoundment and dam;
- Acreage of private land required for the dam and impoundment;
- Access requirements;
- Location relative to the source (i.e. the ECTI pipeline, the Rivanna, etc.);
- Location relative to the treatment facility and service area;
- Environmental, Historical and Cultural impacts;
- Dam size; and
- Other factors as required by the permitting agencies.

The 2009 Timmons Group PER discusses the 2003 Anderson and Associates Water Study for Fluvanna County, which proposed a water treatment plant in the vicinity of the intersection of State Route 6 and State Route 649, included an 800-acre-foot volume reservoir to be included in the Phase 2 improvements.

Since 2003, discussions with East Cost Transport, Inc. have resulted in a plan for a continuous raw water design capacity of 1.5 to 3.0 mgd (uninterruptable and interruptable) for the proposed James River Water System water treatment facility. As a result, raw water storage capacity may be warranted as a source of water for the water treatment plant.

The Timmons PER also notes that depending upon the ultimate operations of the proposed raw water system and the potential costs of a reservoir, it might be in Fluvanna and Louisa Counties best interest to consider constructing a second parallel pipeline in lieu of a storage reservoir. [180]

8.6 Reuse Opportunities

One way to extend the ground water and surface water supply that will be needed to meet increasing demands for water is to use (or reuse) treated wastewater that has undergone a high level of treatment. Studies in other parts of the United States have shown that using reuse water can reduce the demand for potable water by 5 to 20 percent.

Virginia has adopted Water Reuse Regulations that allow for the potential application of reuse water for a variety of potable and non-potable uses. The following table provides a listing of the types of uses that are allowed in Virginia. As shown below, Level 1 requires a higher level of treatment due to the potential for human contact.

[180] See Section 4, page 1 of the 2009 Timmons Group PER.

Table 8-2: Water Reuse Opportunities in Virginia

Level 1 Treatment (Level 1 treatment requires secondary treatment with filtration and higher level of disinfection)	**Level 2 Treatment (Level 2 treatment requires secondary treatment with standard disinfection)**
Residential Lawn Watering	Irrigation of food crops (commercially processed)
Toilet flushing (non-residential)	Irrigation of non-food crops
Fire Fighting and Fire Protection (non-residential)	Landscape impoundments
Commercial Car Wash	Construction (compaction, dust control, concrete)
Commercial Air Conditioning Systems	Livestock Watering
Irrigation of Certain Food Crops	Ship Ballast
Landscape Impoundments	Cooling Towers
Commercial Laundries	
Irrigation of Golf Courses, Recreation Fields	

Currently, there are limited opportunities for developing reuse projects in Fluvanna. But, as the County develops and addresses wastewater needs in Zion Crossroads and Fork Union, opportunities to develop reuse projects should be considered. Further, the opportunities for reuse of effluent from the Lake Monticello wastewater treatment facility, the Department of Corrections facility and the Palmyra facility should be considered to determine if and when the demand for reuse water is significant enough to justify investment in the infrastructure necessary to treat and distribute reuse water.

9.0 SUMMARY

The purpose of the Water Supply Plan is to establish a water supply planning process that accomplishes the following:

- Ensures that adequate and safe drinking water is available to citizens in the County;
- Encourages, promotes and protects the beneficial uses of the water resources;
- Encourages and promotes water conservation; and
- Enables the County to analyze the impact of proposed development on the water resources.
- Further, the Water Supply Plan enables the County to consider the projected future water needs of the County in order to plan to meet those needs.

The demand projections in this report are based on population projections that demonstrate a significant increase in demands that will occur as the population increases, and as business locations in the county increase. Further, this Plan acknowledges that the demand for water in the more densely developed areas of the county and specifically, in Community Planning Areas, can only be met by Community Water Systems. This is the case now, and as the Community Planning Areas grow and are more densely developed or re-developed, the need for a reliable and safe drinking water source that provides both the quality and quantity of water needed to support citizens and business needs will become increasingly important.

As outlined in the demand projections and in the 2009 Preliminary Engineering Report prepared by Timmons Group, the growth that is projected in the Zion Crossroads area, particularly the Urban Development Area, will require a community water system. Several options for supplying water to this area are discussed in this Plan including using the James River or Rivanna River as a source. VDEQ has granted a permit to withdraw water from the James River to provide water to this area. The withdrawal permit was intended to serve not only the northern development area of Fluvanna, but also to provide water to other areas of Fluvanna, including Fork Union and Palmyra and to provide water to Louisa County.

Based on the projected water demands in the northern area of Fluvanna, particularly the projected demands in the Zion Crossroads Urban Development Area, the existing demands in Fork Union and projected demands in the Palmyra area, it is not reasonable to rely solely on water from the Rivanna River for the long-term needs of this area.

Additionally, approximately 50% of the County residents rely on individual wells for water. The County's Comprehensive Plan, which calls for low density development in the rural areas of the County will protect both the quality and quantity of water that is available for self-supplied users throughout the areas where water is not available from a community water system.

APPENDIX G-2
LOUISA COUNTY LONG RANGE REGIONAL WATER SUPPLY PLAN

LOUISA COUNTY

LONG RANGE REGIONAL WATER SUPPLY PLAN

Prepared For:

Louisa County **Town of Louisa**

Town of Mineral **Louisa County Water Authority**

Prepared By:

Dewberry & Davis, Inc.
&
Gannett Fleming

Date: June 2011

Louisa County
Long Range Regional Water Supply Plan

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GRAPHS

REFERENCE MATERIALS

The County of Louisa, Virginia Comprehensive Plan, September 5, 2006

Virginia Employment Commission Louisa Community Profile, April 5, 2008

Weldon Cooper Center Total Population Estimates for Virginia Counties and Cities, 2006 Final and 2007 Provision Estimates, January 28, 2008

Louisa County Countywide Build-Out Analysis Draft Results, July 6, 2007

Fluvanna County Raw Water Intake, Anderson and Associates, Inc. letter, January 25, 2005

County of Louisa Water Quality Management Plan and Groundwater Study, January 1998

Bowlers Mill Lake Safe Yield Analysis, January 2006

Zion Crossroads Service Area Master Plan, August 2004

Virginia Department of Health (VDH)
- Listing of Waterworks and Owners:
  http://www.vdh.state.va.us/DrinkingWater/waterworks_owners.htm
- Monthly Operation Reports
- Groundwater System Sanitary Survey Reports
- Engineering Description Sheets

Virginia Department of Environmental Quality (VDEQ)
- Virginia Water Use Data System
- http://www.deq.virginia.gov
- http://gisweb.deq.state.va.us

United States Department of Agriculture, National Agricultural Statistics Survey
- 2007 Census of Agriculture
- Farm and Ranch Irrigation Survey

Virginia Department of Game and Inland Fisheries Websites:
- http://www.vafwis.org/fwis
- http://www.dgif.virginia.gov

National Park Service Nationwide Rivers Inventory
- http://www.nps.gov/ncrc/programs/rtca/nri/states/va.html

Virginia Department of Historic Resources
- http://www.dhr.virginia.gov

Virginia Department of Conservation and Recreation
- http://www.dcr.virginia.gov
- http://www.dcr.virginia.gov/natural_heritage/clinfo.shtml

National Wetlands Inventory
- http://www.fws.gov/wetlands/

Virginia Department of Forestry
- http://www.dof.virginia.gov/info/my-county.htm

ACRONYMS AND UNIT ABBREVIATIONS

VAC	: Virginia Administrative Code
VDEQ	: Virginia Department of Environmental Quality
VWUDS	: Virginia Water Use Data System
VDH	: Virginia Department of Health
VEC	: Virginia Employment Commission
VUSBC	: Virginia Uniform Statewide Building Code
DCR	: Department of Conservation and Recreation
USDA SCS	: United States Department of Agriculture Soil Conservation Service
NOAA	: National Oceanic & Atmospheric Administration
NCDC	: National Climatic Data Center
USGS	: United States Geological Survey
LCWA	: Louisa County Water Authority
LCBOS	: Louisa County Board of Supervisors
SSU	: Self-Supplied User
GPOD	: Groundwater Protection Overlay District
CO	: Certificate of Occupancy
GA	: Growth Area
SA	: Service Area
CWS	: Community Water System
PWSID	: Public Water System Identification Number
GW	: Groundwater
SW	: Surface Water
SWP	: Surface Water Purchase

GPD	: Gallons per Day
GPD/person	: Gallons per Day per Person
GPD/p	: Gallons per Day per Person
Gal/Mo	: Gallons per Month
Gal/year	: Gallons per Year
MGD	: Million Gallons per Day
BGD	: Billion Gallons per Day
COs/yr	: Certificates of Occupancy Issued per Year

EXECUTIVE SUMMARY

In response to Virginia Code 9 VAC 25-780, “Local and Regional Water Supply Planning”, Louisa County, the Town of Louisa, the Town of Mineral, and the Louisa County Water Authority have completed a plan which outlines the Regional Water Supply for Louisa County. The plan addresses each of the required subsections under Chapter 780 of the Virginia Code and provides guidance for each of the government entities to allow for proper planning through the year 2050.

This plan has analyzed multiple sources of data to outline current population and water demands, proposed growth within the County, Towns, private communities, and County designated growth areas, and projected water demands for the associated planning time steps. Based on this analysis, the combined water demand for municipal community water systems is anticipated to exceed the current permitted public source capacity in 2021, and surpass the known available public source capacity in 2041 to create an estimated public water supply deficit of approximately 841,000 gallons per day in 2050. It is important to note that existing and available public water sources are not in the vicinity of each of the County’s designated growth areas (proposed municipal service areas), which could necessitate the development of new water sources near or within the proposed municipal service areas based on technical and economical feasibility. Private community water systems are not expected to have a water supply deficit through the 2050 planning period.

In response to the public water system deficit, this plan identifies alternatives to support the projected water demands of the County. These alternatives will require future in-depth analysis to ensure that the new sources are strategically located to minimize the potential for environmental disturbances, impacts to the rural communities within the County, and costs associated with the construction and operation of the systems.

The plan has been reviewed by the general public through a series of “open houses”, and accepted by each of the participating governments by their respective Boards and Councils. The plan is a “living document” which will be updated, modified, and expanded as additional information becomes available and new water sources are developed.

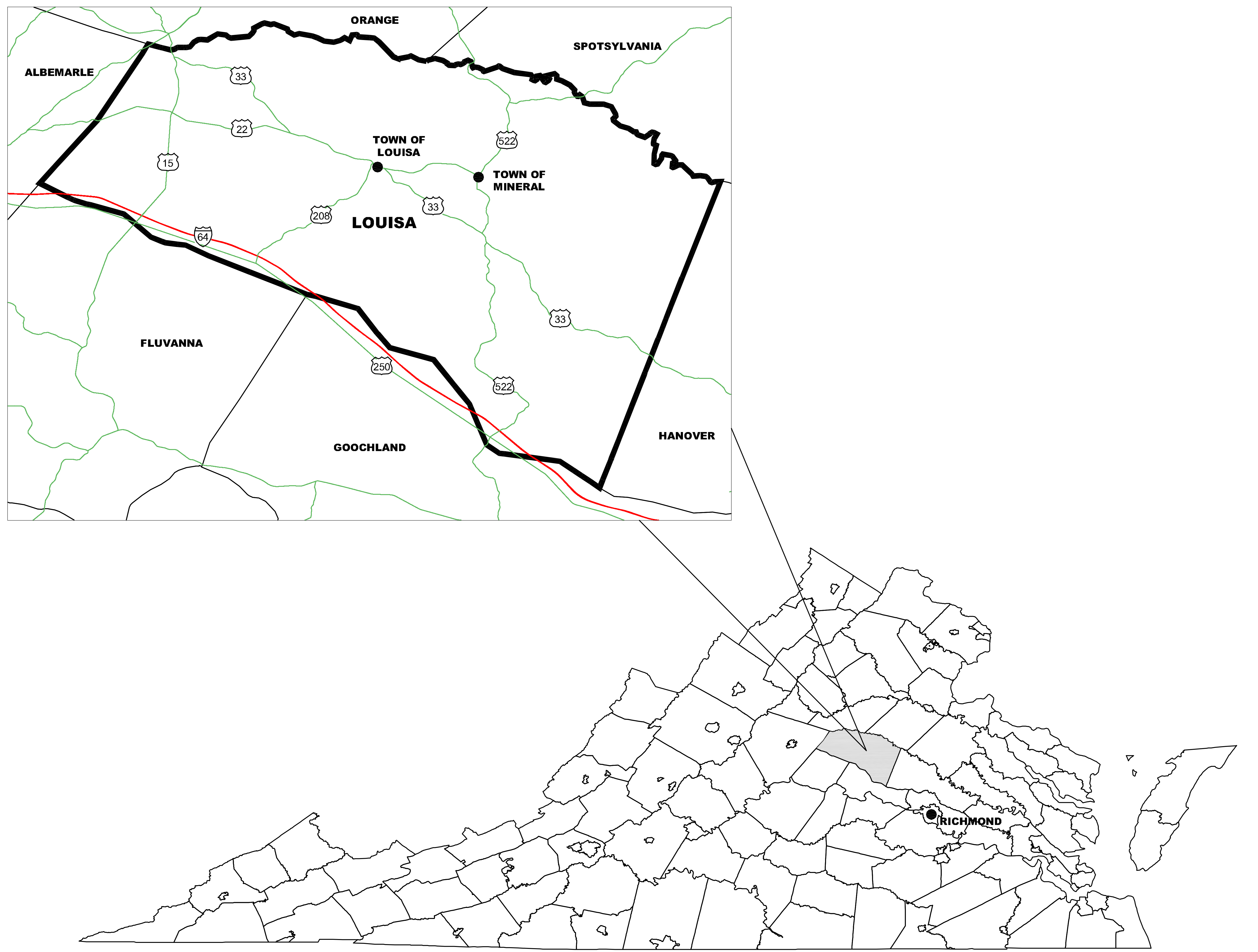
I. INTRODUCTION

A. Purpose

In response to Virginia Code 9 VAC 25-780, "Local and Regional Water Supply Planning", Louisa County, the Town of Louisa, the Town of Mineral, and the Louisa County Water Authority combined efforts to complete this plan, which outlines the Regional Water Supply Plan for all of Louisa County through the year 2050. **Figure 1** shows the location of Louisa County within the Commonwealth of Virginia.

With Louisa's rural character, much of the county utilizes individual wells. However, public water is provided within the limits of two (2) municipal service areas, as well as a few private communities with multiple users. The Louisa County Water Authority (LCWA) was created by the Louisa County Board of Supervisors in 1968 with its primary purpose to establish and operate a water or sewer system, or both, for the benefit of residents and places of business in the County and to exercise all powers granted under the Virginia Water and Sewer Authorities Act (Code of Virginia, § 15.1-1239 et seq.). With respect to water systems, the LCWA operates and maintains the water treatment facilities, as well as portions of the water distribution system for the County's two (2) existing municipal service areas. One (1) service area, located centrally in the County, includes both the Town of Louisa and the Town of Mineral. Both Towns own and maintain the water distribution system within their respective Town limits and bill clients for water usage. The Town of Louisa purchases water from the LCWA and provides it to its residents and businesses. The Town of Mineral supplies water to its customers from its own groundwater source; however, also purchases water from the LCWA to supplement the Town's water demands. Customers within this central service area, but separate from the Towns, are billed directly by the LCWA. The second service area in the County encompasses Zion Crossroads, located at Exit 136 on Interstate 64, which is a designated growth area per the Louisa County Comprehensive Plan. Customers connected to the public water distribution system at Zion Crossroads are billed by the LCWA.

The purpose of the Louisa County Long Range Regional Water Supply Plan is to establish a comprehensive tool to be used by each of the governing bodies in addressing the increasing water demands through the planning period. This document will be updated, modified, and expanded as additional information becomes available and new water sources are developed. The goal of the plan is to be a "living document" that is approved by all governing bodies who participated in its preparation.



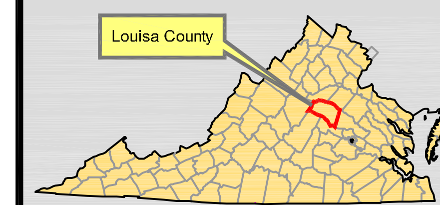
Dewberry

Gannett Fleming

LOUISA COUNTY WATER SUPPLY MASTER PLAN

AREA MAP

LOCATION MAP



LEGEND

PRIMARY ROADS

INTERSTATE

COUNTY BOUNDARY

SOURCE NOTE:

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FIGURE 1

B. Scope of the Regional Water Supply Plan

In accordance with Virginia Code 9 VAC 25-780, the Louisa County Long Range Regional Water Supply Plan addresses all applicable sections of Chapter 780, "Local and Regional Water Supply Planning".

These sections include:

-	Existing Water Source Information	(9 VAC 25-780-70)
-	Existing Water Use Information	(9 VAC 25-780-80)
-	Existing Resource Information	(9 VAC 25-780-90)
-	Projected Water Demand Information	(9 VAC 25-780-100)
-	Water Demand Management Information	(9 VAC 25-780-110)
-	Drought Response and Contingency Plans	(9 VAC 25-780-120)
-	Statement of Need and Alternatives	(9 VAC 25-780-130)

Each section is discussed in detail throughout this plan. Supplemental information regarding the specific sections and data compiled, analyzed, and/or developed through the preparation of the plan is included in the Appendix.

C. Existing Data Collection and Investigation

Within the Local and Regional Water Supply Planning regulations, the Virginia Department of Environmental Quality, Division of Water Resources, Office of Water Supply Planning (VDEQ) was assigned certain program development, guidance and assistance roles. All information related to the required "Existing Water Source Information" (9 VAC 25-780-70) and "Existing Water Use Information" (9 VAC 25-780-80) was collected and utilized in the "Local and Regional Water Supply Plan" templates supplied by VDEQ. These templates were developed for compiling and reporting available data for existing water sources and existing water uses, and made available on VDEQ's website. Extensive coordination with VDEQ and the Virginia Department of Health, Office of Drinking Water (VDH) was completed to secure all available data and compile it in the desired format. At the time of this plan's initial investigation, VDEQ could not provide example documents for other completed plans in response to the "Local and Regional Water Supply Planning" regulation; therefore, the best attempt at presenting the available data and utilizing the templates in an effective manner was made. Information included in this plan was initially collected and input into the VDEQ pilot templates during spring of 2007.

Since the time of completion for the initial data investigation and collection for this plan, VDEQ further developed and revised the templates to be utilized for "Local and Regional Water Supply Planning". The initial data collected was reviewed, verified and/or clarified, and transferred to the latest approved version of the VDEQ templates. These templates are included in **Appendix A**.

As mentioned above, there was close coordination with VDEQ and VDH during the data collection and investigation for this plan. Coordination with VDH included a visit to the VDH office in Lexington, Virginia in March of 2007 to review available records and gather relevant data. To capture relatively rapid growth that had been occurring in the County since about 2005, data was used for the twelve preceding months (March 2006 through February 2007) rather than one calendar year in an effort to keep the data as current as possible through the lengthy plan development process. Monthly production records, Groundwater System Sanitary Survey Reports, and Engineering Description Sheets for Louisa County water systems proved to be most useful and hard copies of available data were obtained. VDH staff members assisted in this process. Monthly production reports identified the water source type, monthly water production, as well as the population served for each water system in the county. Sanitary Surveys offered general information and compliance history, and the Engineering Description Sheets provided more detailed information related to system features such as permitted system capacity, number of wells, well yield, depth, and diameter. Information for active water systems was also available through VDH's website. The VDH listing of Waterworks and Owners provided a spreadsheet containing owner and system name, contact information, source type, service connections, and population served.

Supplemental information was also secured in discussion with County staff, and water system operators to clarify information gathered and supplement data for unknown water system conditions; however, limited additional information was available.

Beginning in April 2008, data for water production and sales in the municipal service areas was requested and obtained from Louisa County Water Authority and both Towns to once again try to capture recent data and expansion, most notably in the Zion Crossroads Service Area, to be utilized in the detailed evaluation of water demand projections. This data spanned the twelve months from April 2007 to March 2008. Population was also clarified with the County, Towns, and the Louisa County Water Authority during this time. Population projection and water demands were discussed with the County, both Towns, the Louisa County Water Authority, and VDEQ. Upon discussion and mutual agreement, a memo summarizing the population projections and water demands through 2050 was submitted to all parties, including VDEQ, in October 2008. This memo is included in **Appendix B**.

During revisions for the Final Draft of this plan, raw water data was reviewed to verify water use utilized in the water demand projections provided in the memo and Preliminary Draft of this plan. Data that was no longer documented or could not be verified was replaced with more current information through coordination with VDH. Also, data for private community systems was clarified to be water production or withdrawal, rather than water usage. Based on these findings, the tables included in the plan from the memo have been updated accordingly.

The preliminary water demand projections did not include surface water withdrawal for self-supplied, non-agricultural users using more than 300,000 gallons per month, and did not include self-supplied, agricultural users using more than 300,000 gallons per month of ground or surface water. As suggested by VDEQ, data for non-agricultural surface water withdrawal was obtained by requesting a report from VDEQ's Virginia Water Use Data System, and data for agricultural water use was estimated from the *2007 Census of Agriculture*, and *Farm and Ranch Irrigation Survey*, both issued by the United States Department of Agriculture, National Agricultural Statistics Service. The United States Geological Survey livestock water use factors provided in the VDEQ templates were utilized with the Census livestock inventory to estimate livestock water use. This data is now provided in tables within this document.

The following sections summarize the findings from the data collection and investigation.

II. EXISTING WATER SOURCE INFORMATION (9 VAC 25-780-70)

Louisa County utilizes both surface water and ground water for its water demands.

The Northeast Creek Reservoir, with a surface area of 185 acres and watershed of 9.73 square miles, is the only reservoir currently used in the County for potable water supply to a community water system. A municipal water distribution system extends north from the Northeast Creek Reservoir on U.S. Route 33 to the center of the Town of Louisa. There is also a water main connected to the system that extends from the Town of Louisa to the east along Route 22/208 to the Town of Mineral. Northeast Creek Reservoir is the main water source for the centrally located municipal service area, also known as the Northeast Creek Reservoir Service Area. While the Northeast Creek Reservoir has a current permitted capacity of 1.0 MGD, the safe yield of the reservoir is approximately 2.77 MGD. The Northeast Creek Reservoir Service Area is also supplemented by water from three (3) groundwater sources: the Louisa County Water Authority Industrial Park Well, and two (2) wells owned by the Town of Mineral.

The municipal Zion Crossroads Service Area and the seven (7) private community water systems located throughout the county are supported solely through the use of groundwater wells. Specific information for each system can be found in the VDEQ templates in **Appendix A**.

County residents who are not supplied by municipal or private community water systems are supplied water by private individual groundwater wells.

In addition to the potable water sources, there are four (4) significant self-supplied systems withdrawing surface water for non-potable uses. Self-supplied systems are waterworks defined by VDH as Non-Community or Non-Transient, Non-Community. A significant self-supplied system is one that uses more than 300,000 gallons per month (Gal/Mo) per the VDEQ templates. The Tanyard Branch Country Club Golf Course in the Town of Louisa is irrigated by surface water withdrawals from Tanyard Branch Creek and Richardson Pond. Spring Creek Development located at Zion Crossroads irrigates its golf course from an onsite irrigation lake which is supplied water from the Camp Creek impoundment. The Louisa County Water Authority supplies raw water from the Bowlers Mill Reservoir (also known as Lake Gordonsville) to Old Dominion Electric Cooperative's Louisa power station near the Town of Gordonsville for use in their cooling system. The County's largest surface water withdrawal from Lake Anna is used for the North Anna Nuclear Power Station's hydro-power and cooling system, which is a "once-through" system that returns the full amount of withdrawal to the Lake and/or to the river below the dam.

With the exception of the North Anna Power Station, limits for the non-potable surface water withdrawals were not included in the data sources used for completing the VDEQ templates. Maximum cooling water withdrawal from Lake Anna is 2.708 billion gallons per day (Unit 1 – 1.354 BGD, Unit 2 – 1.354 BGD). There is also the withdrawal for the two (2) hydro units at the Lake Anna Dam, one with a maximum 25.85 million gallons per day (MGD) operated when the lake level is above 248 feet Mean Sea Level (MSL), and the other with a maximum 84.02 MGD operated when the lake level is above 250 feet MSL.

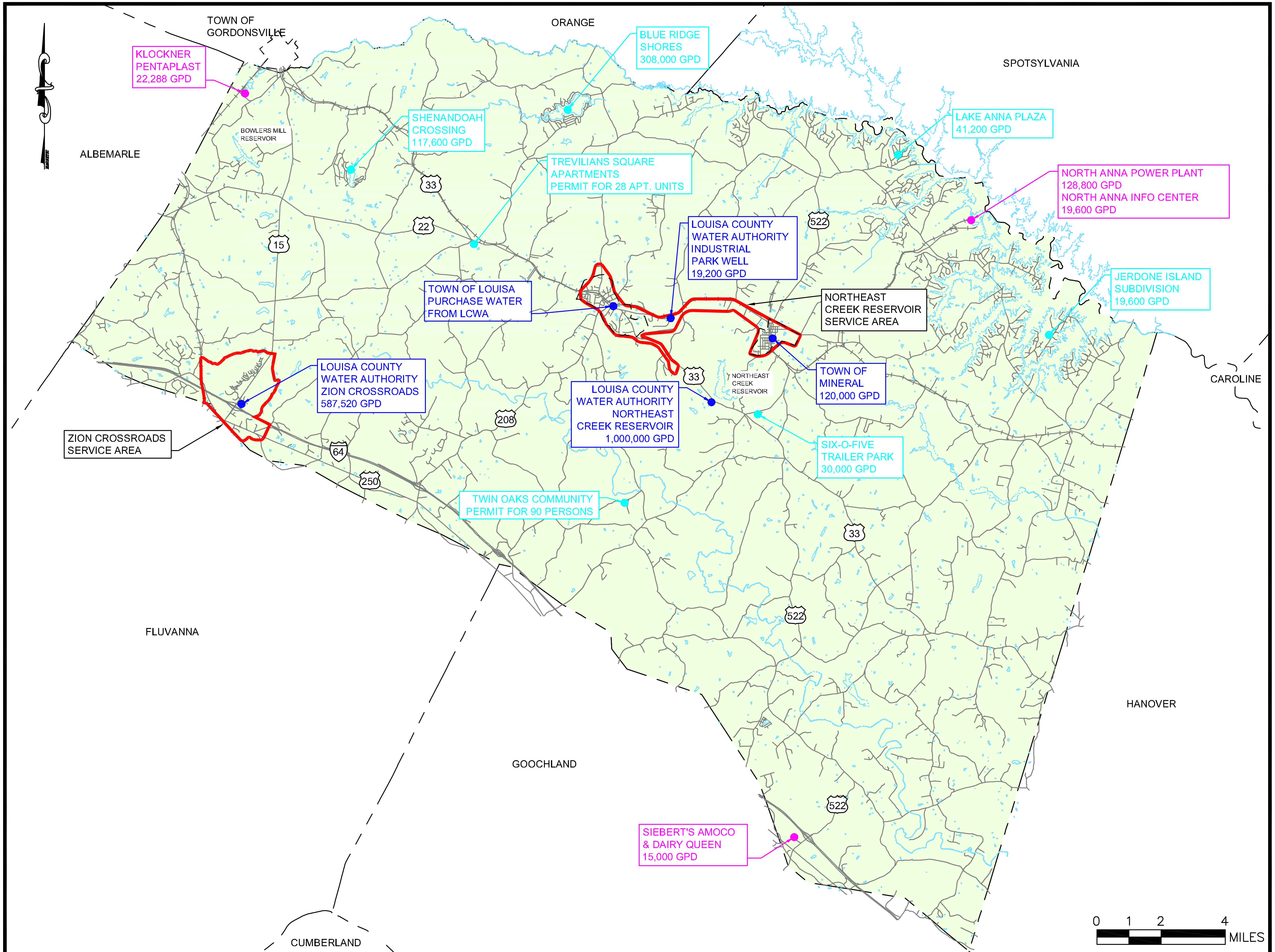
An analysis completed in 2006 determined a safe yield of 0.75 MGD for Bowlers Mill Reservoir, as detailed in the *Bowlers Mill Lake Safe Yield Analysis*, dated January 2006.

Table 1 provides a summary of the existing potable water source information collected in the VDEQ templates in **Appendix A**. Permitted capacity is based on gallons per day (GPD).

Table 1: Existing Potable Water Source Summary

Community Water Systems (Groundwater)	
Municipal Water Systems	***VDH Permitted Capacity (GPD)***
Louisa County Water Authority Industrial Park Well	19,200
Town of Mineral	120,000
Zion Crossroads	587,520
Private Water Systems	***VDH Permitted Capacity (GPD)***
Blue Ridge Shores	308,000
Shenandoah Crossing	117,600
Six-o-Five Village Trailer Park	30,000
Trevilians Square Apartments	Permitted for 28 Apt. Units
Twin Oaks	Permitted for 90 persons
Lake Anna Plaza	41,200
Jerdone Island	19,600
Community Water Systems (Surface Water)	
Municipal Water Systems	***VDH Permitted Capacity (GPD)***
Louisa County Water Authority Northeast Creek Reservoir	1,000,000
Self-Supplied Users > 300,000 Gal/Mo (Groundwater)	
Private Water Systems	***VDH Permitted Capacity (GPD)***
Klockner Pentaplast	22,288
North Anna Power Plant	128,800
North Anna Information Center	19,600
Siebert Amoco and Dairy Queen	15,000
Crossing Pointe *(connected to public water in August 2010)*	was 25,200 (wells no longer active)

Figure 2 identifies the location and daily permitted capacity for potable water sources in gallons per day for the existing community water systems, and self-supplied users using greater than 300,000 Gal/Mo based on the data included in the VDEQ templates, and summarized above.



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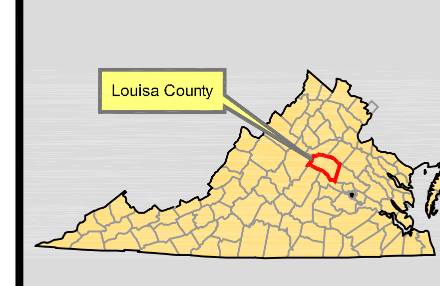
Gannett Fleming

LOUISA COUNTY WATER SUPPLY MASTER PLAN

EXISTING POTABLE WATER SOURCES & DAILY PERMITTED CAPACITY

LOCATION MAP



LEGEND

ROADS
RAILROADS
WATER
COUNTY BOUNDARY
MUNICIPAL SERVICE AREA
MUNICIPAL COMMUNITY WATER SYSTEM
PRIVATE COMMUNITY WATER SYSTEM
SELF-SUPPLIED USER > 300,000 GAL/MONTH

SOURCE NOTE:

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FIGURE 2

III. EXISTING WATER USE INFORMATION (9 VAC 25-780-80)

Louisa County's existing water demand is comprised mainly of residential, commercial, and agricultural users. These uses are met through surface water and groundwater supplied through municipal and private community water systems, and individual self-supplied systems. Detailed information about each system's use is outlined in the section "Projected Water Demand" and included in **Appendix A** and **Appendix B**.

Of the estimated average 4.0* million gallons per day (MGD) of water demand in Louisa County for the base year of 2007, approximately 0.546 MGD or 14% is surface water.

The Louisa County Water Authority currently treats approximately 306,000 gallons per day (GPD) of surface (reservoir) water and distributes this water to the Town of Louisa and customers in the Town of Mineral and surrounding areas. The remaining county demand is met by groundwater wells, either through municipal community water systems, private community water systems or private individual wells.

While Northeast Creek Reservoir is the County's only surface water withdrawal for potable water, there are additional surface water withdrawals in the County for the purpose of irrigation and power station cooling systems. North Anna Power Station uses a considerable amount of water from Lake Anna for cooling.

Current self-supplied users using greater than 300,000 gallons per month (Gal/Mo) for potable water supply are not in the vicinity of an existing municipal service area. The one self-supplied user, Crossing Pointe, that was within the limits of a municipal service area connected to the Zion Crossroads public water system in August 2010 due to quality issues with their private wells. Crossing Pointe private wells were taken off-line in conjunction with the user connecting to public water supply. Water demands for Crossing Pointe are still summarized under self-supplied users, given the collected historical water demand data provided separate water demands for Zion Crossroads Service Area and Crossing Pointe.

Table 2 provides a summary of the existing water withdrawal information collected in the VDEQ templates in **Appendix A**.

**Estimated average water demand of 4.0 MGD does not include the Lake Anna surface water withdrawal for the North Anna Power Station. The North Anna Power Station uses over 500 times the amount of the overall County's average water demand for its cooling system and hydro units.*

Table 2: Existing Water Withdrawal Summary

Community Water Systems (Groundwater)		
Municipal Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Louisa County Water Authority Industrial Park Well	3,364	5,046
Town of Mineral	45,661	68,491
Zion Crossroads	99,397	149,095
Private Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Blue Ridge Shores	54,749	96,707
Shenandoah Crossing	81,081	121,622
Six-o-Five Village Trailer Park	12,587	18,881
Trevilians Square Apartments	6,100	9,150
Twin Oaks	7,628	11,442
Lake Anna Plaza	4,442	6,664
Jerdone Island	6,598	9,896
Community Water Systems (Surface Water)		
Municipal Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Louisa County Water Authority Northeast Creek Reservoir	306,200	459,300
Self-Supplied Users > 300,000 Gal/Mo (Groundwater)		
Private Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Klockner Pentaplast	10,147	15,221
North Anna Power Station	10,998	16,497
North Anna Info Center	766	1,149
Siebert Amoco and Dairy Queen	15,000	22,500
Crossing Pointe	12,625	18,938
Self-Supplied Users > 300,000 Gal/Mo (Surface Water)		
Private Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Tanyard Country Club Golf Course	64,060	96,090
Spring Creek Golf Course	162,342	243,513
North Anna Power Station	2,150,000,000	3,225,000,000
LCWA (ODEC power station)	13,671	20,507
Self-Supplied Users > 300,000 Gal/Mo (Agriculture)		
Private Water Systems	***Annual Average Water Withdrawal (GPD)***	***Peak Day Water Withdrawal (GPD)***
Livestock	174,644	261,966
Irrigated Land	138,644	207,966

IV. EXISTING RESOURCES (9 VAC 25-780-90)

Existing resource data related to geologic, hydrologic, meteorological, and environmental conditions was obtained from a variety of agencies and existing County reports. Primary existing report sources included the Louisa County Comprehensive Plan, dated September 5, 2006, and the *County of Louisa Water Quality Management Plan and Groundwater Study*, dated January 1998. These two reports contained detailed and specific information for the existing resources of Louisa County and are transcribed below.

Existing resources are relevant to water supply planning given they can impact the expansion or creation of a water source or water system, for example conservation easements or historic districts can require additional agency review of design, additional permitting, and/or altering the location of the proposed water system improvements.

A. Geologic Conditions

Louisa County is approximately 514 square miles and located entirely on the Piedmont Plateau in central Virginia. The County's rolling terrain gradually slopes downward to the east and is well dissected by streams. The inter-stream divides are fairly wide and sloping or rolling. In areas along the lower tributaries of large streams, the divides are steep. Entrenchment along the lower tributaries of the major streams has been rapid. As a result, there are many bluffs and V-shaped valleys that have steep sides that rise abruptly from the flood plain. The mean seal level elevation varies from a high of 540 feet to a low of 180 feet (United States Department of Agriculture Soil Conservation Service (USDA SCS), 1976).

The County is underlain by igneous and metamorphic bedrock that ranges in age from 300 million years to more than one billion years. Bedrock in the western portion of the County is predominantly mica schist and phyllite that represent metamorphosed sandstone, siltstone, and mudstone originally deposited in an Early Paleozoic (500 million years ago) ocean basin. The Green Springs area is underlain by a mafic-composition igneous rock, the Green Springs Pluton, and associated granitic rocks. The Ellisville Granodiorite is a granitic igneous rock body that underlies the north-central portion of the County, extending southwestward through the Town of Louisa to beyond Ferncliff. The east-central portion of the County is underlain by metamorphosed mafic and felsic composition volcanic rocks of the Cambrian-age (560 million years ago) Chopawamsic Formation, and the Ordovician-age (450 million years ago) Quantico Slate. The Chopawamsic contains a series of gold and sulfide mineral deposits that extend from north of the Town of Mineral, southwestward to the Shannon Hill area and beyond. The southeastern portion of the County is underlain by billion-year-old garnet-biotite gneisses of the Maidens Formation, which appear to represent ancient sedimentary deposits that have been deeply buried and metamorphosed at high temperatures and pressures. The Maidens is intruded by a series of granitic plutonic rocks. Throughout Louisa County, many of the boundaries between the individual rock formations are faults, some of which are regionally extensive and have histories of multiple movements. **Figure 3** presents the Geology map from the Louisa County Comprehensive Plan.

The characteristics of a soil type may be traced from its parent material, the underlying rock or material moved by water or gravity that has settled as unconsolidated deposits over existing bedrock. Soil type characteristics include texture, mineral content, base saturation, kind and quantity of clay, color, drainage, and agricultural suitability. Louisa County is primarily a rural agricultural area. Many of the soils are suited to a wide variety of crops, and the climate is favorable for both general farming and livestock production.

The quality of soils within a region has a direct relationship to the type and extent of land development that has occurred or is occurring in that region. Content, permeability, and stability of soil types in a region are the primary determining factors for potential land development. There are eight (8) soil types, or classifications within Louisa County. These include: (1) Nason-Tatum-Manteo; (2) Nason-Tatum; (3) Zion-Poindexter-Iredell; (4) Grover-Ashlar-Madison; (5) Appling-Ashlar-Cecil; (6) Appling-Cecil; (7) Sekil-Iredell-Cullen; and (8) Masada-Chewacla. In-depth information about these soil classification types may be obtained from the U.S. Natural Resource Conservation Service (NRCS; formerly Soil Conservation Service), Soil Survey of Louisa County, Virginia. Of the soil types listed above, types (1) and (2) are the least suitable for agriculture or development based on information from the survey. Soil types (3, (7), and (8) are fully suitable for agriculture, but usually not acceptable for most other types of development (VDMME, 1999). **Figure 4** presents the general Soils map from the Louisa County Comprehensive Plan.

B. Hydrologic Conditions

i. Watersheds and Hydrologic Units

Louisa County is drained primarily by the North Anna and South Anna Rivers, and their tributaries, which are part of the York River watershed. There are some small areas along the southern boundary of the County that are part of the James River basin.

The boundaries of the hydrologic units coincide with the specific watersheds of the County. Within Louisa County, the North Anna watershed is made up of the upper North Anna River basin, the Contrary Creek watershed, the Lake Anna / Pamunkey Creek watershed, and the Lower North Anna watershed. The Upper and Lower Little River watersheds, along with the Newfound River watershed also are part of the North Anna River basin, but these rivers do not join the North Anna until many miles east of the Louisa County border. The South Anna River watershed consists of the Upper

FIGURE 3

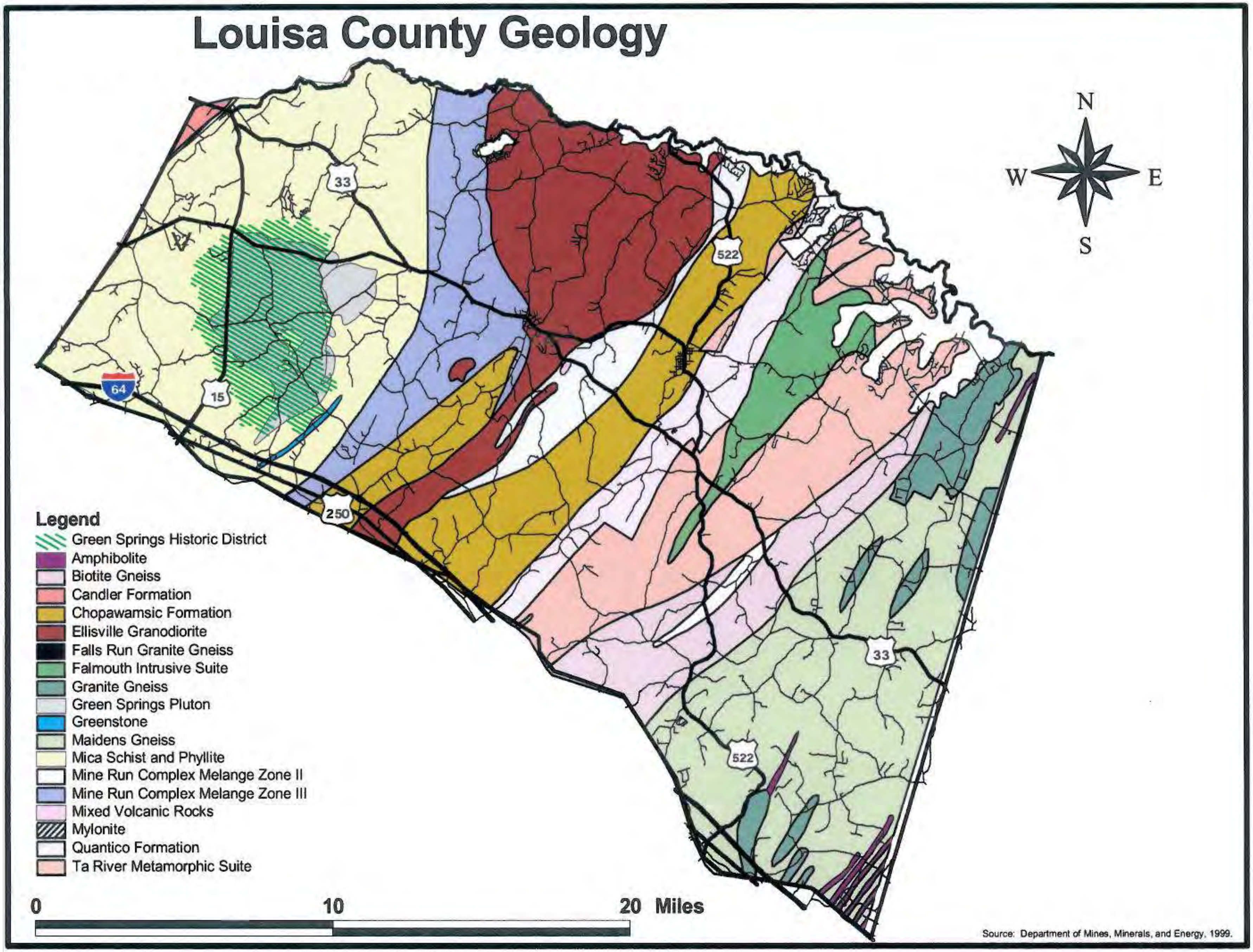
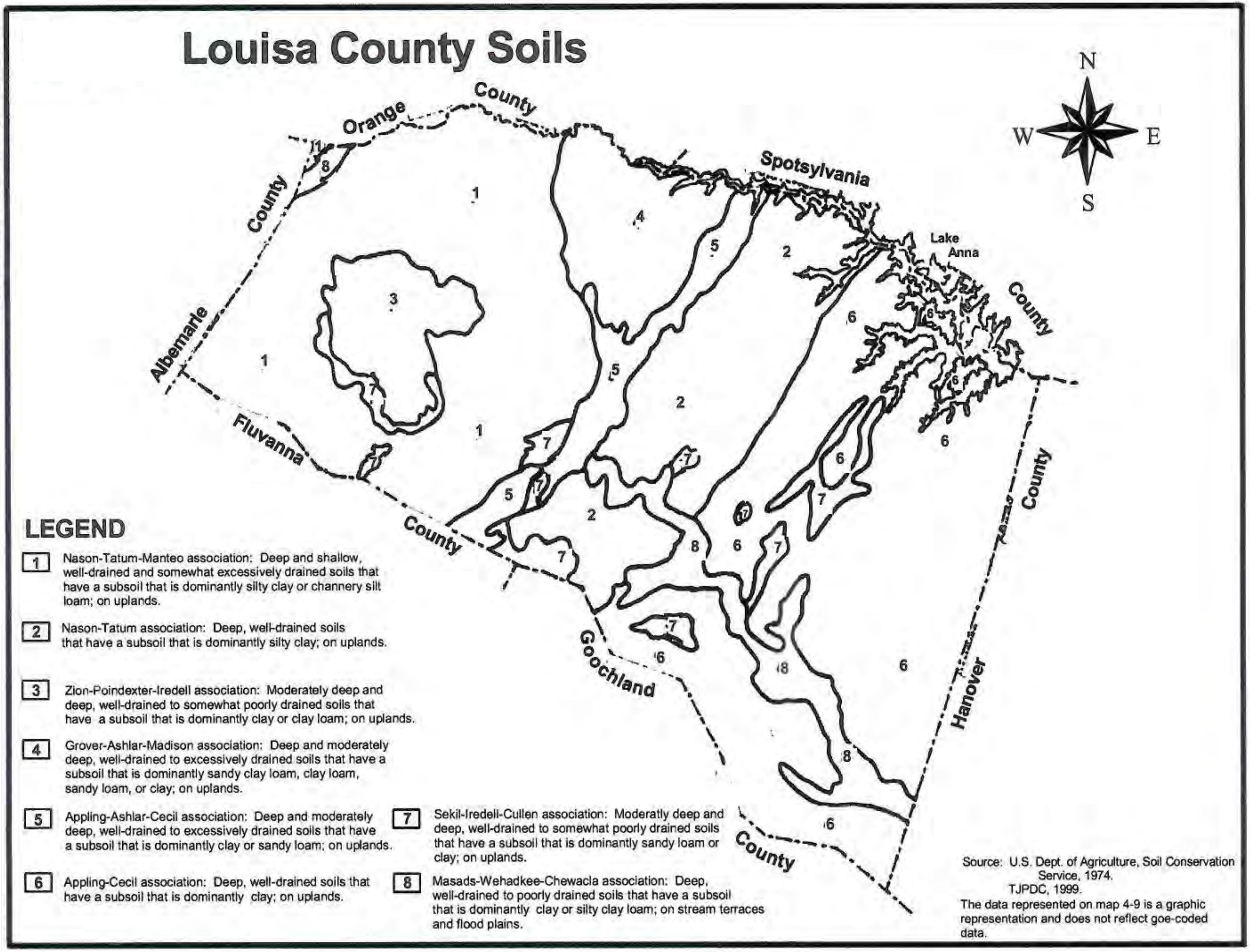

Louisa County Geology
N
W
E
S
33
522
64
15
250
33
522
Legend
Green Springs Historic District
Amphibolite
Biotite Gneiss
Candler Formation
Chopawamsic Formation
Ellisville Granodiorite
Falls Run Granite Gneiss
Falmouth Intrusive Suite
Granite Gneiss
Green Springs Pluton
Greenstone
Maidens Gneiss
Mica Schist and Phyllite
Mine Run Complex Melange Zone II
Mine Run Complex Melange Zone III
Mixed Volcanic Rocks
Mylonite
Quantico Formation
Ta River Metamorphic Suite
0
10
20 Miles
Source: Department of Mines, Minerals, and Energy, 1999.

FIGURE 4


Louisa County Soils
Orange County
Spotsylvania
Lake Anna
County
Albemarle County
Fluvanna County
Goochland County
Hanover County
N
S
E
W
LEGEND
1 Nason-Tatum-Manteo association: Deep and shallow, well-drained and somewhat excessively drained soils that have a subsoil that is dominantly silty clay or channery silt loam; on uplands.
2 Nason-Tatum association: Deep, well-drained soils that have a subsoil that is dominantly silty clay; on uplands.
3 Zion-Poindexter-Iredell association: Moderately deep and deep, well-drained to somewhat poorly drained soils that have a subsoil that is dominantly clay or clay loam; on uplands.
4 Grover-Ashlar-Madison association: Deep and moderately deep, well-drained to excessively drained soils that have a subsoil that is dominantly sandy clay loam, clay loam, sandy loam, or clay; on uplands.
5 Appling-Ashlar-Cecil association: Deep and moderately deep, well-drained to excessively drained soils that have a subsoil that is dominantly clay or sandy loam; on uplands.
6 Appling-Cecil association: Deep, well-drained soils that have a subsoil that is dominantly clay; on uplands.
7 Sekil-Iredell-Cullen association: Moderatly deep and deep, well-drained to somewhat poorly drained soils that have a subsoil that is dominantly sandy loam or clay; on uplands.
8 Masads-Wehadkee-Chewacla association: Deep, well-drained to poorly drained soils that have a subsoil that is dominantly clay or silty clay loam; on stream terraces and flood plains.
Source: U.S. Dept. of Agriculture, Soil Conservation Service, 1974.
TJPDC, 1999.
The data represented on map 4-9 is a graphic representation and does not reflect goe-coded data.

South Anna watershed, the South Anna / Roundabout Creek watershed, and the South Anna / Taylors Creek watershed. The hydrologic basins that are part of the James River watershed include the Mechunk Creek watershed, the Byrd Creek watershed, the Big Lickinghole Creek watershed, and the James River / Beaverdam Creek watershed. **Figure 5** presents the Hydrologic Units map from the Louisa County Comprehensive Plan.

Twelve (12) of the 145 third-order watersheds in Louisa County are classified as high priority. A high priority watershed is at a high level of environmental sensitivity. Another 57 watersheds discharge to the high priority areas and, therefore, may also be considered critical. Expressed in terms of area, about 53,416 acres of Louisa County (about 16% of the County) are within high priority watersheds, and an additional 122,250 acres of the County (about 37%) drain into the high priority watersheds.

The South Anna River was ranked a high priority because of an abundance of associated wetlands. Similarly, wetlands are present in areas adjacent to the County sanitary landfill. The area near Northeast Creek Reservoir is ranked high priority because it is a source of potable water. It is important to note that at least some portions of the Northeast Creek Reservoir watershed appear to drain mining areas (Draper Aden, 1998).

The Department of Housing and Urban Development mapped some stream and river floodplains in Louisa County prior to and during 1974. Louisa County qualified for the Flood Insurance Program in March 1974. Both the South Anna and the Little River watersheds are in the flood control program of the U.S. Natural Resource Conservation Service. A number of impoundments, including the Northeast Creek Reservoir and Bowlers Mill impoundment, have been built under this program. **Figure 6** presents the Flooplains and Hydric Soils map from the Louisa County Comprehensive Plan.

ii. Surface Water

There is a fairly large supply of surface water available from the North Anna and the South Anna Rivers during times of normal precipitation. However, storage reservoirs are needed to provide dependable supplies during periods of prolonged drought. Water volume in the County has never been measured to any great extent. There is a gauging station on Bunch Creek near Boswell's Tavern. The drainage area above the station is only 4.1 square miles, but there is an average stream flow of 3 million gallons per day (MGD). The gauging stations on the North Anna and the South Anna Rivers are in neighboring Hanover County. The North Anna River has a station near Doswell that shows an average stream flow of 2.39 MGD; the station on the South Anna River near Ashland shows an average flow of 2.21 MGD.

FIGURE 5

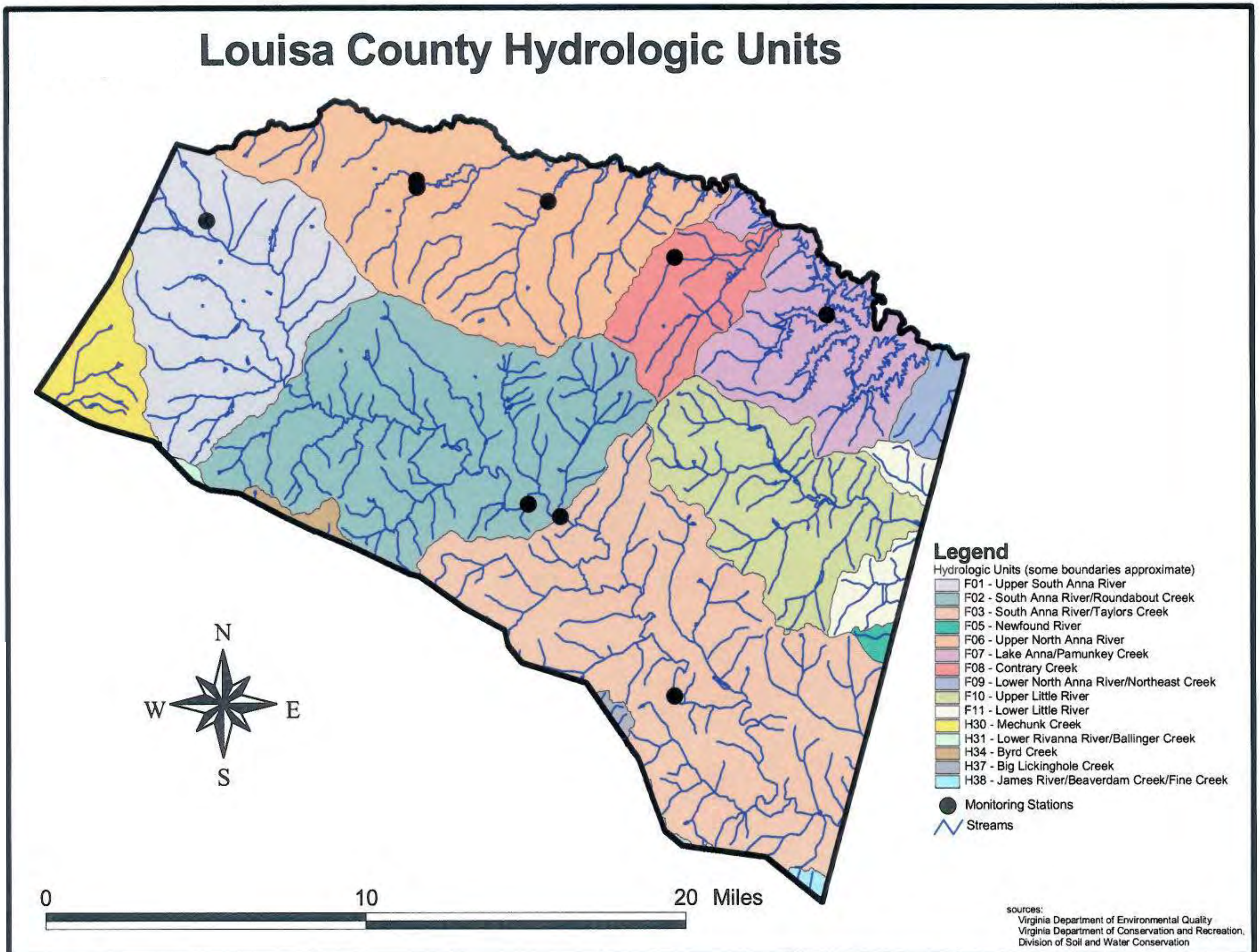
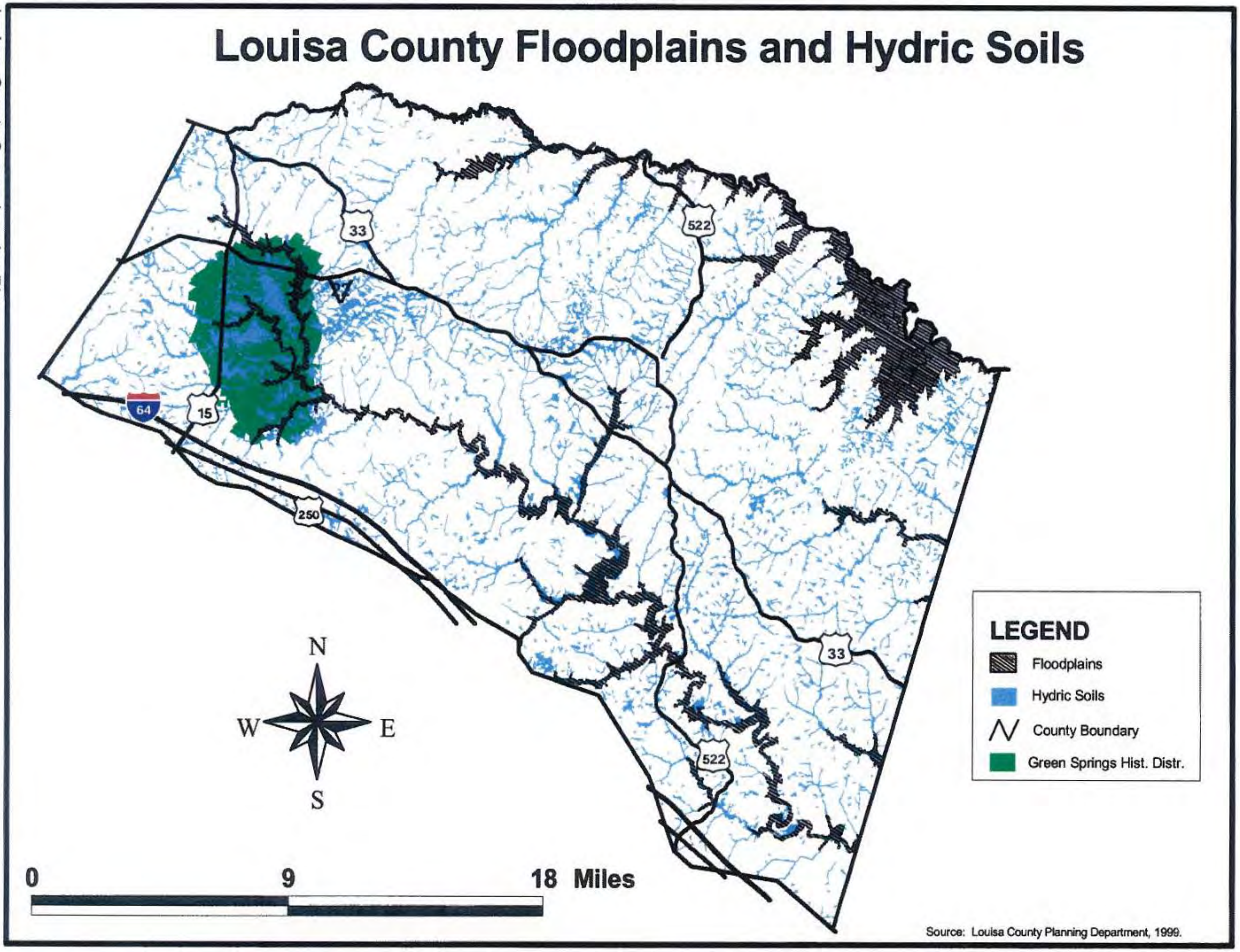

Louisa County Hydrologic Units
N
W
E
S
0
10
20 Miles
Legend
Hydrologic Units (some boundaries approximate)
F01 - Upper South Anna River
F02 - South Anna River/Roundabout Creek
F03 - South Anna River/Taylors Creek
F05 - Newfound River
F06 - Upper North Anna River
F07 - Lake Anna/Pamunkey Creek
F08 - Contrary Creek
F09 - Lower North Anna River/Northeast Creek
F10 - Upper Little River
F11 - Lower Little River
H30 - Mechunk Creek
H31 - Lower Rivanna River/Ballinger Creek
H34 - Byrd Creek
H37 - Big Lickinghole Creek
H38 - James River/Beaverdam Creek/Fine Creek
Monitoring Stations
Streams
sources:
Virginia Department of Environmental Quality
Virginia Department of Conservation and Recreation,
Division of Soil and Water Conservation

FIGURE 6



Louisa County Floodplains and Hydric Soils
33
522
64
15
250
33
522
N
W
E
S
LEGEND
Floodplains
Hydric Soils
County Boundary
Green Springs Hist. Distr.
0
9
18 Miles
Source: Louisa County Planning Department, 1999.

The quality of surface water appears to be good throughout most of Louisa County according to previous studies. All of the surface water is soft, and thus usuable for municipal and industrial areas.

The County's two largest man-made lakes, Lake Anna and Lake Louisa, are in the North Anna watershed. Lake Anna on the County's northern boundary is one of Virginia's largest lakes. Created by Dominion Virginia Power to provide cooling water for its North Anna Nuclear Power Station, the lake is 17 miles long and has 200 miles of shoreline along 13,000 acres of surface water. The lake straddles the border between Louisa County, Orange County, and Spotsylvania County.

Lake Louisa on Hickory Creek is a privately owned 300-acre lake created for the Blue Ridge Shores residential/recreational subdivision. In addition, Bowlers Mill Reservoir is an 80-acre lake on Bowlers Creek in the South Anna watershed. Its planned use is for flood control, recreation, and possible future water supply.

The Northeast Creek Reservoir just north of Route 33 between the Towns of Louisa and Mineral was completed in 1981. This impoundment serves the water needs of both Towns, and will provide water for future development in that area.

iii. Groundwater

A large majority of Louisa County's residents rely on groundwater for their drinking water. Given growth in the County is scattered, it is not economically feasible to serve the entire population with public water, nor is it preferred given the County wants to maintain its rural character. Thus, it is imperative that the County identify potential problem areas or areas in need of protection and institute protective measures to ensure groundwater remains a viable resource for the County and its residents.

The water-bearing properties of the bedrock are fairly uniform throughout the County. The rock types have low permeability and are considered relatively poor producers of groundwater, although a few exceptional yields have occurred. The success of a well is nearly always dependent upon water-filled fractures encountered within the first 200 feet of drilling, and it is generally less effective to drill deeper than 300 feet.

The quality of groundwater appears to be good throughout most of the County. Water from wells drilled in bedrock is soft to moderately hard, and low in dissolved mineral matter. Wells in the Zion Crossroads area have been found to contain zinc. The exception is the central portion of the County where iron and acid conditions have been reported. Water from wells bored in the zone of soil and partially weathered rock (above bedrock) is reported to contain small amounts of iron and lime, and may be moderately hard and turbid.

There are few natural springs in the County. Those that do exist generally are low in yield and intermittent.

DRASTIC is used to evaluate groundwater pollution potential. It is an acronym for seven measured parameters: Depth (to groundwater); Recharge (net); Aquifer media; Soil media; Topographic position; Impact of vadose zone; and hydraulic Conductivity. Based on an analysis of these parameters, a numerical value (index) was assigned to each of the three hydrogeological settings that exist in Louisa County. A higher index value represents a higher pollution potential. The Louisa County DRASTIC mapping project resulted in the production of a map showing the areas of Louisa County that are most vulnerable to groundwater pollution. The report proposed strategies to protect the groundwater in the most vulnerable areas.

The Strategy proposed as a result of the DRASTIC analysis was the development of Groundwater Protection Overlay Districts (GPODs). GPODs overlay the areas within the County with the highest potential for groundwater pollution. In order to address these potentials for groundwater pollution, the DRASTIC report recommends specific strategies for the areas with the GPODs. Full-color maps of these GPODs and strategies are available for review from the Thomas Jefferson Planning District Commission or the Louisa County Planning Department.

A full description of the DRASTIC report process and findings, including recommendations for groundwater protection in the GPODs, is available from the County upon request.

C. Meteorological Conditions

Due to its location in the Central Piedmont region of Virginia, Louisa County typically experiences warm summers, relatively mild winters, and normally adequate rainfall. Elevation differences within the County are not large enough to cause significant difference in the climate. The Atlantic Ocean has only a small moderating effect on the climate since the County is located well inland. The County lies in the path of warm moist air currents moving northward and cold dry air currents moving southward. These alternating currents frequently bring sharp, abrupt changes in daily weather. The Appalachian Mountain range to the west tends to lessen the intensity of winter storms that pass through the area.

Average annual temperature varies slightly from year to year but averages about 56 degrees Fahrenheit. Temperatures of more than 95 degrees and less than 15 degrees Fahrenheit are infrequent. Prolonged periods of very hot or very cold weather are unusual.

The growing season, defined as the period between the average dates of the last freezing temperature in the spring and the first freezing temperature in the fall, is 167 days. This growing season is long enough to allow proper maturation of many crops. The pasture season is slightly longer, but feed and shelter for livestock are necessary during the winter.

Precipitation ranges from an average low of 3.0 inches in October to an average high of 4.6 inches in July. Rainfall is greatest in July and August because of shower and thunderstorm activity; however, it is variable in time and location and usually is insufficient due to the high rates of evaporation also prevalent at this time. Dry spells of various lengths do occur in which moisture demands exceed the available supply. Flooding also may occur during times of excessive rainfall (USDA SCS, 1976).

D. Environmental Conditions

i. State or federal listed threatened or endangered species or habitats of concern

The Virginia Department of Game and Inland Fisheries lists several species that are considered state threatened, federal species of concern, federal candidate, or collection concern. Species such as the upland Sandpiper, loggerhead Shrike, and migrant loggerhead Shrike are state threatened. The bald eagle is a federal species of concern and state threatened. The fluted Kidneyshell is a federal candidate species. The yellow Lance is a federal species of concern. And, the spotted Turtle, and timber Rattlesnake are collection concern species.

ii. Anadromous, trout, and other significant fisheries

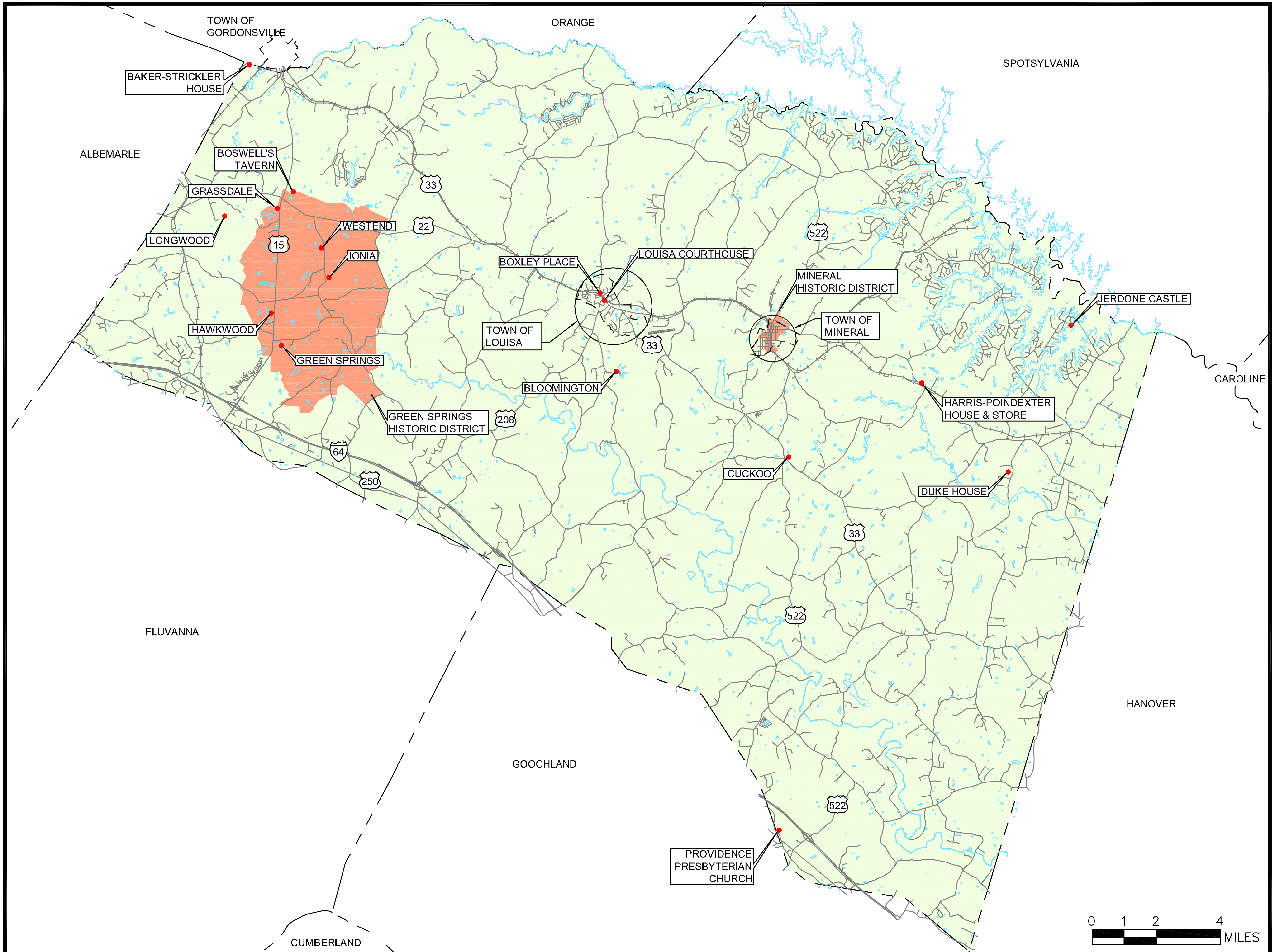
Anadromous refers to those species that migrate to spawn in freshwater after spending most of their life in an estuary or ocean. Virginia's anadromous species include the: shortnose sturgeon, Atlantic sturgeon, blueback herring, alewife, hickory shad, American shad, white perch, and striped bass. Per the Virginia Department of Game and Inland Fisheries, there do not appear to be natural anadromous fisheries in Louisa County. Striped bass is stocked in Lake Anna. Trout and other significant fisheries do not appear to be present in the County.

iii. River segments that have recreational significance, including state scenic river status

According to National Park Service Nationwide Rivers Inventory, the South Anna River within Louisa County is considered recreational and historic.

iv. Sites of historic or archaeological significance

There are several sites in Louisa County that are considered historic or of archaeological significance by the Virginia Department of Historic Resources. These sites are the Boxley Place, Mineral Historic District, Green Springs Historic District, Bloomington, Boswell's Tavern, Cuckoo, Duke House, Grassdale, Harris-Poindexter House & Store, Hawkwood, Ionia, Jerdone Castle, Longwood, and Providence Presbyterian Church. **Figure 7** identifies these locations.



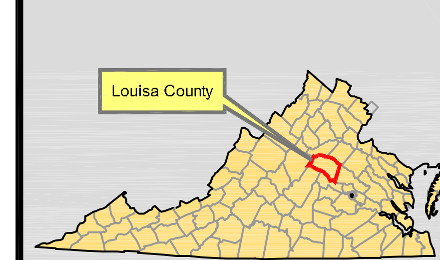
Dewberry

Gannett Fleming

LOUISA COUNTY WATER SUPPLY MASTER PLAN

HISTORIC SITES

LOCATION MAP



LEGEND

- ROADS
- RAILROADS
- WATER
- COUNTY BOUNDARY
- HISTORIC DISTRICT
- HISTORIC SITE

SOURCE NOTE:

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N

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FIGURE 7

v. Unusual geologic formations or special soil types

Due to the variety of bedrock types within Louisa County, a host of economic rock and mineral resources occur within the County, and the mining of these resources has been and continues to be a component of the Louisa County economy. Clay for brick manufacture has been produced near Mineral and Trevilians. Kyanite-bearing layers are present in the schists and gneisses of the area.

Vermiculite is a naturally occurring mineral that is associated with a mafic igneous rock body known as the Green Springs Pluton. This rock body underlies about 12 square miles in the northwestern part of the County. Vermiculite is presently being extracted from a shallow surface mine adjacent to the South Anna River north of Route 22. The County recognizes that vermiculite extraction is a contributing part of the local economy; however, considers it the responsibility of permitted mining operations to be good corporate citizens in terms of safeguarding the environment and quality of life in Louisa.

There is presently one active crushed-stone quarry within the County. Quarrying and crushing of stone for use as aggregate continues to be vital to the construction of roads, buildings, and other infrastructure in the County. It is in the best economic interests of the County to ensure that aggregate continues to be produced locally. The County recognizes the importance of local quarry operations not only in terms of the jobs they provide, but also in terms of how the costs of transporting aggregate into Louisa County from elsewhere would negatively impact construction costs within the County.

Mining operations can create conflicts with existing land uses and with other goals, such as water quality protection and the preservation of the rural character of the County. Precautions should continue to be exercised, as water contact with surface deposits or waste materials caused by the mining process can result in the formation of acids and metallic salts which may enter local drainage and surface water systems.

Figures 8, 9, and 10 present the Inactive, Prospect, and Active Mine Sites from the Louisa County Comprehensive Plan.

FIGURE 8

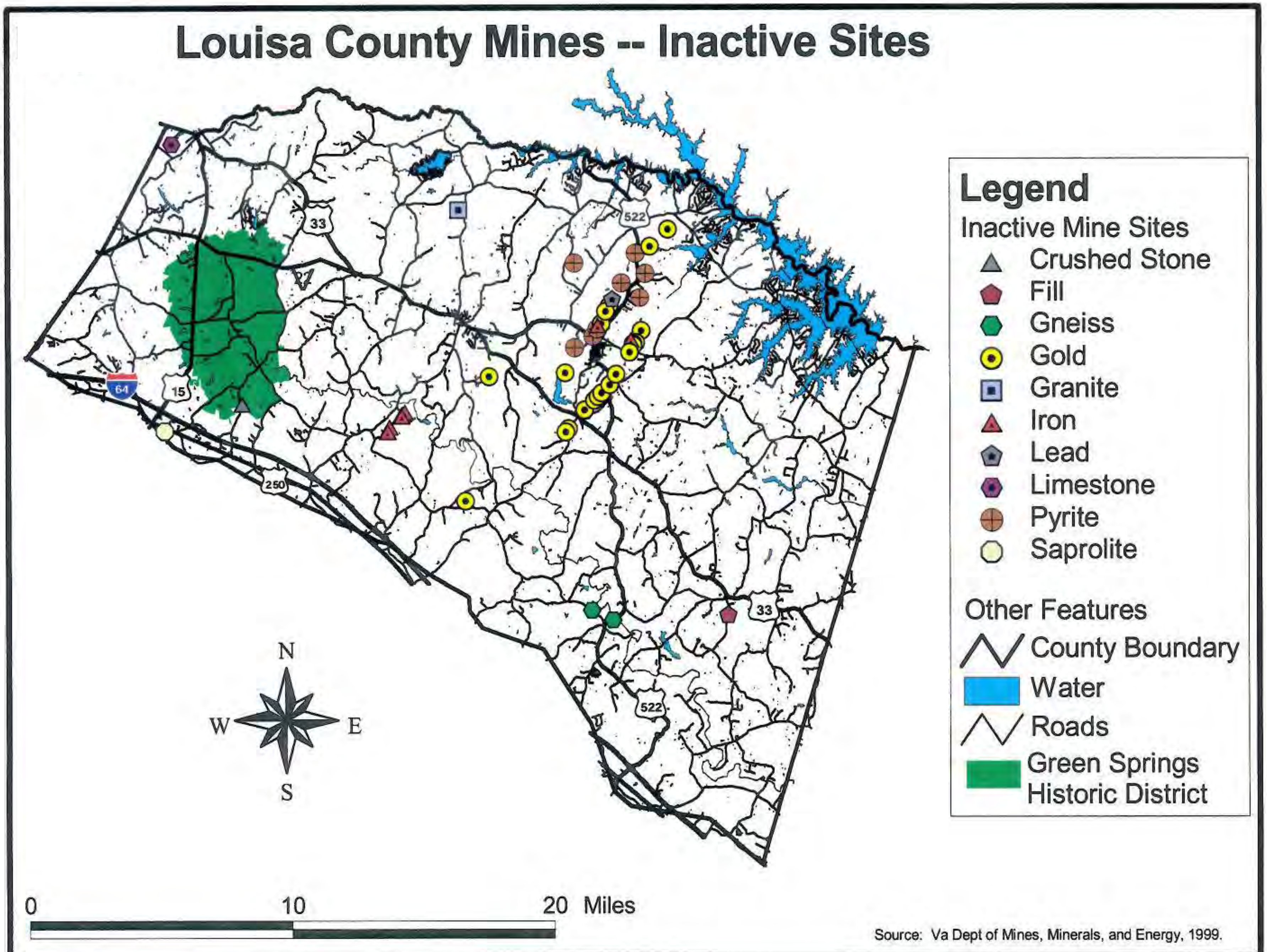

Louisa County Mines -- Inactive Sites
Legend
Inactive Mine Sites
Crushed Stone
Fill
Gneiss
Gold
Granite
Iron
Lead
Limestone
Pyrite
Saprolite
Other Features
County Boundary
Water
Roads
Green Springs
Historic District
33
522
64
15
250
N
S
W
E
0
10
20 Miles
Source: Va Dept of Mines, Minerals, and Energy, 1999.

FIGURE 9

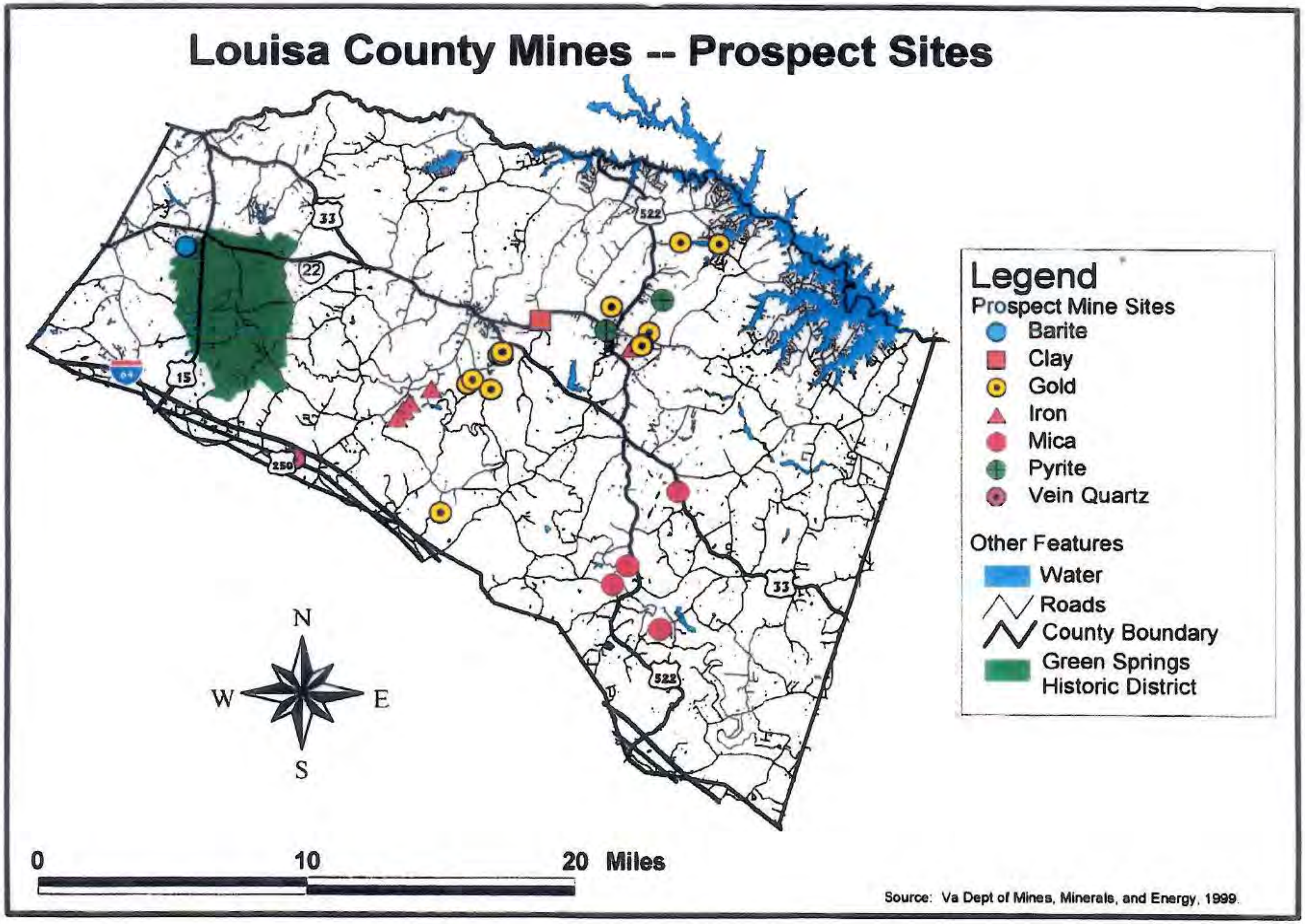
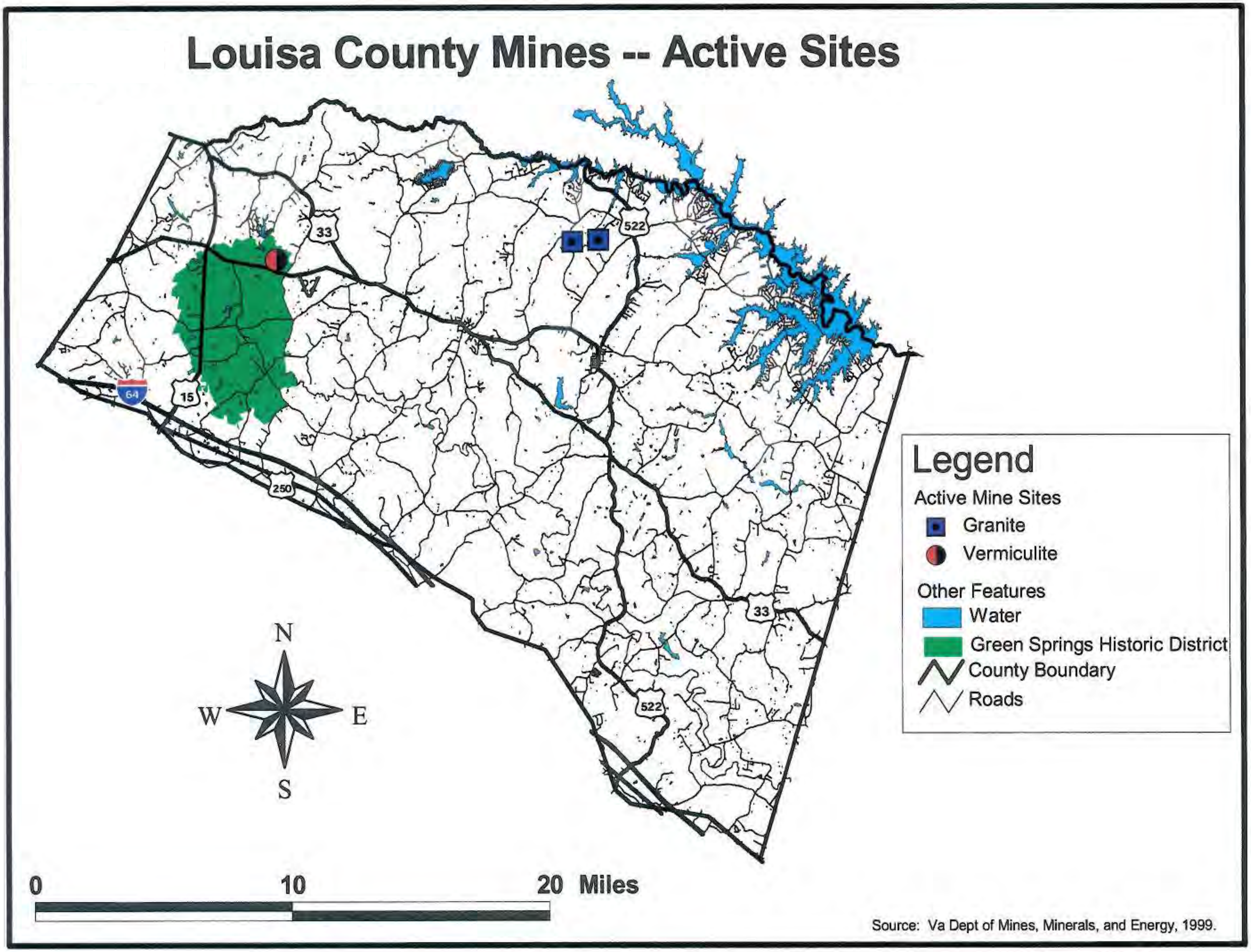

Louisa County Mines -- Prospect Sites
Legend
Prospect Mine Sites
Barite
Clay
Gold
Iron
Mica
Pyrite
Vein Quartz
Other Features
Water
Roads
County Boundary
Green Springs Historic District
N
S
E
W
0
10
20 Miles
33
22
522
15
64
250
Source: Va Dept of Mines, Minerals, and Energy, 1999.

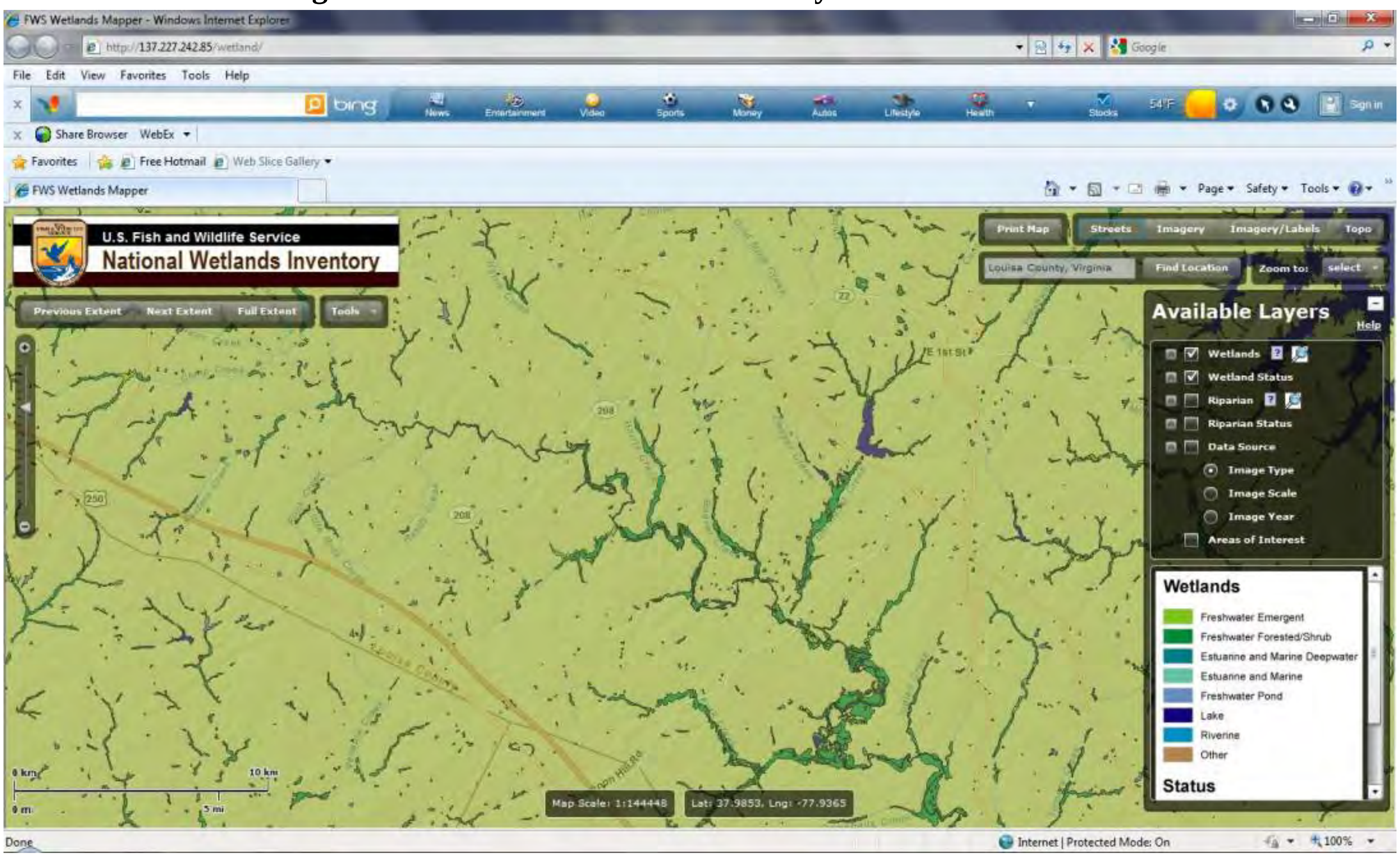
FIGURE 10


Louisa County Mines -- Active Sites
33
522
64
15
250
33
522
N
W
E
S
0
10
20 Miles
Legend
Active Mine Sites
Granite
Vermiculite
Other Features
Water
Green Springs Historic District
County Boundary
Roads
Source: Va Dept of Mines, Minerals, and Energy, 1999.

vi. Wetlands

Wetlands information and mapping is available from the National Wetlands Inventory website. The mapping is a general reference only and does not constitute all the wetlands in the County. A website "screenshot" is provided as **Figure 11**. The wetlands layers cannot be seen when the extents of the window show the full view of the County, so a "zoomed in" view is shown. Northeast Creek Reservoir can be seen towards the upper right of the screenshot.

Figure 11: National Wetlands Inventory Website Screenshot



vii. Riparian buffers and conservation easements;

Riparian buffers information is available from the Virginia Department of Forestry. Conservation easements information is available from the Virginia Department of Conservation. Buffers and easements are generally used to reduce and/or control flooding, and improve water quality and water storage. **Figure 12** provides a website "screenshot" of the Virginia Department of Forestry website mapping. **Figure 13** provides a website "screenshot" of the Virginia Department of Conservation website mapping. More specific information on the conservation easements is available on the results tap, whereas the maps tab (shown on "screenshot") illustrates the location in the County.

Figure 12: Virginia Department of Forestry Website Screenshot

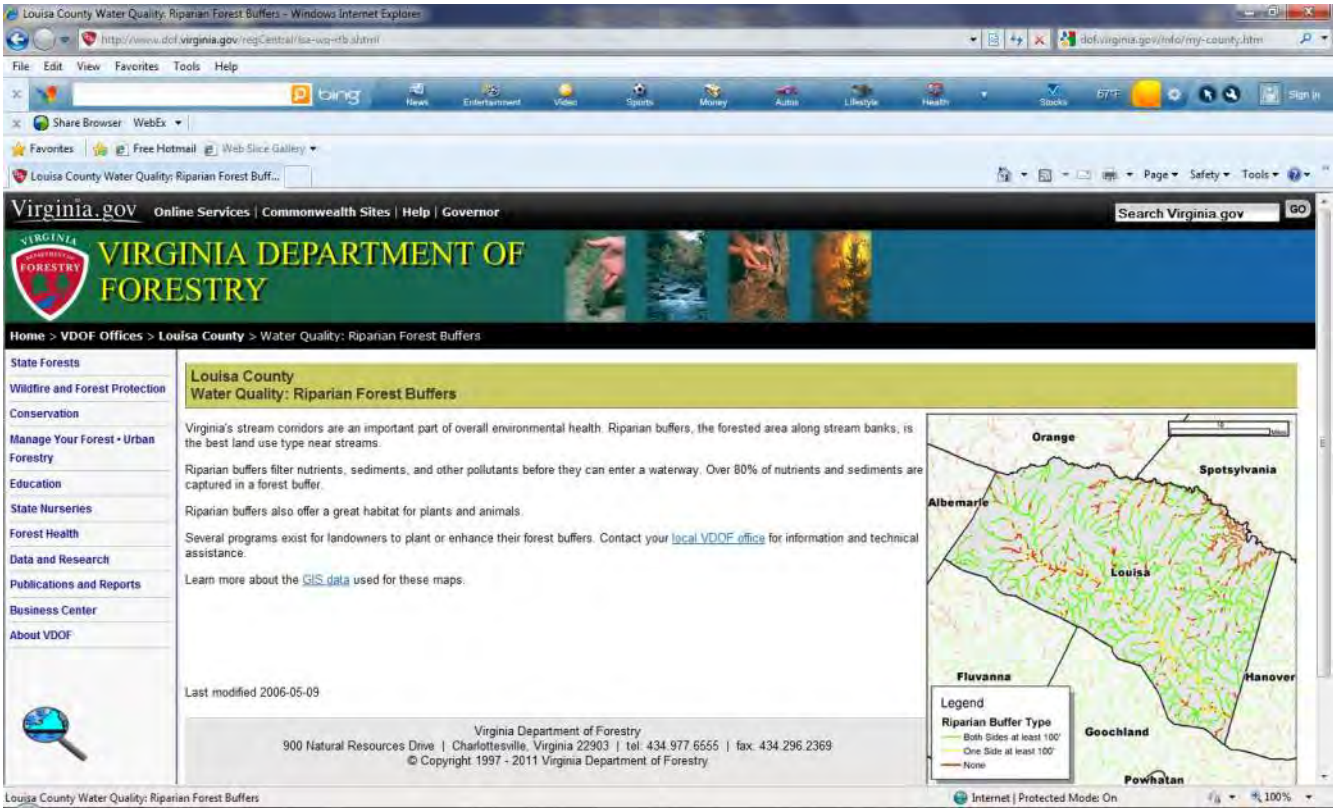
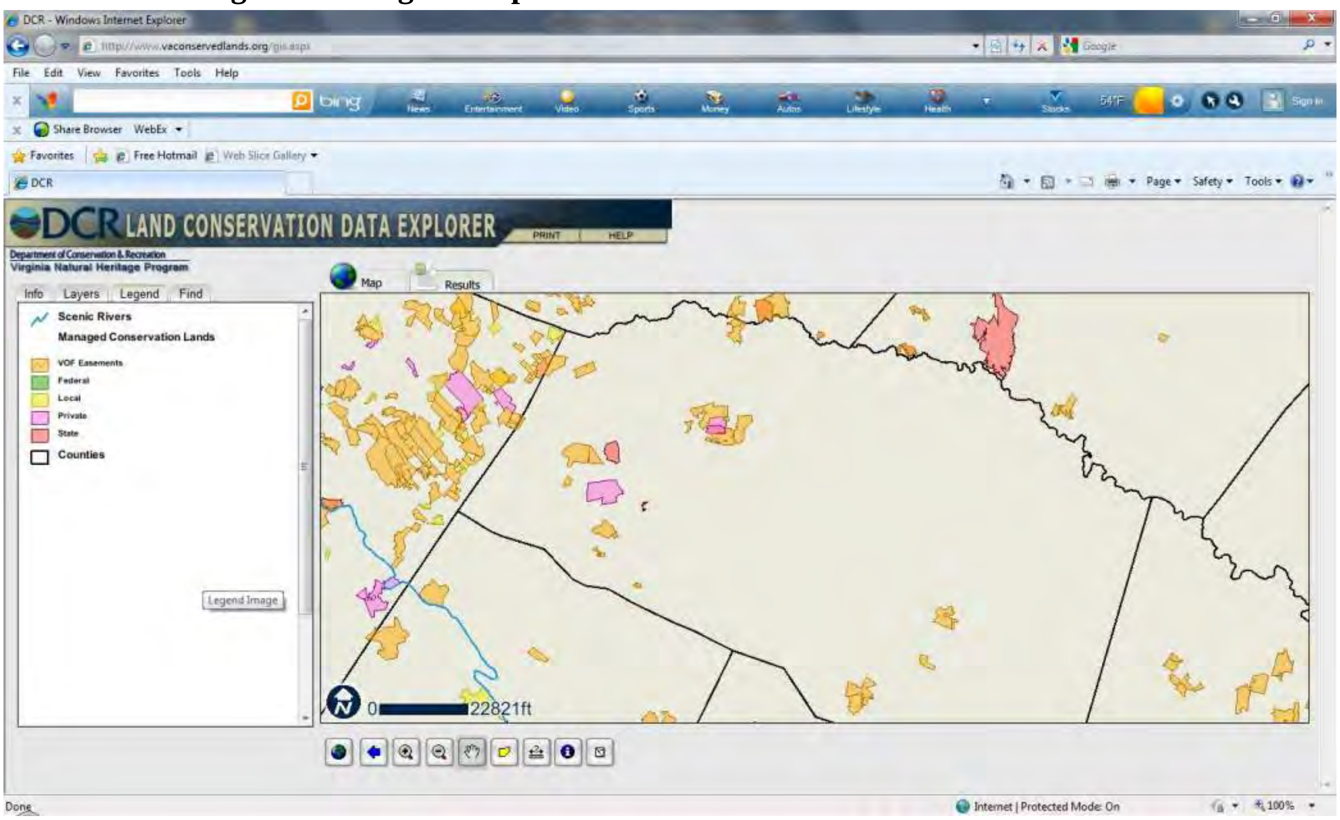


Figure 13: Virginia Department of Conservation Website Screenshot



viii. Land use and land coverage including items such as percentage of impervious cover within a watershed and areas where new development may impact water quality of the source

Runoff is the portion of rainfall that does not infiltrate the soil (to become groundwater) or become captured in local depressions. It is a key component in the local and regional water budget. Stormwater runoff in urbanized or urbanizing areas is a significant source of non-point source pollution. Contaminants introduced into state waters from diffuse activities and locations are collectively call “non-point” source pollution.

Runoff also has implications for groundwater. The greater the percentage of rainfall that flows as runoff, the less groundwater recharge occurs in a given area. In naturally vegetated areas, stormwater gets trapped by vegetation and slowly soaks into the ground. In contrast, in areas intensively affected by human activities, stormwater travels preferentially by overland flow, becomes channelized by drains and ditches, and is rapidly discharged into streams and impoundments. Such channelized flows have high velocities, which entrain (take along with the flow) sediment and pollutants, increase erosion and siltation, and have a negative effect on aquatic ecology, particularly native fish populations. For example, coliform bacteria levels show a strong positive correlation with times of high runoff.

As development occurs, stormwater management programs have handled the increased rate and volume, velocity and flow rate of runoff by requiring developers to construct onsite ponds and drainage systems that control one or more of the runoff characteristics. In urban and suburban areas, studies have shown that runoff increases in direct proportion to the percentage of impervious surface within the drainage sub-basin. Furthermore, studies in more rural areas have shown that agricultural land uses can have similar impact on runoff as do urban land uses. Regional studies encompassing multiple basins have shown that where impervious surfaces reach ten percent or more of the land area, significant degradation of the ecology of local streams becomes apparent.

It is likely that all drainage basins within Louisa County contain less than ten percent impervious surface or equivalent for agricultural land. However, as development proceeds, the combined effect of urban and agricultural land uses will need to be evaluated for significant increases in local runoff and associated environmental problems.

ix. Presence of impaired streams and the type of impairment

Several creeks and portions of rivers in the County are on the current State list of “impaired waters” per VDEQ’s website. The majority of the impairments are E-coli bacterial impairments, which resulted in an impairment classification for recreation use and in some cases fish consumption. Waters with e-coli bacterial impairments are Gold Mine Creek, Christopher Creek, Fork Creek, Cub Creek, Owens Creek, a central portion of the South Anna River, and a portion of Little River. It is important to note that Gold Mine Creek, Christopher Creek, and Contrary Creek are tributaries of Lake Anna. Biologic monitoring found the aquatic life use to be impaired for Wheeler Creek and Locust Creek. An upper portion of South Anna River is listed due to an exceedance for total phosphorus. Dissolved oxygen impairment was monitored in Cub Creek, resulting in an impaired classification for recreation use, and the same portion of Little River mentioned above also has a dissolved oxygen impairment, as well as a pH impairment, resulting in an additional impairment classification for aquatic life use. Contrary Creek has a historic acute exceedance for copper and zinc water quality, and pH impairment, resulting in impaired classification for aquatic life use, and fish consumption. Contrary Creek is impacted by acid mine drainage from a number of abandoned pyrite mines in its watershed. **Figure 14** illustrates the impaired waters in Louisa County.

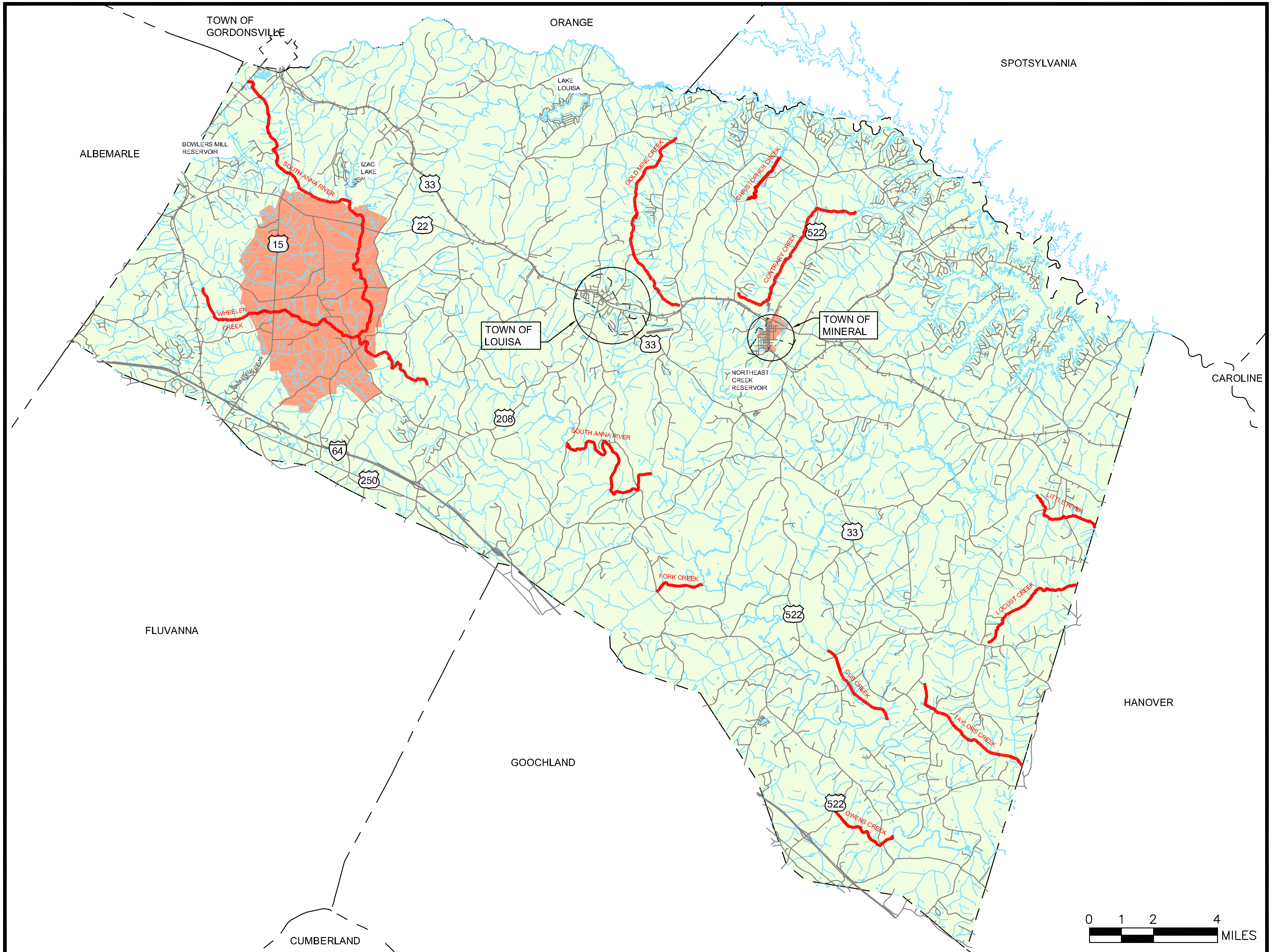
x. Locations of point source discharges

The Environmental Protection Agency Envirofacts Water Data Warehouse lists the following facilities with permits to discharge into rivers in Louisa County: Lake Anna Family Campground, Louisa Regional Sewage Treatment Facility, Northeast Creek Water Treatment Plant, Reedy Creek (Ryan Homes), Six-O-Five Village Trailer Park, Spring Creek (Ryan Homes), Twin Oaks Community, North Anna Power Station, and Zion Crossroads Wastewater Treatment Plant. North Anna Power Station is the only significant Virginia Pollutant Discharge Elimination System (VPDES) discharger located in Louisa per the VDEQ website.

xi. Potential threats to the existing water quantity and quality, other than those from above

Septic systems have been identified by the Environmental Protection Agency as the most frequently reported sources of groundwater contamination in the United States. However, a properly designed, installed, maintained, and utilized septic system should function well for many years.

One reason many septic tank / drainfield systems fail or reach their design life early is because of improper maintenance, primarily not pumping out the septic tank regularly. VDH recommends that homeowners pump out their septic tanks every 3 to 5 years. Because most of these systems are operated and maintained at individual residences, it is difficult to determine the percentage of drainfields that are operating properly and how many are not functioning at the proper treatment standards unless a system has an obvious failure. **Figure 15** presents the Reported Failed Drainfields map from the Louisa County Comprehensive Plan.



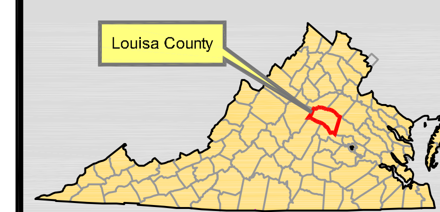
Dewberry

Gannett Fleming

LOUISA COUNTY WATER SUPPLY MASTER PLAN

IMPAIRED WATERS

LOCATION MAP



LEGEND

- ROADS
- RAILROADS
- WATER
- COUNTY BOUNDARY
- HISTORIC DISTRICT
- IMPAIRED WATER

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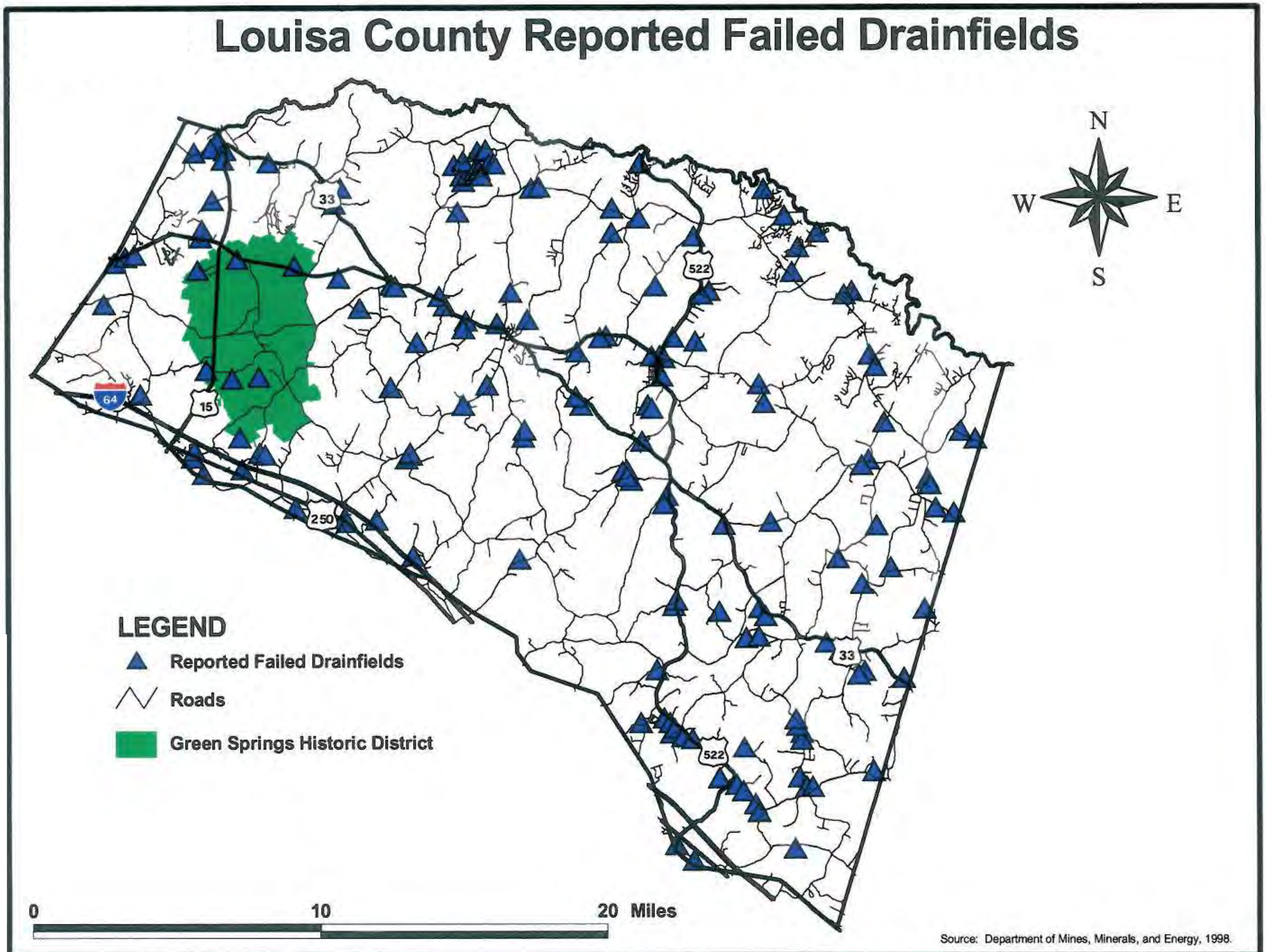
FIGURE 14

FIGURE 15


Louisa County Reported Failed Drainfields
N
W
E
S
33
522
64
15
250
33
522
LEGEND
Reported Failed Drainfields
Roads
Green Springs Historic District
0
10
20 Miles
Source: Department of Mines, Minerals, and Energy, 1998.

V. POPULATION PROJECTIONS

A. Overall County Population

Population trends are an important component in projecting water demands. In development of 9 VAC 25-780-100, “Projected Water Demand Information” a detailed analysis was completed to identify the baseline County Population for 2007, and projected populations for the years 2010, 2020, 2030, 2040, and 2050.

To complete this analysis, several sources were consulted. These sources included the Virginia Employment Commission (VEC) Louisa County Community Profile, Weldon Cooper Center, the Louisa County Comprehensive Plan (dated September 5, 2006), and a Countywide Build Out Analysis performed by Louisa County in July of 2007. Weldon Cooper Center and the Countywide Build Out Analysis provided 2007 populations (Weldon Cooper Center – 31,177 and Countywide Build Out – 31,268), but did not provide specific year predictions for population past 2007. Therefore, only the VEC data and the data obtained from the Louisa County Comprehensive Plan could be analyzed in detail. **Table 3** below is a side-by-side comparison of these two (2) sources.

Table 3: Population Projection by Source

Louisa County Comprehensive Plan	
Year	***Population***
1990	20,325
2000	25,407
2010	30,003
2020	34,599
2030	39,195
2040	43,791
2050	48,387
Interpolate	
2007	**28,624**

VEC Community Profile	
Year	***Population***
1990	20,325
2000	25,627
2010	33,153 *
2020	41,889
2030	50,739
2040	57,474 **
2050	65,183 **
Interpolate	
2007	**30,895**

**** Updated with 2010 Census data***
***** Linear Extrapolation***

Based on discussions with Louisa County representatives, the Comprehensive Plan utilized VEC data from either 1999 or 2000. Therefore, the data would not have accounted for the large population increase around 2005. The County accepted the current VEC profile as the most representative population numbers and projections.

Given the lengthy process for this plan’s preparation, preliminary U.S. Census data is available for 2010 with a population of 33,153 for Louisa County. VEC has not updated their population number of 33,923 for 2010 or projections for their Louisa County Community Profile, as they are waiting for the remaining census data to be released.

However, in an effort to keep the population projections up-to-date, the U.S. Census Louisa County population for 2010 has been utilized in the revisions to this plan's preliminary draft population projections from 2010 to 2050.

The Weldon Cooper Center has evaluated the U.S. Census data from 2000 through 2010 to estimate County population for each year of the decade. An updated Weldon Cooper Center population of 31,220 has been utilized for the baseline year of 2007. While this number is larger than the interpolated 2007 population from the VEC profile, the larger baseline population number was utilized in conjunction with the larger VEC population numbers based on the following criteria:

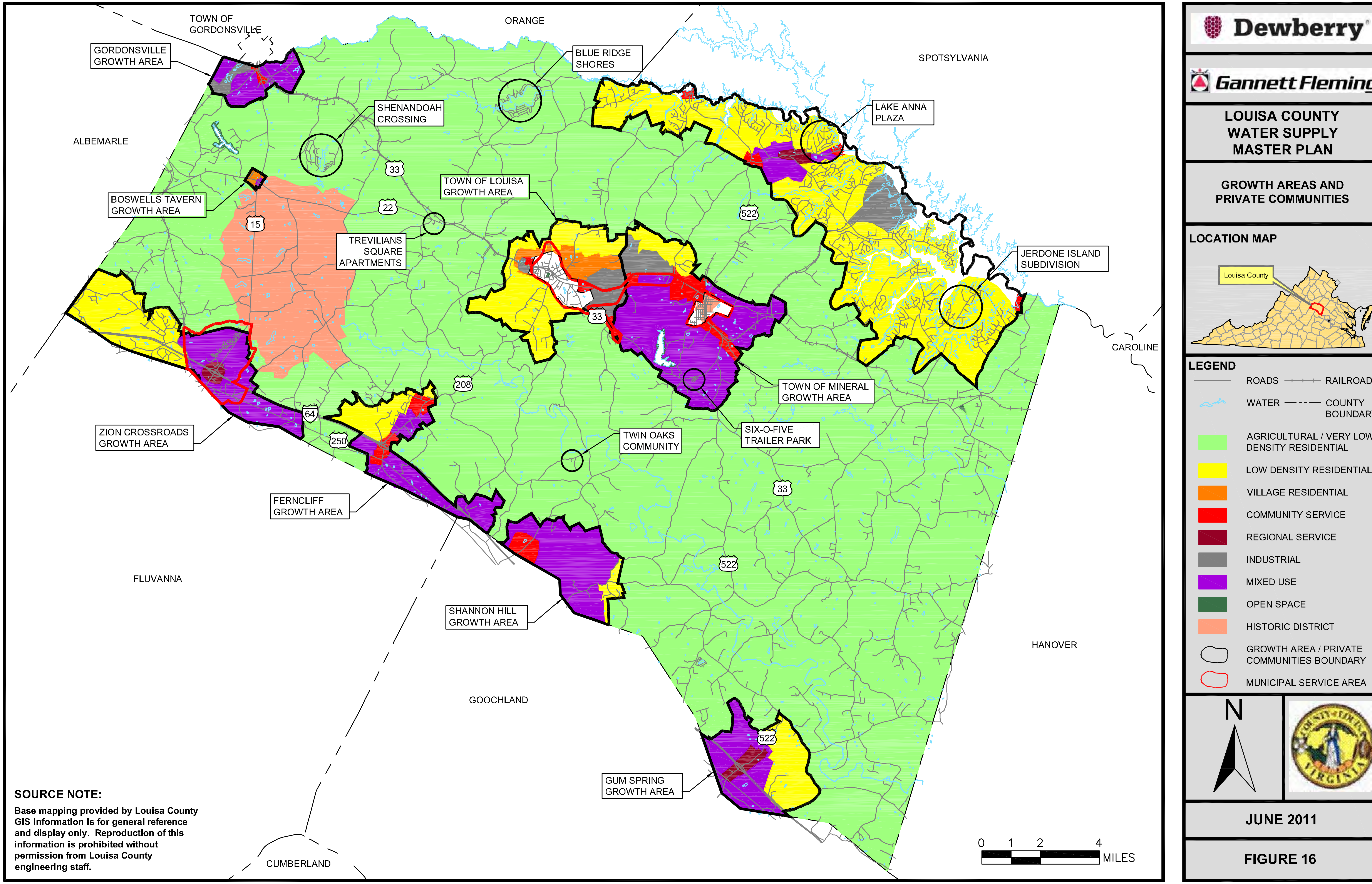
- A more conservative estimate, so water resources will be allocated for a greater population in the plan, and
- Since the Louisa County Build Out Analysis provides for an ultimate population estimate of 283,504 with rezoning, the current VEC population projection (higher projection) will provide for a better planning tool, even though in 2050 it is still only 23% of the potential maximum County population.

As another cross-reference, and at the suggestion of VDEQ, the above population data was compared to the population projections included in the permit application for the James River water withdrawal by Fluvanna County and Louisa County. The consulting firm that completed the water study for the permit utilized population projections from VEC, May 2003. These numbers are slightly different from the current VEC data, but similar to the VEC numbers in the Louisa County Comprehensive Plan. Again, since these numbers do not appear to account for the large population increase in 2005, the most recent VEC population data was used in an effort to provide the most accurate analysis possible.

Once overall County population was determined for the baseline year of 2007 and each time step through 2050, subdivision of the total population into different areas of the County was completed. The subdivision began with an analysis of rural area population versus non-rural area population.

B. County Designated Growth Areas and Existing Private Communities

Louisa is a diverse county with different types of communities and land uses. In accordance with Louisa County's Comprehensive Plan, the County has made a commitment to preserving the rural character of Louisa and focusing development in certain concentrated areas. Nine (9) growth areas have been identified by the County. These designated growth areas will have higher densities, more public services, and more fully developed infrastructure than the remainder of the County. As previously mentioned, Louisa County has seven (7) existing private communities which provide water connections to each community's central water system. **Figure 16** identifies the locations of the growth areas and private communities.



Dewberry
Gannett Fleming
LOUISA COUNTY
WATER SUPPLY
MASTER PLAN
GROWTH AREAS AND
PRIVATE COMMUNITIES
LOCATION MAP
Louisa County
LEGEND
ROADS
RAILROADS
WATER
COUNTY BOUNDARY
AGRICULTURAL / VERY LOW DENSITY RESIDENTIAL
LOW DENSITY RESIDENTIAL
VILLAGE RESIDENTIAL
COMMUNITY SERVICE
REGIONAL SERVICE
INDUSTRIAL
MIXED USE
OPEN SPACE
HISTORIC DISTRICT
GROWTH AREA / PRIVATE COMMUNITIES BOUNDARY
MUNICIPAL SERVICE AREA
N
JUNE 2011
FIGURE 16
TOWN OF GORDONSVILLE
ORANGE
SPOTSYLVANIA
ALBEMARLE
CAROLINE
FLUVANNA
HANOVER
GOOCHLAND
CUMBERLAND
GORDONSVILLE GROWTH AREA
BLUE RIDGE SHORES
SHENANDOAH CROSSING
LAKE ANNA PLAZA
BOSWELLS TAVERN GROWTH AREA
TOWN OF LOUISA GROWTH AREA
TREVILIANS SQUARE APARTMENTS
JERDONE ISLAND SUBDIVISION
TOWN OF MINERAL GROWTH AREA
SIX-O-FIVE TRAILER PARK
TWIN OAKS COMMUNITY
ZION CROSSROADS GROWTH AREA
FERNCLIFF GROWTH AREA
SHANNON HILL GROWTH AREA
GUM SPRING GROWTH AREA
33
22
15
522
208
64
250
0 1 2 4
MILES
SOURCE NOTE:
Base mapping provided by Louisa County GIS Information is for general reference and display only. Reproduction of this information is prohibited without permission from Louisa County engineering staff.

Due to the commitment by the County to support future development in these areas, an analysis was completed to identify the expected population growth in the rural areas versus the non-rural areas (existing private communities and designated growth areas).

In 2007, the growth patterns were examined as part of the Countywide Build Out Analysis based on the issuance of Certificates of Occupancy (CO) from 2001 to 2007. While this analysis did show a higher density of COs issued in growth areas, overall numbers showed that the growth in rural areas and the growth in designated growth areas was equal. Basically, 50% of COs issued were for rural areas and 50% of COs issued were for growth areas.

However, based on additional information from the County Administrator, the two Town Managers, and the General Manager of the Louisa County Water Authority (LCWA), it is believed that this trend will not continue due to recent changes in zoning regulations. It is expected that in coming years more people will settle in the growth areas rather than the rural areas. For example, Louisa County completed modifications to the zoning ordinances which reduced by-right rural densities by more than 50%. This reduction was driven by the desire to maintain the rural character of the County.

Therefore, for the purposes of this plan a uniform percentage increase to population in growth areas and rural areas for 2010, and a higher percentage increase in growth areas for subsequent time steps will be utilized, as shown in **Table 4**.

Table 4: Incremental Population Increase and Distribution

VEC data			Population Distribution		
Year	***Total Population***	***Incremental Population Increase***	***Ratio (rural/growth)***	***Rural Area***	***Private Communities/ Growth Areas***
2007	31,220	--		--	--
2010	33,153*	1,933	50/50	966	967
2020	41,889	8,736	35/65	3,058	5,678
2030	50,739	8,850	25/75	2,212	6,638
2040	57,474	6,735	25/75	1,684	5,051
2050	65,183	7,709	25/75	1,927	5,782

**** 2010 U.S. Census data***

After the division of population between the rural areas and the non-rural areas, the population was further divided within the non-rural areas. The purpose of this analysis was to create a methodology to apply the proposed population increases across each of the designated growth areas and the existing communities. Since some of the private communities have limited opportunities for expansion beyond current development, there may be instances where a population increase in a private community reaches a maximum.

This methodology was developed by investigating the existing number of addresses, the available number of addresses, and the number of certificates of occupancy per year (COs/yr) that have been issued between 2001 and 2007, for each respective community and growth area. In addition, to convert between COs and population, the 2000 census data of 2.56 people per household (or CO) in Louisa County was used unless actual population data was available. This information is shown in **Table 5**.

Table 5: Baseline Year Population Data

Private Communities & Municipal Service Areas	County Info		Countywide Build-Out Analysis Info (Ph 3)		Historical Development	
	Existing Addresses	*Population*	*Available Addresses (COs)*	*Population Increase*	*COs issued (1/01-6/07)*	*COs/yr*
Blue Ridge Shores	575	1,472	633 ***	1621	77	12
Shenandoah Crossing	193	495	276 ***	707	25	4
Six-o-Five Village Trailer Park	97	249	11 ***	29	98	16
Trevilians Sq. Apt.s	7 bldgs	61 **	0 ***	0	0	0
Twin Oaks	15	100 **	0 ***	0	0	0
Lake Anna Plaza (Lake Anna)	43	111	12 ***	31	12	2
Jerdone Island (Lake Anna)	57	146	67 ***	172	22	4
Town of Louisa (GA)	935 *	2,490 *	267	684	151	24
Town of Mineral (GA)	828 *	1,808 *	318	815	84	13
Zion Crossroads (GA)	622	1,593	578 ***	1480	268	42

County Growth Areas (Proposed Service Areas)	County Info		Countywide Build-Out Analysis Info (Ph 3)		Proposed Development
	Existing Addresses	*Population*	*Available Addresses (COs)*	*Population Increase*	
Lake Anna (remaining area)	2292	5,868	2333	5973	Distribution of projected population will be based on the percentage of addresses in that growth area to the total number of growth area addresses
Gum Spring	180	461	122	313	
Ferncliff	235	602	165	423	
Shannon Hill	117	300	70	180	
Boswell's Tavern	27	70	32	82	
Gordonsville	169	433	104	267	

Notes:

1. ***Phase 3 from Countywide Build-Out Analysis assumes build-out of all existing lots - one unit/lot***
2. ***Population column assumes 2.56 people per address unless otherwise noted***
3. ***Certificate of Occupancy (CO) is equivalent to one address***
4. **** Combination of Build-Out Analysis data and Town data; household connections and population within Town limits provided by Towns***
5. ***** Population from internet; not calculated***
6. ****** County provided data for communities not included in the Countywide Build-Out Analysis and updated data for Zion Crossroads***

For the private communities in Table 5, the population is distributed per the historical COs/yr until the available addresses have been exhausted. When all available addresses are occupied, then population growth stops in the existing community. The reason for stopping the population growth in the existing communities is based on information from Louisa County that there are no current plans in review or on file that suggest future growth or expansion for any of the private communities. The only exception to this methodology is Shenandoah Crossing which includes a private residential community and a resort development (Time Share). However, since the methodology cannot predict when the resort development will choose to expand the facilities, the current owners and operators of the community will be required to address future water demands at the time in which an expansion is implemented.

For the designated growth areas, it is assumed that once the available addresses have been exhausted, rezoning will occur during the planning period to allow for more development and growth in each growth area. At that point, the population continues to be distributed to the growth areas; however, it is distributed based on the percentage of addresses in each growth area compared to the total number of addresses in all growth areas.

Table 6 shows the population distribution to each private community, each growth area, and rural area for the entire planning period. It also shows the amount of the population currently connected, and the number of residents projected to be connected to public water under the "connected" column, versus the portion of the population assumed to be on private individual wells under the "not connected" column.

Table 6: Population Projection

SERVICE AREA		2007 POPULATION		2010 POPULATION			2020 POPULATION			2030 POPULATION			2040 POPULATION			2050 POPULATION		
EXISTING PRIVATE AND MUNCIPAL COMMUNITY WATER SYSTE		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
BLUE RIDGE SHORES		--	1,472	--	36	1,564	--	120	1,871	--	120	2,178	--	120	2,485	--	120	2,792
SHENANDOAH CROSSING		--	495	--	12	526	--	40	628	--	40	730	--	40	832	--	40	935
SIX-O-FIVE TRAILER PARK		--	249	--	11	278	--	0	278	--	0	278	--	0	278	--	0	278
TREVILIANS SQUARE APARTMENTS		--	61	--	0	61	--	0	61	--	0	61	--	0	61	--	0	61
TWIN OAKS		--	100	--	0	100	--	0	100	--	0	100	--	0	100	--	0	100
LAKE ANNA GROWTH AREA	LAKE ANNA PLAZA	--	111	--	6	126	--	6	142	--	0	142	--	0	142	--	0	142
	JERDONE ISLAND	--	146	--	12	177	--	40	280	--	15	318	--	0	318	--	0	318
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	--	221	--	***6***	236	--	--	236	--	--	236	--	--	236	--	--	236
	TOWN OF LOUISA (GA)	878	1,501	878	***21***	1,555	790	240	2,258	711	404	3,371	639	290	4,185	575	336	5,109
	TOWN OF MINERAL (GA)	1,058	640	1,058	***0***	640	952	130	1,079	856	130	1,508	770	168	2,024	693	194	2,598
ZION CROSSROADS SERVICE AREA		1,139	454	1,139	***141***	814	1,025	420	2,003	922	401	3,133	829	288	3,963	746	334	4,901
SUB-TOTAL POPULATION (NOT CONNECTED) =		3,075	--	3,075	--	--	2,767	--	--	2,489	--	--	2,238	--	--	2,014	--	--
SUB-TOTAL POPULATION (CONNECTED) =		--	5,450	--	--	6,077	--	--	8,936	--	--	12,055	--	--	14,624	--	--	17,470
COUNTY GROWTH AREAS (PROPOSED MUNICIPAL WATER SYST		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
GUM SPRING		461	--	461	8	20	414	73	254	372	88	521	334	63	720	300	73	941
FERNCLIFF		602	--	602	11	28	541	95	332	486	115	681	437	83	943	393	96	1,232
SHANNON HILL		300	--	300	6	15	270	47	165	243	58	341	218	42	474	196	48	619
LAKE ANNA	REMAINING AREA	5,868	--	5,868	108	277	5,281	929	3,242	4,752	1129	6,661	4,276	812	9,216	3,848	940	12,050
BOSWELL'S TAVERN		70	--	70	0	--	63	11	35	56	13	76	50	9	105	45	11	138
GORDONSVILLE		433	--	433	0	--	389	67	215	350	80	459	315	58	643	283	67	846
SUB-TOTAL POPULATION (NOT CONNECTED) =		7,734	--	7,734	--	--	6,958	--	--	6,259	--	--	5,630	--	--	5,065	--	--
SUB-TOTAL POPULATION (CONNECTED) =		--	0	--	--	340	--	--	4,243	--	--	8,739	--	--	12,101	--	--	15,826
RURAL AREA (INDIVIDUAL WELLS)		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
SUB-TOTAL POPULATION (NOT CONNECTED) =		14,961	--	15,927	--	--	18,985	--	--	21,197	--	--	22,881	--	--	24,808	--	--
TOTAL POPULATION =		**31,220**		**33,153**			**41,889**			**50,739**			**57,474**			**65,183**		

	967 POP =		378 COS	5678 POP =		2218 COS	6638 POP =		2593 COS	5051 POP =		1973 COS	5782 POP =		2259 COS
	COS LEFT =		133 COS	COS LEFT =		1222 COS	COS LEFT =		2288 COS	COS LEFT =		1813 COS	COS LEFT =		2099 COS
GROWTH AREA (GA)	GA	%	COS	GA	%	COS	GA	%	COS	GA	%	COS	GA	%	COS
TOL - TOWN OF LOUISA	TOL	--	***21***	TOL	--	***240***	TOL	17.6%	403.6	TOL	16.0%	290.2	TOL	16.0%	335.9
TOM - TOWN OF MINERAL	TOM	--	***0***	TOM	--	***130***	TOM	--	***130***	TOM	9.3%	168.1	TOM	9.3%	194.6
Z - ZION CROSSROADS	Z	--	***141***	Z	--	***420***	Z	17.5%	401.0	Z	15.9%	288.3	Z	15.9%	333.7
LA - REMAINING LAKE ANNA	LA	81.2%	107.9	LA	76.1%	930.0	LA	49.3%	1128.7	LA	44.8%	811.5	LA	44.8%	939.6
GS - GUM SPRING	GS	6.4%	8.5	GS	6.0%	72.8	GS	3.9%	88.5	GS	3.5%	63.5	GS	3.5%	73.4
F - FERNCLIFF	F	8.3%	11.1	F	7.8%	95.4	F	5.1%	115.6	F	4.6%	83.0	F	4.6%	96.1
SH - SHANNON HILL	SH	4.1%	5.5	SH	3.9%	47.7	SH	2.5%	57.6	SH	2.3%	41.5	SH	2.3%	48.2
BT - BOSWELL'S TAVERN	BT	--	***0***	BT	0.9%	10.6	BT	0.6%	13.0	BT	0.5%	9.4	BT	0.5%	10.8
G - GORDONSVILLE	G	--	***0***	G	5.4%	65.5	G	3.5%	80.0	G	3.2%	57.5	G	3.2%	66.7

- ONCE ALL AVAILABLE ADDRESSES HAVE BEEN OCCUPIED IN THE EXISTING SYSTEMS, POPULATION IS DISTRIBUTED TO GROWTH AREAS BASED ON PERCENTAGE OF TOTAL GROWTH AREA ADDRESSES

VI. PROJECTED WATER DEMAND (9 VAC 25-780-100)

The following section outlines the methodology for developing the projected water demands for Louisa County through year 2050.

A. Rural Areas

Since dwellings with individual wells are typically not metered, a conservative estimate for water usage in rural areas was based on the daily consumption rate of 100 gallons per day (GPD) per person. This rate is as specified by the Virginia Department of Health (VDH) Waterworks Regulations.

B. Municipal Service Areas

Historical municipal community water system data included in the VDEQ templates was utilized to calculate a typical daily water use rate per person for the existing municipal service areas, as well as provide a basis for the water use rate per person for the County designated growth areas or proposed municipal service areas.

Data obtained from the Towns and the Louisa County Water Authority (LCWA) for the VDEQ templates included water production, water sold (if applicable), and water usage. The water usage was categorized as residential or commercial. A difference was identified in comparing the water production records with the water usage/sales records. On average, this difference was approximately 15%, and represented the lost or unaccountable water within the distribution system. The lost or unaccountable water was incorporated into the total water demands within the planning period, and an assumed reduction in lost or unaccountable water was identified as a potential water conservation approach.

Table 7 provides a breakdown of the data analyzed. Again, to convert between households or certificate of occupancy's (COs) and population, the 2000 census data of 2.56 people per household (or CO) in Louisa County was used unless actual population data was available.

Table 7: Municipal Community Water System Usage

Municipal Community Water Systems	Northeast Creek Reservoir Service Area			Zion Crossroads Service Area
	LCWA	***Town of Louisa***	***Town of Mineral***	***LCWA***
Residential Water Usage (gal/year)	4,303,090	35,278,599	14,707,760	12,907,615
Residential Water Usage (GPD)	11,789	96,654	40,295	35,363
Active Residential Households	86	*population data used instead of connections*	*population data used instead of connections*	177
Persons per Household (or CO), 2000 U.S. Census	2.56			2.56
Population	221	1501 *	640 **	454
Residential Water Consumption (GPD/person)	53	64	63	78
Commercial Water Usage (gal/year)	17,025,610	20,393,300	4,887,430	17,703,940
Bulk Sales (gal/year)	1,050	N/A	N/A	1,414,275
Total Water Usage (gal/year)	21,329,750	55,671,899	19,595,190	32,025,830
Residential Water Usage (%)	20.2%	63.4%	75.1%	40.3%
Commercial Water Usage (%)	79.8%	36.6%	24.9%	55.3%

Notes:

1. Water usage/consumption based on water meter reports from the Towns and LCWA for period of April 2007 to March 2008.

2. * Town of Louisa populations provided, not calculated.

3. ** Town of Mineral population provided w/in Town limits; plus calculated to include customers outside Town limits.

4. Based on water production reports versus water meter reports, total water usage equals ~85% of water produced, so 15% of water produced is considered lost/unaccounted which will be included in overall water demands.

While the Towns and Zion Crossroads are each considered growth areas by the Louisa County Comprehensive Plan, there is an obvious distinction in the residential water usage for these areas. The Towns are older, more established areas in comparison to the newer, "booming" growth in the Zion Crossroads area. A large percentage, if not all, of the newer homes in Zion Crossroads have irrigation systems. Based on the data analysis, the following residential water usage rates to the nearest 5 GPD/person will be used:

- Northeast Creek Reservoir Service Area
  - LCWA customers (55 GPD/person)
  - Town of Louisa customers (65 GPD/person)
  - Town of Mineral customers (65 GPD/person)
- Zion Crossroads Service Area (80 GPD/person)
- Proposed Service Areas (80 GPD/person). Remaining proposed service areas include Gum Spring, Ferncliff, Shannon Hill, Boswell's Tavern, Lake Anna, and Gordonsville.

Commercial water usage requires a slightly different projection than residential water usage because it is not possible to calculate commercial water usage per person. **Table 7** above shows the percentage of commercial water usage compared to residential water usage. Since commercial growth is anticipated to continue with residential growth during the planning period, the percentage of commercial water usage for the water demand projections was maintained as it relates to residential usage. This means the population projections were used to obtain the number of residents, the baseline residential water usage per person was used to calculate total residential water usage, and then the commercial water usage was calculated based on the residential and commercial percentages shown in **Table 7** above**.**

Again, due to the differences between the two (2) existing Towns and the Zion Crossroads growth area discussed above, the Zion Crossroads growth area will be considered representative of the remaining designated growth areas (Gum Spring, Ferncliff, Shannon Hill, Boswell's Tavern, Lake Anna, and Gordonsville). Each Town's historical data is used for the Towns growth areas.

However, it is not believed that the percentage breakdown of residential versus commercial water usage in Zion Crossroads can be equally applied to all growth areas. A Wal-Mart Distribution Center is currently located in Zion Crossroads. It is believed that the amount of water being used by this facility is skewing the commercial percentage since residential development has only begun over the last five plus (5+) years (Wal-Mart Usage = Approximately 835,000 Gallons per Month vs. Remaining Commercial = Approximately 640,000 Gallons per Month). **Table 8** shows the percentage breakdown when the Wal-Mart Distribution Center water usage is removed:

Table 8: Residential and Commercial Water Usage in Zion Crossroads Service Area (Without Wal-Mart Distribution Center)

Residential Water Usage (%)	**58.6%**
Commercial Water Usage (%)	**34.9%**
Bulk Sales (%)	**6.4%**

The residential usage in **Table 8** increases to 60% rather than the 40% shown in **Table 7** above. Based on discussions with Louisa County, Town of Louisa, Town of Mineral, and the LCWA, it is believed that the current 60% commercial usage in Zion Crossroads would be representative for the designated growth areas located along Interstate 64 (Zion Crossroads, Gum Spring, Ferncliff, and Shannon Hill), but that the remaining growth areas (Lake Anna, Boswell's Tavern, and Gordonsville) will be closer to 40% commercial usage as shown in **Table 8** above. Therefore, the planning period utilizes the breakdowns outlined above for the representative growth areas.

C. Existing Private Communities

Since the existing private communities also contribute to the overall plan, average consumption rates are required to provide anticipated water resource demands for individual time steps. The water production data from the VDEQ templates was used to calculate each system's average water withdrawal rates per person. **Table 9** shows this information.

Table 9: Private Community Water System Daily Rates (GPD/person)

Private Community Water System	Annual Average Water Withdrawal (GPD/person)	Annual Average Water Usage (GPD/person)	Peak Day Water Withdrawal (GPD/person)	Peak Day Water Usage (GPD/person)
Blue Ridge Shores	37	32	66	56
Shenandoah Crossing	164	139	246	209
Six-o-Five Village Trailer Park	51	43	76	65
Trevilians Square Apartments	100	85	150	128
Twin Oaks	76	65	114	97
Lake Anna Plaza	40	34	60	51
Jerdone Island	45	38	68	58

Notes:

1. ***Water withdrawal based on VDEQ templates, which utilized VDH monthly operation reports.***
2. ***Community water systems do not have commercial water usage.***
3. ***Assume water consumption is 85% of water produced.***

Water withdrawal and usage rates for the existing communities will be based on a rate to the nearest 5 GPD/person.

D. Self-Supplied Users Using > 300,000 Gallons Per Month

In addition to the rural areas, municipal service areas, and the private communities, there are "Self-Supplied Users" in the County that use greater than 300,000 Gallons per Month (Gal/Mo) for non-agricultural and agricultural uses.

Self-supplied users of non-agricultural potable groundwater are Klockner Pentaplast near the Town of Gordonsville, the North Anna Power Station and North Anna Information Center at Lake Anna, and Siebert's Amoco and Dairy Queen. Crossing Pointe at Zion Crossroads was self-supplied until August 2010 when it connected to the public water system.

Self-supplied users of non-agricultural non-potable surface water include Tanyard Country Club Golf Course in the Town of Louisa, Spring Creek Golf Course at Zion Crossroads, North Anna Power Station, and LCWA providing water to Louisa Power Station.

While each self-supplied user is not known for agricultural water use, livestock water use and land irrigation was estimated using the 2007 Census of Agriculture and Farm and Ranch Irrigation Survey, issued by the United States Department of Agriculture, National Agricultural Statistics Service. The United States Geological Survey livestock water use factors provided in the VDEQ templates were utilized with the Census livestock inventory to estimate livestock water use.

These large water consumers are identified in **Table 10** below, and their respective flows were incorporated into each individual time step to provide a complete demand for the County. Since the County does not have any plans on record at this time for future expansion of facilities or demands for any of these large consumers during any of the time steps identified in this plan, their demands remained constant for each step.

Table 10: Self-supplied Users > 300,000 Gallons/Month Daily Rates

Self-Supplied User	Annual Average Water Withdrawal (GPD)	Annual Average Water Usage (GPD)	Peak Day Water Withdrawal (GPD)	Peak Day Water Usage (GPD)	Use Category
Klockner Pentaplast	10,147	8,625	15,221	12,938	Potable Water
North Anna Power Station	10,998	9,348	16,497	14,022	Potable Water
North Anna Info Center	766	651	1,149	977	Potable Water
Siebert's Amoco & Dairy Queen	15,000	12,750	22,500	19,125	Potable Water
Crossing Pointe	12,625	10,731	18,938	16,097	Potable Water
Tanyard Country Club Golf Course	64,060	54,451	96,090	81,677	Irrigation
Spring Creek Golf Course	162,342	137,991	243,513	206,986	Irrigation
North Anna Power Station	2,150,000,000	1,827,500,000	3,225,000,000	2,741,250,000	Cooling and Hydropower
LCWA (ODEC power station)	13,671	11,620	20,507	17,431	Cooling
Agriculture: County Livestock	174,644	148,447	261,966	222,671	Agriculture
Agriculture: Irrigated Land	138,644	117,847	207,966	176,771	Agriculture

Notes:

1. ***Water withdrawal based on VDEQ templates, which utilized VDH monthly operation reports, VDEQ VWUDS, and Ag Census.***
2. ***Assume water consumption is 85% of water withdrawal.***
3. ***Assume Peak Factor of 1.5.***

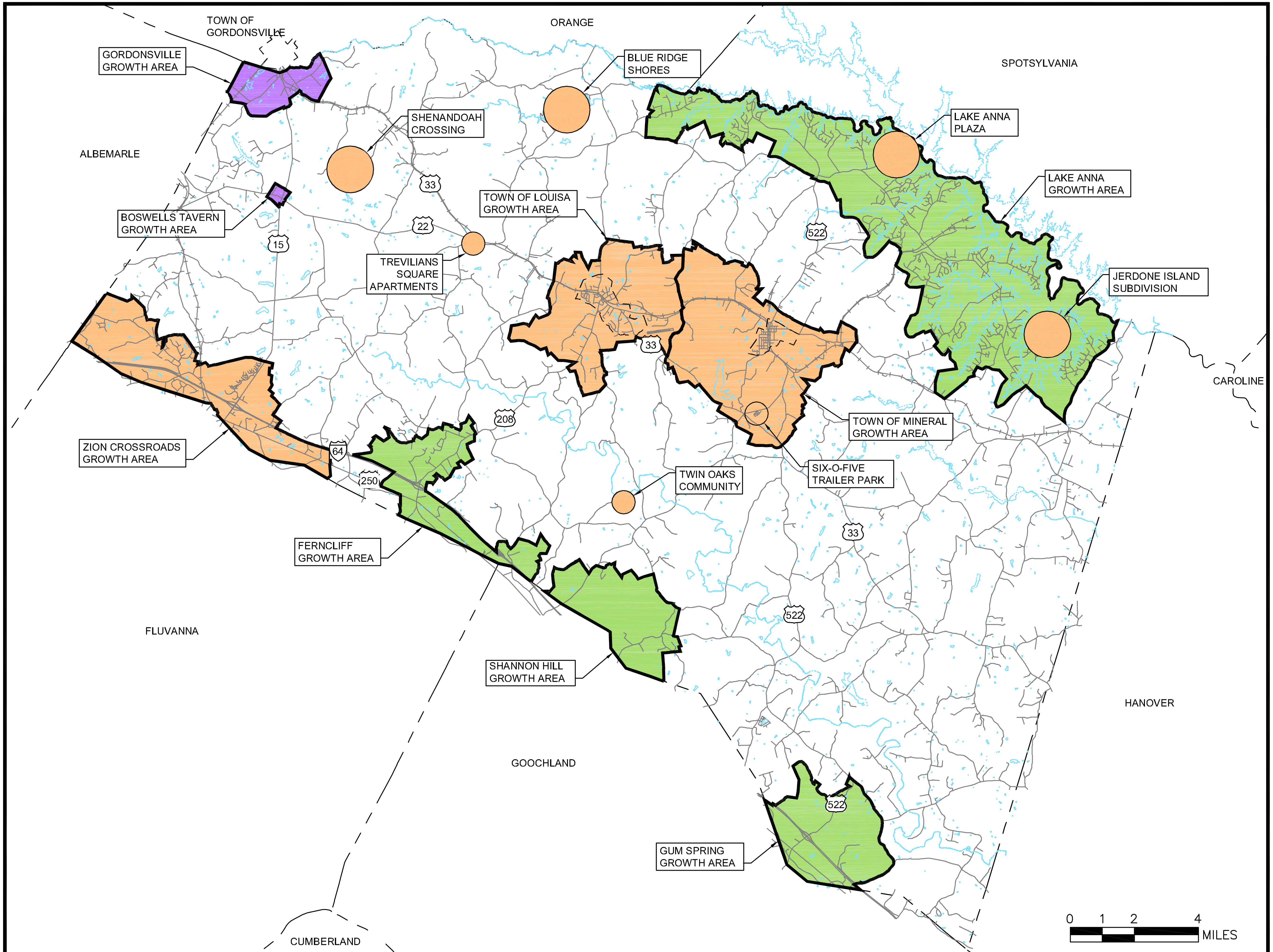
E. Phasing Plan

Once the population projections and the water demand projections were complete, they were loaded across each of the time steps to provide a final Countywide demand through the year 2050. To complete the loading of the time steps, consideration was given to the public infrastructure development or "phasing in" of a municipal service areas in each of the County's designated growth areas.

Per the County's Comprehensive Plan, public infrastructure is a defining quality for each of the nine (9) designated growth areas since public utilities and facilities are expected to encourage and attract development related to the County's land use plan. Of the nine (9) delineated growth areas, only three (3) (Town of Louisa, Town of Mineral, and Zion Crossroads) currently have public utilities provided by the County. The phasing plan illustrates when the County anticipates potentially providing public utilities to each growth area.

While Lake Anna could be considered "in phase" given current development, the existence of County provided public utilities has not been significantly developed to provide a reliable source to a variety of customers. Therefore, for purposes of this plan, Lake Anna is considered a proposed future growth area in the baseline year of 2007.

In an effort to correctly "phase in" the remaining growth areas, an investigation was completed to identify speculative projects or projects under review by County officials. This investigation suggested that four (4) (Lake Anna, Gum Spring, Ferncliff, and Shannon Hill) of the growth areas are likely to become "in phase" during or after the 2010 time step, and the final two (2) growth areas (Boswell's Tavern and Gordonsville) are likely to become "in-phase" during or after the 2020 time step. Therefore, the time steps for the water demand projections were loaded accordingly. **Figure 17** identifies the proposed phasing plan.



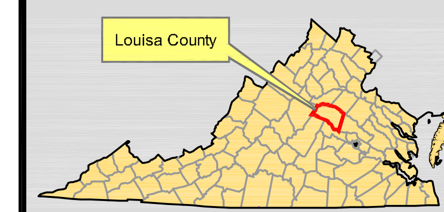
Dewberry

Gannett Fleming

LOUISA COUNTY WATER SUPPLY MASTER PLAN

PHASING PLAN

LOCATION MAP



LEGEND

- ROADS
- RAILROADS
- WATER
- COUNTY BOUNDARY
- CURRENTLY IN PHASE
- TO BE PHASED IN: 2010 - 2020
- TO BE PHASED IN: 2020 - 2050

SOURCE NOTE:

Base mapping provided by Louisa County GIS Information is for general reference and display only. Reproduction of this information is prohibited without permission from Louisa County engineering staff.

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JUNE 2011

FIGURE 17

F. Final Projections

Based on the development of the population projections, water demand projections, and methodology for “phasing in” future service areas, each time step was loaded to achieve the final projections for the planning period. **Table 11** provides a summary of the final population and water demand projections separated by private communities, municipal service areas (existing and proposed), self-supplied users more than 300,000 Gallons/Month, and areas served by individual wells for the 2007, 2010, 2020, 2030, 2040, and 2050 time steps.

As previously stated, the withdrawal water demands for the North Anna Power Station cooling system and hydro units are not included in the total Self-Supplied Users water demands, given the considerable amount of surface water withdrawal is over 500 times the total County water demand, and the water is returned to Lake Anna or the river below the dam after its use. Water demand projections are in Million Gallons per Day (MGD).

Table 11: Projected Population and Water Demand

Year	County Pop.	Private Communities		Municipal Service Areas		SSU > 300,000 Gal/Mo		Individual Wells		Total County Water Demand	
		Ave. (MGD)	Peak (MGD)	Ave. (MGD)	Peak (MGD)	Ave. (MGD)	Peak (MGD)	Ave. (MGD)	Peak (MGD)	Ave. (MGD)	Peak (MGD)
2007	31,220	0.172	0.275	0.424	0.648	0.603	0.904	2.78	4.17	**3.98**	**5.99**
2010	33,153	0.182	0.290	0.571	0.870	0.596	0.894	2.86	4.29	**4.21**	**6.34**
2020	41,889	0.212	0.339	1.62	2.44	0.589	0.884	3.08	4.61	**5.49**	**8.28**
2030	50,739	0.238	0.381	2.77	4.17	0.582	0.874	3.20	4.81	**6.79**	**10.2**
2040	57,474	0.262	0.420	3.61	5.45	0.576	0.864	3.28	4.92	**7.73**	**11.7**
2050	65,183	0.285	0.458	4.54	6.85	0.569	0.854	3.39	5.08	**8.78**	**13.2**

- Pop.: Population
- SSU: Self-Supplied Users
- Ave: Annual Average
-Peak: Peak Day

A more detailed breakdown of each time step can be found in the following **Tables 12 - 17**.

Table 12: 2007 Population and Water Demand Projections

2007																
EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (85% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (85% OF DEMAND) (GPD)	AVERAGE WATER LOST (15% OF DEMAND) (GPD)	PEAK DAY WATER LOST (15% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,472	30	55	44,160	80,960	0	0	--	--	44,160	80,960	7,793	14,287	51,953	95,247
SHENANDOAH CROSSING		495	140	210	69,300	103,950	0	0	--	--	69,300	103,950	12,229	18,344	81,529	122,294
SIX-O-FIVE TRAILER PARK		249	45	65	11,205	16,185	0	0	--	--	11,205	16,185	1,977	2,856	13,182	19,041
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	915	1,399	6,100	9,329
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	1,147	1,765	7,647	11,765
LAKE ANNA	LAKE ANNA PLAZA	111	35	50	3,885	5,550	0	0	--	--	3,885	5,550	686	979	4,571	6,529
	JERDONE ISLAND	146	40	60	5,840	8,760	0	0	--	--	5,840	8,760	1,031	1,546	6,871	10,306
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	221	55	85	12,155	18,785	48,018	74,210	--	--	60,173	92,995	10,619	16,411	70,792	109,406
	TOWN OF LOUISA	1,501	65	100	97,565	150,100	56,323	86,651	--	--	153,888	236,751	27,157	41,780	181,045	278,530
	TOWN OF MINERAL	640	65	100	41,600	64,000	13,793	21,220	--	--	55,393	85,220	9,775	15,039	65,168	100,258
* ZION CROSSROADS SERVICE AREA		454	80	120	36,320	54,480	54,480	81,720	--	--	90,800	136,200	16,024	24,035	106,824	160,235
SUB-TOTAL =		5,450	--	--	333,715	520,700	172,614	263,801	--	--	506,329	784,501	89,352	138,441	595,681	922,942
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (85% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (85% OF DEMAND) (GPD)	AVERAGE WATER LOST (15% OF DEMAND) (GPD)	PEAK DAY WATER LOST (15% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	1,522	2,284	10,147	15,224
NORTH ANNA POWER STATION AND INFO CENTER		--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,765	2,647	11,765	17,647
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	2,250	3,375	15,000	22,500
CROSSING POINTE		--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,894	2,840	12,624	18,935
TANYARD COUNTRY CLUB GOLF COURSE		--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	9,609	14,413	64,059	96,088
SPRING CREEK GOLF COURSE		--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	24,351	36,527	162,341	243,512
LCWA (LOUISA POWER STATION)		--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	2,051	3,076	13,671	20,506
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)		--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	46,993	70,489	313,288	469,929
SUB-TOTAL =		--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	90,434	135,651	602,894	904,341
PRIVATE INDIVIDUAL WELLS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (85% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (85% OF DEMAND) (GPD)	AVERAGE WATER LOST (15% OF DEMAND) (GPD)	PEAK DAY WATER LOST (15% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS		10,809	80	120	864,720	1,297,080	0	0	--	--	864,720	1,297,080	152,598	228,896	1,017,318	1,525,976
RURAL AREA		14,961	100	150	1,496,100	2,244,150	0	0	--	--	1,496,100	2,244,150	264,018	396,026	1,760,118	2,640,176
SUB-TOTAL =		25,770	--	--	2,360,820	3,541,230	0	0	--	--	2,360,820	3,541,230	416,615	624,923	2,777,435	4,166,153
TOTAL =		31,220	--	--	2,694,535	4,061,930	418,779	633,051	266,295	399,440	3,379,609	5,094,421	596,402	899,015	**3,976,011**	**5,993,436**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

Table 13: 2010 Population and Water Demand Projections

2010																
EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (86% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (86% OF DEMAND) (GPD)	AVERAGE WATER LOST (14% OF DEMAND) (GPD)	PEAK DAY WATER LOST (14% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,564	30	55	46,920	86,020	0	0	--	--	46,920	86,020	7,638	14,003	54,558	100,023
SHENANDOAH CROSSING		526	140	210	73,640	110,460	0	0	--	--	73,640	110,460	11,988	17,982	85,628	128,442
SIX-O-FIVE TRAILER PARK		278	45	65	12,510	18,070	0	0	--	--	12,510	18,070	2,037	2,942	14,547	21,012
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	844	1,291	6,029	9,221
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	1,058	1,628	7,558	11,628
LAKE ANNA	LAKE ANNA PLAZA	126	35	50	4,410	6,300	0	0	--	--	4,410	6,300	718	1,026	5,128	7,326
	JERDONE ISLAND	177	40	60	7,080	10,620	0	0	--	--	7,080	10,620	1,153	1,729	8,233	12,349
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	236	55	85	12,980	20,060	51,277	79,247	--	--	64,257	99,307	10,461	16,166	74,718	115,473
	TOWN OF LOUISA	1,555	65	100	101,075	155,500	58,349	89,768	--	--	159,424	245,268	25,953	39,927	185,377	285,196
	TOWN OF MINERAL	640	65	100	41,600	64,000	13,793	21,220	--	--	55,393	85,220	9,017	13,873	64,410	99,093
* ZION CROSSROADS SERVICE AREA		814	80	120	65,120	97,680	97,680	146,520	--	--	162,800	244,200	26,502	39,753	189,302	283,953
	SUB-TOTAL =	6,077	--	--	377,020	586,640	221,100	336,755	--	--	598,120	923,395	97,368	150,320	695,488	1,073,715
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (86% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (86% OF DEMAND) (GPD)	AVERAGE WATER LOST (14% OF DEMAND) (GPD)	PEAK DAY WATER LOST (14% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	1,404	2,107	10,029	15,047
NORTH ANNA POWER STATION AND INFO CENTER		--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,628	2,442	11,628	17,442
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	2,076	3,113	14,826	22,238
CROSSING POINTE		--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,747	2,620	12,477	18,715
TANYARD COUNTRY CLUB GOLF COURSE		--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	8,864	13,296	63,314	94,971
SPRING CREEK GOLF COURSE		--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	22,463	33,695	160,453	240,680
LCWA (LOUISA POWER STATION)		--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	1,892	2,837	13,512	20,267
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)		--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	43,350	65,025	309,645	464,465
	SUB-TOTAL =	--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	83,424	125,136	595,884	893,826
COUNTY DESIGNATED GROWTH AREAS (PROPOSED MUNICIPAL SERVICE AREAS)		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (86% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (86% OF DEMAND) (GPD)	AVERAGE WATER LOST (14% OF DEMAND) (GPD)	PEAK DAY WATER LOST (14% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
* GUM SPRING		20	80	120	1,600	2,400	2,400	3,600	--	--	4,000	6,000	651	977	4,651	6,977
* FERNCLIFF		28	80	120	2,240	3,360	3,360	5,040	--	--	5,600	8,400	912	1,367	6,512	9,767
* SHANNON HILL		15	80	120	1,200	1,800	1,800	2,700	--	--	3,000	4,500	488	733	3,488	5,233
LAKE ANNA	REMAINING AREA	277	80	120	22,160	33,240	14,773	22,160	--	--	36,933	55,400	6,012	9,019	42,946	64,419
BOSWELL'S TAVERN (NOT IN PHASE)		--	--	--	--	--	0	0	--	--	0	0	0	0	0	0
GORDONSVILLE (NOT IN PHASE)		--	--	--	--	--	0	0	--	--	0	0	0	0	0	0
	SUB-TOTAL =	340	--	--	27,200	40,800	22,333	33,500	--	--	49,533	74,300	8,064	12,095	57,597	86,395
PRIVATE INDIVIDUAL WELLS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (86% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (86% OF DEMAND) (GPD)	AVERAGE WATER LOST (14% OF DEMAND) (GPD)	PEAK DAY WATER LOST (14% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS		10,809	80	120	864,720	1,297,080	0	0	--	--	864,720	1,297,080	140,768	211,153	1,005,488	1,508,233
RURAL AREA		15,927	100	150	1,592,700	2,389,050	0	0	--	--	1,592,700	2,389,050	259,277	388,915	1,851,977	2,777,965
	SUB-TOTAL =	26,736	--	--	2,457,420	3,686,130	0	0	--	--	2,457,420	3,686,130	400,045	600,068	2,857,465	4,286,198
	TOTAL =	33,153	--	--	2,861,640	4,313,570	489,598	739,505	266,295	399,440	3,617,533	5,452,515	588,901	887,619	**4,206,434**	**6,340,133**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 14: 2020 Population and Water Demand Projections

2020																
EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (87% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (87% OF DEMAND) (GPD)	AVERAGE WATER LOST (13% OF DEMAND) (GPD)	PEAK DAY WATER LOST (13% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,871	30	55	56,130	102,905	0	0	--	--	56,130	102,905	8,387	15,377	64,517	118,282
SHENANDOAH CROSSING		628	140	210	87,920	131,880	0	0	--	--	87,920	131,880	13,137	19,706	101,057	151,586
SIX-O-FIVE TRAILER PARK		278	45	65	12,510	18,070	0	0	--	--	12,510	18,070	1,869	2,700	14,379	20,770
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	775	1,185	5,960	9,115
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	971	1,494	7,471	11,494
LAKE ANNA	LAKE ANNA PLAZA	142	35	50	4,970	7,100	0	0	--	--	4,970	7,100	743	1,061	5,713	8,161
	JERDONE ISLAND	280	40	60	11,200	16,800	0	0	--	--	11,200	16,800	1,674	2,510	12,874	19,310
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	236	55	85	12,980	20,060	51,277	79,247	--	--	64,257	99,307	9,602	14,839	73,859	114,146
	TOWN OF LOUISA	2,258	65	100	146,770	225,800	84,728	130,351	--	--	231,498	356,151	34,592	53,218	266,090	409,369
	TOWN OF MINERAL	1,079	65	100	70,135	107,900	23,254	35,775	--	--	93,389	143,675	13,955	21,469	107,343	165,144
* ZION CROSSROADS SERVICE AREA		2,003	80	120	160,240	240,360	240,360	360,540	--	--	400,600	600,900	59,860	89,790	460,460	690,690
	SUB-TOTAL =	8,936	--	--	574,540	888,805	399,620	605,913	--	--	974,160	1,494,718	145,564	223,349	1,119,724	1,718,067
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (87% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (87% OF DEMAND) (GPD)	AVERAGE WATER LOST (13% OF DEMAND) (GPD)	PEAK DAY WATER LOST (13% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	1,289	1,934	9,914	14,874
NORTH ANNA POWER STATION AND INFO CENTER		--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,494	2,241	11,494	17,241
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	1,905	2,858	14,655	21,983
CROSSING POINTE		--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,603	2,405	12,333	18,500
TANYARD COUNTRY CLUB GOLF COURSE		--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	8,136	12,204	62,586	93,879
SPRING CREEK GOLF COURSE		--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	20,619	30,929	158,609	237,914
LCWA (LOUISA POWER STATION)		--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	1,736	2,604	13,356	20,034
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)		--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	39,791	59,686	306,086	459,126
	SUB-TOTAL =	--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	76,574	114,862	589,034	883,552
COUNTY DESIGNATED GROWTH AREAS (PROPOSED MUNICIPAL SERVICE AREAS)		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (87% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (87% OF DEMAND) (GPD)	AVERAGE WATER LOST (13% OF DEMAND) (GPD)	PEAK DAY WATER LOST (13% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
* GUM SPRING		254	80	120	20,320	30,480	30,480	45,720	--	--	50,800	76,200	7,591	11,386	58,391	87,586
* FERNCLIFF		332	80	120	26,560	39,840	39,840	59,760	--	--	66,400	99,600	9,922	14,883	76,322	114,483
* SHANNON HILL		165	80	120	13,200	19,800	19,800	29,700	--	--	33,000	49,500	4,931	7,397	37,931	56,897
LAKE ANNA	REMAINING AREA	3,242	80	120	259,360	389,040	172,907	259,360	--	--	432,267	648,400	64,592	96,887	496,858	745,287
BOSWELL'S TAVERN		35	80	120	2,800	4,200	1,867	2,800	--	--	4,667	7,000	697	1,046	5,364	8,046
GORDONSVILLE		215	80	120	17,200	25,800	11,467	17,200	--	--	28,667	43,000	4,284	6,425	32,950	49,425
	SUB-TOTAL =	4,243	--	--	339,440	509,160	276,360	414,540	--	--	615,800	923,700	92,016	138,024	707,816	1,061,724
PRIVATE INDIVIDUAL WELLS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (87% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (87% OF DEMAND) (GPD)	AVERAGE WATER LOST (13% OF DEMAND) (GPD)	PEAK DAY WATER LOST (13% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS		9,725	80	120	778,000	1,167,000	0	0	--	--	778,000	1,167,000	116,253	174,379	894,253	1,341,379
RURAL AREA		18,985	100	150	1,898,500	2,847,750	0	0	--	--	1,898,500	2,847,750	283,684	425,526	2,182,184	3,273,276
	SUB-TOTAL =	28,710	--	--	2,676,500	4,014,750	0	0	--	--	2,676,500	4,014,750	399,937	599,905	3,076,437	4,614,655
	TOTAL =	41,889	--	--	3,590,480	5,412,715	922,145	1,389,703	266,295	399,440	4,778,920	7,201,858	714,091	1,076,140	**5,493,011**	**8,277,998**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 15: 2030 Population and Water Demand Projections

2030

EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (88% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (88% OF DEMAND) (GPD)	AVERAGE WATER LOST (12% OF DEMAND) (GPD)	PEAK DAY WATER LOST (12% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,178	30	55	65,340	119,790	0	0	--	--	65,340	119,790	8,910	16,335	74,250	136,125
SHENANDOAH CROSSING		730	140	210	102,200	153,300	0	0	--	--	102,200	153,300	13,936	20,905	116,136	174,205
SIX-O-FIVE TRAILER PARK		278	45	65	12,510	18,070	0	0	--	--	12,510	18,070	1,706	2,464	14,216	20,534
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	707	1,081	5,892	9,011
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	886	1,364	7,386	11,364
LAKE ANNA	LAKE ANNA PLAZA	142	35	50	4,970	7,100	0	0	--	--	4,970	7,100	678	968	5,648	8,068
	JERDONE ISLAND	318	40	60	12,720	19,080	0	0	--	--	12,720	19,080	1,735	2,602	14,455	21,682
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	236	55	85	12,980	20,060	51,277	79,247	--	--	64,257	99,307	8,762	13,542	73,020	112,849
	TOWN OF LOUISA	3,371	65	100	219,115	337,100	126,492	194,603	--	--	345,607	531,703	47,128	72,505	392,736	604,208
	TOWN OF MINERAL	1,508	65	100	98,020	150,800	32,499	49,999	--	--	130,519	200,799	17,798	27,382	148,317	228,181
* ZION CROSSROADS SERVICE AREA		3,133	80	120	250,640	375,960	375,960	563,940	--	--	626,600	939,900	85,445	128,168	712,045	1,068,068
SUB-TOTAL =		12,055	--	--	790,180	1,219,190	586,229	887,789	--	--	1,376,409	2,106,979	187,692	287,315	1,564,101	2,394,295

SELF-SUPPLIED USERS > 300,000 GAL/MONTH	POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (88% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (88% OF DEMAND) (GPD)	AVERAGE WATER LOST (12% OF DEMAND) (GPD)	PEAK DAY WATER LOST (12% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST	--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	1,176	1,765	9,801	14,705
NORTH ANNA POWER STATION AND INFO CENTER	--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,364	2,045	11,364	17,045
SIEBERT AMOCO AND DAIRY QUEEN	--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	1,739	2,608	14,489	21,733
CROSSING POINTE	--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,463	2,195	12,193	18,290
TANYARD COUNTRY CLUB GOLF COURSE	--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	7,425	11,138	61,875	92,813
SPRING CREEK GOLF COURSE	--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	18,817	28,225	156,807	235,210
LCWA (LOUISA POWER STATION)	--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	1,585	2,377	13,205	19,807
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)	--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	36,313	54,469	302,608	453,909
SUB-TOTAL =	--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	69,881	104,821	582,341	873,511

COUNTY DESIGNATED GROWTH AREAS (PROPOSED MUNICIPAL SERVICE AREAS)		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (88% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (88% OF DEMAND) (GPD)	AVERAGE WATER LOST (12% OF DEMAND) (GPD)	PEAK DAY WATER LOST (12% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
* GUM SPRING		521	80	120	41,680	62,520	62,520	93,780	--	--	104,200	156,300	14,209	21,314	118,409	177,614
* FERNCLIFF		681	80	120	54,480	81,720	81,720	122,580	--	--	136,200	204,300	18,573	27,859	154,773	232,159
* SHANNON HILL		341	80	120	27,280	40,920	40,920	61,380	--	--	68,200	102,300	9,300	13,950	77,500	116,250
LAKE ANNA	REMAINING AREA	6,661	80	120	532,880	799,320	355,253	532,880	--	--	888,133	1,332,200	121,109	181,664	1,009,242	1,513,864
BOSWELL'S TAVERN		76	80	120	6,080	9,120	4,053	6,080	--	--	10,133	15,200	1,382	2,073	11,515	17,273
GORDONSVILLE		459	80	120	36,720	55,080	24,480	36,720	--	--	61,200	91,800	8,345	12,518	69,545	104,318
SUB-TOTAL =		8,739	--	--	699,120	1,048,680	568,947	853,420	--	--	1,268,067	1,902,100	172,918	259,377	1,440,985	2,161,477

PRIVATE INDIVIDUAL WELLS	POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (88% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (88% OF DEMAND) (GPD)	AVERAGE WATER LOST (12% OF DEMAND) (GPD)	PEAK DAY WATER LOST (12% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS	8,748	80	120	699,840	1,049,760	0	0	--	--	699,840	1,049,760	95,433	143,149	795,273	1,192,909
RURAL AREA	21,197	100	150	2,119,700	3,179,550	0	0	--	--	2,119,700	3,179,550	289,050	433,575	2,408,750	3,613,125
SUB-TOTAL =	29,945	--	--	2,819,540	4,229,310	0	0	--	--	2,819,540	4,229,310	384,483	576,724	3,204,023	4,806,034
TOTAL =	50,739	--	--	4,308,840	6,497,180	1,155,176	1,741,209	266,295	399,440	5,464,016	8,238,389	745,093	1,123,417	**6,791,450**	**10,235,317**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

*2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.*

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 16: 2040 Population and Water Demand Projections

2040																
EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (89% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (89% OF DEMAND) (GPD)	AVERAGE WATER LOST (11% OF DEMAND) (GPD)	PEAK DAY WATER LOST (11% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,485	30	55	74,550	136,675	0	0	--	--	74,550	136,675	9,214	16,892	83,764	153,567
SHENANDOAH CROSSING		832	140	210	116,480	174,720	0	0	--	--	116,480	174,720	14,396	21,595	130,876	196,315
SIX-O-FIVE TRAILER PARK		278	45	65	12,510	18,070	0	0	--	--	12,510	18,070	1,546	2,233	14,056	20,303
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	641	980	5,826	8,910
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	803	1,236	7,303	11,236
LAKE ANNA	LAKE ANNA PLAZA	142	35	50	4,970	7,100	0	0	--	--	4,970	7,100	614	878	5,584	7,978
	JERDONE ISLAND	318	40	60	12,720	19,080	0	0	--	--	12,720	19,080	1,572	2,358	14,292	21,438
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	236	55	85	12,980	20,060	51,277	79,247	--	--	64,257	99,307	7,942	12,274	72,199	111,581
	TOWN OF LOUISA	4,185	65	100	272,025	418,500	157,037	241,595	--	--	429,062	660,095	53,030	81,585	482,092	741,679
	TOWN OF MINERAL	2,024	65	100	131,560	202,400	43,620	67,107	--	--	175,180	269,507	21,651	33,310	196,831	302,817
* ZION CROSSROADS SERVICE AREA		3,963	80	120	317,040	475,560	475,560	713,340	--	--	792,600	1,188,900	97,962	146,943	890,562	1,335,843
SUB-TOTAL =		14,624	--	--	966,520	1,490,095	727,494	1,101,289	--	--	1,694,014	2,591,384	209,372	320,283	1,903,386	2,911,667
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (89% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (89% OF DEMAND) (GPD)	AVERAGE WATER LOST (11% OF DEMAND) (GPD)	PEAK DAY WATER LOST (11% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	1,066	1,599	9,691	14,539
NORTH ANNA POWER STATION AND INFO CENTER		--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,236	1,854	11,236	16,854
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	1,576	2,364	14,326	21,489
CROSSING POINTE		--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,326	1,989	12,056	18,084
TANYARD COUNTRY CLUB GOLF COURSE		--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	6,730	10,095	61,180	91,770
SPRING CREEK GOLF COURSE		--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	17,055	25,582	155,045	232,567
LCWA (LOUISA POWER STATION)		--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	1,436	2,154	13,056	19,584
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)		--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	32,913	49,369	299,208	448,809
SUB-TOTAL =		--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	63,338	95,007	575,798	863,697
COUNTY DESIGNATED GROWTH AREAS (PROPOSED MUNICIPAL SERVICE AREAS)		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (89% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (89% OF DEMAND) (GPD)	AVERAGE WATER LOST (11% OF DEMAND) (GPD)	PEAK DAY WATER LOST (11% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
* GUM SPRING		720	80	120	57,600	86,400	86,400	129,600	--	--	144,000	216,000	17,798	26,697	161,798	242,697
* FERNCLIFF		943	80	120	75,440	113,160	113,160	169,740	--	--	188,600	282,900	23,310	34,965	211,910	317,865
* SHANNON HILL		474	80	120	37,920	56,880	56,880	85,320	--	--	94,800	142,200	11,717	17,575	106,517	159,775
LAKE ANNA	REMAINING AREA	9,216	80	120	737,280	1,105,920	491,520	737,280	--	--	1,228,800	1,843,200	151,874	227,811	1,380,674	2,071,011
BOSWELL'S TAVERN		105	80	120	8,400	12,600	5,600	8,400	--	--	14,000	21,000	1,730	2,596	15,730	23,596
GORDONSVILLE		643	80	120	51,440	77,160	34,293	51,440	--	--	85,733	128,600	10,596	15,894	96,330	144,494
SUB-TOTAL =		12,101	--	--	968,080	1,452,120	787,853	1,181,780	--	--	1,755,933	2,633,900	217,025	325,538	1,972,959	2,959,438
PRIVATE INDIVIDUAL WELLS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (89% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (89% OF DEMAND) (GPD)	AVERAGE WATER LOST (11% OF DEMAND) (GPD)	PEAK DAY WATER LOST (11% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS		7,868	80	120	629,440	944,160	0	0	--	--	629,440	944,160	77,796	116,694	707,236	1,060,854
RURAL AREA		22,881	100	150	2,288,100	3,432,150	0	0	--	--	2,288,100	3,432,150	282,799	424,198	2,570,899	3,856,348
SUB-TOTAL =		30,749	--	--	2,917,540	4,376,310	0	0	--	--	2,917,540	4,376,310	360,595	540,892	3,278,135	4,917,202
TOTAL =		57,474	--	--	4,852,140	7,318,525	1,515,347	2,283,069	266,295	399,440	6,367,487	9,601,594	786,993	1,186,714	**7,730,278**	**11,652,004**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 17: 2050 Population and Water Demand Projections

2050																
EXISTING PRIVATE AND MUNICIPAL COMMUNITY WATER SYSTEMS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (90% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (90% OF DEMAND) (GPD)	AVERAGE WATER LOST (10% OF DEMAND) (GPD)	PEAK DAY WATER LOST (10% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,792	30	55	83,760	153,560	0	0	--	--	83,760	153,560	9,307	17,062	93,067	170,622
SHENANDOAH CROSSING		935	140	210	130,900	196,350	0	0	--	--	130,900	196,350	14,544	21,817	145,444	218,167
SIX-O-FIVE TRAILER PARK		278	45	65	12,510	18,070	0	0	--	--	12,510	18,070	1,390	2,008	13,900	20,078
TREVILIANS SQUARE APARTMENTS		61	85	130	5,185	7,930	0	0	--	--	5,185	7,930	576	881	5,761	8,811
TWIN OAKS		100	65	100	6,500	10,000	0	0	--	--	6,500	10,000	722	1,111	7,222	11,111
LAKE ANNA	LAKE ANNA PLAZA	142	35	50	4,970	7,100	0	0	--	--	4,970	7,100	552	789	5,522	7,889
	JERDONE ISLAND	318	40	60	12,720	19,080	0	0	--	--	12,720	19,080	1,413	2,120	14,133	21,200
NORTHEAST CREEK RESERVOIR SERVICE AREA	LCWA	236	55	85	12,980	20,060	51,277	79,247	--	--	64,257	99,307	7,140	11,034	71,397	110,341
	TOWN OF LOUISA	5,109	65	100	332,085	510,900	191,708	294,936	--	--	523,793	805,836	58,199	89,537	581,993	895,373
	TOWN OF MINERAL	2,598	65	100	168,870	259,800	55,990	86,139	--	--	224,860	345,939	24,984	38,438	249,845	384,376
* ZION CROSSROADS SERVICE AREA		4,901	80	120	392,080	588,120	588,120	882,180	--	--	980,200	1,470,300	108,911	163,367	1,089,111	1,633,667
SUB-TOTAL =		17,470	--	--	1,162,560	1,790,970	887,096	1,342,502	--	--	2,049,656	3,133,472	227,740	348,164	2,277,396	3,481,635
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (90% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (90% OF DEMAND) (GPD)	AVERAGE WATER LOST (10% OF DEMAND) (GPD)	PEAK DAY WATER LOST (10% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	--	--	8,625	12,940	0	0	8,625	12,940	958	1,438	9,583	14,378
NORTH ANNA POWER STATION AND INFO CENTER		--	--	--	--	--	10,000	15,000	0	0	10,000	15,000	1,111	1,667	11,111	16,667
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	--	--	12,750	19,125	0	0	12,750	19,125	1,417	2,125	14,167	21,250
CROSSING POINTE		--	--	--	--	--	10,730	16,095	0	0	10,730	16,095	1,192	1,788	11,922	17,883
TANYARD COUNTRY CLUB GOLF COURSE		--	--	--	--	--	54,450	81,675	0	0	54,450	81,675	6,050	9,075	60,500	90,750
SPRING CREEK GOLF COURSE		--	--	--	--	--	137,990	206,985	0	0	137,990	206,985	15,332	22,998	153,322	229,983
LCWA (LOUISA POWER STATION)		--	--	--	--	--	11,620	17,430	0	0	11,620	17,430	1,291	1,937	12,911	19,367
AGRICULTURE (LIVESTOCK & IRRIGATED LAND)		--	--	--	--	--	0	0	266,295	399,440	266,295	399,440	29,588	44,382	295,883	443,822
SUB-TOTAL =		--	--	--	--	--	246,165	369,250	266,295	399,440	512,460	768,690	56,940	85,410	569,400	854,100
COUNTY DESIGNATED GROWTH AREAS (PROPOSED MUNICIPAL SERVICE AREAS)		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (90% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (90% OF DEMAND) (GPD)	AVERAGE WATER LOST (10% OF DEMAND) (GPD)	PEAK DAY WATER LOST (10% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
* GUM SPRING		941	80	120	75,280	112,920	112,920	169,380	--	--	188,200	282,300	20,911	31,367	209,111	313,667
* FERNCLIFF		1,232	80	120	98,560	147,840	147,840	221,760	--	--	246,400	369,600	27,378	41,067	273,778	410,667
* SHANNON HILL		619	80	120	49,520	74,280	74,280	111,420	--	--	123,800	185,700	13,756	20,633	137,556	206,333
LAKE ANNA	REMAINING AREA	12,050	80	120	964,000	1,446,000	642,667	964,000	--	--	1,606,667	2,410,000	178,519	267,778	1,785,185	2,677,778
BOSWELL'S TAVERN		138	80	120	11,040	16,560	7,360	11,040	--	--	18,400	27,600	2,044	3,067	20,444	30,667
GORDONSVILLE		846	80	120	67,680	101,520	45,120	67,680	--	--	112,800	169,200	12,533	18,800	125,333	188,000
SUB-TOTAL =		15,826	--	--	1,266,080	1,899,120	1,030,187	1,545,280	--	--	2,296,267	3,444,400	255,141	382,711	2,551,407	3,827,111
PRIVATE INDIVIDUAL WELLS		POPULATION	AVERAGE RESIDENTIAL WATER USAGE RATE (GPD/P)	PEAK DAY RESIDENTIAL WATER USAGE RATE (GPD/P)	AVERAGE RESIDENTIAL WATER USAGE (GPD)	PEAK DAY RESIDENTIAL WATER USAGE (GPD)	AVERAGE COMMERCIAL WATER USAGE (GPD)	PEAK DAY COMMERCIAL WATER USAGE (GPD)	AVERAGE AGRICULTURAL WATER USAGE (GPD)	PEAK DAY AGRICULTURAL WATER USAGE (GPD)	AVERAGE TOTAL USAGE (90% OF DEMAND) (GPD)	PEAK DAY TOTAL USAGE (90% OF DEMAND) (GPD)	AVERAGE WATER LOST (10% OF DEMAND) (GPD)	PEAK DAY WATER LOST (10% OF DEMAND) (GPD)	AVERAGE WATER DEMAND (GPD)	PEAK DAY WATER DEMAND (GPD)
GROWTH AREAS		7,079	80	120	566,320	849,480	0	0	--	--	566,320	849,480	62,924	94,387	629,244	943,867
RURAL AREA		24,808	100	150	2,480,800	3,721,200	0	0	--	--	2,480,800	3,721,200	275,644	413,467	2,756,444	4,134,667
SUB-TOTAL =		31,887	--	--	3,047,120	4,570,680	0	0	--	--	3,047,120	4,570,680	338,569	507,853	3,385,689	5,078,533
TOTAL =		65,183	--	--	5,475,760	8,260,770	1,917,283	2,887,782	266,295	399,440	7,393,043	11,148,552	821,449	1,238,728	**8,783,892**	**13,241,380**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 7.

*2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.*

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

VII. WATER DEMAND MANAGEMENT (9 VAC 25-780-110 & 120)

Section VII outlines Louisa County's response to 9 VAC 25-780-110 "Water Demand Management Information" and 9 VAC 25-780-120 "Drought Response and Contingency Plans". This section will review existing and potential future water use efficiency, conservation, and water loss reduction approaches by the County, along with the County's anticipated response to drought.

A. Water Use Efficiency

Louisa County's Board of Supervisors adopted the Virginia Uniform Statewide Building Code (VUSBC) in 1971 (Chapter 18, Section 18-1). Both Town Councils adopted the VUSBC in 1973 (Town of Louisa Chapter 47, Section 47-1); Town of Mineral Chapter 150, Section 150-2). The Building Inspection Department as established by the Louisa County Board of Supervisors has the full authority and responsibility to enforce the provisions of the VUSBC for the County and both Towns. Changes to the VUSBC which limit maximum flow of water closets, urinals, and appliances were adopted in 2000.

There are currently no ordinances in place for the County, Towns, or Louisa County Water Authority (LCWA) to develop or implement a master plan for water efficient landscaping, and no homeowner's associations have policies regarding the use of low-water use landscaping. Ordinances declaring wasteful water use and/or excess running of water do not exist, and water suppliers currently do not implement water use efficiency measures. At present, there are no water suppliers or landscape irrigation professionals in the County which participate in the Environmental Protection Agency's WaterSense partners program.

The LCWA and both Towns each implement a practice to increase irrigation efficiency by billing sewer charges based on water use, including irrigation. To avoid sewer charges for irrigation, customers have the option to install a separate meter for irrigation.

B. Water Conservation

Both Towns have ordinances in place for reduction of water use in cases of emergency. The Mayor may, if at any time is of the opinion that there is a shortage in the Town water supply and that an emergency exists with respect thereto, at such time, give due and adequate notice of the existence of such emergency and prescribe the extent to which the use of water shall be curtailed. Any person found guilty of using water other than as permitted by the terms of the order of the Mayor after due publication of the notice shall be guilty of a misdemeanor (Town of Louisa Chapter 160, Section 160-8; Town of Mineral Chapter 418, Section 418-15: both included in **Appendix C**). The Town Council reserves the right to reserve a sufficient supply of water at all times in its reservoirs to provide for fires and other emergencies and to restrict or regulate the quantity or quality of water used by consumers in the case of scarcity or whenever the public welfare may require it (Town of Louisa Chapter 160, Section 160-9; Town of Mineral Chapter 418, Section 418-16: both included in **Appendix C**).

Water suppliers in the County presently do not have water conservation plans, or standard operating procedures in place to improve water conservation. There are no low-flow and/or no-flow fixtures in the water supplier facilities. No State Revolving Funds have been used to upgrade/retrofit facility fixtures, build new facilities, purchase efficient landscape irrigation equipment for publicly owned facilities, or provide public education on water conservation measures. However, both Town Halls have had water conserving plumbing fixtures installed with their respective renovations.

There are no dual-pipe distribution systems or parallel distribution networks in the County to use reclaimed water for residential, industrial, business, institutional, or irrigational users for non-potable water use purposes.

There are no incentives programs offered to customers for implementing measures to conserve water, other than the tiered rate structure which charges a minimum use rate with additional charges over a certain amount set by each Town and the LCWA. The LCWA distributes an annual flyer to customers with conservation tips.

C. Water Loss Reduction

Based on water production and sales records from the LCWA and the Town of Louisa, it is estimated that the County is currently experiencing an approximate average of 15% loss or unaccountable water in production or transmission of their systems. The Town of Louisa is actually seeing a rise in their water loss when comparing their surface water purchase to water sales. The Town believes meter inaccuracy is part of the issue and has been replacing approximately 100 meters a year for the past two years. There are approximately 760 meters in the Town of Louisa. State Revolving Funds have not been utilized to install meters or implement water audit and leak detection practices. Both Towns track water loss, and the Town of Mineral has performed some audio leak detection in the past.

Leaks in any public water system are repaired as quickly as possible after discovery. When possible, water supply is shutoff in areas requiring repair to minimize water loss. Replacement of water lines that have a history of several emergency repairs, most likely due to age and material, are typically budgeted by the respective governing body.

Other than citizens reporting, there are no policies in place to track unauthorized connections.

For the purposes of this plan, a reduction of lost or unaccountable water of approximately 1% was assumed for every ten year period for all of Louisa County. This reduction can be accomplished through detailed reporting of water system flushing, and water system repairs. The reduction will also be achieved by upgrades to existing pipes, tanks, and equipment that will begin to lose efficiency in their operation during their useful life.

D. Drought Response and Contingency Planning (9 VAC 25-780-120)

In addition to water use efficiency, conservation, and loss reduction this plan addresses a coordinated response to drought in Louisa County. In response to the 9 VAC 25-780 Regulations, the preparation and adoption of a "Drought Response and Contingency Plan" is required.

VDH currently permits 11 Community Water Systems in Louisa County. The drought contingency program impacts only those systems using over 300,000 gallons per month; those systems are marked with an asterisk '*' below in **Table 18**.

Table 18: Community Water Systems (Ranked by Approximate Population Served)

PWSID	System Name	# of Connections	Approx. Population Served	Source
VA2109450	Town of Louisa*	706	1,501	SWP
VA2109265	Blue Ridge Shores*	575	1,472	GW
VA2109525	Town of Mineral*	338	640	GW
VA2109650	Shenandoah Crossing*	193	495	GW
VA2109990	Louisa County Water Authority Zion Crossroads *	187	454	GW
VA2109675	Six-O-Five Village Trailer Park*	97	249	GW
VA2109510	Louisa County Water Authority*	152	221	SW
VA2109625	Jerdone Island Subdivision	57	146	GW
VA2109340	Lake Anna Plaza	43	111	GW
VA2109825	Twin Oaks Community	15	100	GW
VA2109800	Trevilians Square Apartments	28	61	GW
		2,391	**5,450**	**Totals**

- GW = GROUNDWATER (WELLS)
- SW = SURFACE WATER
- SWP = SURFACE WATER PURCHASED
- * = USERS OVER 300,000 GALLONS PER MONTH

i. State & Local Regulations, Policies, and Ordinances Regarding Drought Response

VDEQ has established drought evaluation regions within the Commonwealth, and has assigned Louisa County to the Northern Piedmont Region. The Virginia Drought Coordinator makes recommendations to the Governor on declaring a drought emergency in all or any portions of the Commonwealth. Such declarations require a certain percentage reduction in total water use, but it remains the responsibility of the Counties, Cities, and Water Authorities to adopt ordinances and policies with specific water use prohibitions.

The Louisa County Board of Supervisors (LCBOS) has an ordinance in place for drought management, including water use restrictions, which takes effect upon the declaration by the Governor of Virginia of a Drought Emergency that includes Louisa County. The LCBOS should also have a drought management ordinance in place to take effect upon the declaration by the LCBOS of a Drought Emergency. A copy of the adopted County ordinance and a model ordinance are included in **Appendix C** of this plan.

ii. Drought Stages and Indicators/Triggers for Drought Declaration in Louisa County

The Virginia Drought Monitoring Task Force (Task Force) makes recommendations to the Virginia Drought Coordinator based on four phases for drought declaration and potential water shortage: Normal Conditions, Stage I (Drought Watch), Stage II (Drought Warning), and Stage III (Drought Emergency). There are four drought indicators used by the Task Force as initial parameters for consideration when declaring a specific drought stage:

Precipitation Deficits: Using data collected by the Office of the State Climatologist, deficits are measured by comparing present precipitation amounts with historical normal long-term average precipitation values.

The National Oceanic & Atmospheric Administration (NOAA) and the National Climatic Data Center (NCDC) have rain gages for Louisa County, as well as a summary of the monthly average precipitation values for the past 30 years. Information can be found on the NCDC and NOAA website (www.ncdc.noaa.gov). Precipitation information for Louisa County, as well as data from the last two years from two rain gages, can be found at the Weather Underground website (www.wunderground.com).

Streamflows: Using streamflow gauges that represent drought evaluation regions, streamflow responses to drought conditions are monitored by comparing representative daily flow values to historic flow statistics for the period of record.

The gauge selected to monitor drought severity in the Northern Piedmont Drought Evaluation Region is the Rapidan River near Culpeper, U.S. Geological Survey (USGS) #01667500. The USGS does not have daily discharge data current up to the present date.

USGS also has one gauge in Louisa County on the North Anna River near Partlow (USGS #01670400).

Ground Water Levels: Using water table ground water monitoring wells that represent drought evaluation regions, the ground water responses to drought conditions are monitored by comparing measured ground water levels with historic level statistics for the period of record.

The monitoring well chosen to be the drought monitor for the Northern Piedmont Drought Evaluation Region is the Gordonsville Observation Well, USGS #45P 1 SOW 030.

Reservoir Storage: Water supply reservoirs will be used as a drought indicator based on the estimated number of days of remaining useable storage they have available. Louisa County uses the Northeast Creek Reservoir, which is operated by the LCWA. Lake Anna is not used for water supply purposes. Although the Virginia drought response plan indicates Lake Anna could be used as an indicator for reservoir levels, the Northeast Creek Reservoir storage levels will be used for Louisa County and obtained through the LCWA.

Formal public declaration of a change in drought stage for all or part of Louisa County will be guided by the Task Force's indicator conditions below:

Stage I Indicator - Drought Watch (entire county)

a. Precipitation levels are at or below the percent of normal precipitation for the time period in the Precipitation Deficit Table. See **Table 19** below.
b. Streamflows fall between the 10^{th} and 25^{th} percentile (e.g. streamflow at the 10^{th} percentile indicates that 90% of streamflows exceed the current flow for the period of record).
c. Measured ground water levels fall between the 10^{th} and 25^{th} percentile for all historic levels.
d. Water supply reservoirs contain between 90 and 120 days of useable storage.

Table 19: Precipitation Deficit Table

Months Analyzed	Normal (% of Normal Precipitation)	Watch (% of Normal Precipitation	Warning (% of Normal Precipitation)	Emergency (% of Normal Precipitation)
October – December	>75.0	< 75.0	< 65.0	< 55.0
October – January	>80.0	< 80.0	< 70.0	< 60.0
October – February	>80.0	< 80.0	< 70.0	< 60.0
October – March	>80.0	< 80.0	< 70.0	< 60.0
October – April	>81.5	< 81.5	< 71.5	< 61.5
October – May	>82.5	< 82.5	< 72.5	< 62.5
October – June	>83.5	< 83.5	< 73.5	< 63.5
October – July	>85.0	< 85.0	< 75.0	< 65.0
October – August	>85.0	< 85.0	< 75.0	< 65.0
October – September (and previous 12 months)	>85.0	< 85.0	< 75.0	< 65.0

Stage II Indicator - Drought Warning (entire county)

a. Precipitation levels are at or below the percent of normal precipitation for the time period in the precipitation table.
b. Streamflows fall between the 5th and 10th percentile.
c. Measured ground water levels fall between the 5th and 10th percentile for all historic levels.
d. Water supply reservoirs contain between 60 and 90 days of useable storage.

Stage III Indicator - Drought Emergency (portions of county as indicated)

a. Precipitation levels are at or below the percent of normal precipitation for the time period in the precipitation table. (Surface Water Users)
b. Streamflows are at or below the 5th percentile. (Surface Water Users)
c. Measured ground water levels are at or below the 5th percentile for all historic levels. (Groundwater Users)
d. Water supply reservoirs contain 60 days or less of useable storage. (Surface Water Users)

iii. Critical Action Plan for Drought Stages

The following is a list of critical actions for each drought stage (note that drought watch and drought warning conditions are recommended, and compliance is voluntary):

Stage I Action - Drought Watch

a. Set a voluntary water-use reduction goal of 15% for all community and non-community water systems that use more than 300,000 gallons per month, and/or serve a population of 100 persons or more.

b. Initiate contact with state and federal agencies including Federal Emergency Management Agency (FEMA), USGS, Environmental Protection Agency (EPA), and the United States Department of Agriculture (USDA) in order to identify federal assistance capabilities and drought workshops.
c. Initiate weekly reservoir level reporting to see changes and behavior trends over time
d. Request local health directors to track and report on both shallow and deep wells.
e. Consider preparations to reactivate "emergency" and "inactive" sources and systems of water supply for potential use.

Stage II Action - Drought Warning

a. Set a water use reduction goal of 20% for all community and non-community water systems that use more than 300,000 gallons per month, and/or serve a population of 100 persons or more.
b. Identify leaks and focus on accelerated repairs and implementation of water conservation measures.
c. Increase public education and information.
d. Undertake physical measures necessary to bring emergency and inactive sources of water supply on-line.
e. Identify non-essential water uses for implementation at the Drought Emergency stage.

Stage III Action - Drought Emergency

a. Mandate 25% water conservation for all community and non-community water systems that use more than 300,000 gallons per month and/or serve a population of 100 persons or more. Also mandate 25% water conservation for all individual wells, systems, and communities that use 300,000 gallons per month or less.
b. Apply for federal assistance and funding as appropriate.
c. Initiate use of emergency and inactive sources of water supply.
d. Assist owners of residential wells with drought-related problems and the obtaining of permits to construct wells, or evaluate the possibility of connecting to a public water supply.

iv. Notification of Drought Conditions

When one or more of the conditions specified under the "Critical Action for Drought Stages" outlined above are met indicating that the local community has reached a Drought Watch stage, the County Administrator will recommend to the LCBOS that a Drought Watch be officially declared for the County. At the time a Drought Watch is declared, the LCBOS will authorize the County Administrator, in consultation with the General Manager of the LCWA, the Town Manager of the Town of Mineral, and the Town Manager of the Town of Louisa, to declare a Drought Warning or a Drought Emergency should drought conditions later reach the levels defined by the guidance outlined above.

The County Administrator will provide appropriate immediate notification to the LCBOS, the General Manager of the LCWA, the Town Manager of the Town of Mineral, the Town Manager of the Town of Louisa, and the news media at any time a new drought stage has been declared. At that time, retail providers will activate water use restrictions and other conservation measures as defined in this Plan. The Town of Mineral and the Town of Louisa will require action by their respective Town Councils to activate a drought stage.

Drought stages may be discontinued or reduced in severity after the water supply has sufficiently recovered such that water use restrictions are no longer necessary. It is recommended that drought declarations remain in force until such time that recovery has reached an acceptable level.

v. <u>Procedures for Implementation and Enforcement of Water Restrictions</u>

There are three ways that water use restrictions can be initiated: (1) a declaration by the Governor of a drought emergency that includes Louisa County; (2) a declaration by the LCBOS, or the County Administrator acting on behalf of the Board, that a drought emergency exists county-wide; or (3) a declaration by the LCWA, Town of Mineral, or Town of Louisa that a drought emergency exists in their own customer service area.

It is important to note that LCWA's Northeast Creek Reservoir has ample capacity, such that water use restrictions on the rest of the County may not apply to customers supplied by the Northeast Creek Reservoir, except in the case of a Governor-declared drought emergency.

During periods of time in which drought stages are declared, water use restrictions will be in effect and enforced within the following jurisdictional areas as defined below:

Town of Mineral: At the direction of the Town Council, the Town Manager will implement and enforce water use restrictions on water customers within the Town.

Town of Louisa: At the direction of the Town Council, the Town Manager will implement and enforce water use restrictions on water customers within the Town.

Louisa County Water Authority: At the direction of the LCBOS, the LCWA General Manager will implement and enforce water use restrictions on LCWA water customers who may not be within the Town of Mineral or the Town of Louisa.

Remainder of Louisa County: At the direction of the LCBOS, the County Administrator will implement and enforce water use restrictions on all remaining water users who are not LCWA customers nor within the Town of Mineral or the Town of Louisa.

Local governments of the Commonwealth are authorized to adopt local ordinances to enforce mandatory non-essential water use restrictions and to establish, collect, and retain fines for violations of these restrictions. **Appendix C** provides an example ordinance to help guide Louisa County, the Town of Mineral, and the Town of Louisa in the development of a formal government action. Nothing contained in this drought response plan should be construed to limit the powers of local government to adopt and enforce local emergency ordinances as necessary to protect the public welfare, safety and health.

Local governments and public waterworks may impose water use restrictions more stringent than the mandatory non-essential water use restrictions consistent with local water supply conditions at any time.

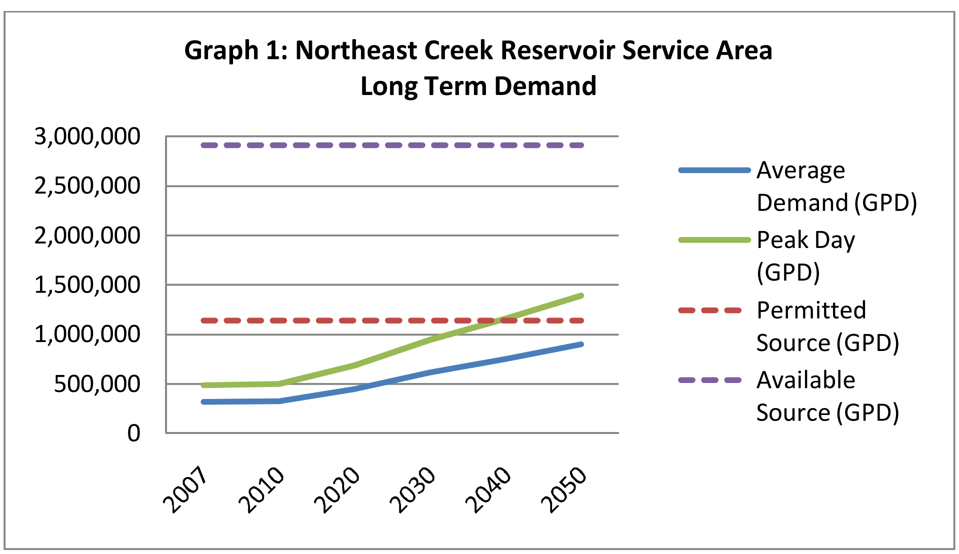
VIII. STATEMENT OF NEED (9 VAC 25-780-130)

In response to 9 VAC 25-780-130, the following two sections of this plan will address the "Statement of Need and Alternatives" for Louisa County. As stated previously, information on individual wells serving residents in rural areas is unknown. Individual groundwater wells for residents who will not connect to a public water system during the planning period are assumed to have adequate capacity for projected water demands. To identify a statement of need, a comparison of the currently permitted water source capacity and available source capacity versus the projected long-term water demands for the existing municipal and private community water systems is presented in this section. Existing permitted capacity and available source for the current municipal water systems is also examined against the projected water demands for the County's designated growth areas, given the County anticipates providing public water for these areas.

A. Existing Municipal Community Water Systems

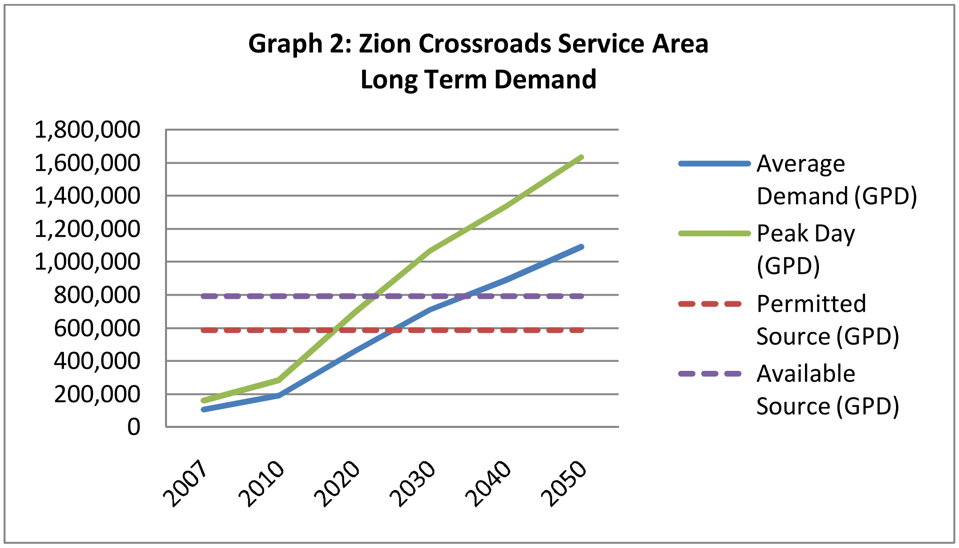
Northeast Creek Reservoir Service Area

The Northeast Creek Reservoir Service Area water system is operated and maintained by the Louisa County Water Authority (LCWA) and serves customers in the Town of Louisa, Town of Mineral, and nearby areas. The current permitted capacity of the three (3) water sources supplying this service area is 1,139,200 GPD (Northeast Creek Reservoir: 1.0 MGD, LCWA Industrial Park Well: 19,200 GPD, and Town of Mineral wells: 120,000 GPD), which is more than sufficient to meet the average water demands of the service area through 2050; however the peak day water demand surpasses the permitted capacity in 2039. Additional source capacity is available at the Town of Mineral wells in the amount of 1,600 GPD, and the safe yield of 2.77 MGD for the Northeast Creek Reservoir. Improvements at the Town of Mineral wells site and Northeast Creek Water Treatment Plant would be required to utilize the available source.

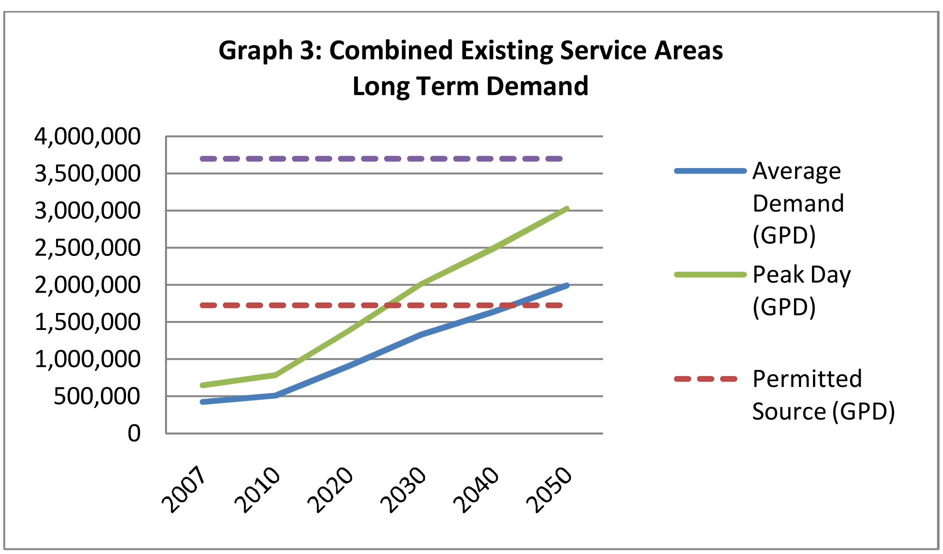


Zion Crossroads Service Area

The LCWA currently operates six (6) of the eight (8) wells in the Zion Crossroads Service Area with a combined permitted capacity of 587,520 GPD. The additional two (2) wells, when developed, will provide an additional capacity of 204,800 GPD. Although the permitted capacity of the existing wells is ample for the current population served, the water demand is expected to outpace the permitted supply by the year 2025 for average day demand and the year 2017 for peak day demand. The additional two wells will provide additional source that will be outpaced by the year 2034 for average day demand and 2022 for peak day demand.



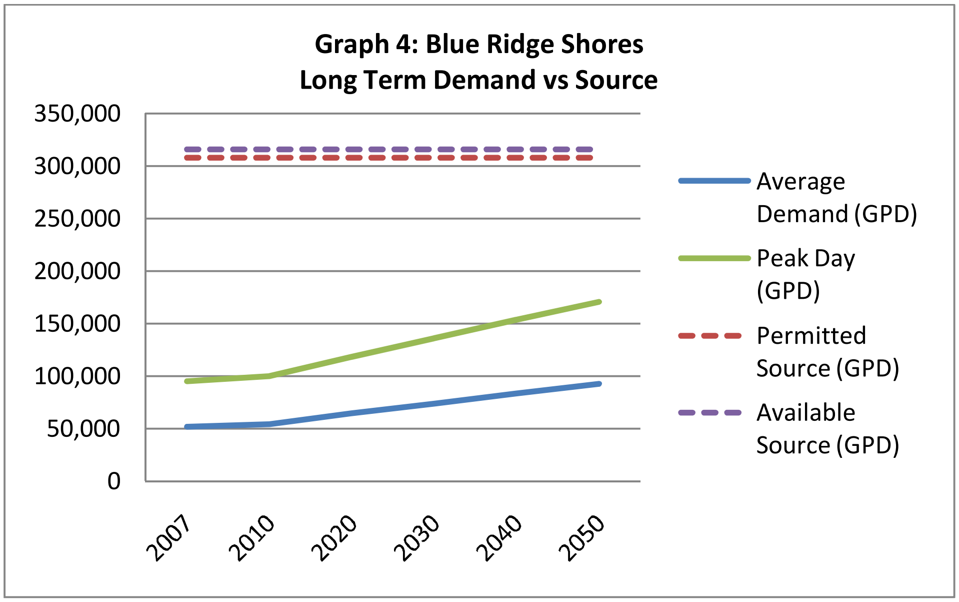
Given the additional source available in the Northeast Creek Reservoir Service Area, a graph combining the two existing service areas illustrates that if the service areas were to be connected and all available source capacity developed, Zion Crossroad's supply deficit would be eliminated for the planning period.



B. Existing Private Community Water Systems

Blue Ridge Shores

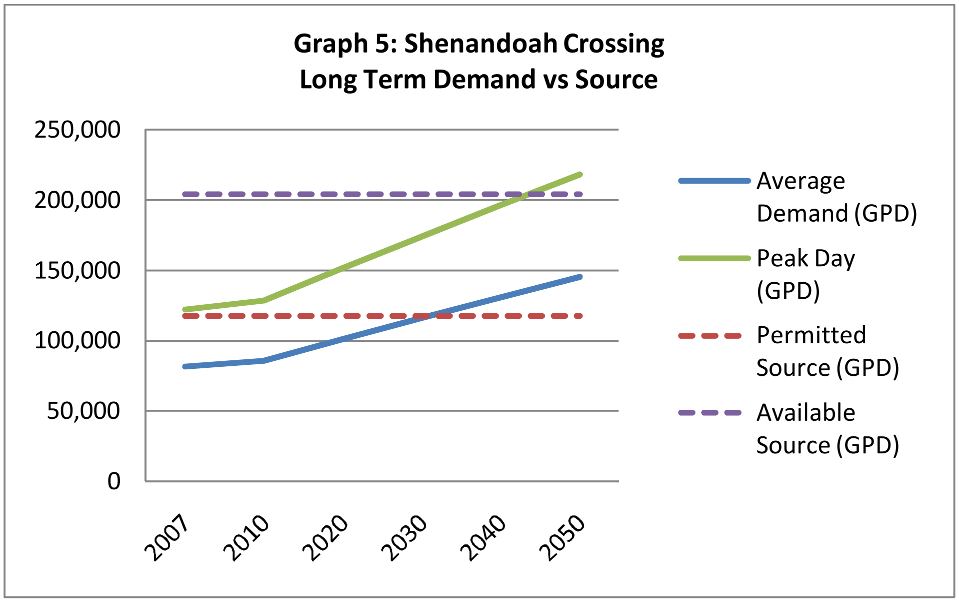
Blue Ridge Shores owns and operates eight (8) wells with a permitted system capacity of 308,000 GPD. As shown in the graph, there is ample capacity in the current system to meet projected water demands through 2050.



Shenandoah Crossing

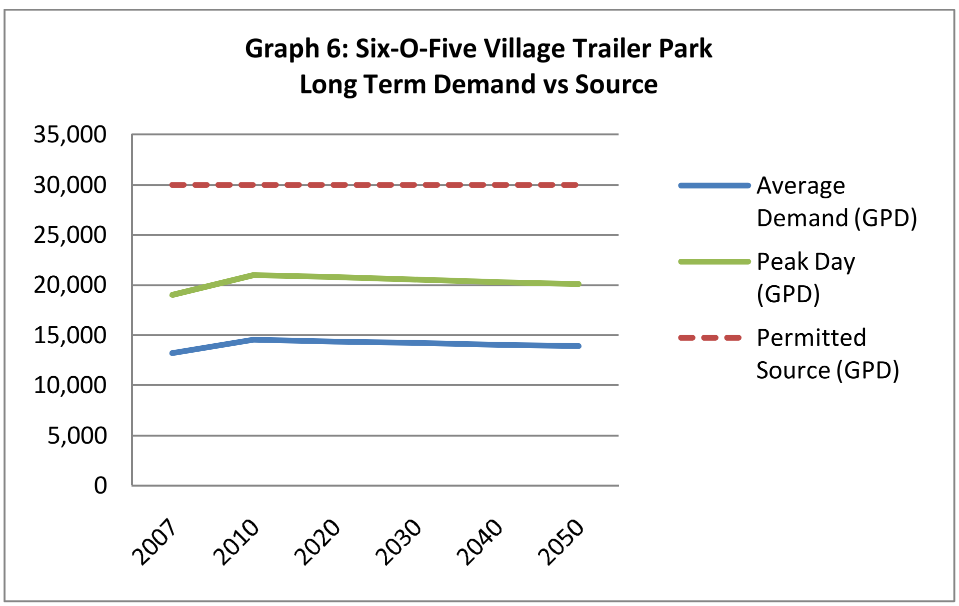
Shenandoah Crossing owns and operates six (6) wells with a permitted system capacity of 117,600 GPD. Monthly data for this system is unfortunately skewed since large leaks were discovered during the summer of 2010. Water system production for January 2010 was reported at 2.94 MGD; whereas water production for January 2011 was 1.59 MGD, a reduction of 46% for withdrawal. Given a full year's worth of data without water system leaks is unavailable, the projected demands through 2050 are unfortunately elevated. Therefore, even though the below graph illustrates that the annual average day demand and peak day demand surpass the current permitted capacity of the system and eventually the available source during the planning period, it is inaccurate to assume this water system will need additional water source. Actually, if the peak day projection of 218,167 GPD for 2050 is reduced by 46% to 117,810 GPD, then the available source for this system can be developed to meet demands.

As stated in Section V, Shenandoah Crossing includes both residential and resort development (time shares). The historical water demand includes water supplied to the existing resort development. Projected water demands are based on the existing resort development, and anticipated growth of the residential portion. Shenandoah Crossing has plans to expand their resort development, but ultimate resort water demands are unknown. Based on the resort development, additional water sources may be required.



Six-O-Five Village Trailer Park

The Six-O-Five Village Trailer Park owns and operates two wells with a permitted system capacity of 30,000 GPD. Original 2006 water production data provided by VDEQ for this system reported an average daily withdrawal over 50,000 GPD. This data obviously appeared unreasonable based on the permitted capacity. 2009 data illustrated an annual average usage of approximately 13,000 GPD. Based on the updated data, this system has ample capacity to meet this community's water demand through 2050.



Trevilians Square Apartments

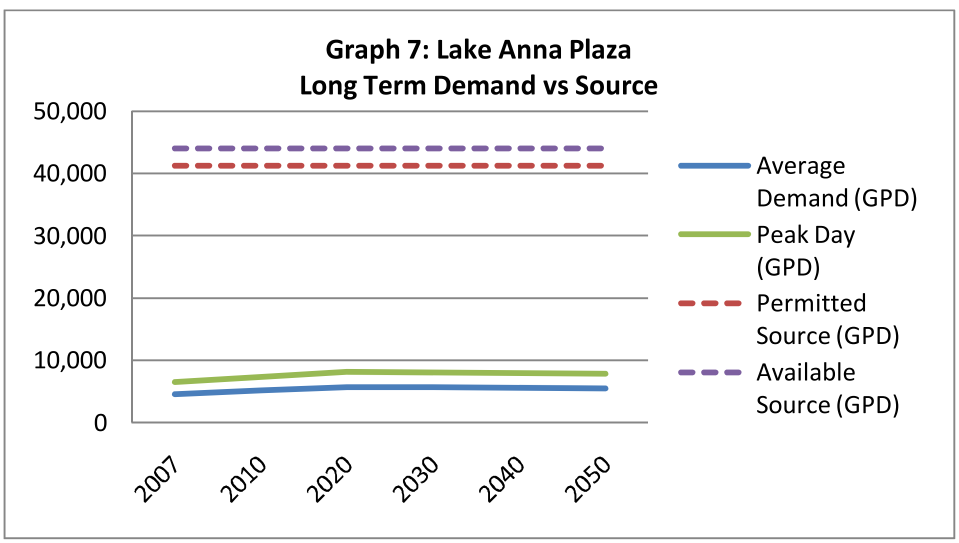
Trevilians Square Apartments is supplied water through two (2) groundwater sources, one (1) primary well and one (1) emergency well. Well yield data is not available for either well. Given this lack of information, VDH has permitted this system on the design basis of the existing 28 apartment units. The population is not expected to change over the planning period, and so it is assumed that the current permitted system capacity is adequate to meet the projected water demands. If the apartment complex ever expanded, well drawdown tests would need to be completed to determine the true available source of the two (2) existing wells. At that time, additional capacity may be required and the apartment complex would need to investigate options for additional water source if needed.

Twin Oaks

Twin Oaks is supplied water through one (1) groundwater source. Well yield data is not available for the well. Given this lack of information, VDH has permitted this system on the design basis of a population of 90 persons. Twin Oaks website states there are 100 residents in their community, which was the basis for the projected water demands. The population is not expected to change over the planning period, and so it is assumed that the current permitted system capacity is adequate to meet the projected water demands. If the community ever expanded, a well drawdown test would need to be completed to determine the true available source of the existing well. At that time, additional capacity may be required and the community would need to investigate options for additional water source if needed.

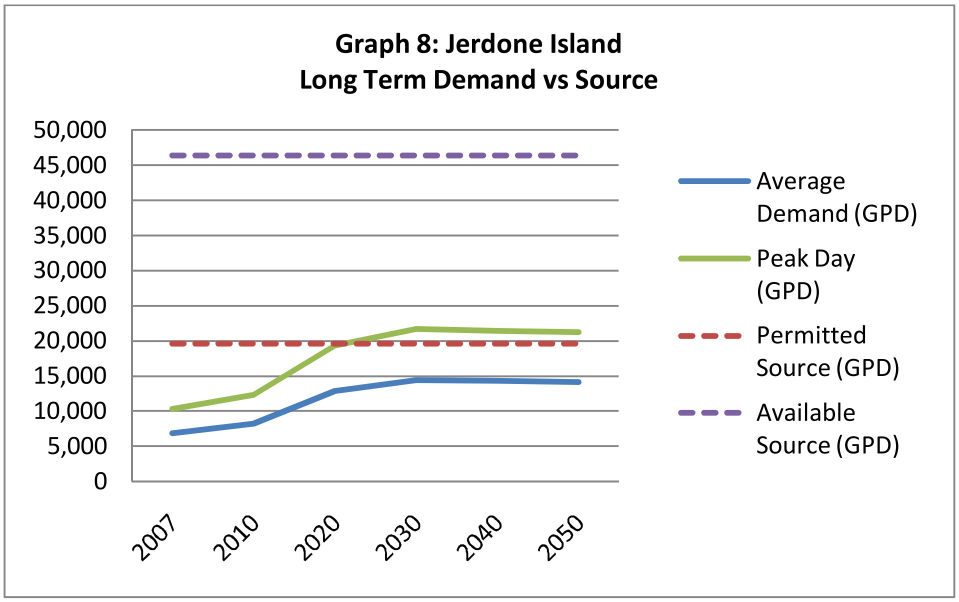
Lake Anna Plaza

Lake Anna Plaza owns and operates two (2) wells with a permitted system capacity of 41,200 GPD. As shown in the graph, there is ample capacity in the current system to meet projected water demands through 2050.



Jerdone Island Subdivision

The Jerdone Island Subdivision owns and operates one (1) well with a permitted system capacity of 19,600 GPD. Current permitted capacity is sufficient to meet the annual average water demand through 2050; however, peak day demands exceed the current permitted capacity in the year 2021. Based on the well yield, additional capacity is available in the existing well. As demands increase and approach the permitted limit, the subdivision will need to investigate what measures need to be taken to obtain approval from VDH for an increased system capacity. An additional well source may be required for redundancy.

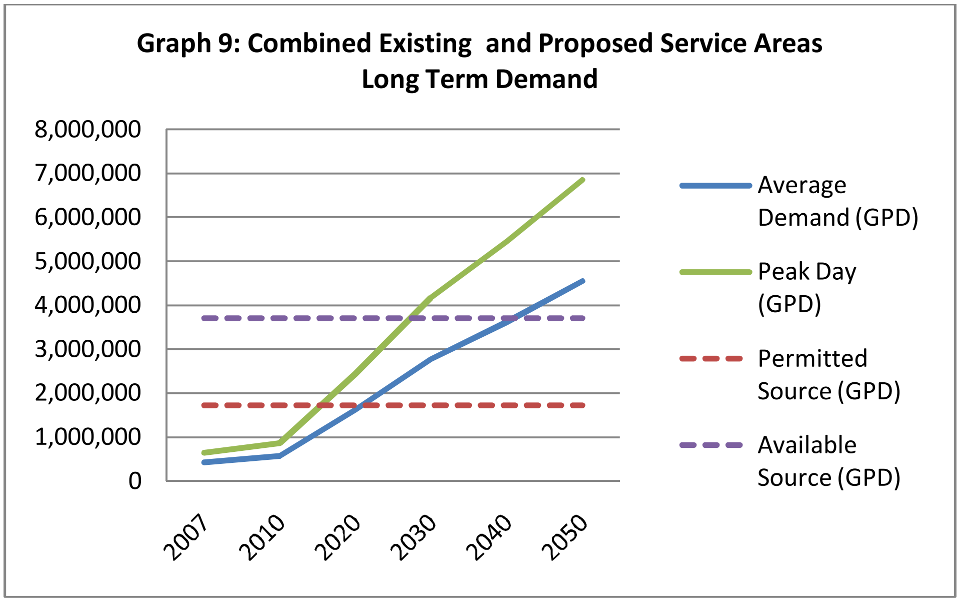


C. Proposed Municipal Community Water Systems

County Designated Growth Areas (Proposed Service Areas)

Currently, the only County designated growth areas with public water are the Town of Louisa, the Town of Mineral, and Zion Crossroads. The remaining County designated growth areas, Gum Spring, Ferncliff, Shannon Hill, Lake Anna, Boswell's Tavern, and Gordonsville are anticipated to receive access to public water based on the timeline presented with the phasing plan included in Section VI. While a small number of Louisa users (estimate of 20 residences) in the Gordonsville area are connected to the Town of Gordonsville public water supply, it is unknown if the Town of Gordonsville could supply all the necessary water for the Gordonsville growth area.

The combined existing and proposed public service area demands are graphed against the current permitted public source capacity, as well as the available public source capacity. Even if all existing available municipal water source capacity were developed, the proposed municipal community water system demands could not be met. Projected average day demands for the combined existing and proposed municipal service areas exceed the existing permitted public sources in the year 2021, and surpass the available public sources in the year 2041. Peak day projections for the combined existing and proposed municipal service areas outpace the existing permitted sources in the year 2015, and exceed the available public sources capacity in the year 2027.



D. Estimated County Water Surplus and Deficit for the Planning Period

Based on the review of each existing and proposed community water system above, it is clear that Louisa County will require additional water source(s) to meet the anticipated demands for proposed municipal service areas in the County.

All private community water systems are anticipated to have adequate water source to meet projected water demands through 2050 with the exception of Shenandoah Crossing. As previously mentioned, it is likely Shenandoah Crossing has the necessary water source capacity to meet projected water demands given the system's elevated water production data due to water system leaks. Therefore, additional water sources are not anticipated for private community water systems.

While peak day demands are graphed above for each system, annual average day demands are more relevant when planning for development of additional water source. Annual average day demands account for peak days throughout the year, and water system design typically includes water storage within the system to meet peak day demands. **Table 20** provides the average demands through 2050 for the existing and proposed municipal community water systems, as well as compares the demands to the current permitted capacity and available public source. Water surplus (+) and water deficit (-) are also presented at each time step.

Table 20: Municipal Community Water Surplus / Deficit

Existing Municipal Water Systems	2010 *Average Demand (GPD)*	2020 *Average Demand (GPD)*	2030 *Average Demand (GPD)*	2040 *Average Demand (GPD)*	2050 *Average Demand (GPD)*
NE Creek Reservoir SA	324,505	447,292	614,073	751,122	903,235
Public Source	1,139,200	1,139,200	1,139,200	1,139,200	1,139,200
Surplus/Deficit (+/-)	+814,695	+691,908	+525,127	+388,078	+235,965
Year of Deficit	N/A	N/A	N/A	N/A	N/A
Zion Crossroads SA	189,302	460,460	712,045	890,562	1,089,111
Public Source	587,520	587,520	792,320	792,320	792,320
Surplus/Deficit (+/-)	+398,218	+127060	+80,275	-98,242	-296,791
Year of Deficit	N/A	N/A	***Available Source Required 2025***	**2034**	--
Combined SA Demands	*513,807*	*907,752*	*1,326,118*	*1,641,684*	*1,992,346*
Public Source	*1,726,720*	*1,726,720*	*1,726,720*	*1,726,720*	*3,703,120*
Surplus/Deficit (+/-)	*+1,212,913*	*+818,968*	*+400,602*	*+85,036*	*+1,710,774*
Year of Deficit	*N/A*	*N/A*	*N/A*	*N/A*	***Available Source Required 2042***
Proposed Municipal Water Systems	**2010** *Average Demand (GPD)*	**2020** *Average Demand (GPD)*	**2030** *Average Demand (GPD)*	**2040** *Average Demand (GPD)*	**2050** *Average Demand (GPD)*
Gum Spring	4,651	58,391	118,409	161,798	209,111
Ferncliff	6,512	76,322	154,773	211,910	273,778
Shannon Hill	3,488	37,931	77,500	106,517	137,556
Lake Anna	42,946	496,858	1,009,242	1,380,674	1,785,185
Boswells Tavern	0	5,364	11,515	15,730	20,444
Gordonsville	0	32,950	69,545	96,330	125,333
Subtotal =	***57,597***	***707,816***	***1,440,985***	***1,972,959***	***2,551,407***
TOTAL SA Demands	***571,404***	***1,615,568***	***2,767,103***	***3,614,643***	***4,543,753***
Public Source	*1,726,720*	*1,726,720*	*3,703,120*	*3,703,120*	*3,703,120*
Surplus/Deficit (+/-)	*+1,155,316*	*+111,152*	*+936,017*	*+88,477*	*-840,633*
Year of Deficit	*N/A*	*N/A*	***Available Source Required 2021***	*N/A*	**2041**

Notes:
1. *"Average Demand" represents an annual average daily demand*
2. *SA: Service Area*
3. *Source for Northeast Creek Reservoir Service Area includes Northeast Creek Reservoir (1,000,000 GPD), LCWA Industrial Park Well (19,200 GPD), and Town of Mineral Wells (120,000 GPD).*
4. *"Year of Deficit" is interpolated from individual graphs.*

Based on the above table, current permitted source can meet all water demands for existing and proposed municipal community water systems through the year 2021. At that time available source would need to be developed, which could meet the County's public water system needs through the year 2041. However, existing and available public water sources are not in the vicinity of each of the County's designated growth areas (proposed municipal service areas), which could make the development of new water sources near or within the proposed municipal service areas more technically and economically feasible.

The following section outlines available alternatives to address the deficit in overall water sources and their locations.

IX. ALTERNATIVES (9 VAC 25-780-130)

As stated in Section VIII, Louisa County is predicted to generate municipal community water system demand deficits during the planning period based on the population projections included in this plan.

Zion Crossroads Service Area will require its available source capacity to be developed by 2025. Additional source capacity will then need to be identified and developed by 2034, given the projected demand deficit of approximately 98,000 GPD for 2040 and 297,000 GPD for 2050. However, there is available public water source in the Northeast Creek Reservoir Service Area, which would eliminate the deficit in Zion Crossroads if the two systems were connected.

Available public water source in the County was also compared to the projected water demands for all the proposed municipal community water systems in the last section. Available public water sources would need to be developed by 2021. Additional source capacity would need to be identified and developed by 2041, given the projected overall County municipal water demand deficit of approximately 841,000 GPD in 2050.

Several alternatives to either expand existing community water systems with excess water source capacity or develop additional water sources to meet the anticipated growth and water demand in several areas of the overall County are available. However, each alternative will require careful planning and analysis of the available safe yield, environmental impacts, existing resource impacts, and financial viability. Alternatives for private community water systems and municipal community water systems are offered below with a brief description of the process to expand an existing water source or develop a new water source.

Existing Private Community Water Sources

It is anticipated that all existing private community water systems will continue to meet current demands through the use of groundwater. The County does not have plans at this time to take ownership of any of the private community water systems, nor provide future connections to municipal community water systems. As outlined in Section V and Section VIII, future growth of these private community water systems is expected to generate water demands that are within the limits of their existing water sources. In the event that future plans require expansion of the water sources, additional groundwater wells are anticipated. The process for developing additional groundwater wells for private community water systems is identical to the explanation provided in the below section for “New Municipal Community Water Sources”.

Existing Municipal Community Water Sources

Northeast Creek Reservoir Service Area (Town of Louisa & Town of Mineral Growth Areas)

As stated previously, Northeast Creek Reservoir in conjunction with the Louisa County Water Authority (LCWA) Industrial Park well serve the municipal water system for the Town of Louisa and the LCWA customers outside the Town limits. In addition, it supplements the municipal water system for the Town of Mineral, which utilizes two (2) groundwater wells. Currently, there is approximately 1.14 million gallons per day (MGD) of permitted available water source to meet demands for the Town of Louisa and Town of Mineral Growth Areas. This available water is in large part limited by the current permitted capacity of the Northeast Creek Water Treatment Plant of 1.0 MGD. However, if the plant were to be expanded, total available water could be at least 2.77 MGD. Average water demand in the Northeast Creek Reservoir Service Area is not expected to exceed 0.903 MGD through the year 2050; therefore, there is the possibility that some of the excess source capacity could be redirected to other areas within the County that may show insufficient existing water sources to meet current or future demands.

In evaluating the distribution of water outside of the Northeast Creek Reservoir Service Area, there are several factors that must be taken into consideration. These include an analysis between the development of new sources in closer proximity to existing or proposed water demands versus the extension of transmission mains to these areas. In addition, it has been previously discussed that the intent of Louisa County is to maintain the rural character of the County. It may be considered difficult to maintain the rural character if finished water transmission mains are extended throughout the majority of the County.

Zion Crossroads Service Area (and Growth Area)

As stated in Section VIII, Zion Crossroads currently utilizes six (6) wells to meet the existing water demand and these six (6) wells will be outpaced by average water demand by 2025. The two (2) additional wells that are not currently being used can provide a water surplus until 2034. Therefore, additional water sources must be identified to further support Zion Crossroads, and the surrounding area.

Louisa County had begun development of a new water source for designated growth areas in the County through a partnership with Fluvanna County. This partnership included a water withdrawal from the James River and a maximum source of 6.0 MGD. The initial phase of the project would have included a firm source capacity of 1.5 MGD for Louisa County, and ultimately 3.0 MGD. While a withdrawal permit has been obtained, Fluvanna County is currently not proceeding with necessary design and construction to utilize this water source. At such time that Fluvanna County proceeds with water withdrawal from the James River, the James River water available to Louisa County in conjunction with the existing Zion Crossroads wells would be sufficient to serve the Zion Crossroads Growth Area through the 2050 planning period.

As with the Northeast Creek Reservoir analysis above, the County will need to evaluate the benefit of extending the potential water surplus to other areas of the County that may have a deficit or no water at all.

Public Water Use Efficiency, Conservation, and Loss Reduction

While water use efficiency, conservation, and loss reduction do not provide additional water source, there are respective measures for each category that can help reduce water withdrawal, thereby allowing existing water sources to support public water demands for a longer period of time. As stated in Section VII, the County currently has very few measures in place to address these items. The following suggestions have been identified by the LCWA as actions for County review and potential implementation.

1. <u>Reduction of the 15% Lost or Unaccountable Water</u>

   An assumption has been made that through detailed reporting of water system flushing and repairs, and upgrades to existing pipes, tanks, and equipment, the County can reduce its lost or unaccountable water by at least 1% for every ten year period. If the County chooses to implement a plan which focuses on identifying leaks within the public distribution system(s), it is possible that a greater reduction in lost water in a shorter amount of time could occur with the repair of identified leaks.

2. <u>Incentives to Reward Conservation and Punish Waste</u>

   There are currently no regulations in place to encourage or enforce water use efficiency or water conservation. A more stringent rate structure with several tiers of usage could be passed to promote more efficient water use. Limits could also be set for irrigation usage, or separate meters could be required for irrigation.

3. <u>Public Infrastructure for Non-Potable Purposes</u>

   Any public infrastructure provided or made available by the County for recycled and/or grey water for non-potable water usage would promote water efficiency and/or water conservation. New County ordinances could be established to encourage an initiative for County residents to use reclaimed water.

Proposed Municipal Community Water Sources

County Designated Growth Areas

The remaining six (6) growth areas currently do not have a developed public water source. To meet the anticipated growth outlined in this plan, a new water source will need to be developed in each of the proposed areas or a transmission main will need to be extended from another source. This source may be within or outside the limits of Louisa County. In addition, consideration shall be given to aquifer recharge when groundwater is identified as a potential source. This would include an analysis of aquifers that support Louisa County, and their ability to sustain long term groundwater withdrawals.

Alternatives for new public community water sources follow with a brief description of the analysis required to determine the water source yield, as well as the necessary steps for the County to utilize the water source. Without detailed analysis, it is difficult to identify or estimate the potential water yields from many of the alternatives.

1. Groundwater Wells

   Development of groundwater wells typically begins with the completion of a Hydrogeologic Report, which can include identification of well location(s), drilling of well(s), determination of well yield through a 48-hour drawdown test, aquifer response analysis to determine ability to sustain long term groundwater withdrawals, and water quality testing. Some of these items could be performed independently of the Hydrogelogic Report. Virginia Department of Health (VDH) must be contacted prior to drilling wells to obtain approval for any proposed well site. If the Hydrogeologic Report results are favorable and support the estimated water system needs, the remaining process to develop the well(s) can proceed. A construction permit must be obtained from VDH. Information required to obtain this permit will be the investigation results previously mentioned, as well as a well lot plat and dedication document. Treatment of the groundwater will vary depending on the water quality test results. At a minimum, chlorination for disinfection is assumed and potentially corrosion inhibitors. However, various media filters, softeners, or other processes may be required to address water quality deficiencies.

2. Water Withdrawal from a Stream or River or other Surface Water

   The first step towards water withdrawal from a stream or river or other surface water would be an investigation to analyze and determine the surface water's safe yield. This investigation would most likely be in the form of a feasibility study and could include installation of a stream/river gage to monitor and collect stream/river flow data, an analysis of the watershed feeding the surface water, and a determination of the available water withdrawals and associated required bypass needed to sustain downstream aquatic resources. A water withdrawal permit would be required through Virginia Department of Environmental Quality (VDEQ). A pre-application process is required for major withdrawals, including coordination with VDEQ, public notice, and public information meetings. Once a water withdrawal permit is obtained, the County could proceed with design and construction of the necessary surface water intake structure. During design, a joint permit application would need to be submitted to Virginia Marine Resources Commission, VDEQ, and Army Corps of Engineers. VDH would also need to review and approve the intake structure design and its incorporation with an existing or proposed water system.

3. Water Withdrawal from Surface Water with a New Off-line Reservoir

   In addition to the steps listed above for determining the safe yield for withdrawal from surface water, a preliminary engineering report to analyze the creation of an off-line reservoir, as well as a detailed water budget analysis with modeling of reservoir storage scenarios would also be needed. An "off-line" reservoir is simply a large manmade holding pond that is not naturally fed from a stream or river. Off-line reservoirs are typically much less environmentally damaging than creating an impoundment on an existing stream or river. The intake structure would gravity feed or pump water to the off-line reservoir. To create an off-line reservoir, a suitable site would need to be identified, along with a potential land purchase or leasing agreement. A geotechnical report to evaluate the soil type(s) of the proposed site, and provide recommendations for the reservoir design, such as a potential requirement of a liner would be required. As with the intake structure, VDH would need to review and approve the off-line reservoir design and its incorporation with an existing or proposed water system.

4. Extension of Water Transmission Mains from Other Growth Area(s)

   While typical water main extensions within an existing water system don't require a study or preliminary engineering report, a significant water transmission main extension between growth areas would warrant a preliminary engineering report to analyze alternate routes, topography, water quality, environmental impacts, resource impacts, and water system modeling for average and peak day demands, as well as fire protection. Not only is the preliminary engineering report recommended, but it would most likely be required by Virginia Department of Health. Upon completion of a preliminary engineering report, and selection of a preliminary design and route, the design and construction of the water transmission main could proceed. Given the extent of such a transmission water main, design submission would be anticipated to several review agencies for review and permitting, such as Virginia Marine Resources Commission, VDEQ, Army Corps of Engineers, VDH, Virginia Department of Transportation, Virginia Department of Conservation and Recreation.

5. Upgrade Existing Northeast Creek Water Treatment Plant

An initial step towards upgrading the existing Northeast Creek Water Treatment Plant would be the VDH required preliminary engineering report to evaluate different expansion alternatives. The preliminary engineering report would provide advantages and disadvantages of each alternative, preliminary design calculations, preliminary layouts, and cost estimates for each alternative. Once an alternative is chosen, design and construction of the chosen expansion alternative could proceed. Review and permitting of the new construction would be required by VDH, and most likely Virginia Department of Conservation and Recreation. In addition, if modifications to the existing intake structure are required, a Joint Permit Application would need to be submitted to Virginia Marine Resources Commission, VDEQ, and Army Corps of Engineers.

6. Partnership with Neighboring County for Regional Water Withdrawal

The potential partnership with Fluvanna County was mentioned earlier in this section, which would provide Louisa County as much as 3.0 MGD. Currently, this option is not viable given Fluvanna is unable to fund the design and construction of the intake structure and transmission main. However, this potential water source is important to note, as it may be developed in the future.

Another potential partnership could be with the Town of Gordonsville in Orange County. The Town of Gordonsville currently purchases their municipal water supply from Rapidan Service Authority. Based on a 1971 contract, the limit of their contract is 800,000 GPD. The Town of Gordonsville uses anywhere from 300,000 GPD to 600,000 GPD of their contract limit. The projected average day demand for Louisa County's Gordonsville growth area is approximately 125,000 GPD. Depending on the anticipated growth of the Town of Gordonsville, it's possible that Louisa County could develop an agreement with the Town of Gordonsville or Rapidan Service Authority to purchase public water supply for the Gordonsville growth area.

Additional partnerships may be found with Albemarle County or Goochland County in the future.

7. Upgrade Bowlers Mill Reservoir

An intake structure, pump station, and raw water transmission main currently exist at Bowlers Mill Reservoir to provide untreated water for cooling purposes to the Old Dominion Electric Cooperative (ODEC) power station near the Town of Gordonsville. At present, the surface water withdrawal is solely for non-potable use. However, the addition of a water treatment plant near or at this site would allow the Bowlers Mill Reservoir to be used for public water supply. The safe yield for Bowlers Mill was determined to be 0.75 MGD in January 2006. A water transmission main could be constructed to provide public water source to one or more of the County's designated growth areas. A water treatment plant and finished water transmission main would require the same procedures outlined in Items 7 and 8 above.

8. New Reservoir (Impoundment)

   While a new reservoir is a potential alternative for a new water source, it would most likely be the last alternative considered given there are several more practicable and less environmentally damaging alternatives mentioned above. Creating an impoundment on an existing stream or creek would involve a much more difficult permitting process than the other alternatives as well given the environmental impacts; specifically the Joint Permit Application would require an alternative analysis, most likely in the form of a preliminary engineering report to prove a new reservoir is the preferred option. Steps involved in developing a new reservoir would entail identification of a stream or creek, as well as a feasibility study which could include installation of a stream/creek gage to monitor and collect stream/creek flow data, an analysis of the watershed, a determination of the available water and associated required bypass needed to sustain downstream aquatic resources, and a detailed water budget analysis with modeling of reservoir storage scenarios. An environmental impact report would need to be completed and submitted to all necessary environmental assessment agencies for their review and input. As with the off-line reservoir, a suitable site would need to be identified, along with a potential land purchase or leasing agreement. A geotechnical report would also be required, although excavation should be less than with an off-line reservoir. Once permitting has been approved, design and construction can proceed as with the other alternatives.

Each alternative presents opportunities and potential impacts for the citizens of Louisa County. The County will be committed to investigate each alternative to analyze the best solution for meeting the anticipated water demands. In addition to safe yield analyses, the investigations will include environmental impacts and resource impacts resulting from source development and/or new construction.

Table 21 provides a list of the growth areas currently without a municipal community water system and summarizes the different alternatives that may be considered for each area. A new reservoir is not a likely alternative at this time, and is therefore not included in the table. For alternatives where a specific water source or growth area extension is anticipated, the specific consideration is included in parentheses and clarified by notes.

Table 21 – New Municipal Water Source Alternatives

Growth Area	Groundwater Wells	Water Withdrawal (Stream or River)	Water Withdrawal (Stream or River) w/ Off-line Reservoir	Water Withdrawal (Surface Water)	Extend Water Main from Other Growth Area(s)	Upgrade Existing Northeast Creek WTP	Partner w/ Neighboring County for Water Withdrawal
Gum Spring	✓	✓ *(SA)*	✓		✓ *(SH)*		✓ *(JR)*
Ferncliff	✓		✓		✓ *(SH, ZC, and/or NCR)*	✓	✓ *(JR)*
Shannon Hill	✓	✓ *(SA)*	✓		✓ *(GS, F, and/or NCR)*	✓	✓ *(JR)*
Lake Anna	✓	✓ *(NA)*	✓	✓ *(LA)*	✓ *(NCR)*	✓	✓
Boswells Tavern	✓			✓ *(BMR)*	✓ *(ZC,G)*		
Gordonsville	✓			✓ *(BMR)*			✓ *(ToG - RR)*

Notes:
SA - South Anna River ***NA - North Anna River*** ***JR - James River*** ***RR - Rapidan River***
LA - Lake Anna ***BMR - Bowler's Mill Reservoir***
SH - Shannon Hill Growth Area ***ZC - Zion Crossroads Growth Area***
GS - Gum Springs Growth Area ***F - Ferncliff Growth Area***
G - Gordonsville Growth Area ***ToG - Town of Gordonsville***
NCR – Northeast Creek Reservoir Service Area

APPENDIX A

VDEQ WATER SYSTEM TEMPLATES

LOCAL AND REGIONAL WATER SUPPLY PLANNING

Existing Water Source and Water Use Data Entry Template

LOCAL OR REGIONAL P	LOCAL ☐	REGIONAL ☑
POLITICAL LOCALITY(S):	LOUISA COUNTY, LOUISA COUNTY WATER AUTHORITY, TOWN OF LOUISA, TOWN OF MINERAL	
LOCALITY FIPS CODE(S	109	
PLANNING AREA POPULAT	31,473 (LOUISA COUNTY VEC INTERPOLATION FOR 2007)	
RIVER BASIN(S):	York	
	James	
RIVER SUB-BASIN(S):	Pamunkey (02080106)	
	Mattaponi (02080105)	
CONTACT NAM	HEATHER A. CAMPBELL, P.E.	
TITLE	PROJECT MANAGER	
MAILING ADDRES	4180 INNSLAKE DRIVE	
CITY AND ZIP CODE	GLEN ALLEN, VIRGINIA	
PHONE:	804-205-3351	
FAX:	804-290-7928	
E-MAIL	HCAMPBELL@DEWBERRY.COM	

THE FOLLOWING DATA ENTRY SPREADSHEETS WILL ALLOW YOU TO ENTER INFORMATION REGARDING THE EXISTING WATER SOURCE (9 VAC 25-780-70) AND EXISTING WATER USE (9 VAC 25-780-80) WATER SUPPLY PLANNING CRITERIA.

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNIN

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNING

LIST ALL WELL INFORMATION FOR COMMUNITY WATER SYSTEMS USING GROUNDWATER. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NOTE ACCORDINGLY. IF APPLICABLE, MARK WELL LOCATIO ASSOCIATED MAP.

COMMUNITY WATER SYSTEMS (MUNCIPAL & PRIVATE) USING GROUND WATER (9 VAC 25-780-70 B)

PWSID	WATER SYSTEM NAME	VDH PERMITTED SYSTEM CAPACITY (GPD)	CALCULATED VDH PERMITTED SYSTEM CAPACITY (MGD)	INDIVIDUAL WELL DATA: WELL NAME AND ID #	WELL DEPTH (FEET)	CASING DEPTH (FEET)	SCREEN DEPTH (TOP & BOTTOM) OR WATER ZONES	WELL DIAMETER (INCHES)	WITHDRAWAL DESIGN CAPACITY: AVERAGE DAILY (GPD)	WITHDRAWAL DESIGN CAPACITY: AVERAGE DAILY (MGD)	WITHDRAWAL DESIGN CAPACITY: MAXIMUM DAILY (GPD)	WITHDRAWAL DESIGN CAPACITY: MAXIMUM DAILY (MGD)	GROUNDWATER MANAGEMENT AREA WELLS: DEQ PERMITTED MONTHLY WITHDRAWAL (MGD)	GROUNDWATER MANAGEMENT AREA WELLS: DEQ PERMITTED ANNUAL WITHDRAWAL (MGD)	NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)
2109075	BLUE RIDGE SHORES	308,000.00	0.31	1 (154-013)	163	51	140 - 163	6.5		0.00	79,200.00	0.08			CONTACT: DELTON HANSON
			0.00	1A	405	61	135 - 137 277 - 278	8		0.00		0.00			540-967-1408
			0.00	2	300	50		7		0.00	14,400.00	0.01			
			0.00	3 (154-011)	239	50	115 - 115.5 148 - 149	5		0.00	14,400.00	0.01			WELL 1A DOES NOT HAVE IT'S OWN SOURCE CAPACITY --- IT'S COMBINED
			0.00	5	260	113	100 - 155 470 - 477	8		0.00	360,000.00	0.36			WITH WELL 1.
			0.00	6	850	129	493 - 494 497 - 498	8		0.00	96,480.00	0.10			VDH ENGINEERING DESCRIPTION SHE FOR MAJORITY OF DATA.
			0.00	7	575	104		8		0.00	37,440.00	0.04			
			0.00	8	545	61	130 - 140	8		0.00	266,400.00	0.27			
2109650	SHENANDOAH CROSSING	117,600.00	0.12	1	280	115		6		0.00	123,840.00	0.12			CONTACT: TIM BERNHARDT
			0.00	2	300	80		6		0.00	97,920.00	0.10			540-832-9400
			0.00	3	280	55		6		0.00	36,000.00	0.04			TIM.BERNHARDT@BLUEGREENCORP.COM
			0.00	4	305	55		6		0.00	34,560.00	0.03			VDH ENGINEERING DESCRIPTION SHEET
			0.00	5	455	69		6		0.00	44,640.00	0.04			USED FOR DATA.
			0.00	6	605	50		6		0.00	30,240.00	0.03			
2109675	SIX-O-FIVE VILLAGE (TRAILER PARK)	30,000.00	0.03	1	310	105		6		0.00	43,200.00	0.04			VDH ENGINEERING DESCRIPTION SHEET
			0.00	2	365	113		6		0.00	10,800.00	0.01			USED FOR DATA.
2109800	TREVILIANS SQUARE APARTMENTS		0.00	1	N.I.	N.I.		6		0.00		0.00			CONTACT: DON GRAY, 540-967-0965
			0.00	2 (EMERGENCY)	N.I.	N.I.		6		0.00		0.00			PERMITTED FOR 28 APARTMENT UNITS PER VDH ENGINEERING DESCRIPTION SHEET.
2109825	TWIN OAKS COMMUNITY		0.00	1	N.I.	N.I.		N.I.		0.00		0.00			CONTACT: WOODY KAWATSKI, 540-894-5126 PERMITTED FOR 90 PERSONS PER VDH ENGINEERING DESCRIPTION SHEET.
2109340	LAKE ANNA PLAZA	41,200.00	0.04	1	335	77		6		0.00	11,520.00	0.01			CONTACT: BJ, 540-894-4400
			0.00	2	230	110		6		0.00	86,400.00	0.09			VDH ENGINEERING DESCRIPTION SHE FOR DATA.
2109265	JERDONE ISLAND SUBDIVISION	19,600.00	0.02		200	51		6		0.00	83,520.00	0.08			CONTACT: JAMES LEWIS 540-872-0289 VDH ENGINEERING DESCRIPTION SHE FOR DATA.
2109510	LOUISA COUNTY WATER AUTHORITY INDUSTRIAL PARK WELL	19,200.00	0.02	154-121	550	98		6		0.00	34,560.00	0.03			CONTACT: STEVE KVECH, VDH ODW 540-463-7136 X524 VDH ENGINEERING DESCRIPTION SHE FOR DATA.
2109525	TOWN OF MINERAL	120,000.00	0.12	4 (154-001)	200	98		8		0.00	201,600.00	0.20			CONTACT: SHELLY ORTIZ, SYDNOR HYDRO 804-643-2725 X249
			0.00	5 (154-157)	365	63		6		0.00	17,280.00	0.02			VDH ENGINEERING DESCRIPTION SHE FOR DATA.
2109990	LOUISA COUNTY WATER AUTHORITY	587,520.00	0.59	ZC-1	325	60		8		0.00	53,280.00	0.05			CONTACT: STEVE KVECH, VDH ODW
	ZION CROSSROADS		0.00	ZC-2	225	55		8		0.00	50,400.00	0.05			540-463-7136 X524
			0.00	GS-3	400	120		8		0.00	63,360.00	0.06			VDH ENGINEERING DESCRIPTION SHEET
			0.00	GS-4	500	55		8		0.00	364,320.00	0.36			USED FOR DATA.
			0.00	GS-5	600	60		8		0.00	93,600.00	0.09			
			0.00	SC-3	590	83		8		0.00	499,680.00	0.50			
	WELL DRILLED, BUT NOT DEVELOPED		0.00	SC-1	605	103		8		0.00		0.00			SC-1 WELL YIELD = 82 GPM
	WELL DRILLED, BUT NOT DEVELOPED		0.00	SC-2	605	82		8		0.00		0.00			SC-2 WELL YIELD = 174 GPM
Existing Source Totals - for all CWS's using wells (MGD)			1.24							0.00		2.85	0.00	0.00	

COMMUNITY WATER SYSTEMS: RESERVOIR SOURCES
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNING/

LIST RESERVOIR INFORMATION FOR ALL COMMUNITY WATER SYSTEMS USING SURFACE WATER RESERVOIRS. THIS LIST SHOULD ALSO INCLUDE ANY QUARRIES THAT ARE BEING USED AS MUNICIPAL SURFACE WATER RESERVOIRS. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA APPLICABLE, MARK RESERVOIRS AND INTAKES ON ASSOCIATED MAP.

COMMUNITY WATER SYSTEMS (MUNICIPAL & PRIVATE) USING SURFACE WATER RESERVOIRS (9 VAC 25-780-70 C)

IS YOUR WATER SYSTEM COMPRISED OF INTERCONNECTED RESERVOIRS? ☐ **YES** ☑ **NO**

IF YES, DESIGNATE WHICH RESERVOIRS AND WHICH INTAKES CONSTITUTE A SYSTEM. REPORT THE DRAINAGE AREA AND AMOUNT OF STORAGE AVAILABLE FOR WATER SUPPLY FROM EACH RESERVOIR INDEPENDENTLY. DESIGNED MAXIMUM DAILY WITHDRAWAL AND THE SA ENTIRE SYSTEM OR SUBSETS OF THE SYSTEM.

PWSID #	WATER SYSTEM NAME	RESERVOIR NAME	RESERVOIR WATERSHED **BASIN/ SUB-BASIN**	RESERVOIR WATERSHED **DRAINAGE AREA** (SQUARE MILES)	ON-STREAM STORAGE AVAILABLE FOR WATER SUP (GALLONS)	ON-STREAM STORAGE AVAILABLE FOR WATER SUP (MG)	DESIGN CAPACITY: **AVERAGE DAILY** WITHDRAWAL (GPD)	**AVERAGE DAILY** WITHDRAWAL (MGD)	**MAXIMUM DAILY** WITHDRAWAL (GPD)	**MAXIMUM DAILY** WITHDRAWAL (MGD)	ASSOCIATED **WATER TREATMENT PLANT** (GPD)	ASSOCIATED **WATER TREATMENT PLANT** (MGD)	RESERVOIR **SAFE YIELD** (MGD)	VDH PERMITTED SYSTEM CAPACITY (GPD)	VDH PERMITTED SYSTEM CAPACITY (MGD)	LIMITATIONS ON WITHDRAWAL PERMIT	**NOTES OR COMMENTS** **(THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)**
						0.00		0.00		0.00		0.00			0.00		
2109510	LOUISA COUNTY WATER AUTHORITY	NORTHEAST CREEK	NORTHEAST CREEK WATERSHED	9.73	479,653,303.50	479.65	1,000,000.00	1.00	1,000,000.00	1.00	1,000,000.00	1.00	2,770,000.00	1,000,000.00	1.00	N/A	CONTACT: STEVE KVECH
			PAMUNKEY WATERSHED			0.00		0.00		0.00		0.00			0.00		W VDH ODW
			YORK RIVER BASIN			0.00		0.00		0.00		0.00			0.00		540-463-7136 X525
						0.00		0.00		0.00		0.00			0.00		VDH ENGINEERING DESCRIPTION
						0.00		0.00		0.00		0.00			0.00		SHEET USED FOR DATA.
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
						0.00		0.00		0.00		0.00			0.00		
Existing Source Totals - for all CWS's using surface water reservoirs (MG or MGD)						479.65		1.00		1.00		1.00			1.00		

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LIST INTAKE INFORMATION FOR ALL COMMUNITY WATER SYSTEMS USING STREAM INTAKES. ADDITIONALLY, INCLUDE A QUALITATIVE DESCRIPTION OF EXISTING IN-STREAM BENEFICIAL USES WITHIN THE PLANNING AREA OR OUTSIDE THE PLANNING AREA THAT MAY BE AFFECTED BY POINT OF STREAM WITHDRAWAL. REFERENCE SOURCES AND NOTE ANY ASS... APPLICABLE, NOTE ACCORDINGLY. IF APPLICABLE, MARK INTAKES ON ASSOCIATED MAP.

COMMUNITY WATER SYSTEMS (MUNICIPAL & PRIVATE) USING STREAM INTAKES* (9 VAC 25-780-70 D, - 80 B10)

*** FOR MUNICIPAL OR PRIVATE COMMUNITY WATER SYSTEM(S) USING SPRINGS, LIST APPLICABLE INFORMATION FOR YOUR SPRING SOURCES BELOW.**

PWSID #	WATER SYSTEM NAME	STREAM, RIVER, OR SPRING NAME	BASIN / SUB-BASIN	INTAKE DRAINAGE AREA (SQUARE MILES)	DESIGN CAPACITY: AVERAGE DAILY WITHDRAWAL (GPD)	AVERAGE DAILY WITHDRAWAL (MGD)	MAXIMUM DAILY WITHDRAWAL (GPD)	MAXIMUM DAILY WITHDRAWAL (MGD)	PUMP STATION (GPD)	PUMP STATION (MGD)	WATER TREATMENT PLANT (GPD)	WATER TREATMENT PLANT (MGD)	SAFE YIELD OF STREAM (MGD)	LOWEST DAILY FLOW OF RECORD (CFS)	VDH PERMITTED CAPACITY (GPD)	VDH PERMITTED CAPACITY (MGD)	LIMITATIONS ON WITHDRAWAL PERMIT	EXISTING INSTREAM BENEFICIAL USES: WITHIN PLANNING AREA	OUTSIDE PLANNING AREA	NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)
						0.00		0.00		0.00		0.00				0.00				
N/A						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
						0.00		0.00		0.00		0.00				0.00				
Existing Source Totals - for all CWS's using stream intakes &/or springs (MGD)						0.00		0.00		0.00		0.00				0.00				

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629 EAST MAIN STR
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URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNING/

LIST INFORMATION REGARDING THE AMOUNT OF GROUND OR SURFACE WATER TO BE PURCHASED FROM WATER SUPPLY SYSTEMS OUTSIDE THE GEOGRAPHIC BOUNDARIES OF THE PLANNING AREA (9 VAC 25-780-70G). REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CAL
APPLICABLE, NOTE ACCORDINGLY. IF APPLICABLE, MARK AND LABEL ON ASSOCIATED MAP.

AMOUNT OF GROUND OR SURFACE WATER TO BE PURCHASED FROM WATER SUPPLY SYSTEMS OUTSIDE THE GEOGRAPHIC BOUNDARIES OF THE PLANNING AREA (9 VAC 25-780-70G)

PWSID#, COMMUNITY WATER SYSTEM NAME	SOURCE: GROUND WATER WELL NAME & ID NO.	SURFACE WATER RESERVOIR & SUB-BASIN OR STREAM/RIVER NAME & SUB-BASIN	AMOUNT TO BE PURCHASED: MAXIMUM DAILY (GPD)	MAXIMUM DAILY (MGD)	AVERAGE ANNUAL (GPD)	AVERAGE ANNUAL (MGD)	CONTRACT LIMITATIONS: SUPPLIER(S) NAME(S) (PWSID #)	CONTRACT OR AGREEMENT TERMS	RECIPIENT(S) OR AREA(S) SERVED	CONTRACT LIMITS	OTHER
				0.00		0.00					
6137400, TOWN OF GORDONSVILLE		TOWN PURCHASES SURFACE WATER FROM RAPIDAN SERVICE AUTHORITY		0.00	5,120.00	0.01	6137400, TOWN OF GORDONSVILLE	N/A (INDIVIDUALLY BILLED)	20 LOUISA RESIDENTIAL CONNECTIONS	N/A	TOWN OF GORDONSVILLE TRE TABITHA CARPENTER
		SOURCE: RAPIDAN RIVER		0.00		0.00					CONFIRMED 10 DEFINITE
				0.00		0.00					CONNECTIONS, AND STATED AN
				0.00		0.00					ESTIMATED 20 CONNECTIONS
				0.00		0.00					TOTAL WOULD BE AN OVERLY
				0.00		0.00					CONSERVATIVE ESTIMATE OF THE
				0.00		0.00					LOUISA CONNECTIONS TO THEIR
				0.00		0.00					WATER SYSTEM.
				0.00		0.00					
				0.00		0.00					20 X 2.56 X 100 GPD =
				0.00		0.00					5,120 GPD
				0.00		0.00					
				0.00		0.00	ADDITIONAL INFORMATION FOR TOWN OF GORDONSVILLE:				
				0.00		0.00	6127300, RSA 15 6137500, TOWN OF ORANGE	TOWN PURCHASES WATER FROM RAPIDAN SERVICE AUTHORITY	6137400, TOWN OF GORDONSVILLE	PER 1971 CONTRACT LIMIT IS 800,000 GPD	TOWN OF GORDONSVILLE USES 300,000 TO 600,000 GPD
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
Total Amount of Water To Be Purchased Outside the Planning Area (MGD):				**0.00**		**0.01**					

LIST INFORMATION FOR THE AMOUNT OF GROUND OR SURFACE WATER AVAILABLE TO BE PURCHASED FROM OUTSIDE THE GEOGRAPHIC BOUNDARIES OF THE PLANNING AREA FROM WATER SUPPLY SYSTEMS WITH THE CAPACITY TO DRAW MORE THAN 300,000 GALLONS P
ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NOTE ACCORDINGLY. IF APPLICABLE, MARK AND LABEL ON ASSOCIATED MAP.

AMOUNT OF WATER AVAILABLE TO BE PURCHASED, OUTSIDE THE PLANNING AREA, FROM ANY SOURCE WITH CAPACITY TO WITHDRAW MORE THAN 300,000 GALLONS PER MONTH OF SURFACE OR GROUND WATER
(9 VAC 25-780-70H)

PWSID#, COMMUNITY WATER SYSTEM NAME	SOURCE: GROUND WATER WELL NAME & ID NO.	SURFACE WATER RESERVOIR & SUB-BASIN OR STREAM/RIVER NAME & SUB-BASIN	AMOUNT AVAILABLE TO BE PURCHASED: MAXIMUM DAILY (GPD)	MAXIMUM DAILY (MGD)	AVERAGE ANNUAL (GPD)	AVERAGE ANNUAL (MGD)	CONTRACT LIMITATIONS: SUPPLIER(S) NAME(S) (PWSID #)	CONTRACT OR AGREEMENT TERMS	RECIPIENT(S) OR AREA(S) SERVED	CONTRACT LIMITS	OTHER
				0.00		0.00					
N/A				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
				0.00		0.00					
Total Amount of Water Available for Purchase Outside the Planning Area				**0.00**		**0.00**					

OFFICE OF WATER SUPPLY PLANNING
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P.O. BOX 1105, RICHMOND, VA 23218
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NOTE FINDINGS AND RECOMMENDATIONS FROM SOURCE WATER ASSESSMENT PLANS AND/OR WELLHEAD PROTECTION PROGRAMS. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NOTE ACCORDINGLY.

FINDINGS AND RECOMMENDATIONS FROM APPLICABLE SOURCE WATER ASSESSMENT PLANS OR WELLHEAD PROTECTION PROGRAMS

	SOURCE WATER ASSESSMENT PLAN(S):		WELLHEAD PROTECTION PROGRAM(S):	
LOCALITY NAME	DATE OF PLAN	SUMMARY OF FINDINGS AND RECOMMENDATIONS	DATE OF PROGRAM	SUMMARY OF FINDINGS AND RECOMMENDATIONS
	2/15/2006	VDH SOURCE WATER ASSESSMENT PLAN: SWAP'S GOAL IS TO ESTABLISH PROCEDURES AND PROVIDE A FOUNDATION OF SUPPORT FOR PROTECTING THE COMMONWEALTH'S DRINKING WATER RESOURCES FROM DEGRADATION. DEGRADATION CAN BE A RESULT OF RESIDENTIAL, INDUSTRIAL, COMMERCIAL, AGRICULTURAL, WASTE MANAGEMENT, OR TRANSPORTATION'S: ACCIDENTAL INTRODUCTION OF CONTAMINANTS; IMPROPER LAND USE PRACTICES; ILLEGAL MATERIAL HANDLING PRACTICES; AND OTHER CONDITIONS. THE OFFICE OF DRINKING WATER ENCOURAGES PUBLIC WATERWORKS TO PURCHASE LAND AND/OR ESTABLISH CONSERVATION EAS PROTECTION OF VITAL DRINKING WATER RESOURCES. THE SWAP HAS IDENTIFIED FUTURE LAND USE DEVELOPMENT IN SOURCE WATER PROTECTION AREAS AS A PREDOMINANT RISK TO THE VIABILITY OF PUBLIC WATERWORKS.	N/A	N/A
2109075 - BLUERIDGE SHORES		HIGH SUSCEPTIBILITY		
2109650 - SHENANDOAH CROSSING		HIGH SUSCEPTIBILITY		
2109675 - SIX-O-FIVE VILLAGE		HIGH SUSCEPTIBILITY		
2109800 - TREVILIANS SQUARE APTS		HIGH SUSCEPTIBILITY		
2109825 - TWIN OAKS COMMUNITY		HIGH SUSCEPTIBILITY		
2109340 - LAKE ANNA PLAZA		HIGH SUSCEPTIBILITY		
2109265 - JERDONE ISLAND SUBDIVISION		HIGH SUSCEPTIBILITY		
2109510 - LCWA NORTHEAST CREEK RESERVOIR & INDUSTRIAL PARK WELL		HIGH SUSCEPTIBILITY		
2109525 - TOWN OF MINERAL		HIGH SUSCEPTIBILITY		
2109990 - LCWA ZION CROSSROADS		HIGH SUSCEPTIBILITY		
2109300 - KLOCKNER PENTAPLAST, INC.		HIGH SUSCEPTIBILITY		
2109600 - NORTH ANNA POWER PLANT		HIGH SUSCEPTIBILITY		
2109145 - CROSSING POINTE		HIGH SUSCEPTIBILITY		
2109130 - CHRISTOPHER RUN CAMPGROUND		HIGH SUSCEPTIBILITY		
2109150 - EXPRESSIONS I LEARNING CENTER		HIGH SUSCEPTIBILITY		
2109260 - JOUETT ELEMENTARY SCHOOL		HIGH SUSCEPTIBILITY		
2109090 - LAKE ANNA RESCUE		HIGH SUSCEPTIBILITY		
2109640 - PROSPECT HILL		HIGH SUSCEPTIBILITY		
9109925 - SMALL COUNTRY CAMPGROUND		HIGH SUSCEPTIBILITY		
2109725 - TAVERN ON THE RAIL		HIGH SUSCEPTIBILITY		
2109025 - TREVILIANS ELEMENTARY SCHOOL		HIGH SUSCEPTIBILITY		
2109100 - ZION CROSSROADS BURGER KING		HIGH SUSCEPTIBILITY		

COMMUNITY WATER SYSTEMS: WITHDRAWAL INFORMATION
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQVIRGINIA.GOV/WATERSUP

INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NOTE ASSOCIATED MAP. **NOTE THE DATA REFERENCE YEAR IN ROW 3 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: ***water withdrawal information*** **(9 VAC 25-780-80 B1-B3)**

YEAR: MAR 2006 - FEB 2007

PWSID	WATER SYSTEM NAME	SOURCE NAME	POPULATION SERVED	NUMBER OF CONNECTIONS	WITHDRAWAL: AVERAGE DAILY (MGD)	WITHDRAWAL: MAXIMUM DAILY (MGD)	NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)
Municipal Systems							
Municipal Community Water System Totals:			0	0	0.00		
Private Systems							
							SOURCES/ASSUMPTIONS:
2108075	BLUERIDGE SHORES		1,472	575	0.054749	0.096707	# OF ADDRESSES WITHIN EACH COMMUNITY PROVIDED BY LOUISA COUNTY PLANNER IN JULY 2008.
2109800	TREVILIANS SQUARE APARTMENTS		61	28	0.006100	0.00915	TREVILIANS SQ APTS. POPULATION FROM VDH LISTING OF WATERWORKS AND OWNERS
2109825	TWIN OAKS COMMUNITY		100	15	0.007628	0.011442	TWIN OAKS POPULATION IS FROM THEIR WEBSITE.
2109340	LAKE ANNA PLA		111	43	0.004442	0.006664	ASSUME # OF ADDRESSES = # OF CONN
2109265	JERDONE ISLAND SUBDIVISION		146	57	0.006580	0.009896	POPULATION = # OF CONNECTIONS X 2.56
							AVERAGE DAILY WITHDRAWAL AVAILABLE FROM '
							OPERATION REPORTS.
							DAILY DATA AVAILABLE ONLY FOR BLUERIDGE SHORES.
							MAX DAILY WITHDRAWAL ASSUMED TO BE 1.5 X AVERAGE DAILY
							AS INSTRUCTED ON WORKSHEET 80 B5 "PEAK DAY USE" FOR
							REMAINDER OF SYSTEMS.
Private Community Water System Totals:			1,890	718	0.08		
Municipal and Private Community Water System Totals:			1,890	718	0.08		

COMMUNITY WATER SYSTEMS: WITHDRAWAL INFORMATION
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
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COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: *water withdrawal information* (9 VAC 25-780-80 B1-B3)

YEAR: APR 2007 - MAR 2008					WITHDRAWAL:		
PWSID	WATER SYSTEM NAME	SOURCE NAME	POPULATION SERVED	NUMBER OF CONNECTIONS	AVERAGE DAILY (MGD)	MAXIMUM DAILY (MGD)	NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)
Municipal Systems							
							SOURCES/ASSUMPTIONS:
	NORTHEAST CREEK SERVICE AREA						# OF ACTIVE RESIDENTIAL AND COMMERCIAL CONNECTIONS PROVIDED BY LCWA AND TOWNS IN 2008
2109510	LOUISA COUNTY WATER AUTHORITY NORTHEAST CREEK RESERVOIR AND INDUSTRIAL PARK WELL		221	152	0.307896	0.461844	WHEN POPULATION WAS UNKNOWN, IT WAS CALCULATED BY MULTIPLYING 2.56 X RESIDENTIAL CONNECTIONS.
2109450	TOWN OF LOUISA		1,501	706	0		TOWN OF LOUISA PROVIDED CENSUS POPULATION OF 1501.
2109525	TOWN OF MINERAL		640	338	0.045661	0.06849	TOWN OF MINERAL 2007 CENSUS ESTIMATE = 471; TOWN ALSO STATED THERE ARE 66 RESIDENTIAL CONNECTIONS OUTSIDE LIMITS, SO 66 X 2.56 = ~169. 471 + 169 = 640
							AVERAGE DAILY WITHDRAWAL PROVIDED BY LCWA AND TOWNS.
	ZION CROSSROADS SERVICE AREA						MAX DAILY WITHDRAWAL ASSUMED TO BE 1.5 X AVERAGE DAILY AS INSTRUCTED ON WORKSHEET 80 B5 "PEAK DAY USE" SINCE DAILY
2109990	LOUISA COUNTY WATER AUTHORITY ZION CROSSROADS		454	187	0.099397	0.149095	DATA ISN'T AVAILABLE.
Municipal Community Water System Totals:			**2,816**	**1,383**	**0.45**		
Private Systems							
Private Community Water System Totals:			**0**	**0**	**0.00**		
Municipal and Private Community Water System Totals:			**2,816**	**1,383**	**0.45**		

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INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NO ASSOCIATED MAP. **NOTE THE DATA REFERENCE YEAR IN ROW 3 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: *water withdrawal information* (9 VAC 25-780-80 B1-B3)

YEAR: 2009

PWSID	WATER SYSTEM NAME	SOURCE NAME	POPULATION SERVED	NUMBER OF CONNECTIONS	WITHDRAWAL: AVERAGE DAILY (MGD)	WITHDRAWAL: MAXIMUM DAILY (MGD)	NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS ETC.)
Municipal Systems							
	Municipal Community Water System Totals:		**0**	**0**	**0.00**		
Private Systems							
							SOURCES/ASSUMPTIONS:
2109650	SHENANDOAH CROSSING		495	193	0.081081	0.121622	# OF ADDRESSES WITHIN EACH COMMUNITY PROVIDED BY LOUISA COUNTY PLANNER IN JULY 2008.
2109675	SIX-O-FIVE VILLAGE (TRAILER PARK)		249	97	0.012587	0.018881	
							ASSUME # OF ADDRESSES = # OF CONI
							POPULATION = # OF CONNECTIONS X 2.56
							AVERAGE DAILY WITHDRAWAL AVAILABLE FROM VDH MONTHLY OPERATION REI
							MAX DAILY WITHDRAWAL ASSUMED TO BE 1.5 X AVERAGE DAILY AS INSTRUCTED ON WORKSHEET 80 B5 "PEAK DAY USE" FOR REMAINDER OF SYSTEMS.
	Private Community Water System Totals:		**744**	**290**	**0.09**		
	Municipal and Private Community Water System Totals:		**744**	**290**	**0.09**		

CWS ANNUAL AVERAGE AND AVERAGE MONTHLY WATER USE
LOUISA COUNTY

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INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOTAR
MARK SERVICE AREAS ON ASSOCIATED MAP.

NOTE THE DATA REFERENCE YEAR IN ROW 6 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: ***Annual average and average monthly water use*** **(9 VAC 25-780-80 B4)**

YEAR 2006-2007	PWSID #2108075 BLUERIDGE SHORES SOURCE (GW) - PRIVATE			PWSID #2109800 TREVILIANS SQUARE APARTMENTS SOURCE (GW) - PRIVATE			PWSID #2109825 TWIN OAKS COMMUNITY SOURCE (GW) - PRIVATE			PWSID #2109340 LAKE ANNA PLAZA SOURCE (GW) - PRIVATE			PWSID #2109265 JERDONE ISLAND SOURCE (GW) - PRIVATE			LOCALITY OR REGION TOTAL WATER USE (MG/MO)	LOCALITY OR REGION TOTAL AVERAGE MONTHLY BY MONTH (MGD)
	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)		
JANUARY	1,428,145.00	1.43	0.046	189,100.00	0.19	0.006	216,030.00	0.22	0.007	248,600.00	0.25	0.008	253,900.00	0.25	0.008	2.34	0.08
FEBRUARY	1,248,500.00	1.25	0.045	170,800.00	0.17	0.006	175,250.00	0.18	0.006	181,500.00	0.18	0.006	278,100.00	0.28	0.010	2.05	0.07
MARCH	1,497,891.00	1.50	0.048	189,100.00	0.19	0.006	189,990.00	0.19	0.006	110,200.00	0.11	0.004	221,900.00	0.22	0.007	2.21	0.07
APRIL	1,429,187.00	1.43	0.048	183,000.00	0.18	0.006	215,000.00	0.22	0.007	85,000.00	0.09	0.003	123,700.00	0.12	0.004	2.04	0.07
MAY	2,042,264.00	2.04	0.066	189,100.00	0.19	0.006	260,280.00	0.26	0.008	101,600.00	0.10	0.003	129,900.00	0.13	0.004	2.72	0.09
JUNE	1,950,986.00	1.95	0.065	183,000.00	0.18	0.006	253,660.00	0.25	0.008	199,700.00	0.20	0.007	227,700.00	0.23	0.008	2.82	0.09
JULY	2,006,310.00	2.01	0.065	189,100.00	0.19	0.006	301,810.00	0.30	0.010	191,200.00	0.19	0.006	245,000.00	0.25	0.008	2.93	0.09
AUGUST	2,280,507.00	2.28	0.074	189,100.00	0.19	0.006	282,010.00	0.28	0.009	126,500.00	0.13	0.004	288,100.00	0.29	0.009	3.17	0.10
SEPTEMBER	1,602,423.00	1.60	0.053	183,000.00	0.18	0.006	228,270.00	0.23	0.008	157,400.00	0.16	0.005	128,900.00	0.13	0.004	2.30	0.08
OCTOBER	1,704,401.00	1.70	0.055	189,100.00	0.19	0.006	269,090.00	0.27	0.009	83,500.00	0.08	0.003	123,500.00	0.12	0.004	2.37	0.08
NOVEMBER	1,573,987.00	1.57	0.052	183,000.00	0.18	0.006	195,630.00	0.20	0.007	69,000.00	0.07	0.002	166,700.00	0.17	0.006	2.19	0.07
DECEMBER	1,218,690.00	1.22	0.039	189,100.00	0.19	0.006	197,130.00	0.20	0.006	67,300.00	0.07	0.002	220,700.00	0.22	0.007	1.89	0.06
TOTAL ANNU (MG)		19.98			2.23			2.78			1.62			2.41		29.02	
AVERAG MONTHLY (MG/MO)		1.67			0.19			0.23			0.14			0.20		2.42	
AVERAG DAILY (MGD)		0.055			0.006			0.008			0.004			0.007		0.080	
NOTES OR COMMENTS:	SOURCE: VDH MONTHLY OPERATION REPORTS, **MAR 2006 - FEB 2007**			SOURCE: NO INFORMATION AVAILABLE. POPULATION = 61. ASSUME 100 GPD PER PERSON.			SOURCE: VDH MONTHLY OPERATION REPORTS, **MAR 2006 - FEB 2007**			SOURCE: VDH MONTHLY OPERATION REPORTS, **MAR 2006 - FEB 2007**			SOURCE: VDH MONTHLY OPERATION REPORTS, **MAR 2006 - FEB 2007**				

OFFICE OF WATER SUPPLY PLANNING
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CWS ANNUAL AVERAGE AND AVERAGE MONTHLY WATER USE
LOUISA COUNTY

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NOTE THE DATA REFERENCE YEAR IN ROW 6 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: *General average and average monthly water use* (9 VAC 25-780-80 B4)

YEAR	PWSID #2109510 LCWA NORTHEAST CREEK RESERVOIR			PWSID #2109510 LCWA INDUSTRIAL PARK WELL			PWSID #2109450 TOWN OF LOUISA			PWSID #2109525 TOWN OF MINERAL			PWSID #2109525 TOWN OF MINERAL			PWSID #2109990 LCWA ZION CROSSROADS			LOCALITY OR REGION TOTAL WATER USE (MG/MO)	LOCALITY OR REGION TOTAL AVERAGE MONTHLY BY MONTH (MGD)
	SOURCE (SW) - MUNICIPAL			SOURCE (GW) - MUNICIPAL			SOURCE (SWP) - MUNICIPAL			SOURCE (GW) - MUNICIPAL			SOURCE (SWP) - MUNICIPAL			SOURCE (GW) - MUNICIPAL				
2007-2008	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)		
JANUARY	2,501,300.00	2.50	0.081	0.00	0.00	0.000	6,497,900.00	6.50	0.210	1,111,285.00	1.11	0.036	527,100.00	0.53	0.017	2,165,700.00	2.17	0.070	12.80	0.41
FEBRUARY	2,649,800.00	2.65	0.095	0.00	0.00	0.000	5,840,200.00	5.84	0.209	2,156,845.00	2.16	0.077	350,000.00	0.35	0.013	2,021,300.00	2.02	0.072	13.02	0.46
MARCH	2,808,200.00	2.81	0.091	0.00	0.00	0.000	6,194,300.00	6.19	0.200	971,240.00	0.97	0.031	244,100.00	0.24	0.008	2,186,700.00	2.19	0.071	12.40	0.40
APRIL	3,953,900.00	3.95	0.132	0.00	0.00	0.000	4,573,500.00	4.57	0.152	1,408,410.00	1.41	0.047	172,800.00	0.17	0.006	2,946,000.00	2.95	0.098	13.05	0.44
MAY	3,987,300.00	3.99	0.129	135,420.00	0.14	0.004	5,487,100.00	5.49	0.177	1,317,820.00	1.32	0.043	192,800.00	0.19	0.006	3,233,600.00	3.23	0.104	14.35	0.46
JUNE	4,364,000.00	4.36	0.145	138,790.00	0.14	0.005	6,037,500.00	6.04	0.201	1,360,260.00	1.36	0.045	370,300.00	0.37	0.012	4,091,700.00	4.09	0.136	16.36	0.55
JULY	4,044,100.00	4.04	0.130	20,410.00	0.02	0.001	6,027,900.00	6.03	0.194	1,473,890.00	1.47	0.048	80,500.00	0.08	0.003	4,349,000.00	4.35	0.140	16.00	0.52
AUGUST	3,486,400.00	3.49	0.112	128,330.00	0.13	0.004	6,121,100.00	6.12	0.197	1,489,720.00	1.49	0.048	268,100.00	0.27	0.009	3,793,700.00	3.79	0.122	15.29	0.49
SEPTEMBER	3,417,700.00	3.42	0.114	156,330.00	0.16	0.005	5,617,100.00	5.62	0.187	928,710.00	0.93	0.031	253,700.00	0.25	0.008	3,716,800.00	3.72	0.124	14.09	0.47
OCTOBER	2,912,000.00	2.91	0.094	39,680.00	0.04	0.001	6,226,800.00	6.23	0.201	1,654,850.00	1.65	0.053	123,900.00	0.12	0.004	3,648,100.00	3.65	0.118	14.61	0.47
NOVEMBER	2,666,400.00	2.67	0.089	0.00	0.00	0.000	5,118,300.00	5.12	0.171	1,014,642.00	1.01	0.034	161,700.00	0.16	0.005	2,257,200.00	2.26	0.075	11.22	0.37
DECEMBER	2,831,800.00	2.83	0.091	0.00	0.00	0.000	5,469,200.00	5.47	0.176	1,778,418.00	1.78	0.057	183,100.00	0.18	0.006	1,869,980.00	1.87	0.060	12.13	0.39
TOTAL ANNUAL (MG)		39.62			0.62			69.21			16.67			2.93			36.28		165.33	
AVERAGE MONTHLY (MG/MO)		3.30			0.05			5.77			1.39			0.24			3.02		13.78	
AVERAGE DAILY (MGD)		0.109			0.002			0.190			0.046			0.008			0.099		0.453	
NOTES OR COMMENTS:	SOURCE: WATER PRODUCTION AND SALES SPREADSHEET PROVIDED BY LCWA IN APRIL 2008 FOR **APR 2007 - MAR 2008** ABOVE NUMBERS DO NOT INCLUDE SALES SOLD TO TOWN OF LOUISA AND TOWN OF MINERAL. RAW WATER AMOUNTS UNAVAILABLE FOR JULY-OCT; FINISHED WATER AMOUNTS USED FOR THOSE MONTHS.			SOURCE: WATER PRODUCTION AND SALES SPREADSHEET PROVIDED BY LCWA IN APRIL 2008 FOR **APR 2007 - MAR 2008.**			SOURCE: WATER PRODUCTION AND SALES SPREADSHEET PROVIDED BY LCWA IN APRIL 2008 FOR **APR 2007 - MAR 2008.**			SOURCE: WATER SOURCE AND USAGE SPREADSHEET PROVIDED BY TOWN OF MINERAL IN MAY 2008 FOR **APR 2007 - MAR 2008.**			SOURCE: WATER SOURCE AND USAGE SPREADSHEET PROVIDED BY TOWN OF MINERAL IN MAY 2008 FOR **APR 2007 - MAR 2008.**			SOURCE: WATER PRODUCTION AND SALES SPREADSHEET PROVIDED BY LCWA IN APRIL 2008 FOR **APR 2007 - MAR 2008.** RAW WATER PUMPED AMOUNT UNAVAILABLE FOR DEC; WATER USAGE (BILLING) AMOUNT USED FOR THAT MONTH.				

CWS ANNUAL AVERAGE AND AVERAGE MONTHLY WATER USE
LOUISA COUNTY

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MARK SERVICE AREAS ON ASSOCIATED MAP.

NOTE THE DATA REFERENCE YEAR IN ROW 6 AND A SEPARATE SPREADSHEET FOR EACH DATA YEAR.

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: ***annual average and average monthly water use*** **(9 VAC 25-780-80 B4)**

YEAR 2009	PWSID #2109650 SHENANDOAH CROSSING			PWSID #2109675 SIX-O-FIVE VILLAGE (TRAILER PARK)			PWSID # SYSTEM NAME			PWSID # SYSTEM NAME			PWSID # SYSTEM NAME			LOCALITY OR REGION TOTAL WATER USE (MG/MO)	LOCALITY OR REGION TOTAL AVERAGE MONTHLY BY MONTH (MGD)
	SOURCE (GW) - PRIVATE			SOURCE (GW) - PRIVATE			SOURCE (SW OR GW)			SOURCE (SW OR GW)			SOURCE (SW OR GW)				
	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)	MONTHLY READINGS (GALLONS)	MONTHLY READINGS (MG)	AVERAGE MONTHLY (MGD)		
JANUARY	1,587,665.00	1.59	0.051	437,100.00	0.44	0.014		0.00	0.000		0.00	0.000		0.00	0.000	2.02	0.07
FEBRUARY	1,026,396.00	1.03	0.037	361,200.00	0.36	0.013		0.00	0.000		0.00	0.000		0.00	0.000	1.39	0.05
MARCH	1,835,789.00	1.84	0.059	328,383.00	0.33	0.011		0.00	0.000		0.00	0.000		0.00	0.000	2.16	0.07
APRIL	2,559,060.00	2.56	0.085	332,820.00	0.33	0.011		0.00	0.000		0.00	0.000		0.00	0.000	2.89	0.10
MAY	2,849,272.00	2.85	0.092	405,294.00	0.41	0.013		0.00	0.000		0.00	0.000		0.00	0.000	3.25	0.10
JUNE	2,852,070.00	2.85	0.095	485,040.00	0.49	0.016		0.00	0.000		0.00	0.000		0.00	0.000	3.34	0.11
JULY	2,938,769.00	2.94	0.095	340,194.00	0.34	0.011		0.00	0.000		0.00	0.000		0.00	0.000	3.28	0.11
AUGUST	2,918,247.00	2.92	0.094	421,600.00	0.42	0.014		0.00	0.000		0.00	0.000		0.00	0.000	3.34	0.11
SEPTEMBER	2,522,100.00	2.52	0.084	396,000.00	0.40	0.013		0.00	0.000		0.00	0.000		0.00	0.000	2.92	0.10
OCTOBER	2,747,437.00	2.75	0.089	328,600.00	0.33	0.011		0.00	0.000		0.00	0.000		0.00	0.000	3.08	0.10
NOVEMBER	2,791,320.00	2.79	0.093	372,000.00	0.37	0.012		0.00	0.000		0.00	0.000		0.00	0.000	3.16	0.11
DECEMBER	2,966,607.00	2.97	0.096	386,167.00	0.39	0.012		0.00	0.000		0.00	0.000		0.00	0.000	3.35	0.11
TOTAL ANNUAL (MG)		29.59			4.59			0.00			0.00			0.00		34.19	
AVERAGE MONTHLY (MG/MO)		2.47			0.38			0.00			0.00			0.00		2.85	
AVERAGE DAILY (MGD)		0.081			0.013			0.000			0.000			0.000		0.094	
NOTES OR COMMENTS:	SOURCE: 2006 DATA APPEARS UNDOCUMENTED. REQUESTED WATER PRODUCTION REPORT FROM STEVE KVECH (VDH); ABOVE DATA REPRESENTS **APR 09 - DEC 09, JAN 11 - MAR 11**; MARC LEAKS WERE DISCOVERED IN 2010 AND USAGE HAS SIGNIFICANTLY DROPPED SINCE REPAIR; ACTUAL SUMMER USAGE REMAINS TO BE SEEN.			SOURCE: 2006 DATA WAS OBTAINED FROM ED MORROW (VDEQ) WITH DAILY AVERAGE OF 50,416 GPD, WHICH APPEARS UNREASONABLE BASED ON SYSTEM'S PERMITTED CAPACITY. STEVE KVECH (VDH) CONTACTED. THE ONLY FULL YEAR OF DATA AVAILABLE IS FOR **2009** (SHOWN ABOVE).													

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INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, MARK SERVICE AREAS ON ASSOCIATED MAP. **NOTE THE DATA REFERENCE YEAR IN ROW 6 AND USE A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: *peak day use* (9 VAC 25-780-80 B5)

YEAR 2006-2007	PWSID #2108075 BLUERIDGE SHORES SOURCE (GW) - PRIVATE		PWSID #2109800 TREVILIANS SQUARE APARTMENTS SOURCE (GW) - PRIVATE		PWSID #2109825 TWINOAKS COMMUNITY SOURCE (GW) - PRIVATE		PWSID #2109340 LAKE ANNA PLAZA SOURCE (GW) - PRIVATE		PWSID #2109265 JERDONE ISLAND SOURCE (GW) - PRIVATE	
	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)
JANUARY	48,581.00	0.049	9,150.00	0.009		0.000	6,664.00	0.007		0.000
FEBRUARY	58,670.00	0.059		0.000		0.000		0.000		0.000
MARCH	53,914.00	0.054	9,150.00	0.009		0.000		0.000		0.000
APRIL		0.000		0.000		0.000		0.000		0.000
MAY	95,628.00	0.096	9,150.00	0.009		0.000		0.000		0.000
JUNE	91,104.00	0.091		0.000		0.000		0.000		0.000
JULY	95,631.00	0.096	9,150.00	0.009	11,442.00	0.011		0.000		0.000
AUGUST	96,707.00	0.097	9,150.00	0.009		0.000		0.000	9,896.00	0.010
SEPTEMBER	63,938.00	0.064		0.000		0.000		0.000		0.000
OCTOBER	57,815.00	0.058	9,150.00	0.009		0.000		0.000		0.000
NOVEMBER	63,613.00	0.064		0.000		0.000		0.000		0.000
DECEMBER	50,761.00	0.051	9,150.00	0.009		0.000		0.000		0.000
NOTES OR COMMENTS:	SOURCE: VDH MONTHLY OPERATION REPORTS. 3-DAY READINGS WERE AVERAGED FOR GPD.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.	

WORKSHEET INSTRUCTIONS:

1) ENTER THE DATA YEAR AND YOUR SYSTEM NAME.

2) ENTER SOURCE CODE (GW = GROUND WATER; SW = SURFACE WATER).

3) ENTER PEAK DAY WATER USE FOR EACH MONTH IN GALLONS (GPD). IF YOU ONLY HAVE PEAK DAY DATA FOR YOUR PEAK MONTH (ONE MONTH), ENTER THAT VALUE IN THE APPROPRIATE CEL

4) IF YOU DO NOT HAVE DAILY DATA FOR YOUR SYSTEM, BUT KNOW YOUR PEAK MONTH THEN ESTIMATE YOUR PEAK DAY USE BY USING THE FOLLOWING EQUATION AND ENTER THIS INFORMATION INTO THE APPLICABLE MONTH CELL ABOVE.

PEAK DAY "RAW" WATER USE (GPD) =
AVERAGE DAILY WITHDRAWAL* (MGD) X 10^6 (GAL/MG) X 1.5 PEAKING FACTOR
from worksheet "80 B1-B3 CWS Use"

5) ENTER NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.) IN THE APPRORIATE CELLS.

6) IF YOU NEED ADDITIONAL DATA ENTRY COLUMNS, "UNHIDE" COLUMNS K THROUGH AN.

COMMUNITY WATER SYSTEMS: PEAK DAY USE
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STREET
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNING/

INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE, NOTE ACCORDINGLY. IF APPLICABLE, MARK SERVICE AREAS ON A SEPARATE MAP. **NOTE THE DATA REFERENCE YEAR IN ROW 6 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATERS: *Peak Day Use* (9 VAC 25-780-80 B5)

YEAR 2007-2008	PWSID #2109510 LCWA NORTHEAST CREEK RESERVOIR SOURCE (SW) - MUNICIPAL		PWSID #2109510 LCWA INDUSTRIAL PARK WELL SOURCE (GW) - MUNICIPAL		PWSID #2109450 TOWN OF LOUISA SOURCE (SWP) - MUNICIPAL		PWSID #2109525 TOWN OF MINERAL SOURCE (GW) - MUNICIPAL		PWSID #2109525 TOWN OF MINERAL SOURCE (SWP) - MUNICIPAL		PWSID #2109990 LCWA ZION CROSSROADS SOURCE (GW) - MUNICIPAL	
	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)
JANUARY		0.000		0.000	284,428.00	0.284		0.000	12,033.00	0.012		0.000
FEBRUARY		0.000		0.000		0.000	68,491.00	0.068		0.000		0.000
MARCH		0.000		0.000		0.000		0.000		0.000		0.000
APRIL		0.000		0.000		0.000		0.000		0.000		0.000
MAY		0.000		0.000		0.000		0.000		0.000		0.000
JUNE		0.000		0.000		0.000		0.000		0.000		0.000
JULY	162,834.00	0.163		0.000		0.000		0.000		0.000	149,095.00	0.149
AUGUST		0.000		0.000		0.000		0.000		0.000		0.000
SEPTEMBER		0.000	5,046.00	0.005		0.000		0.000		0.000		0.000
OCTOBER		0.000		0.000		0.000		0.000		0.000		0.000
NOVEMBER		0.000		0.000		0.000		0.000		0.000		0.000
DECEMBER		0.000		0.000		0.000		0.000		0.000		0.000
NOTES OR COMMENTS:	DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.	

WORKSHEET INSTRUCTIONS:

1) ENTER THE DATA YEAR AND YOUR SYSTEM NAME.

2) ENTER SOURCE CODE (GW = GROUND WATER; SW = SURFACE WATER).

3) ENTER PEAK DAY WATER USE FOR EACH MONTH IN GALLONS PER DAY (GPD). IF YOU ONLY HAVE PEAK DAY DATA FOR YOUR PEAK MONTH (ONE MONTH), ENTER THAT VALUE IN THE APPROPRIATE CELL.

4) IF YOU DO NOT HAVE DAILY DATA FOR YOUR SYSTEM, BUT KNOW YOUR PEAK MONTH THEN ESTIMATE YOUR PEAK DAY USE BY USING THE FOLLOWING EQUATION AND ENTER THIS INFORMATION INTO THE APPLICABLE MONTH CELL ABOVE.

PEAK DAY "RAW" WATER USE (GPD) = AVERAGE DAILY WITHDRAWAL* (MGD) X (10^6 GAL/MG) X 1.5 PEAKING FACTOR
from worksheet "80 B1-B3 CWS Use"

5) ENTER NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES, DATA SOURCES, DATA GAPS, ETC.) IN THE APPRORIATE CELLS.

6) IF YOU NEED ADDITIONAL DATA ENTRY COLUMNS, "UNHIDE" COLUMNS K THROUGH AN.

COMMUNITY WATER SYSTEMS: PEAK DAY USE
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STREET
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URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUPPLYPLANNING/

INCLUDE THE FOLLOWING WATER USE INFORMATION FOR EACH COMMUNITY WATER SYSTEM WITHIN THE PLANNING AREA. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPLICABLE NOTE ACCORDINGLY. IF APPLICABLE, MARK SERVICE AREAS ON ASSOCIATED MAP. **NOTE THE DATA REFERENCE YEAR IN ROW 6 AND USE A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

COMMUNITY WATER SYSTEMS USING GROUND AND SURFACE WATER: *peak day use* (9 VAC 25-780-80 B5)

YEAR 2009	PWSID #2109650 SHENANDOAH CROSSING		PWSID #2109675 SIX-O-FIVE VILLAGE (TRAILER PARK)		PWSID # SYSTEM NAME		PWSID # SYSTEM NAME		PWSID # SYSTEM NAME		PWSID # SYSTEM NAME	
	SOURCE (SW) - MUNICIPAL		SOURCE (GW) - MUNICIPAL		SOURCE (GW OR SW)		SOURCE (GW OR SW)		SOURCE (GW OR SW)		SOURCE (GW OR SW)	
	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)	PEAK DAY READINGS (GPD)	PEAK DAY READINGS (MGD)
JANUARY		0.000		0.000		0.000		0.000		0.000		0.000
FEBRUARY		0.000		0.000		0.000		0.000		0.000		0.000
MARCH		0.000		0.000		0.000		0.000		0.000		0.000
APRIL		0.000		0.000		0.000		0.000		0.000		0.000
MAY		0.000		0.000		0.000		0.000		0.000		0.000
JUNE		0.000	18,881.00	0.019		0.000		0.000		0.000		0.000
JULY		0.000		0.000		0.000		0.000		0.000		0.000
AUGUST		0.000		0.000		0.000		0.000		0.000		0.000
SEPTEMBER		0.000		0.000		0.000		0.000		0.000		0.000
OCTOBER		0.000		0.000		0.000		0.000		0.000		0.000
NOVEMBER		0.000		0.000		0.000		0.000		0.000		0.000
DECEMBER	121,622.00	0.122		0.000		0.000		0.000		0.000		0.000
NOTES OR COMMENTS:	DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.		DAILY READINGS UNAVAILABLE. PEAK DAY READING CALCULATED PER INSTRUCTIONS BELOW.									

<u>WORKSHEET INSTRUCTIONS</u>:

1) ENTER THE DATA YEAR AND YOUR SYSTEM NAME.

2) ENTER SOURCE CODE (GW = GROUND WATER; SW = SURFACE WATER).

3) ENTER PEAK DAY WATER USE FOR EACH MONTH IN GALLONS PER DAY (GPD). IF YOU ONLY HAVE PEAK DAY DATA FOR YOUR PEAK MONTH (ONE MONTH), ENTER THAT VALUE IN THE APPROPRIATE CELL.

4) IF YOU DO NOT HAVE DAILY DATA FOR YOUR SYSTEM, BUT KNOW YOUR PEAK MONTH THEN ESTIMATE YOUR PEAK DAY USE BY USING THE FOLLOWING EQUATION AND ENTER THIS INFORMATION INTO THE APPLICABLE MONTH CELL ABOVE.

PEAK DAY "RAW" WATER USE (GPD) =
AVERAGE DAILY WITHDRAWAL* (MGD) X (10^6 GAL/MG) X 1.5 PEAKING FACTOR
from worksheet "80 B1-B3 CWS Use"

5) ENTER NOTES OR COMMENTS (THIS MAY INCLUDE REFERENCES, DATA SOURCES, DATA GAPS, ETC.) IN THE APPRORIATE CELLS.

6) IF YOU NEED ADDITIONAL DATA ENTRY COLUMNS, "UNHIDE" COLUMNS K THROUGH AN.

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URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUP

FOR EACH COMMUNITY WATER SYSTEM INCLUDED IN THE WATER PLAN, INCLUDE AN ESTIMATE OF THE DISAGGREGATED ANNUAL AVERAGE AMOUNT OF WATER USED IN CATEGORIES OF USE APPROPRIATE FOR THE SYSTEM. REFERENCE SOURCES AND NOTE ANY DATA OR DATA GAPS IN THE NOTES/COMMENTS COLUMN AND HIGHLIGHT APPLICABLE CELLS. NOTE THE DATA REFERENCE YEAR OR FOR THE MOST RECENT DATA YEAR.

COMMUNITY WATER SYSTEMS (MUNICIPAL & PRIVATE): DISAGGREGATED ANNUAL AVERAGE WATER USE AMOUNTS (9 VAC 25-780-80 B9)

			USAGE CATEGORIES:														SALES TO OTHER CWS'			NOTES OR COMMENTS
YEAR: 2006-2008																				
PWSID	WATER SYSTEM NAME	SYSTEM TOTAL (MGD)	RESIDENTIAL (GPD)	RESIDENTIAL (MGD)	COMMERCIAL INSTITUTIONAL LIGHT INDUSTRIAL ***CIL*** (GPD)	COMMERCIAL INSTITUTIONAL LIGHT INDUSTRIAL ***CIL*** (MGD)	HEAVY INDUSTRIAL (GPD)	HEAVY INDUSTRIAL (MGD)	MILITARY (GPD)	MILITARY (MGD)	OTHER (GPD)	OTHER (MGD)	PRODUCTION PROCESSES (GPD)	PRODUCTION PROCESSES (MGD)	UNACCOUNTED FOR LOSSES (GPD)	UNACCOUNTED FOR LOSSES (MGD)	AMOUNT SOLD (GPD)	AMOUNT SOLD (MGD)	SYSTEM NAME	**(THIS MAY INCLUDE REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)**
	MUNICIPAL	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109510	LCWA NORTHEAST CREEK RESERVOIR AND LCWA INDUSTRIAL PARK WELL	0.308	11,789.00	0.012	46,646.00	0.047		0.000		0.000		0.000	7,134.00	0.007	44,683.00	0.045	197,644.00	0.198	TOWN OF LOUISA, TOWN OF MINERAL	AMOUNT SOLD TO TOWN OF LOUISA AND TOWN OF MINERAL NEEDS TO BE SUBTRACTED FROM THE SYSTEMS TOTAL, OTHERWISE IT IS COUNTED TWICE.
2109450	TOWN OF LOUISA	0.190	96,654.00	0.097	55,872.00	0.056		0.000		0.000		0.000		0.000	37,163.00	0.037		0.000		"UNACCOUNTED FOR LOSSES" IS THE DIFFERENCE BETWEEN WATER PRODUCED/SOLD VERSUS BILLING.
2109525	TOWN OF MINERAL	0.054	40,295.00	0.040	13,390.00	0.013		0.000		0.000		0.000		0.000		0.000		0.000		"OTHER" REPRESENTS BULK WATER PURCHASES.
2109990	LCWA ZION CROSSROADS	0.100	35,363.00	0.035	48,504.00	0.049		0.000		0.000	3,875.00	0.004		0.000	12,736.00	0.013		0.000		MUNICIPAL WATER AMOUNTS REPRESENT USAGE BASED ON BILLING.
	PRIVATE	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2108075	BLUERIDGE SHORES	0.055	54,749.00	0.055		0.000		0.000		0.000		0.000		0.000		0.000		0.000		PRIVATE WATER AMOUNTS REPRESENT PRODUCTION BASED ON SYSTEM'S MONTHLY OPERATION REPORTS.
2109650	SHENANDOAH CROSSING	0.081	81,081.00	0.081		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109675	SIX-O-FIVE VILLAGE (TRAILER PARK)	0.013	12,587.00	0.013		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109800	TREVILIAN SQUARE APARTMENTS	0.006	6,100.00	0.006		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109825	TWIN OAKS COMMUNITY	0.008	7,628.00	0.008		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109340	LAKE ANNA PLAZA	0.004	4,442.00	0.004		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
2109265	JERDONE ISLAND	0.007	6,598.00	0.007		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000		
Total Use By Category in MGD (for All Community Water Systems)		0.825		0.357		0.164		0.000		0.000		0.004		0.007		0.095		0.198		

NON-AGRICULTURAL, SELF-SUPPLIED USERS OF SURFACE WATER
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUP

LIST NON-AGRICULTURAL SURFACE WATER SOURCE AND USE INFORMATION FOR SELF-SUPPLIED USERS OF MORE THAN 300,000 GALLONS PER MONTH. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT APPL
USERS ON ASSOCIATED MAP. **NOTE THE DATA REFERENCE YEAR IN COLUMN I, ROW 6 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

SELF-SUPPLIED, NON-AGRICULTURAL USERS USING MORE THAN 300,000 GAL/MONTH OF SURFACE WATER (9 VAC 25-780-70 E, - 80 B6, AND - 80 C)

WATER USER NAME	WATERBODY SOURCE NAME	USE CATEGORY	DESIGN CAPACITY: **AVERAGE DAILY** WITHDRAWAL (GPD)	**AVERAGE DAILY** WITHDRAWAL (MGD)	**MAXIMUM DAILY** WITHDRAWALS (GPD)	**MAXIMUM DAILY** WITHDRAWALS (MGD)	LIMITATIONS ON WITHDRAWAL PERMIT(S)	**WATER USE:** ESTIMATED **ANNUAL AVERAGE** (MGD) YEAR 2006-2007	**NOTES OR COMMENTS** **(INCLUDE SERVICE AREA USER FALLS WITHIN AND REFERENCES TO ANY MAPS, DATA SOURCES, DATA GAPS, ETC.)**
WITHIN COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS									
				0.000		0.000			
TANYARD COUNTRY CLUB GOLF COURSE	TANYARD BRANCH	IRR		0.000		0.000		0.027	ANNUAL AVERAGE AMOUNTS FROM VDEQ VWUDS DATABASE,
	RICHARDSON POND	IRR		0.000		0.000		0.037	**MAR06-FEB07**
				0.000		0.000			
				0.000		0.000			NO INFORMATION AVAILABLE FOR
				0.000		0.000			AVERAGE AND MAXIMUM DAILY
				0.000		0.000			WITHDRAWALS
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
SPRING CREEK GOLF COURSE	MAIN IRRIGATION LAKE	IRR		0.000		0.000		0.162	PUMP FLOW METER DATA
	(PUMPED FROM CAMP CREEK TRANSFER LAKE)			0.000		0.000			**MAR 06 - FEB 07**
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
Within Community Water System Service Area Totals (MGD):				0.000		0.000		0.226	
OUTSIDE COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS									
				0.000		0.000			
NORTH ANNA POWER STATION	LAKE ANNA UNIT 1	PN		0.000	1,354,000,000.00	1,354.000		1,044.000	SW WITHDRAWAL RETURNED TO OUTFALL 001
	LAKE ANNA UNIT 2	PN		0.000	1,354,000,000.00	1,354.000		1,055.000	SW WITHDRAWAL RETURNED TO OUTFALL 001
	LAKE ANNA HYDRO DAM	PH		0.000	84,020,000.00	84.020		51.000	SW WITHDRAWAL RELEASED TO RIVER BELOW DAM
				0.000		0.000			CONTACT: JUD WHITE PROVIDED MAX DAILY AMOUNTS.
				0.000		0.000			ANNUAL AVERAGE AMOUNTS FROM VDEQ VWUDS DATABASE,
				0.000		0.000			**MAR06 - FEB07**
				0.000		0.000			
LOUISA COUNTY WATER AUTHORITY	BOWLERS MILL RESERVOIR	OTH		0.000		0.000		0.014	ANNUAL AVERAGE AMOUNTS FROM VDEQ VWUDS DATABASE,
				0.000		0.000			**ALL 2006** DATA, SO AS TO CAPTURE
				0.000		0.000			LARGEST WITHDRAWALS (JAN 06 -
				0.000		0.000			FEB 06)
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
				0.000		0.000			
Outside Community Water System Service Area Totals (MGD):				0.000		2,792.020		2150.014	
Self-Supplied Nonagricultural Users of Surface Water Totals (MGD):				0.000		2,792.020		2150.240	

NON-AGRICULTURAL, SELFSUPPLIED USERS OF GROUND WATER
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQ.VIRGINIA.GOV/WATERSUF

LIST NON-AGRICULTURAL GROUNDWATER SOURCE AND USE INFORMATION FOR ALL SELFSUPPLIED USERS OF MORE THAN 300,000 GALLONS PER MONTH. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DA
ASSOCIATED MA **NOTE THE DATA REFERENCE YEAR IN COLUMN M, ROW 4 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

SELF-SUPPLIED, NON-AGRICULTURAL USERS USING MORE THAN 300,000 GAL/MONTH OF GROUND WATER (9 VAC 25-780-70 F, - 80 B6, AND - 80 C)

WATER USER NAME	USE CATEGORY	DESIGN CAPACITY: **AVERAGE DAILY** WITHDRAWALS (GPD)	**AVERAGE DAILY** WITHDRAWALS (MGD)	**MAXIMUM DAILY** WITHDRAWALS (GPD)	**MAXIMUM DAILY** WITHDRAWALS (MGD)	INDIVIDUAL WELL DATA: WELL NAMES AND ID #	WELL DEPTH (FEET)	CASING DEPTH (FEET)	SCREEN DEPTH (TOP & BOTTOM) **OR** WATER ZONES	WELL DIAMETER (INCHES)	LIMITATIONS ON WITHDRAWAL PERMIT(S)	WATER USE: ESTIMATED **ANNUAL AVERAGE** (MGD) YEAR **2006-2007**	NOTES OR COMMENTS **(INCLUDE SERVICE AREA USER FALLS WITHIN AND REFERENCES TO ANY MAPS, DATA SOURCES, DATA GAPS, ETC.)**
WITHIN COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS													
			0.000		0.000								
CROSSING POINTE	COM		0.000		0.000	1	305	52		6	14800	0.013	WITHIN LCWA ZION CROSSROADS
PERMITTED CAPACITY WAS 25,200 GPD			0.000		0.000	2	305	52		6	10400		SERVICE AREA.
(WELLS TAKEN OFFLINE IN AUGUST 2010)			0.000		0.000								
			0.000		0.000								AVERAGE DAILY FROM VDH
			0.000		0.000								MONTHLY OPERATION REPORTS
			0.000		0.000								FOR TOTAL SYSTEM (WELLS 1&2)
			0.000		0.000								**MAR 06 - FEB 07**
			0.000		0.000								VDH ENGINEERING DESCRIPTION
			0.000		0.000								SHEET USED FOR MAX DAILY.
			0.000		0.000								
			0.000		0.000								***UPDATE*** - THIS USER
			0.000		0.000								CONNECTED TO THE LCWA
			0.000		0.000								ZION CROSSROADS PUBLIC WATER
			0.000		0.000								SYSTEM IN **AUGUST 2010**
Within CWS Service Area Totals (MGD):			0.000		0.000							0.013	
OUTSIDE COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS													
			0.000		0.000								
KLOCKNER PENTAPLAST	COM		0.000	57,600.00	0.058	2(1972)	280	50		8	32000	0.010	CONTACT: KEITH ROBERTS
PERMITTED CAPACITY = 22,288 GPD			0.000	388,800.00	0.389	1-PROCESS (1992)	245	95		8	216000		L.MITCHELL@KPFILMS.COM JIM GIBSON, 540-832-1400 X549
			0.000	288,000.00	0.288	2-PROCESS (1992)	120	114		8	160000		ANNUAL AVERAGE FROM VDH
			0.000	33,120.00	0.033	3	125	90		8	18400		MONTHLY OPERATION R
			0.000		0.000	BARRIER WELL ABANDONED	305	76		8	29600		FOR TOTAL SYSTEM **MAR 06 - FEB 07**
			0.000		0.000								VDH ENGINEERING DESCRIPTION
			0.000		0.000								SHEET USED FOR MAX DAILY.
			0.000		0.000								
NORTH ANNA POWER STATION	PN		0.000	63,360.00	0.063	4(NEW)	305	111		6	35200	0.011	CONTACT: TONY BANKS
PERMITTED CAPACITY = 128,800 GPD			0.000	79,200.00	0.079	6	375	142		6	44000		804-273-2170;
			0.000	89,280.00	0.089	7	730	103		8	49600		TONY.BANKS@DOM.COM
			0.000		0.000	2(EMERG.) ABANDONED	385	103		5	7200		OR JUD WHITE, ENVIRONMENTAL MANAGER
			0.000		0.000	4(OLD) ABANDONED	200	100		6	43200		ANNUAL AVERAGES FROM VDH MONTHLY OPERATION REPORTS
			0.000		0.000								**MAR 06 - FEB 07**
NORTH ANNA INFORMATION CENTER	PN		0.000	89,280.00	0.089	1	260	72		8	59200	0.001	
PERMITTED CAPACITY = 19,600 GPD			0.000		0.000								VDH ENGINEERING DESCRIPTION
			0.000		0.000								SHEET USED FOR MAX DAILY.
			0.000		0.000								
SIEBERT AMOCO AND DAIRY QUEEN	COM		0.000	63,360.00	0.063	1	300	115		6	15000	0.015	CONTACT: RANDY SIEBERT
PERMITTED CAPACITY = 15,000 GPD			0.000		0.000								804-276-3728 X30
			0.000		0.000								ANNUAL AVERAGE BASED ON 1500 CUSTOMERS PER DAY AND ASSUME 10GPD/CUSTOMER
			0.000		0.000								VDH ENGINEERING DESCRIPTION
			0.000		0.000								SHEET USED FOR MAX DAILY
Outside CWS Service Area Totals (MGD):			0.000		1.152							0.037	
Self-Supplied Nonagricultural Users of Ground Water Totals (MGD):			0.000		1.152							0.050	
Self-Supplied Nonagricultural Users Totals (surface and groundwater in MGD):			0.000		2,793.172							2,150.290	

AGRICULTURAL, SELF-SUPPLIED USERS
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX 1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQVIRGINIA.GOV/WATERSUP

LIST DATA FOR ALL AGRICULTURAL USERS WHO UTILIZE MORE THAN 300,000 GALLONS PER MONTH OF GROUND OR SURFACE WATER. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA OR DATA NOT AP
ASSOCIATED MAP **NOTE THE DATA REFERENCE YEAR IN COLUMN F, ROW 4 AND FILL OUT A SEPARATE SPREADSHEET FOR EACH DATA YEAR.**

SELF-SUPPLIED, AGRICULTURAL USERS > 300,000 GAL/MONTH OF GROUND OR SURFACE WATER (9 VAC 25-780-70 I, -80B7, AND -80D)

USER NAME	SOURCE TYPE: GROUND WATER WELL NAME & ID NO.	SOURCE TYPE: SURFACE WATER RESERVOIR & SUB-BASIN OR STREAM/RIVER NAME & SUB-BASIN	USE TYPE: IRRIGATION (PLACE AN "X" IN APPROPRIATE COLUMN CELL)	USE TYPE: NONIRRIGATION	WATER USE: ESTIMATED ANNUAL AVERAGE (MGD) YEAR: 2007 SURFACE WATER (MGD)	WATER USE: ESTIMATED ANNUAL AVERAGE (MGD) YEAR: 2007 GROUND WATER (MGD)	NOTES OR COMMENTS (INCLUDE SERVICE AREA USER FALLS WITHIN AND ANY REFERENCES TO MAPS, DATA SOURCES, DATA GAPS, ETC.)
WITHIN COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS							
Within Community Water System Service Area Water Use Totals (MGD):					**0.000**	**0.000**	
OUTSIDE COMMUNITY WATER SYSTEM (MUNICIPAL & PRIVATE) SERVICE AREAS							
TOTAL COUNTY LIVESTOCK (INVENTORY):							SOURCE:
MILK COWS (442)				X		0.015	2007 CENSUS OF AGRICULTURE USDA,
BEEF COWS (6,847)				X		0.082	NATIONAL AGRICULTURAL STATISTICS SERVICE,
OTHER CATTLE (5,083)				X		0.061	AND FARM AND RANCH IRRIGATION SURVEY
HOGS AND PIGS (364)				X		0.001	
SHEEP (264)				X		0.001	USGS LIVESTOCK WATER USE
GOATS (782)				X		0.002	
HORSES AND PONIES (957)				X		0.011	WATER SOURCE TYPE **UNKNOWN.**
MULES, BURROS, AND DONKEYS (97)				X		0.001	ALL WATER USE IS SHOWN AS GROUND WATER.
TOTAL COUNTY IRRIGATED LAND (ACRES):							
FORAGE - ALL HAY, GRASS SILAGE, & GREENCHOP (25)			X			0.004	
LAND IN ORCHARDS (37)			X			0.023	
HAY - INCLUDING ALFALFA, AND SMALL GRAIN (12)			X			0.003	
VEGETABLES (8)			X			0.003	
REMAINING IRRIGATED LAND (196)			X			0.105	
Outside Community Water System Service Area Water Use Totals (MGD):					**0.000**	**0.313**	
Estimated Total Agricultural Useage By Source (MGD):					**0.000**	**0.313**	

SELF-SUPPLIED, INDIVIDUAL WELL USERS
LOUISA COUNTY

OFFICE OF WATER SUPPLY PLANNING
629 EAST MAIN STR
P.O. BOX1105, RICHMOND, VA 23218
URL: HTTP://WWW.DEQVIRGINIA.GOV/WATERSUP

ESTIMATE WELL USE INFORMATION FOR SMALL, SELF-SUPPLIED USERS ON INDIVIDUAL WELLS. REFERENCE SOURCES AND NOTE ANY ASSUMPTIONS REGARDING CALCULATIONS. IF UNABLE TO FIND DATA, NOTE THE DATA REFERENCE YEAR IN ROW 7, NOTE ACCORDINGLY.

ESTIMATED NUMBER OF RESIDENCES AND BUSINESSES THAT ARE SELF-SUPPLIED BY INDIVIDUAL WELLS WITHDRAWING LESS THAN 300,000 GALLONS PER MONTH (9 VAC 25-780-70J); ESTIMATED WATER USE BY SELF-SUPPLIED USERS ON INDIVIDUAL WELLS (9 VAC 25-780-80 B8 AND -80 E)

	ESTIMATING SMALL SELF-SUPPLIED USERS						ESTIMATING SMALL SELF-SUPPLIED WATER USE								
	STEP 1: ESTIMATE TOTAL POPULATION OF INDIVIDUAL SELF-SUPPLIED WELL USERS			STEP 2: ESTIMATE NUMBER OF RESIDENCES AND BUSINESSES ON INDIVIDUAL WELLS			STEP 3: ESTIMATE TOTAL SELF-SUPPLIED WATER USE OUTSIDE COMMUNITY WATER SYSTEM SERVICE AREA				STEP 4: ESTIMATE TOTAL SELF-SUPPLIED WATER USE INSIDE COMMUNITY WATER SYSTEM SERVICE AREA				
LOCALITY	LOCALITY POPULATION YEAR 2007	TOTAL POPULATION SERVED BY COMMUNITY WATER SYSTEM(S) YEAR 2007	ESTIMATED POPULATION SERVED BY INDIVIDUAL WELLS	LOCALITY SPECIFIC POPULATION PER HOUSEHOLD FACTOR	ESTIMATED NUMBER OF **RESIDENCES** ON WELLS (COLUMN D ÷ COLUMN E)	ESTIMATED NUMBER OF **BUSINESSES** ON WELLS	ESTIMATED POPULATION SERVED BY INDIVIDUAL WELLS	PER CAPITA WATER USE FACTOR (GAL/PERSON/DAY)	AVERAGE ANNUAL RESIDENTIAL USE (GPD) (COLUMN H X COLUMN I)	ESTIMATED AVERAGE ANNUAL USE (MGD)	# OF SELF-SUPPLIED RESIDENCES WITHIN SERVICE AREA	LOCALITY SPECIFIC POPULATION PER HOUSEHOLD FACTOR	PER CAPITA WATER USE FACTOR (GAL/PERSON/DAY)	AVERAGE ANNUAL RESIDENTIAL USE (GPD) (COLUMNS M X N X O)	ESTIMATED ANNUAL AVERAGE USE (MGD)
NORTHEAST CREEK RESERVOIR SERVICE AREA:			0		-		0		0	0.000				0	0.000
TOWN OF LOUISA	2,379	1,501	878	2.56	343		878		0	0.000	343	2.56	65	57,075	0.057
TOWN OF MINERAL	1,698	640	1,058	2.56	413		1,058		0	0.000	413	2.56	65	68,723	0.069
LCWA CUSTOMERS	221	221	0	2.56	-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
ZION CROSSROADS SERVICE AREA	1,593	454	1,139	2.56	445	1	1,139		0	0.000	445	2.56	80	91,136	0.091
			0		-		0		0	0.000				0	0.000
FUTURE SERVICE AREAS:			0		-		0		0	0.000				0	0.000
GUM SPRING	461	0	461	2.56	180	1	461	80	36,880	0.037				0	0.000
FERNCLIFF	602	0	602	2.56	235	1	602	80	48,160	0.048				0	0.000
SHANNON HILL	300	0	300	2.56	117		300	80	24,000	0.024				0	0.000
LAKE ANNA	5,868	0	5,868	2.56	2,292	3	5,868	80	469,440	0.469				0	0.000
BOSWELLS TAVERN	70	0	70	2.56	27		70	80	5,600	0.006				0	0.000
GORDONSVILLE	433	0	433	2.56	169	1	433	80	34,640	0.035				0	0.000
			0		-		0		0	0.000				0	0.000
RURAL AREA	15,214	0	15,214	2.56	5,943	8	15,214	100	1,521,400	1.521				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
			0		-		0		0	0.000				0	0.000
Planning Area Totals:	28,839	2,816	26,023		10,165	15	26,023		2,140,120	2.140	1,201			216,934	0.217

NOTES OR COMMENTS: (THIS MAY INCLUDE REFERENCES TO MAPS,DATA SOURCES, DATA GAPS, ETC.)	ESTIMATED NUMBER OF BUSINESSES = NC AND NTNC WATER SYSTEMS FROM WATERWORKS/OWNERS LIST.

APPENDIX B

DETAILED WATER DEMAND MEMORANDUM

Dewberry
4180 Innslake Drive
Glen Allen, VA 23060
804.290.7957
804.290.7928 (fax)

Memorandum

Date: October 14, 2008

To: Lee Lintecum {Louisa County}
Bar Delk {Louisa County Water Authority}
Brian Marks {Town of Louisa}
Willie Harper {Town of Mineral}
Andrea Putscher {VDEQ}

From: Skip Notte, P.E. and Heather Campbell, P.E. {Dewberry}

RE: Louisa County Long Range Water Resource Plan
Determination of Population Projection and Water Demand

==

This memo outlines the methodology utilized to establish the population projection and water demands for the Louisa County Long Range Water Resource Plan from 2007 to 2050.

Population Projection

Overall County Population

Several sources were consulted to determine the current population in Louisa County and develop projections for the increase in population through 2050. These sources included the Virginia Employment Commission (VEC), Weldon Cooper Center, the Louisa County Comprehensive Plan (dated September 5, 2006), and a Countywide Build Out Analysis performed by Louisa County in July of 2007. Weldon Cooper Center and the Countywide Build Out Analysis provided 2007 populations (Weldon Cooper Center – 31,177 and Countywide Build Out – 31,268), but did not provide specific year predictions for population past 2007. Therefore, only the VEC data and the data obtained from the Louisa County Comprehensive Plan could be analyzed in detail. **Table 1** is a side-by-side comparison of these two (2) sources.

Table 1: Population Projection by Source

LOUISA COUNTY COMPREHENSIVE PLAN		VEC COMMUNITY PROFILE	
YEAR	POPULATION	YEAR	POPULATION
1990	20,325	1990	20,506
2000	25,407	2000	25,757
2010	30,003	2010	33,923
2020	34,599	2020	41,889
2030	39,195	2030	50,739
2040	43,791	2040 *	57,542
2050	48,387	2050 *	65,202
		* EXTRAPOLATE W/ LINEAR TRENDLINE	
INTERPOLATE		INTERPOLATE	
2007	28,624	2007	31,473

It is not completely understood why there is a discrepancy between the Louisa County Comprehensive Plan and the current VEC community profile since the Comprehensive Plan cites VEC as its source. Louisa County has stated that the VEC data which was included in the Comprehensive Plan was from either 1999 or 2000. Therefore, the data would not have accounted for the population boom around 2005. The County believes the current VEC profile has updated their numbers and adjusted the projection accordingly. In addition, the data from the current VEC profile, Weldon Cooper Center, and the Build Out Analysis appear to compare quite well for the year 2007.

Based on the above comparison, Dewberry's recommendation is to use the larger population numbers from the current VEC community profile; first, it is a more conservative estimate, so water resources will be allocated for a greater population in the Long Range Water Resources Plan, and second, since the Louisa County Build Out Analysis provides for a population estimate of 283,504 at complete county build-out with rezoning, the current VEC population projection (higher projection) will provide for a better planning tool, even though it is still only 23% of the potential maximum population in 2050.

As another cross-reference, the Virginia Department of Environmental Quality (VDEQ) suggested comparing the above population data to the population projections included in the permit application for the James River withdrawal by Fluvanna County and Louisa County. The consulting firm that completed the water study for the permit utilized population projections from VEC, May 2003. These numbers are slightly different from the current VEC data, but similar to the VEC numbers in the Louisa County Comprehensive Plan. Again, since these numbers do not appear to account for the population boom in 2005, Dewberry still recommends using the most recent VEC population data in an effort to provide the most accurate analysis possible.

Growth Rates By Area

After development of the overall County population projections, the second element for consideration is whether or not population growth would increase by a greater percentage in some areas vs. others for the analysis period. As part of the 2006 comprehensive plan, Louisa County identified nine specific areas (Town of Louisa, Town of Mineral, Zion Crossroads, Gum Spring, Ferncliff, Shannon Hill, Boswell's Tavern, Lake Anna, and Gordonsville) in the County for guiding growth and development. The county's intention for these growth areas was to have higher densities, more public services, and more fully developed infrastructure than the rest of the county.

In addition, the County also has individual communities (Blue Ridge Shores, Shenandoah Crossing, Six-o-Five Trailer Park, Trevilians Square Apartments, Twin Oaks, Lake Anna Plaza, and Jerdone Island) that provide private connections to central services. For the purposes of this analysis, these communities have been included with the growth areas for the entire County, however, they have been restricted to the amount of growth potential based on current subdivision of the community and/or current plans submitted for review by the County for future development within the respective community.

In 2007, the growth patterns were examined as part of the Countywide Build Out Analysis based on the issuance of Certificates of Occupancy (CO) from 2001 to 2007. While this analysis did show a higher density of COs issued in growth areas, overall numbers showed that the growth in rural areas and the growth in designated growth areas was equal. Basically, 50% of COs issued were for rural areas and 50% of COs issued were for growth areas. Dewberry consulted with the County Administrator, the two Town Managers, and the General Manager of the Louisa County Water

Authority (LCWA) to determine if this trend should be continued for the purposes of the Long Range Water Resources Plan. Per this consultation it is believed that this trend will not continue due to recent changes in zoning regulations, and in coming years more people will settle in the growth areas rather than the rural areas. Louisa County has just completed modifications to the zoning ordinances which have reduced by-right rural densities by more than 50%. This reduction was driven by the desire to maintain the rural character of the county. ***Based on suggestions made by the County and Town officials, Dewberry recommends a uniform percentage increase to population in growth areas and rural areas for 2010, and a higher percentage increase in growth areas for subsequent time steps***, as shown in **Table 2**.

Table 2: Incremental Population Increase and Distribution

VEC DATA			POPULATION DISTRIBUTION		
YEAR	TOTAL POPULATION	INCREMENTAL POPULATION INCREASE	RATIO (RURAL/GROWTH)	RURAL AREA	EXISTING COMMUNITIES AND GROWTH AREAS
2007	31,473	--		--	--
2010	33,923	2,450	50/50	1,225	1,225
2020	41,889	7,966	35/65	2,788	5,178
2030	50,739	8,850	25/75	2,212	6,638
2040	57,542	6,803	25/75	1,701	5,102
2050	65,202	7,660	25/75	1,915	5,745

Additional data was also collected from the County on the existing private communities and proposed nine growth areas, such as the current number of addresses, the available number of addresses, and the number of COs issued from 2001 to 2007. This information is shown in **Table 3**.

Table 3: Population Data

EXISTING COMMUNITIES AND EXISTING GROWTH AREAS (GA)	COUNTY INFO: CURRENT ADDRESSES	COUNTY INFO: CURRENT POPULATION	COUNTYWIDE BUILD-OUT ANALYSIS INFO (PH 3): AVAILABLE ADDRESSES (COS)	COUNTYWIDE BUILD-OUT ANALYSIS INFO (PH 3): POPULATION INCREASE	HISTORICAL DEVELOPMENT: COS ISSUED (1/01-6/07)	HISTORICAL DEVELOPMENT: COS/YR
BLUE RIDGE SHORES	575	1,472	633 ***	1621	77	12
SHENANDOAH CROSSING	193	495	276 ***	707	25	4
SIX-O-FIVE TRAILER PARK	97	249	11 ***	29	98	16
TREVILIANS SQ. APT.S	7 BLDGS	61 **	0 ***	0	0	0
TWIN OAKS	15	100 **	0 ***	0	0	0
LAKE ANNA PLAZA (LAKE ANNA)	43	111	12 ***	31	12	2
JERDONE ISLAND (LAKE ANNA)	57	146	67 ***	172	22	4
TOWN OF LOUISA (GA)	935 *	2,490 *	267	684	151	24
TOWN OF MINERAL (GA)	828 *	1,808 *	318	815	84	13
ZION CROSSROADS (GA)	622	1,593	578 ***	1480	268	42

PROPOSED GROWTH AREAS	CURRENT ADDRESSES	CURRENT POPULATION	AVAILABLE ADDRESSES (COS)	POPULATION INCREASE	PROPOSED DEVELOPMENT
LAKE ANNA (REMAINING AREA)	2292	5,868	2333	5973	DISTRIBUTION OF PROJECTED POPULATION WILL BE BASED ON THE PERCENTAGE OF ADDRESSES IN THAT GROWTH AREA TO THE TOTAL NUMBER OF GROWTH AREA ADDRESSES
GUM SPRING	180	461	122	313	
FERNCLIFF	235	602	165	423	
SHANNON HILL	117	300	70	180	
BOSWELL'S TAVERN	27	70	32	82	
GORDONSVILLE	169	433	104	267	

Notes:

1. ***Phase 3 from Countywide Build-Out Analysis assumes build-out of all existing lots - one unit/lot***
2. ***Current Population column assumes 2.56 people per address unless otherwise noted***
3. ***Certificate of Occupancy (CO) is equivalent to one address***
4. ****** combination of Build-Out Analysis data and Town data; household connections and population within Town limits provided by Towns***
5. ***** current population from internet; not calculated***
6. ****** County provided data for communities not included in the Countywide Build-Out Analysis and updated data for Zion Crossroads***

Based on this information, the percentage of the incremental population increase designated to existing communities and growth areas at each time step (Table 2) can then be further distributed among each existing community and each proposed growth area. For the existing communities, the population is distributed per the historical COs/yr until the available addresses have been exhausted. When all available addresses are occupied, then population growth stops in the existing community. For the growth areas, it is assumed that even once the available addresses have been exhausted, rezoning will occur to allow for more development and growth in each growth area. At that point, the population is distributed based on the percentage of addresses in each growth area compared to the total number of addresses in all growth areas. **Table 4** shows the population distribution to each existing community, each growth area, and rural area.

Table 4: Population Projection

SERVICE AREA		2007 POPULATION		2010 POPULATION			2020 POPULATION			2030 POPULATION			2040 POPULATION			2050 POPULATION		
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATER SY		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
BLUE RIDGE SHORES		--	1,472	--	36	1,564	--	120	1,871	--	120	2,178	--	120	2,485	--	120	2,792
SHENANDOAH CROSSING		--	495	--	12	526	--	40	628	--	40	730	--	40	832	--	40	935
SIX-O-FIVE TRAILER PARK		--	249	--	11	278	--	0	278	--	0	278	--	0	278	--	0	278
TREVILIANS SQUARE APARTMENTS		--	61	--	0	61	--	0	61	--	0	61	--	0	61	--	0	61
TWIN OAKS		--	100	--	0	100	--	0	100	--	0	100	--	0	100	--	0	100
LAKE ANNA	LAKE ANNA PLAZA	--	111	--	6	126	--	6	142	--	0	142	--	0	142	--	0	142
	JERDONE ISLAND	--	146	--	12	177	--	40	280	--	15	318	--	0	318	--	0	318
	LCWA (GA)	--	221	--	--	221	--	--	221	--	--	221	--	--	221	--	--	221
NORTHEAST CREEK RESERVOIR	TOWN OF LOUISA (GA)	878	1,501	878	72	1,685	790	303	2,549	711	451	3,783	639	326	4,690	575	371	5,704
	TOWN OF MINERAL (GA)	1,058	640	1,058	39	740	952	130	1,179	856	130	1,608	770	179	2,152	693	203	2,749
ZION CROSSROADS (GA)		1,139	454	1,139	126	777	1,025	420	1,966	922	404	3,103	829	292	3,944	746	332	4,876
SUB-TOTAL POPULATION (NOT CONNECTED) =		3,075	--	3,075	--	--	2,767	--	--	2,489	--	--	2,238	--	--	2,014	--	--
SUB-TOTAL POPULATION (CONNECTED) =		--	5,450	--	--	6,255	--	--	9,275	--	--	12,522	--	--	15,223	--	--	18,176
PROPOSED GROWTH AREA WATER SYSTEMS		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
GUM SPRING		461	--	461	10	26	414	58	221	372	86	483	334	62	680	300	71	896
FERNCLIFF		602	--	602	14	36	541	75	289	486	112	631	437	81	887	393	92	1,166
SHANNON HILL		300	--	300	7	18	270	38	145	243	56	315	218	40	442	196	46	582
LAKE ANNA	REMAINING AREA	5,868	--	5,868	133	340	5,281	734	2,806	4,752	1091	6,128	4,276	789	8,624	3,848	897	11,348
BOSWELL'S TAVERN		70	--	70	0	--	63	8	27	56	12	65	50	9	94	45	10	125
GORDONSVILLE		433	--	433	0	--	389	51	174	350	76	408	315	55	584	283	62	775
SUB-TOTAL POPULATION (NOT CONNECTED) =		7,734	--	7,734	--	--	6,958	--	--	6,259	--	--	5,630	--	--	5,065	--	--
SUB-TOTAL POPULATION (CONNECTED) =		--	0	--	--	420	--	--	3,662	--	--	8,030	--	--	11,311	--	--	14,892
RURAL AREA (INDIVIDUAL WELLS)		NOT CONNECTED	CONNECTED	NOT CONNECTED	COS ISSUED (2007-2010)	CONNECTED	NOT CONNECTED	COS ISSUED (2010-2020)	CONNECTED	NOT CONNECTED	COS ISSUED (2020-2030)	CONNECTED	NOT CONNECTED	COS ISSUED (2030-2040)	CONNECTED	NOT CONNECTED	COS ISSUED (2040-2050)	CONNECTED
SUB-TOTAL POPULATION (NOT CONNECTED) =		15,214	--	16,439	--	--	19,227	--	--	21,439	--	--	23,140	--	--	25,055	--	--
TOTAL POPULATION =		**31,473**		**33,923**			**41,889**			**50,739**			**57,542**			**65,202**		

	1225 POP =		478 COS	5178 POP =		2023 COS	6638 POP =		2593 COS	5102 POP =		1993 COS	5745 POP =		2244 COS
	COS LEFT =		164 COS	COS LEFT =		1267 COS	COS LEFT =		2288 COS	COS LEFT =		1833 COS	COS LEFT =		2084 COS
GROWTH AREA (GA)	GA	%	COS	GA	%	COS	GA	%	COS	GA	%	COS	GA	%	COS
TOL - TOWN OF LOUISA	TOL	--	***72***	TOL	23.9%	303.0	TOL	19.7%	450.7	TOL	17.8%	326.0	TOL	17.8%	370.6
TOM - TOWN OF MINERAL	TOM	--	***39***	TOM	--	***130***	TOM	--	***130***	TOM	9.7%	178.7	TOM	9.8%	203.2
Z - ZION CROSSROADS	Z	--	***126***	Z	--	***420***	Z	17.6%	403.7	Z	15.9%	291.9	Z	15.9%	332.0
LA - REMAINING LAKE ANNA	LA	430.5%	706.1	LA	57.9%	733.9	LA	47.7%	1091.6	LA	43.1%	789.1	LA	43.1%	897.2
GS - GUM SPRING	GS	33.8%	55.5	GS	4.5%	57.6	GS	3.7%	85.7	GS	3.4%	62.0	GS	3.4%	70.5
F - FERNCLIFF	F	44.2%	72.4	F	6.0%	75.4	F	4.9%	112.0	F	4.4%	81.0	F	4.4%	92.1
SH - SHANNON HILL	SH	22.0%	36.1	SH	3.0%	37.6	SH	2.4%	56.0	SH	2.2%	40.5	SH	2.2%	45.9
BT - BOSWELL'S TAVERN	BT	--	***0***	BT	0.7%	8.3	BT	0.5%	12.1	BT	0.5%	8.8	BT	0.5%	10.0
G - GORDONSVILLE	G	--	***0***	G	4.0%	51.2	G	3.3%	76.0	G	3.0%	55.0	G	3.0%	62.5

- ONCE ALL AVAILABLE ADDRESSES HAVE BEEN OCCUPIED IN THE EXISTING SYSTEMS, POPULATION IS DISTRIBUTED TO GROWTH AREAS BASED ON PERCENTAGE OF TOTAL GROWTH AREA ADDRESSES

Water Demand

As stated previously, Louisa County is comprised of existing communities, nine growth areas, and rural areas. Dwellings in existing communities and growth areas are generally connected to public water systems, whereas dwellings in rural areas generally have individual wells.

Since individual wells are typically not metered, the conservative estimate for water usage in rural areas is recommended to be the daily consumption rate of 100 gallons per day (gpd) per person which is specified by the Virginia Department of Health (VDH) Waterworks Regulations.

In an effort to calculate a more accurate water consumption rate per person for the existing communities and the nine growth areas, Dewberry utilized water usage history from the Towns, LCWA, and the VDEQ templates for the Long Range Water Resource Plan. The templates were created from data and reports from VDH and VDEQ.

The data received from the Towns and LCWA represents water usage from April 2007 to March 2008 for the Northeast Creek Reservoir service area (Town of Louisa, Town of Mineral, and LCWA customers), and for the Zion Crossroads service area (LCWA customers), and was categorized as residential or commercial. See **Table 5**.

Table 5: Water Usage for the Towns and LCWA

	NORTHEAST CREEK RESERVOIR SERVICE AREA			ZION CROSSROADS SERVICE AREA
	LCWA	TOWN OF LOUISA	TOWN OF MINERAL	LCWA
RESIDENTIAL WATER USAGE (GAL/YEAR)	4,303,090	35,278,599	14,707,760	12,907,615
RESIDENTIAL WATER USAGE (GPD)	11,789	96,654	40,295	35,363
ACTIVE RESIDENTIAL HOUSEHOLDS	86	--	--	177
PERSONS PER HOUSEHOLD, 2000 U.S. CENSUS	2.56	--	--	2.56
POPULATION	221	1501 *	640 **	454
RESIDENTIAL WATER CONSUMPTION (GPD/PERSON)	53	64	63	78
COMMERCIAL WATER USAGE (GAL/YEAR)	17,025,610	20,393,300	4,887,430	17,703,940
BULK SALES (GAL/YEAR)	1,050	N/A	N/A	1,414,275
TOTAL WATER USAGE (GAL/YEAR)	21,329,750	55,671,899	19,595,190	32,025,830
RESIDENTIAL WATER USAGE (%)	20.2%	63.4%	75.1%	40.3%
COMMERCIAL WATER USAGE (%)	79.8%	36.6%	24.9%	55.3%

Notes:

1. *Water usage/consumption based on water meter reports from the Towns and LCWA for period of April 2007 to March 2008.*
2. ** Town of Louisa populations provided, not calculated.*
3. *** Town of Mineral population provided w/in Town limits; calculated for customers outside Town limits.*
4. *Based on water production reports versus water meter reports, total water usage equals ~85% of water produced, so 15% of water produced is considered lost/unaccounted.*

The data received from the Towns and LCWA also identified a difference between the water produced and the water sold. This difference was approximately 15%, and is considered lost or unaccountable water. Therefore, the plan will look to provide future resources that take this into consideration, while also identifying reduction in lost or unaccountable water as a potential water conservation approach. ***Dewberry recommends that the methodology includes a reduction of 1% in lost or unaccountable water for each time step as a goal for conservation.***

While the Towns and Zion Crossroads are each considered growth areas by the Louisa County Comprehensive Plan, there is an obvious distinction in the water usage for these areas. The Towns are older, more established areas in comparison to the newer, booming growth in the Zion Crossroads area. A large percentage, if not all, of the newer homes in Zion Crossroads also have irrigation systems. ***Based on this information, Dewberry recommends using a water consumption rate to the nearest 5 GPD/person for the LCWA customers within the Northeast Creek Reservoir service area (55 GPD/person), the Town of Louisa (65 GPD/person), and the Town of Mineral (65 GPD/person), and 80 GPD/person for the growth areas (Zion Crossroads, Gum Spring, Ferncliff, Shannon Hill, Boswell's Tavern, Lake Anna, and Gordonsville).***

Commercial water usage requires a slightly different projection than residential water usage because it's not possible to calculate commercial water consumption per person. Table 5 shows the percentage of commercial water usage compared to residential water usage. ***Dewberry recommends maintaining the percentage of commercial water usage for the water demand projections. This means the population projections will be used to obtain the number of residents, the baseline residential water consumption per person will be used to calculate residential water usage, and then the commercial water usage can be calculated based on the residential and commercial percentages shown in Table 5.***

Zion Crossroads will again be representative of the growth areas (not the Towns). However, Dewberry does not believe the percentage breakdown of residential versus commercial water usage in Zion Crossroads applies to all growth areas. A Wal-mart Distribution Center is currently located in Zion Crossroads. It is believed that the amount of water being used by this facility is skewing the commercial percentage since residential development has only begun over the last five plus years. **Table 6** shows the percentage breakdown when the Wal-mart Distribution Center water usage is removed:

Table 6: Residential and Commercial Water Usage in Growth Areas

	ZION CROSSROADS SERVICE AREA
RESIDENTIAL WATER USAGE (%)	58.6%
COMMERCIAL WATER USAGE (%)	34.9%
BULK SALES (%)	6.4%

The residential usage changes to 60% rather than the 40% shown in Table 5. The County Administrator, the two Town Managers, and the General Manager of LCWA believe that the current 60% commercial usage in Zion Crossroads would be representative for growth areas located along Interstate 64 (Zion Crossroads, Gum Spring, Ferncliff, Shannon Hill), but that the remaining growth areas (Lake Anna, Boswell's Tavern, Gordonsville) will be closer to 40% commercial usage.

As stated above, water usage reports on record with VDH and VDEQ were used to complete the VDEQ templates for the Louisa County Long Range Water Resources Plan. Since the private communities will contribute to the overall plan, average consumption rates are required to provide anticipated water resource demands for individual time steps. The templates and water usage records were used to calculate the average water consumption rates. **Table 7** shows this information.

Table 7: Water Usage for Existing Communities

	BLUE RIDGE SHORES	SHENANDOAH CROSSING	SIX-O-FIVE TRAILER PARK	TREVILIANS SQUARE APTS	TWIN OAKS	LAKE ANNA SERVICE AREA	
						LAKE ANNA PLAZA	JERDONE ISLAND
RESIDENTIAL WATER CONSUMPTION (GPD/PERSON)	35	113	251	100	85	41	133

Notes:
1. ***Water consumption based on VDEQ templates, which utilized VDH and VDEQ water reports.***
2. ***Community water systems do not have commercial water usage.***
3. ***Assume water consumption is 85% of water produced.***

As recommended previously with the Towns and LCWA customers, Dewberry also recommends using a water consumption rate to the nearest 5 GPD/person for the existing communities.

In addition to the rural areas, nine growth areas, and the private existing communities, there are four "Self-Supplied Users" that use greater than 300,000 gallons/month of groundwater for non-agricultural uses that are not located in existing growth areas. These large water consumers will need to be identified in the plan and incorporated into each individual time step to help provide a complete demand for the County. ***Since it is uncertain at this time if any of these large consumers will expand in any of the time steps identified in this plan, Dewberry recommends their consumptions to remain constant for each step.*** **Table 8** shows this information.

Table 8: Water Usage for Self-supplied Users > 300,000 GPD/month

	KLOCKNER PENTAPLAST	NORTH ANNA POWER PLANT	SIEBERT AMOCO AND DAIRY QUEEN	CROSSING POINTE
COMMERCIAL WATER USAGE (GPD)	10,150	11,710	15,000	12,760

Notes:
1. ***Water consumption based on VDEQ templates, which utilized VDH and VDEQ water reports.***
2. ***Assume water consumption is 85% of water produced.***

Phasing of New Service Areas

After development of the population projections and the water demand projections, the final portion of the methodology includes loading each of the time steps to generate overall Countywide demands. To complete this final portion, consideration must be given to the "phasing in" of new service areas. As stated above, the County has nine growth areas. Only three (Town of Louisa, Town of Mineral, and Zion Crossroads) of the nine growth areas, currently have public utilities provided by the County. While Lake Anna can be considered "in phase", the existence of County provided public utilities has not been significantly developed to provide a reliable source to a variety of customers. Therefore, for purposes of this methodology, Lake Anna will be considered a proposed growth area. Based on this approach and an initial investigation of speculation projects or projects under review by County officials, ***Dewberry recommends that four (Lake Anna, Gum Spring, Ferncliff, and Shannon Hill)***

of the remaining six growth areas become "in phase" in the 2010 time step. This will leave the final two growth areas (Boswell's Tavern and Gordonsville), which are recommended to come "in-phase" in the 2020 time step.

<u>Conclusion</u>

The attached tables illustrate the recommended final population and water demand projections separated by existing communities, growth areas (existing and proposed), self-supplied users more than 300,000 gal/mo, and rural areas for the 2007, 2010, 2020, 2030, 2040, and 2050 time steps.

Table 9 summarizes the total population and total water demand for Louisa County at each time step.

Table 9: Projected Population and Water Demand

YEAR		2007	2010	2020	2030	2040	2050
TOTAL POPULATION		31,473	33,923	41,889	50,739	57,542	65,202
TOTAL WATER DEMAND (MGD)	*Existing Communities*	0.246	0.265	0.305	0.333	0.354	0.376
	Growth Areas	0.424	0.597	1.55	2.70	3.55	4.47
	SSU > 300,000 gal/mo	0.0584	0.0577	0.0570	0.0564	0.0558	0.0551
	Individual Wells	2.81	2.92	3.10	3.23	3.31	3.41
TOTAL COUNTY WATER DEMAND (MGD)		3.54	3.84	5.02	6.32	7.27	8.31

- SSU: Self-Supplied Users

Table 10: 2007 Population and Water Demand Projections

2007								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (85% OF DEMAND) (GPD)	WATER LOST (15% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,472	35	51,520	0	51,520	9,092	60,612
SHENANDOAH CROSSING		495	115	56,925	0	56,925	10,046	66,971
SIX-O-FIVE TRAILER PARK		249	250	62,250	0	62,250	10,985	73,235
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	1,076	7,176
TWIN OAKS		100	85	8,500	0	8,500	1,500	10,000
LAKE ANNA	LAKE ANNA PLAZA	111	40	4,440	0	4,440	784	5,224
	JERDONE ISLAND	146	135	19,710	0	19,710	3,478	23,188
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	10,619	70,792
	TOWN OF LOUISA (GA)	1,501	65	97,565	56,323	153,888	27,157	181,045
	TOWN OF MINERAL (GA)	640	65	41,600	13,793	55,393	9,775	65,168
* ZION CROSSROADS (GA)		454	80	36,320	54,480	90,800	16,024	106,824
SUB-TOTAL =		5,450	--	397,085	172,614	569,699	100,535	670,234
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (85% OF DEMAND) (GPD)	WATER LOST (15% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,791	11,941
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	2,066	13,776
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	2,647	17,647
CROSSING POINTE		--	--	--	12,760	12,760	2,252	15,012
SUB-TOTAL =		--	--	--	49,620	49,620	8,756	58,376
WATERSOURCE: INDIVIDUAL WELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (85% OF DEMAND) (GPD)	WATER LOST (15% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		10,809	80	864,720	0	864,720	152,598	1,017,318
RURAL AREA		15,214	100	1,521,400	0	1,521,400	268,482	1,789,882
SUB-TOTAL =		26,023	--	2,386,120	0	2,386,120	421,080	2,807,200
TOTAL=		31,473	--	2,783,205	222,234	3,005,439	530,372	**3,535,811**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

Table 11: 2010 Population and Water Demand Projections

2010								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (86% OF DEMAND) (GPD)	WATER LOST (14% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,564	35	54,740	0	54,740	8,911	63,651
SHENANDOAH CROSSING		526	115	60,490	0	60,490	9,847	70,337
SIX-O-FIVE TRAILER PARK		278	250	69,500	0	69,500	11,314	80,814
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	993	7,093
TWIN OAKS		100	85	8,500	0	8,500	1,384	9,884
LAKE ANNA	LAKE ANNA PLAZA	126	40	5,040	0	5,040	820	5,860
	JERDONE ISLAND	177	135	23,895	0	23,895	3,890	27,785
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	9,796	69,969
	TOWN OF LOUISA (GA)	1,685	65	109,525	63,227	172,752	28,122	200,875
	TOWN OF MINERAL (GA)	740	65	48,100	15,948	64,048	10,426	74,474
* ZION CROSSROADS (GA)		777	80	62,160	93,240	155,400	25,298	180,698
SUB-TOTAL =		6,255	--	460,205	220,434	680,639	110,802	791,440
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (86% OF DEMAND) (GPD)	WATER LOST (14% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,652	11,802
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	1,906	13,616
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	2,442	17,442
CROSSING POINTE		--	--	--	12,760	12,760	2,077	14,837
SUB-TOTAL =		--	--	--	49,620	49,620	8,078	57,698
PROPOSED GROWTH AREA WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (86% OF DEMAND) (GPD)	WATER LOST (14% OF DEMAND) (GPD)	WATER DEMAND (GPD)
* GUM SPRING		26	80	2,080	3,120	5,200	847	6,047
* FERNCLIFF		36	80	2,880	4,320	7,200	1,172	8,372
* SHANNON HILL		18	80	1,440	2,160	3,600	586	4,186
LAKE ANNA	REMAINING AREA	340	80	27,200	18,133	45,333	7,380	52,713
BOSWELL'S TAVERN (NOT IN PHASE)		--	--	--	--	--	--	--
GORDONSVILLE (NOT IN PHASE)		--	--	--	--	--	--	--
SUB-TOTAL =		420	--	33,600	27,733	61,333	9,984	71,318
WATERSOURCE: INDIVIDUAL WELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (86% OF DEMAND) (GPD)	WATER LOST (14% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		10,809	80	864,720	0	864,720	140,768	1,005,488
RURAL AREA		16,439	100	1,643,900	0	1,643,900	267,612	1,911,512
SUB-TOTAL =		27,248	--	2,508,620	0	2,508,620	408,380	2,917,000
TOTAL=		33,923	--	3,002,425	297,787	3,300,212	537,244	**3,837,456**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 12: 2020 Population and Water Demand Projections

2020								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (87% OF DEMAND) (GPD)	WATER LOST (13% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		1,871	35	65,485	0	65,485	9,785	75,270
SHENANDOAH CROSSING		628	115	72,220	0	72,220	10,791	83,011
SIX-O-FIVE TRAILER PARK		278	250	69,500	0	69,500	10,385	79,885
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	911	7,011
TWIN OAKS		100	85	8,500	0	8,500	1,270	9,770
LAKE ANNA	LAKE ANNA PLAZA	142	40	5,680	0	5,680	849	6,529
	JERDONE ISLAND	280	135	37,800	0	37,800	5,648	43,448
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	8,991	69,165
	TOWN OF LOUISA (GA)	2,549	65	165,685	95,648	261,333	39,050	300,383
	TOWN OF MINERAL (GA)	1,179	65	76,635	25,409	102,044	15,248	117,292
* ZION CROSSROADS (GA)		1,966	80	157,280	235,920	393,200	58,754	451,954
	SUB-TOTAL =	9,275	--	677,040	404,995	1,082,035	161,683	1,243,718
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (87% OF DEMAND) (GPD)	WATER LOST (13% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,517	11,667
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	1,750	13,460
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	2,241	17,241
CROSSING POINTE		--	--	--	12,760	12,760	1,907	14,667
	SUB-TOTAL =	--	--	--	49,620	49,620	7,414	57,034
PROPOSED GROWTH AREA WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (87% OF DEMAND) (GPD)	WATER LOST (13% OF DEMAND) (GPD)	WATER DEMAND (GPD)
* GUM SPRING		221	80	17,680	26,520	44,200	6,605	50,805
* FERNCLIFF		289	80	23,120	34,680	57,800	8,637	66,437
* SHANNON HILL		145	80	11,600	17,400	29,000	4,333	33,333
LAKE ANNA	REMAINING AREA	2,806	80	224,480	149,653	374,133	55,905	430,038
BOSWELL'S TAVERN		27	80	2,160	1,440	3,600	538	4,138
GORDONSVILLE		174	80	13,920	9,280	23,200	3,467	26,667
	SUB-TOTAL =	3,662	--	292,960	238,973	531,933	79,484	611,418
WATERSOURCE: INDIVIDUALWELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (87% OF DEMAND) (GPD)	WATER LOST (13% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		9,725	80	778,000	0	778,000	116,253	894,253
RURAL AREA		19,227	100	1,922,700	0	1,922,700	287,300	2,210,000
	SUB-TOTAL =	28,952	--	2,700,700	0	2,700,700	403,553	3,104,253
	TOTAL=	41,889	--	3,670,700	693,588	4,364,288	652,135	**5,016,423**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 13: 2030 Population and Water Demand Projections

2030								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (88% OF DEMAND) (GPD)	WATER LOST (12% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,178	35	76,230	0	76,230	10,395	86,625
SHENANDOAH CROSSING		730	115	83,950	0	83,950	11,448	95,398
SIX-O-FIVE TRAILER PARK		278	250	69,500	0	69,500	9,477	78,977
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	832	6,932
TWIN OAKS		100	85	8,500	0	8,500	1,159	9,659
LAKE ANNA	LAKE ANNA PLAZA	142	40	5,680	0	5,680	775	6,455
	JERDONE ISLAND	318	135	42,930	0	42,930	5,854	48,784
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	8,205	68,379
	TOWN OF LOUISA (GA)	3,783	65	245,895	141,952	387,847	52,888	440,735
	TOWN OF MINERAL (GA)	1,608	65	104,520	34,654	139,174	18,978	158,153
* ZION CROSSROADS (GA)		3,103	80	248,240	372,360	620,600	84,627	705,227
	SUB-TOTAL =	12,522	--	903,700	596,985	1,500,685	204,639	1,705,324
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (88% OF DEMAND) (GPD)	WATER LOST (12% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,384	11,534
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	1,597	13,307
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	2,045	17,045
CROSSING POINTE		--	--	--	12,760	12,760	1,740	14,500
	SUB-TOTAL =	--	--	--	49,620	49,620	6,766	56,386
PROPOSED GROWTH AREA WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (88% OF DEMAND) (GPD)	WATER LOST (12% OF DEMAND) (GPD)	WATER DEMAND (GPD)
* GUM SPRING		483	80	38,640	57,960	96,600	13,173	109,773
* FERNCLIFF		631	80	50,480	75,720	126,200	17,209	143,409
* SHANNON HILL		315	80	25,200	37,800	63,000	8,591	71,591
LAKE ANNA	REMAINING AREA	6,128	80	490,240	326,827	817,067	111,418	928,485
BOSWELL'S TAVERN		65	80	5,200	3,467	8,667	1,182	9,848
GORDONSVILLE		408	80	32,640	21,760	54,400	7,418	61,818
	SUB-TOTAL =	8,030	--	642,400	523,533	1,165,933	158,991	1,324,924
WATERSOURCE: INDIVIDUALWELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (88% OF DEMAND) (GPD)	WATER LOST (12% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		8,748	80	699,840	0	699,840	95,433	795,273
RURAL AREA		21,439	100	2,143,900	0	2,143,900	292,350	2,436,250
	SUB-TOTAL =	30,187	--	2,843,740	0	2,843,740	387,783	3,231,523
	TOTAL=	50,739	--	4,389,840	1,170,138	5,559,978	758,179	**6,318,157**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 14: 2040 Population and Water Demand Projections

2040								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (89% OF DEMAND) (GPD)	WATER LOST (11% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,485	35	86,975	0	86,975	10,750	97,725
SHENANDOAH CROSSING		832	115	95,680	0	95,680	11,826	107,506
SIX-O-FIVE TRAILER PARK		278	250	69,500	0	69,500	8,590	78,090
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	754	6,854
TWIN OAKS		100	85	8,500	0	8,500	1,051	9,551
LAKE ANNA	LAKE ANNA PLAZA	142	40	5,680	0	5,680	702	6,382
	JERDONE ISLAND	318	135	42,930	0	42,930	5,306	48,236
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	7,437	67,610
	TOWN OF LOUISA (GA)	4,690	65	304,850	175,986	480,836	59,429	540,265
	TOWN OF MINERAL (GA)	2,152	65	139,880	46,378	186,258	23,021	209,279
* ZION CROSSROADS (GA)		3,944	80	315,520	473,280	788,800	97,492	886,292
	SUB-TOTAL =	15,223	--	1,087,770	743,663	1,831,433	226,357	2,057,789
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (89% OF DEMAND) (GPD)	WATER LOST (11% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,254	11,404
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	1,447	13,157
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	1,854	16,854
CROSSING POINTE		--	--	--	12,760	12,760	1,577	14,337
	SUB-TOTAL =	--	--	--	49,620	49,620	6,133	55,753
PROPOSED GROWTH AREA WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (89% OF DEMAND) (GPD)	WATER LOST (11% OF DEMAND) (GPD)	WATER DEMAND (GPD)
* GUM SPRING		680	80	54,400	81,600	136,000	16,809	152,809
* FERNCLIFF		887	80	70,960	106,440	177,400	21,926	199,326
* SHANNON HILL		442	80	35,360	53,040	88,400	10,926	99,326
LAKE ANNA	REMAINING AREA	8,624	80	689,920	459,947	1,149,867	142,118	1,291,985
BOSWELL'S TAVERN		94	80	7,520	5,013	12,533	1,549	14,082
GORDONSVILLE		584	80	46,720	31,147	77,867	9,624	87,491
	SUB-TOTAL =	11,311	--	904,880	737,187	1,642,067	202,952	1,845,019
WATERSOURCE: INDIVIDUAL WELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (89% OF DEMAND) (GPD)	WATER LOST (11% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		7,868	80	629,440	0	629,440	77,796	707,236
RURAL AREA		23,140	100	2,314,000	0	2,314,000	286,000	2,600,000
	SUB-TOTAL =	31,008	--	2,943,440	0	2,943,440	363,796	3,307,236
	TOTAL=	57,542	--	4,936,090	1,530,469	6,466,559	799,238	**7,265,797**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

Table 15: 2050 Population and Water Demand Projections

2050								
EXISTING COMMUNITY AND EXISTING GROWTH AREA (GA) WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (90% OF DEMAND) (GPD)	WATER LOST (10% OF DEMAND) (GPD)	WATER DEMAND (GPD)
BLUE RIDGE SHORES		2,792	35	97,720	0	97,720	10,858	108,578
SHENANDOAH CROSSING		935	115	107,525	0	107,525	11,947	119,472
SIX-O-FIVE TRAILER PARK		278	250	69,500	0	69,500	7,722	77,222
TREVILIANS SQUARE APARTMENTS		61	100	6,100	0	6,100	678	6,778
TWIN OAKS		100	85	8,500	0	8,500	944	9,444
LAKE ANNA	LAKE ANNA PLAZA	142	40	5,680	0	5,680	631	6,311
	JERDONE ISLAND	318	135	42,930	0	42,930	4,770	47,700
NORTHEAST CREEK RESERVOIR	LCWA (GA)	221	55	12,155	48,018	60,173	6,686	66,859
	TOWN OF LOUISA (GA)	5,704	65	370,760	214,035	584,795	64,977	649,772
	TOWN OF MINERAL (GA)	2,749	65	178,685	59,244	237,929	26,437	264,366
* ZION CROSSROADS (GA)		4,876	80	390,080	585,120	975,200	108,356	1,083,556
SUB-TOTAL =		18,176	--	1,289,635	906,418	2,196,053	244,006	2,440,058
SELF-SUPPLIED USERS > 300,000 GAL/MONTH		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (90% OF DEMAND) (GPD)	WATER LOST (10% OF DEMAND) (GPD)	WATER DEMAND (GPD)
KLOCKNER PENTAPLAST		--	--	--	10,150	10,150	1,128	11,278
NORTH ANNA POWER PLANT		--	--	--	11,710	11,710	1,301	13,011
SIEBERT AMOCO AND DAIRY QUEEN		--	--	--	15,000	15,000	1,667	16,667
CROSSING POINTE		--	--	--	12,760	12,760	1,418	14,178
SUB-TOTAL =		--	--	--	49,620	49,620	5,513	55,133
PROPOSED GROWTH AREA WATERSYSTEMS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (90% OF DEMAND) (GPD)	WATER LOST (10% OF DEMAND) (GPD)	WATER DEMAND (GPD)
* GUM SPRING		896	80	71,680	107,520	179,200	19,911	199,111
* FERNCLIFF		1,166	80	93,280	139,920	233,200	25,911	259,111
* SHANNON HILL		582	80	46,560	69,840	116,400	12,933	129,333
LAKE ANNA	REMAINING AREA	11,348	80	907,840	605,227	1,513,067	168,119	1,681,185
BOSWELL'S TAVERN		125	80	10,000	6,667	16,667	1,852	18,519
GORDONSVILLE		775	80	62,000	41,333	103,333	11,481	114,815
SUB-TOTAL =		14,892	--	1,191,360	970,507	2,161,867	240,207	2,402,074
WATERSOURCE: INDIVIDUAL WELLS		POPULATION	RESIDENTIAL WATER USAGE (GPD/P)	RESIDENTIAL WATER USAGE (GPD)	COMMERCIAL WATER USAGE (GPD)	TOTAL USAGE (90% OF DEMAND) (GPD)	WATER LOST (10% OF DEMAND) (GPD)	WATER DEMAND (GPD)
GROWTH AREAS		7,079	80	566,320	0	566,320	62,924	629,244
RURAL AREA		25,055	100	2,505,500	0	2,505,500	278,389	2,783,889
SUB-TOTAL =		32,134	--	3,071,820	0	3,071,820	341,313	3,413,133
TOTAL=		65,202	--	5,552,815	1,926,544	7,479,359	831,040	**8,310,399**

Notes:

1. The Towns and LCWA utilize the Commercial Water Usage % shown in Table 5.

2. * Growth Areas along I-64 utilize a projection of 60% Commercial Water Usage and 40% Residential Water Usage.

3. Remaining Proposed Growth Areas utilize a projection of 40% Commerical Water Usage and 60% Residential Water Usage.

APPENDIX C

DROUGHT RESPONSE AND CONTINGENCY PLAN ORDINANCES

RES02.153

BOARD OF SUPERVISORS
COUNTY OF LOUISA
RESOLUTION

At a regular meeting of the Board of Supervisors of the County of Louisa held in the Louisa County Office Building at 5:00 p.m. on the 21st day of October 2002, at which the following members were present, the following resolution was adopted by a majority of all members of the Board of Supervisors, the vote being recorded in the minutes of the meeting as shown below:

PRESENT	VOTE
C. Edward Kube, Jr., Chairman	Yes
Willie L. Harper, Vice-Chairman	Yes
Fitzgerald A. Barnes	Yes
Edward T. Deale	Yes
David B. Morgan, M.D.	Yes
William A. Seay, Jr.	Yes
Jack T. Wright	Yes

On motion of Mr. Wright, seconded by Mr. Barnes, which carried by a vote of 7-0, the following resolution was adopted:

A RESOLUTION TO ESTABLISH PROVISIONS RELATING TO MANDATORY RESTRICTIONS ON THE USE OF SURFACE AND GROUND WATER IN THE COUNTY, INCLUDING PROVISIONS TO RESTRICT THE USE OF WATER FOR IRRIGATION PURPOSES, TO ESTABLISH CERTAIN OTHER RESTRICTIONS ON THE USE OF WATER, AND TO ESTABLISH PENALITIES OF FIFTY DOLLARS FOR THE SECOND VIOLATION AND ONE HUNDRED DOLLARES FOR THE EACH SUBSEQUENT VIOLATION OF THE RESTRICTIONS, PURSUANT TO TITLE 15.2, CHAPTER 21 OF THE CODE OF VIRGINIA, AND INCLUDING SPECIFICALLY VIRGINIA CODE §15.2-924(A) AND TITLE 44, CHAPTER 3.2, INCLUDING SPECIFICALLY VIRGINIA CODE §44-146.17(1).

WHEREAS, stream flows and ground water have reached historic low levels that necessitate limiting use of the public and private water sources for the protection of the health, safety and general welfare of the citizens of the County; and

WHEREAS, on August 30, 2002, the Governor of the Commonwealth of Virginia issued Executive Order Number 33, entitled Declaration of a State of Emergency Due to Extreme Drought Conditions throughout the Commonwealth (the "Executive Order"), in which he proclaimed a state of emergency throughout the Commonwealth due to drought conditions, instituted mandatory restrictions on certain uses of surface and ground water in the County and in other localities in the Commonwealth, mandated agencies of both state and local governments to render appropriate assistance to address drought conditions, and authorized local governments to establish, collect, and retain fines for violations of the water restrictions.

NOW, THEREFORE, BE IT ORDAINED by the Board of Supervisors of Louisa County:

1. That the following Ordinance is hereby adopted to read in its entirety as follows:

Sec. 1. Finding of an Emergency.

It is hereby determined and found that a state of emergency exists, as proclaimed in the Executive Order of the Governor of the Commonwealth, due to extreme drought conditions in the County and throughout the Commonwealth, and that a water supply emergency continues to exist in the Commonwealth, due to the impact of the drought on the Commonwealth's water supply sources for its public water system and anticipated demand in the immediate future, which together necessitate the adoption of this Ordinance mandating restrictions on the use of water in the County under the terms and conditions set forth in this Ordinance.

Sec. 2. Definitions.

The following words and phrases, when used in this Ordinance, shall have the meaning ascribed to them below, except in those instances where the context clearly indicates a different meaning:

Assessment date: The date of the water bill on which a fine for violation of this Ordinance is imposed.

Fountain: A water display where water is sprayed strictly for ornamental purposes.

Lawn: Grass areas of any property, including residential, commercial or industrial areas, but excluding agricultural fields and athletic fields.

Person: Any individual, corporation, partnership, association, company, business, trust, joint venture or other legal entity.

Vegetable garden: Any "non-commercial" vegetable garden planted primarily for household use; "non-commercial" includes incidental direct selling of produce from such a vegetable garden to the public.

Sec. 3. Mandatory Surface and Ground Water Use Restriction Measures.

All persons and households in the County shall limit their use of surface water, which includes water from the public water system, and ground water including but not limited to private wells consistent with the Executive Order, and in accordance with this section:

a) Lawns. Watering of lawns is prohibited at all times. New and replanted or resodded lawns may be watered for a period not to exceed 30 days.

b) Vegetable Gardens, Flowers, Trees and Shrubs. Watering is limited to three (3) days per week by address. Addresses ending with an odd number may water only on Tuesday, Thursday and Saturday. Addresses ending with an even number, or with no number, may water only on Wednesday, Friday and Sunday. Watering is prohibited on Mondays. Watering with buckets that have a capacity of 5 or fewer gallons is permitted at any time.

c) Vehicle Washing. Vehicle washing by persons other than commercial car washes is prohibited at all times. Commercial car washes, auto dealers, body shops and car rental agencies are permitted to operate under normal conditions, except that such businesses may not wash corporate fleet vehicles. This restriction shall not apply to the washing of emergency vehicles for health and safety purposes.

d) Swimming Pools. Filling is prohibited at all times, with the exception of pools used by health care facilities for patient care and rehabilitation, which are permitted to operate under normal conditions. New or repaired pools may be filled as needed to maintain the structural integrity of the pool. Indoor pools may be filled as necessary to ensure swimmer health and safety.

e) Golf Courses. Watering of tees and greens is permitted daily between the hours of 8:00 p.m. and 8:00 a.m. All other watering is prohibited at all times, except that new and refurbished fairways may be watered for a period not to exceed 30 days.

f) Fountains. Water use is prohibited.

g) Paved Areas. Washing is prohibited except for health and safety requirements.

h) Restaurants. Water shall be served to customers only upon request.

i) All Other Businesses. Water use is limited to uses essential for business use and human hygiene.

Sec. 4. When Restrictions Go Into Effect.

a) The water use restrictions set forth in this Ordinance shall take effect immediately.

b) The water use restrictions shall remain in effect so long as the Executive Order remains in full force and effect.

Sec. 5. Notice.

Notice of these public water use restrictions shall be published in the Central Virginian Newspaper for a period of every week for one (1) month during which the restrictions are in force.

Sec. 6. Violation.

It shall be a violation of this Ordinance for any person to use water, or allow or cause the use of water, in violation of the provisions of this Ordinance after the first publication required by Section 5 of this Ordinance.

Sec. 7. Penalty.

a) Any person who violates any provision of this Ordinance shall be subject to the following penalties:

1) For the first offense, violators shall receive a written warning delivered in person or posted by the Code Enforcement Officer and Building Inspectors.
2) For the second offense, violators shall be fined $50.00.

3) For the third and each subsequent offense, violators shall be fined $100.00 for each offense.

4) Each violation by a person shall be counted as a separate violation by that person, irrespective of the location at which the violation occurs.

b) Persons who have been assessed a penalty shall have the right to challenge the assessment by providing a written notice to the County Attorney within ten (10) days of the date of the assessment of the penalty. The County Attorney shall determine whether the penalty was properly assessed and notify the complaining person in writing of his determination. Should the County Attorney determine that the penalty was properly assessed; the person may appeal that determination by providing written notice to the County Administrator within ten (10) days of receiving the notice of determination. The County Administrator shall determine whether the penalty was properly assessed and notify the complaining person in writing of his determination.

c) The County Attorney may waive the penalty if he determines that the violation occurred due to no fault of the person.

2. That the provisions of this Ordinance are severable, and the unenforceability of any provision in the Ordinance, as determined by a court of competent jurisdiction, shall not affect the enforceability of any other provision in the Ordinance.

3. That this Ordinance shall take effect immediately.

A Copy, teste:

C. Lee Lintecum

C. Lee Lintecum, Clerk
Board of Supervisors
Louisa County, Virginia

CHAPTER 160 WATER

[HISTORY: ADOPTED BY THE TOWN COUNCIL OF THE TOWN OF LOUISA 5-28-1981 AS CH. 19 OF THE 1981 CODE. AMENDMENT
APPLICABLE.]

GENERAL REFERENCES

BUILDING CONSTRUCTION — SEE CH. 47.

FIRE PROTECTION — SEE CH. 82.

SEWERS — SEE CH. 132.

STREETS, SIDEWALKS AND PUBLIC PLACES — SEE CH. 139.

SUBDIVISION OF LAND — SEE CH. 143.

ZONING — SEE CH. 165.

ARTICLE I GENERAL PROVISIONS (§ 160-1 — § 160-20)

§ 160-1 **DUTIES OF SUPERINTENDENT.**

§ 160-2 **PREMISES INTENDED FOR HUMAN HABITATION OR OCCUPANCY.**

§ 160-3 **APPLICATION FOR CONNECTION.**

§ 160-4 **SUPPLYING WATER OUTSIDE TOWN.**

§ 160-5 **METER DEPOSIT.**

§ 160-6 **CONNECTIONS TO BE SUPERVISED.**

§ 160-7 **CHECK AND CUTOFF VALVES REQUIRED.**

§ 160-8 **WATER EMERGENCIES.**

THE MAYOR MAY, IF AT ANY TIME HE IS OF THE OPINION THAT THERE IS A SHORTAGE IN THE TOWN WATER SUPPLY AND TH
WITH RESPECT THERETO, AT S GIVE DUE AND ADEQUATE NOTICE OF THE EXISTENCE OF SUCH EMERGENCY AND PRESCRIB
WHICH THE USE OF WATER SHALL BE CURTAILED. ANY PERS OF USING WATER OTHER THAN AS PERMITTED BY THE TERM
THE MAYOR AFTER DUE PUBLICATION OF THE NOTICE SHALL BE GUILTY OF A MISDEMEANOR.

§ 160-9 **RIGHT OF TOWN COUNCIL TO CONTROL WATER.**

THE TOWN COUNCIL RESERVES THE RIGHT TO RESERVE A SUFFICIENT SUPPLY OF WATER AT ALL TIMES IN ITS RESERVOIRS
EMERGENCIES AND TO RESTRICT OR REGULATE THE QUANTITY OR QUALITY OF WATER USED BY CONSUMERS IN THE CASE
PUBLIC WELFARE MAY REQUIRE IT.

§ 160-10 **RIGHT OF TOWN COUNCIL TO CUT OFF WATER SUPPLY.**

§ 160-11 **LIABILITY OF TOWN.**

§ 160-12 **WATER CUTOFFS.**

§ 160-13 **RENEWAL OF DISCONTINUED OR SUSPENDED SUPPLY.**

§ 160-14 **DETERMINATION TO CORRECT DISCONTINUED OR SUSPENDED SUPPLY.**

§ 160-15 **PERMISSION TO SUPPLY WATER REQUIRED.**

§ 160-16 **INTRODUCING FOREIGN SUBSTANCES UNLAWFUL.**

§ 160-17 **DAMAGING SYSTEM PROPERTY UNLAWFUL.**

CHAPTER 418 WATER

[HISTORY: ADOPTED BY THE TOWN COUNCIL OF THE TOWN OF MINERAL EFFECTIVE 1-1-1982 AS CH. 20, ARTS. I, II AND IV C
AMENDMENTS NOTED WHERE APPLICABLE.]

GENERAL REFERENCES

STREETS AND SIDEWALKS — SEE CH. 375.

SEWERS — SEE CH. 355.

SUBDIVISION OF LAND — SEE CH. 380.

ARTICLE I WATER SUPPLY SYSTEM GENERALLY (§ 418-1 — § 418-20)

EDITOR'S NOTE: FOR STATE LAW AS TO WATER SUPPLY SYSTEMS GENERALLY, SEE TITLE 15.2, CH. 21, CODE OF VIRGINIA.
COUNCIL WITH RESPECT TO UTILITIES, SEE § 15.2-2109, CODE OF VIRGINIA. FOR THE STATE WATER CONTROL LAW, SEE §
OF VIRGINIA. AS TO CONSERVATION OF WATER RESOURCES, SEE § 62.1-44.36 ET SEQ., CODE OF VIRGINIA.

§ 418-1 DUTIES OF TOWN MANAGER.

§ 418-2 WATER SUPPLY FOR PREMISES INTENDED FOR HUMAN OCCUPANCY.

§ 418-3 APPLICATION FOR INTRODUCTION OF WATER TO PREMISES IN TOWN.

§ 418-4 SUPPLYING WATER OUTSIDE OF TOWN.

§ 418-5 METER DEPOSIT REQUIRED OF APPLICANTS.

§ 418-6 HOW WATER INTRODUCED INTO PREMISES.

§ 418-7 WATER CONNECTION FEES FOR PROPERTY IN TOWN.

§ 418-8 WATER CONNECTION FEES FOR PROPERTY OUTSIDE TOWN.

§ 418-9 CONNECTION OF SPRINKLER OR FIRE PROTECTION SYSTEM.

§ 418-10 RESTORATION OF SERVICE AFTER TERMINATION FOR NONPAYMENT.

§ 418-11 CHARGE FOR TURNING OFF WATER AT REQUEST OF CUSTOMER.

§ 418-12 HOW CUTOFFS MADE.

§ 418-13 CHECKVALVES AND CUTOFF VALVES REQUIRED.

§ 418-14 DAMAGING PROPERTY PERTAINING TO SYSTEM.

§ 418-15 EMERGENCY CONSEQUENT UPON SHORTAGE OF WATER.

THE MAYOR MAY, IF AT ANY TIME HE IS OF THE OPINION THAT THERE IS A SHORTAGE IN THE TOWN WATER SUPPLY AND T
WITH RESPECT THERETO, AT SUCH TIME, GIVE DUE NOTICE OF THE EXISTENCE OF SUCH EMERGENCY AND PRESCRIBE TH
WHICH T USE OF WATER SHALL BE CURTAILED. ANY PERSON FOUND GUILTY OF USING WATER OTHER THAN AS PERMITTED BY THE TERMS OF T
THE MAYOR AFTER DUE PUBLICATION OF THE NOTICE SHALL BE GUILTY OF A MISDEMEANOR.

§ 418-16 MAINTENANCE OF SUPPLY IN RESERVOIRS; RESTRICTIONS ON USE OF WATER.

THE TOWN COUNCIL RESERVES THE RIGHT TO RESERVE A SUFFICIENT SUPPLY OF WATER AT ALL TIMES IN ITS RESERVOI
EMERGENCIES AND TO RESTRICT OR REGULATE THE QUANTITY OR QUALITY OF WATER USED BY CONSUMERS IN THE CASE
PUBLIC WELFARE MAY REQUIRE IT.

§ 418-17 CUTTING OFF WATER SUPPLY.

§ 418-18 LIABILITY OF TOWN.

DRAFT

Model Drought Ordinance

Louisa County, Virginia

WHEREAS, THE VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY'S DROUGHT MANAGEMENT TASK FORCE MONITORS THE OCCURRENCE AND SEVERITY OF DROUGHTS THROUGHOUT THE COMMONWEALTH OF VIRGINIA; AND

WHEREAS, DROUGHT CONDITIONS MAY DEVELOP AND OCCUR WITHIN LOUISA COUNTY FROM TIME TO TIME WHICH COULD CREATE SHORTAGES OF DRINKING WATER FOR THE CITIZ OF THE COUNTY; AND

WHEREAS, THE LOUISA COUNTY BOARD OF SUPERVISORS HAS THE AUTHORITY TO DECLARE DROUGHT WATCHES, DROUGHT WARNINGS AND DROUGHT EMERGENCIES WITHIN THE COU AND

WHEREAS, THE LOUISA COUNTY BOARD OF SUPERVISORS HAS THE AUTHORITY TO ESTABLISH, COLLECT, AND RETAIN FINES FOR A VIOLATION OF THE RESTRICTIONS PROMUL HEREIN; AND

WHEREAS, THE BOARD OF SUPERVISORS OF LOUISA COUNTY FINDS THAT A VIOLATION OF THE MANDATORY RESTRICTIONS OF THIS ORDINANCE DURING A DROUGHT EMERGENCY SHALL ENFORCED AS A CLASS 3 MISDEMEANOR;

NOW, THEREFORE, BE IT HEREBY ORDAINED THAT:

A. SHOULD THE BOARD OF SUPERVISORS, AT ANY TIME, DECLARE THERE TO BE AN EMERGENCY IN THE COUNTY ARISING WHOLLY OR SUBSTANTIALLY OUT OF A SHORTAGE WATER SUPPLY, THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF TH BOARD ARE HEREBY AUTHORIZED DURING CONTINUATION OF THE WATER EMERGENCY TO ORDER THE RESTRICTION OR PROHIBITION OF ANY OR ALL USES OF THE WATER SUPPLY INCLUDING BUT NOT LIMITED TO:

   1. WATERING OF OUTSIDE SHRUBBERY, TREES, LAWN, GRASS, PLANTS, HOME VEGETABLE GARDENS, OR ANY OTHER VEGETATION, EXCEPT FROM A WATERING CAN OR OTHER CONTAINER NOT EXCEEDING THREE (3) GALLONS IN CAPACITY. THIS

LIMITATION SHALL NOT APPLY TO COMMERCIAL GREENHOUSES OR NURSERY STOCKS WHICH MAY BE WATERED IN THE MINIMUM AMOUNT REQUIRED TO PRESERVE PLANT LIFE BEFORE 7:00 A.M. OR AFTER 8:00 P.M.

2. WASHING OF AUTOMOBILES, TRUCKS, TRAILERS, OR ANY OTHER TYPE OF MOBILE EQUIPMENT, EXCEPT IN LICENSED COMMERCIAL VEHICLE WASH FACILITIES.
3. WASHING OF SIDEWALKS, STREETS, DRIVEWAYS, PARKING LOTS, SERVICE STATIC APRONS, EXTERIORS OF HOMES OR APARTMENTS, COMMERCIAL OR INDUSTRIAL BUILDINGS OR ANY OTHER OUTDOOR SURFACE, EXCEPT WHERE MANDATED BY FEDERAL, STATE, OR LOCAL LAW.

4. THE OPERATION OF ANY ORNAMENTAL FOUNTAIN OR OTHER STRUCTURE MAKING A SIMILAR USE OF WATER.

5. THE FILLING OF SWIMMING OR WADING POOLS REQUIRING MORE THAN FIVE GALLONS OF WATER, OR THE REFILLING OF SWIMMING OR WADING POOLS WHIC WERE DRAINED AFTER THE EFFECTIVE DATE OF THE DECLARATION OF EMERGEN EXCEPT THAT POOLS MAY BE FILLED TO A LEVEL OF TWO FEET BELOW NORMAL, WATER MAY BE ADDED TO BRING THE LEVEL TO TWO FEET BELOW NORMAL, OR AS NECESSARY TO PROTECT THE STRUCTURE FROM HYDROSTATIC DAMAGE, FOR POOL CONSTRUCTED OR CONTRACTED FOR ON OR BEFORE THE EFFECTIVE DATE TH DECLARATION OF EMERGENCY RESTRICTIONS.

6. THE USE OF WATER FROM FIRE HYDRANTS FOR ANY PURPOSE OTHER THAN FIRE SUPPRESSION, UNLESS OTHERWISE APPROVED BY THE COUNTY ADMINISTRATOR.

7. THE SERVING OF DRINKING WATER IN RESTAURANTS, EXCEPT UPON REQUEST.

8. THE OPERATION OF ANY WATER-COOLED COMFORT AIR CONDITIONING THAT DOES NOT HAVE WATER-CONSERVING EQUIPMENT IN OPERATION.

9. ANY ADDITIONAL WATER USE RESTRICTION DEEMED NECESSARY.

THE ABOVE RESTRICTIONS, OR ANY OF THEM, SHALL BECOME EFFECTIVE UPON THE BEING PRINTED IN ANY NEWSPAPER OF GENERAL CIRCULATION IN THE COUNTY, C BROADCAST UPON ANY RADIO OR TELEVISION STATION SERVING THE COUNTY.

B. UPON IMPLEMENTATION OF SUBSECTION A, ABOVE, THE COUNTY ADMINISTRATOR SHAL ESTABLISH AN APPEALS PROCEDURE TO REVIEW CUSTOMER APPLICATIONS FO EXEMPTIONS FROM THE PROVISIONS OF SUBSECTIONS A ON A CASE BY CASE BASIS AND, IF WARRANTED, TO MAKE EQUITABLE ADJUSTMENTS TO SUCH PROVISIONS. TH COUNTY ADMINISTRATOR SHALL ALSO BE EMPOWERED TO ESTABLISH REGULATION GOVERNING THE GRANTING OF TEMPORARY EXEMPTIONS APPLICABLE TO ALL OR SOME C THE USES OF THE WATER SUPPLY SET FORTH IN SUBSECTION A. THE COUNT ADMINISTRATOR SHALL, IN DECIDING APPLICATIONS, BALANCE ECONOMIC AND OTH HARDSHIPS TO THE APPLICANT RESULTING FROM THE IMPOSITION OF WATER US

RESTRICTIONS OR ALLOCATIONS AGAINST THE INDIVIDUAL AND CUMULATIVE IMPACTS T
WATER SUPPLY RESULTING FROM THE GRANTING OF EXEMPTIONS.

C. SHOULD MEASURES TAKEN PURSUANT TO SUBSECTION A OF THIS SECTION PROVE INSUFFICIENT TO PRESERVE SUFFICIENT SUPPLIES OF WATER FOR THE CITIZENS O COUNTY, THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD ARE HEREBY FURTHER AUTHORIZED TO IMPOSE TEMPORARY RATE INCREASES OR SURCHARGES ON THE CONSUMPTION OF WATER, TO RESTRICT OR DISCONTINUE THE SUPPLY OF WATE ANY INDUSTRIAL OR COMMERCIAL ACTIVITY WHICH USES WATER BEYOND THE SANITA AND DRINKING NEEDS OF ITS EMPLOYEES AND INVITEES, TO DECLARE A MORATORIUM ON NEW WATER CONNECTIONS TO BUILDINGS ISSUED A BUILDING PERMIT AFTER THE DAT DECLARATION OF EMERGENCY, AND TO RESTRICT WATER USE TO BASIC HUMAN NEED ONLY.

D. ANY PERSON VIOLATING ANY PROVISION OF THIS SECTION, OR ANY ORDER OF THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, ISSUED PURSUANT TO TI AUTHORITY GRANTED HEREUNDER SHALL BE GUILTY OF A CLASS 3 MISDEMEANOR.

E. IN ADDITION, THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF TH BOARD ARE HEREBY AUTHORIZED TO TERMINATE THE WATER SERVICE, FOR THE DURATION O THE EMERGENCY, TO ANY PERSON CONVICTED OF SUCH VIOLATION.

F. IN ADDITION TO THE PENALTIES SET FORTH IN SUBSECTION D, ABOVE, THE LOUIS COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, MAY IMPOSE PENALTY CHARGES ON ANY PERSON VIOLATING ANY PROVISION OF THIS SECTION. SUCH PENALT CHARGES SHALL BE IN AN AMOUNT DETERMINED BY THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, AND SHALL BE IMPOSED ON TH VIOLATOR'S NEXT WATER BILL. IF A VIOLATION CONTINUES AFTER A NOTICE OF VIOLATIO BEEN ISSUED, OR IF SUCH PENALTY CHARGES ARE NOT PAID WHEN DUE, THE LOUISA COUNTY WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, ARE AUTHORIZED TO TERMINATE THE WATER SERVICE AND TAKE ANY ADDITIONAL MEASURES AUTHORIZED B LAW. PERSONS WHO HAVE BEEN ASSESSED A PENALTY CHARGE SHALL HAVE THE RIG TO CHALLENGE THE ASSESSED CHARGE BY PROVIDING A WRITTEN NOTICE WITHIN TEN DAYS OF THE DATE OF THE ASSESSMENT OF THE PENALTY CHARGE. THE LOUISA COUN

WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, OR HIS DESIGNEE SHALL DETERMI WHETHER THE PENALTY CHARGE WAS PROPERLY ASSESSED AND NOTIFY THE COMPLAIN PERSON IN WRITING OF HIS DETERMINATION. ANY PERSON AGGRIEVED BY THE DECISIO MAY APPEAL THAT DECISION TO A COMMITTEE OF THE LOUISA COUNTY WATER AUTHORITY, THE TOWN COUNCIL OF THE TOWN OF LOUISA, THE TOWN COUNCIL OF THI TOWN OF MINERAL, OR THE COUNTY BOARD OF SUPERVISORS, BY FILING AN APPEAL IN WRITING WITHIN FIVE (5) DAYS OF NOTICE OF THE DECISION BY THE LOUISA COUNT WATER AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD. THE PENALTY CHARGE MAY BE WAIVED IF IT IS DETERMINED THAT THE VIOLATION OCCURRED DUE TO NO FAULT OF PERSON. WATER SERVICE SHALL NOT BE TERMINATED DURING THE PENDANCY OF AN APPEAL.

G. NOTHING IN THIS SECTION SHALL BE CONSTRUED TO PROHIBIT THE LOUISA COUNTY WA AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, FROM RESCINDING ANY ORDERS ISSUED THEREUNDER WHEN THE CONDITIONS CREATING THE NEED FOR SUCH ORDE HAVE ABATED.

H. NOTHING IN THIS SECTION SHALL BE CONSTRUED TO PROHIBIT THE LOUISA COUNTY WA AUTHORITY (LCWA) AND ITS GENERAL MANAGER, THE TOWN OF LOUISA AND ITS TOWN MANAGER, THE TOWN OF MINERAL AND ITS TOWN MANAGER, AND THE COUNTY ADMINISTRATOR ACTING ON BEHALF OF THE BOARD, FROM EXERCISING ANY AND AL POWERS AND TAKING ANY AND ALL ACTIONS AUTHORIZED BY THE VIRGINIA WATER AND WASTE AUTHORITIES ACT, VIRGINIA CODE §§ 15.2-5100, ET AL.

STATE LAW REFERENCE—VA CODE §15.2-924.

12/30/2008

APPENDIX D

LOCAL GOVERNMENT RESOLUTIONS

APPENDIX E

RECORD OF LOCAL PUBLIC HEARINGS

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL
LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

JANUARY 29, 2008 AND JANUARY 30, 2008
TOWN OF LOUISA, TOWN HALL
4PM TO 6PM

SIGN-IN SHEET

NAME	NAME	NAME
Skip Notte		
Doug Frago		
James Dillard		
Pam Stone		
Jason Pauley		
Willie Harper		
James [illegible]		
Bernice Kube		
[illegible]		
Ed Kube		
Heather Campbell		
Wick Hawcasey		
Willie Gentry		

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL
LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

JANUARY 29, 2008 AND JANUARY 30, 2008
TOWN OF LOUISA, TOWN HALL
4PM TO 6PM

SIGN-IN SHEET

NAME	NAME	NAME
BRAD HUMPHREY		
Brian Marks		

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

JANUARY 29, 2008 AND JANUARY 30, 2008
TOWN OF LOUISA, TOWN HALL
4PM TO 6PM

SIGN-IN SHEET

NAME	NAME	NAME
Mary Jean Clark		
Bill MARTIN		
Darren Coffey		
BAR DEUK		
Tommy J. Barlow		

JES - 3/31/09

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

MARCH 30, 2009 at LOUISA COUNTY BETTY J. QUEEN INTERGENERATIONAL CENTER
MARCH 31, 2009 at JOUETT ELEMENTARY SCHOOL

7PM TO 9PM

SIGN-IN SHEET

NAME	NAME	NAME
Ed Vaike - LAO		
DAN Byer		
JACK Wright		
Doug Smith		
Jeremy CAMP		
SKip Notte		
DALE G. Mullen		
BARBARA CRAWFORD		
Robin Patter		
Amanda Welch		

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL
LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

MARCH 30, 2009 at LOUISA COUNTY BETTY J. QUEEN INTERGENERATIONAL CENTER
MARCH 31, 2009 at JOUETT ELEMENTARY SCHOOL

7PM TO 9PM

SIGN-IN SHEET

NAME	NAME	NAME
Barbara Crawford		

LOUISA COUNTY, TOWN OF LOUISA, AND TOWN OF MINERAL
LONG RANGE WATER RESOURCE PLAN

PUBLIC INFORMATION SESSION

MARCH 30, 2009 at LOUISA COUNTY BETTY J. QUEEN INTERGENERATIONAL CENTER
MARCH 31, 2009 at JOUETT ELEMENTARY SCHOOL

7PM TO 9PM

SIGN-IN SHEET

NAME	NAME	NAME
Richard Havasy		
Willie Harper		
Edwin Keller		
Dale G. Mullen		
Willie Gentry		
Jeremy Camp		
Skip Notte		

APPENDIX H
ALTERNATIVE ANALYSIS

<u>APPENDIX H-1</u>

ALTERNATIVE WATER SUPPLY SCREENING SUPPORT DOCUMENTS

<u>APPENDIX H-1-1</u>

DOMINION LETTER REGARDING LOUISA COUNTY APPLICATION FOR WATER WITHDRAWAL FROM LAKE ANNA

<u>APPENDIX H-1-2</u>

GROUNDWATER SUPPORT DOCUMENTS

<u>APPENDIX H-1-2-1</u>

COUNTY OF LOUISA WATER QUALITY MANAGEMENT PLAN AND GROUNDWATER STUDY

<u>APPENDIX H-1-2-2</u>

FLUVANNA COUNTY GEOLOGY AND WATER WELL PRODUCTIVITY

<u>APPENDIX H-1-3</u>

RWSA LETTER

<u>APPENDIX H-2</u>

PUMP STATION DETAILS

<u>APPENDIX H-3</u>

MEMORANDUM REGARDING MEETING WITH MATHEW W. REYNOLDS, VDOT STATE UTILITIES & PROPERTY MANAGER RIGHT OF WAY & UTILITIES DIVISION

<u>APPENDIX H-4</u>

ALTERNATIVE WATER MAIN ROCK EXCAVATION EXHIBIT

<u>APPENDIX H-5</u>

CSX CROSSINGS AND DOCUMENTS

<u>APPENDIX H-5-1</u>

FACILITY ENCROACHMENT AGREEMENT

<u>APPENDIX H-5-2</u>

CSX PREFERRED ALTERNATIVE LETTER

<u>APPENDIX H-5-3</u>

PROPOSED ACCESS ROAD AND RAIL LINE CROSSING PROFILES

<u>APPENDIX H-6</u>

SELECTED VIRGINIA ADMINISTRATIVE CODE

<u>APPENDIX H-6-1</u>

VIRGINIA ADMINISTRATIVE CODE TITLE 12. HEALTH AGENCY 5. DEPARTMENT OF HEALTH CHAPTER 590. WATERWORKS REGULATIONS 12VAC5-590-200 PROCUREMENT OF OBTAINING A CONSTRUCTION PERMIT

<u>APPENDIX H-6-2</u>

VIRGINIA ADMINISTRATIVE CODE TITLE 9. AGENCY 25. STATE WATER CONTROL BOARD. CHAPTER 260. WATER QUALITY STANDARDS PART IX. RIVER BASIN SECTION TABLES 9VAC25-260-360. SECTION NUMBER AND DESCRIPTIVE COLUMNS

<u>APPENDIX H-7</u>

GEOTECHNICAL REPORTS

<u>APPENDIX H-7-1</u>

BREMO BRIDGE GEOTECHNICAL REPORT

<u>APPENDIX H-7-2</u>

COLUMBIA BRIDGE GEOTECHNICAL REPORT

<u>APPENDIX H-8</u>

3-PHASE POWER TIE-IN LOCATIONS SUPPORT DOCUMENT

APPENDIX H (CONTINUED)
ALTERNATIVE ANALYSIS

APPENDIX H-9

COST CONSIDERATION SUPPORT DOCUMENTS

- **APPENDIX H-9-1**

  CONSTRUCTION COST CONSIDERATIONS

- **APPENDIX H-9-2**

  OPINION OF PROBABLE COST

- **APPENDIX H-9-3**

  2015 MEMO VS. 2020 ALTERNATIVES COST COMPARISON

- **APPENDIX H-9-4**

  PROPERTY ACQUISITION COST ANALYSIS

APPENDIX H-10

CO-LOCATION OF UTILITIES EXHIBIT

APPENDIX H-11

ENVIRONMENTAL JUSTICE DOCUMENTS

- **APPENDIX H-11-1**

  EJSCREEN ENVIRONMENTAL JUSTICE MINORITY POPULATIONS

- **APPENDIX H-11-2**

  EJSCREEN ENVIRONMENTAL JUSTICE LOW INCOME POPULATION

- **APPENDIX H-11-3**

  ENVIRONMENTAL JUSTICE STUDY AREA CENSUS BLOCK RAW DATA

APPENDIX H-12

AQUATIC RESOURCE DOCUMENTATION

- **APPENDIX H-12-1**

  STREAMSTATS REPORT

- **APPENDIX H-12-2**

  ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DELINEATION MAP

- **APPENDIX H-12-3**

  ESTIMATES JURISDICTIONAL WATERS OF THE U.S. IMPACTS MAP

- **APPENDIX H-12-4**

  ENVIRONMENTAL INVENTORY MAP – ALTERNATE SITES

APPENDIX H-13

THREATENED AND ENDANGERED SPECIES INFORMATION

APPENDIX H-14

VIRGINIA CULTURAL RESOURCES INFORMATION SYSTEM MAPPING

APPENDIX H-13

THREATENED AND ENDANGERED SPECIES INFORMATION

APPENDIX H-14

VIRGINIA CULTURAL RESOURCES INFORMATION SYSTEM MAPPING

APPENDIX H-1
ALTERNATIVE WATER SUPPLY SCREENING SUPPORT DOCUMENTS

APPENDIX H-1-1

DOMINION LETTER REGARDING LOUISA COUNTY APPLICATION FOR WATER WITHDRAWAL FROM LAKE ANNA

David A. Heacock
President and Chief Nuclear Officer
Dominion Nuclear

A business unit of
Dominion Resources, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard, Glen Allen, VA 23060
Phone: 804-273-3551, Fax: 804-273-3759
E-mail: David.Heacock@dom.com

Dominion®

February 6, 2012

Louisa County Board of Supervisors
Attn: Mr. Willie L. Harper
P.O. Box 160
Louisa, Virginia 23093

RE: Louisa County Application for Water Withdrawal from Lake Anna

Dear Board of Supervisors:

Dominion understands that the Louisa County Water Authority intends to apply for a Virginia Water Protection permit to withdraw water from Lake Anna to be used for public water supply. As you know, Dominion created Lake Anna in the early 1970's for the essential purpose of providing cooling water for operation of the North Anna Power Station (Station). Lake Anna also supports recreational activities. In accordance with various approvals received from the State Corporation Commission, Dominion acquired all the land under and along the shoreline of Lake Anna up to elevation 255 feet mean sea level to control access to the lake. Using Lake Anna for public water supply conflicts with Dominion's rights and responsibilities for several reasons, including:

1. Allowing another entity to control withdrawals from Lake Anna would interfere with Dominion's ability to safely and efficiently operate the Station's existing and proposed units.
2. Additional withdrawals would alter lake levels and downstream flows, which Dominion controls at the Lake Anna Dam in compliance with permit conditions designed to ensure protection of other beneficial uses such as recreation.
3. The Virginia Water Quality Standards (9VAC25-260) establish public water supply numeric criteria that are more restrictive than the existing criteria for Lake Anna. The establishment of more restrictive criteria in Lake Anna could (a) result in additional restrictions on waste water discharges from the Station requiring material changes to Station operations, (b) impact Dominion's ability to perform pest/invasive species control measures, if needed, and (c) result in restrictions to existing recreational uses on Lake Anna.
4. By agreeing to grant access to Louisa County for a water withdrawal, Dominion may be compelled to consider future requests for additional water withdrawals from the County or other entities – which would further undermine Dominion's interest in managing Lake Anna for the reasons stated above.

For these and other reasons, Dominion will not grant access to Louisa County, or any other entity, for the competing purpose of establishing a water withdrawal intake and infrastructure.

Last, the Louisa County Long Range Regional Water Supply Plan identifies seven alternatives for meeting the County's projected water supply needs in the Lake Anna growth area through 2050. Dominion does not believe the six other alternatives have been fully evaluated, and we do not believe Lake Anna is a practicable alternative given the concerns noted above. Dominion appreciates the County's need to plan for future water supply demand, and we remain willing to assist the County in identifying other available water sources for that purpose. We respectfully suggest that the Louisa County Water Authority pursue water supply options other than Lake Anna.

Please do not hesitate to contact James Beazley at (804)-775-5942 should you have any questions.

Sincerely,

David A. Heacock

cc: Richard Havasy, Louisa County Board of Supervisors
Tommy Barlow, Louisa County Board of Supervisors
Fitzgerald A. Barnes, Louisa County Board of Supervisors
Dan Byers, Louisa County Board of Supervisors
Willie L. Gentry, Jr., Louisa County Board of Supervisors
Troy Wade, Louisa County Board of Supervisors
Dean Rodgers, Louisa County Water Authority
David K. Paylor, DEQ
Scott W. Kudlas, DEQ

APPENDIX H-1-2
GROUNDWATER SUPPORT DOCUMENTS

APPENDIX H-1-2-1

COUNTY OF LOUISA WATER QUALITY MANAGEMENT PLAN AND GROUNDWATER STUDY

County of Louisa, Virginia

County *of* Louisa

Water Quality Management Plan and Groundwater Study

Prepared By:

Thomas Jefferson Planning District Commission
Virginia Division of Mineral Resources
Louisa County Planning Department
Louisa County Water Authoirty
Draper Aden Associates

January , 1998

County of Louisa, Virginia

County *of* Louisa

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Draper Aden Associates

January , 1998

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EXECUTIVE SUMMARY

This report is a comprehensive Water Quality Management Study that puts forth three strategies to accommodate future growth expected to occur in Louisa County over the next 20 years and direct the growth as desired by the County in its planning documents:

1. Water needs for the future, both from impoundments and groundwater;
2. Wastewater treatment needs; and
3. Non-point source pollution protection to insure the continuing quality for the water resources in Louisa County.

Growth pressures are being felt from nearby growing urban areas such as Richmond, Charlottesville and Fredericksburg. Population growth in the County has already exceeded original projections for the year 2000. With increasing growth in the County, more and more pressure can be expected to be placed on the limited water and wastewater resources available within the County. This Study is a tool that can be used to assist Louisa County planners in ensuring that development occurs logically within the County, that appropriate public utilities are made available to facilitate growth in a planned manner, and that areas important to existing and future water resources are identified for recommended non-point source pollution protection strategies.

Based on the 1993 Louisa County Comprehensive Plan, seven potential growth areas have been identified. These areas are the primary areas considered for service by public water and sewer. The seven potential growth areas are Zion Crossroads, Ferncliff, Gum Springs, the Town of Louisa area, the Town of Mineral area, the Lake Gordonsville area, and the Lake Anna area.

The water resources in Louisa County include impoundments (lakes), rivers, streams, and groundwater. These resources are utilized to provide drinking water, recreational activities, and aesthetic value to County residents. The overall water quality of Louisa County's water resources appears to be good at the present time but will need to be protected as future growth occurs. Some of the lakes include Lake Anna, the Northeast Creek Reservoir, Lake Gordonsville, and Lake Louisa. The primary rivers within the County are the South Anna River, the North Anna River and the Little River.

There are some areas of the County where groundwater appears to have been affected by failing septic systems. One area of the County that has a high incidence of reported septic system failures is the Blue Ridge Shores subdivision at Lake Louisa. Past mining activities have affected the water quality of Contrary Creek, which flows into Lake Anna.

A database of over 2000 drilled wells in Louisa County was evaluated and the average well yield was 14.5 gallons per minute (gpm). There were 82 wells that had reported initial yields greater than 50 gpm. Fifty of these wells are located immediately adjacent to Lake Anna. The average casing length of all drilled wells was approximately 65 feet. There are 34 wells that serve multiple users (public and private systems) within the County. Of these wells, the average yield was 42 gpm, almost three times greater than the average yield of all drilled wells.

The existing public water system is presently limited to the Town of Louisa/Town of Mineral areas. Other areas of the County do have private systems with multiple users such as Zion Crossroads, Blue Ridge Shores, Shenandoah Crossings, and areas along Lake Anna. The only surface water source presently being utilized for public drinking water is Northeast Creek Reservoir. The Louisa County Water Authority (LCWA) is presently treating approximately 220,000 gallons of water per day for distribution to customers in the Town of Louisa/Mineral service area.

Groundwater serves as the primary drinking water source for all other areas of the County including many private residential developments and businesses. Groundwater also continues to provide or supplement the water supplies within the Towns of Louisa and Mineral. The Town of Mineral currently provides their residents with approximately 90,000 gallons of water per day from their existing groundwater wells and springs.

For wastewater treatment, the majority of Louisa County is served by septic tanks and sanitary drainfields (approximately 80 percent). The only publicly operated wastewater treatment plants (WWTPs) are the Louisa regional WWTP and the Town of Louisa WWTP. The existing Louisa County Wastewater Treatment Plant presently treats approximately 200,000 gallons/day of wastewater from the southern portion of the Town of Louisa, most of the Town of Mineral and several schools within the service area. This facility is presently in the process of being expanded to a 400,000 gallon/day plant. The Town of Louisa presently owns and operates a trickling filter wastewater treatment facility with an average daily treatment capacity of approximately 60,000 gallons/day that serves the northern portion of the Town of Louisa. Other areas of the County do have private wastewater treatment systems with multiple users such as Zion Crossroads, Shenandoah Crossings, and the North Anna Power Plant.

The existing population of Louisa County is approximately 25,000. Population projections indicate that the County may grow to between 32,000 and 46,000 by the year 2015. Using this population range, the estimated demand for public water and wastewater services for seven potential growth areas has been determined (Tables 5-1 and 5-2). It is estimated that **average daily demands** for public water and wastewater will be between **2.8 MGD** (million gallons per day) **and 4.1 MGD** to serve the seven potential growth areas by the **year 2015**. These estimates include a reserve of between 0.9 MGD and 1.2 MGD for commercial/industrial development within the growth areas, but does not include any major industrial users (in excess of 300,000 gallons per day). Estimated peak day demands are **between 4.5 MGD and 6.6 MGD**. Based on the present County Comprehensive Plan, the **ultimate demand** (Table 5-5) for public water and wastewater in the seven potential growth areas is estimated to be approximately **37 MGD** for the average daily demand and approximately **60 MGD** for the peak daily demand.

To meet the projected water demands for the year 2015, it appears that the best water supply options are development/expansion of two existing surface water impoundments, the **Northeast Creek Reservoir and Lake Gordonsville,** supplemented by the available groundwater supply. The LCWA water treatment plant at Northeast Creek Reservoir can presently provide up to **1 MGD** of drinking water. Based on a Department of Environmental Quality (DEQ) safe yield analysis, the water treatment plant can be expanded to a capacity of **2.8 MGD** for future demands. Lake Gordonsville is presently used for flood control and does not have a water treatment plant. Based on a DEQ analysis, approximately **1 MGD** of water can be used for drinking water purposes. Based on the available well data and the geology of Louisa County, it is possible that a significant amount of the projected water demand may be available from the groundwater supply. To meet water demands beyond the next 20 years or for heavy industrial water users will probably require either a large groundwater supply, construction of a new surface water impoundment, or an agreement to purchase water from a neighboring jurisdiction.

To meet wastewater demands over the next 20 years, it appears that several wastewater treatment plants will need to be constructed in different areas of the County. The combination of low summer flows in the South Anna River and its tributaries and very stringent water quality criteria will require most of the wastewater treatment plants in Louisa County to have stringent treatment discharge limits. In the Lake Anna area, it may be difficult to obtain a permit or too costly for a direct discharge to the Lake. To serve this area may require wastewater treatment combined with discharging the treated effluent to nearby spray irrigation fields.

For wastewater treatment outside of potential growth areas, the use of septic systems for individual homeowners should be developed in a manner consistent with ground/surface water protection and County requirements.

Due to the limited water resources in Louisa County, it is very important to protect the long term use of the lakes, rivers, streams, and groundwater supply. Specific management plans should be developed for Northeast Creek Reservoir, Lake Gordonsville, and Lake Anna.

Based on the estimated 20 year demands for public water and wastewater, proposed water system and wastewater system master plans have been developed. These master plans show approximate locations of the major components that will be necessary to provide a significant supply of public water and wastewater services to each of the seven potential growth areas. The Water System Master Plan (Figure 9-1) has been developed around the Northeast Creek Reservoir and Lake Gordonsville and includes a network of long transmission mains and water storage tanks. Primary water transmission mains have been shown to provide at least two routes to each growth area in order to improve system reliability and fire protection. The Wastewater System Master Plan (Figure 9-2) has been developed around the concept of providing individual wastewater treatment plants to serve the Zion Crossroads area, the Gum Springs area, the Lake Gordonsville area, and the Lake Anna area. The Louisa and Mineral areas are shown to continue to use the Louisa Regional WWTP. Service to the Ferncliff area is shown to be provided by pumping to the Zion Crossroads WWTP. Based on the Water and Wastewater System Master Plans, capital cost estimates have been performed for providing initial public utilities to all potential growth areas and are summarized on the following table.

WATER AND WASTEWATER SYSTEM MASTER PLAN
PRELIMINARY COST SUMMARY OF PROJECTS

Zion Crossroads

A. Water Main Extension from Louisa Area (along Rte 22 and Rte 15)	$3,552,120
B. 600,000 Gal. Elevated Storage Tank near Zion Crossroads	$920,700
C. 500,000 GPD Wastewater Treatment Plant Expansion for Zion Crossroads	$3,207,600
Total For Projects In Zions Crossroads	**$7,680,420**

Lake Gordonsville

A. 800,000 GPD Water Plant @ Lake Gordonsville	$2,851,200
B. Water Main Extension along Route 15 from North Limits to Route 22	$983,664
C. 500,000 Gal. Elevated Storage Tank near Water Plant	$873,180
D. 350,000 GPD Wastewater Treatment Plant Near Shenandoah Crossings	$3,207,600
Total For Projects In Lake Gordonsville	**$7,915,644**

Ferncliff

A. Water Main Extension from Zion Crossroads (along Rte 250)	$1,306,800
B. 250,000 Gal. Elevated Storage Tank near I-64	$570,240
C. Wastewater Treatment Infrastructure	$1,223,640
Total For Projects In Ferncliff	**$3,100,680**

Louisa/Mineral

A. Upgrade Existing Water Plant to 2.5 MGD	$3,267,000
B. Water Main Extensions in Louisa Area (along Rte 613 and Rte 208)	$1,235,520
C. 500,000 Gal. Elevated Storage Tank	$825,660
D. 750,000 GPD Wastewater Treatment Plant Expansion for Existing WWTP	$4,217,400
Total For Projects In Louisa/Mineral	**$9,545,580**

Lake Anna

A. Water Main Extension from Mineral along Rte 522	$1,559,844
B. 600,000 Gal. Elevated Storage Tank	$920,700
C. 500,000 GPD Wastewater Treatment Plant to Spray Fields	$4,930,200
Total For Projects In Lake Anna	**$7,410,744**

Gum Springs

A. Water Main Extension along Rte 33 and Rte 522	$3,831,300
B. 600,000 Gal. Elevated Storage Tank near I-64	$920,700
C. 600,000 GPD Wastewater Treatment Plant for Gum Springs	$4,989,600
Total For Projects In Gum Springs	**$9,741,600**

Some of the funding options that may be available to Louisa County for providing public water and wastewater services include Community Development Block Grants, the Virginia Revolving Loan Fund, and the Rural Utilities Service.

This Water Quality Management Plan is a three pronged approach: water resources (ground and surface), wastewater treatment, and non-point source protection. There are ten overall recommendations that are presented in this section to enhance the Plan:

Recommendation #1 - Utilize the proposed Water and Wastewater System Master Plans as a baseline for providing public services to Potential Growth Areas. Develop a "Phased approach" for implementation, which should be based on anticipated revenue and growth control.

Recommendation #2 - Revise the present Louisa County Comprehensive Plan based on water resource protection, growth control strategies, and detailed mapping of the County (soils, geology, etc. on the new GIS).

Recommendation #3 - Develop specific watershed protection plans for both of the Countys' present and future drinking water supplies, the Northeast Creek Reservoir and Lake Gordonsville.

Recommendation #4 - Using the new County mapping system, work with the Virginia Division of Mineral Resources to develop a more accurate groundwater potential yield map and septic system favorability map. These maps will be useful for potential development throughout the County.

Recommendation #5 - Conduct detailed field studies for groundwater resource development in potential growth areas, especially areas located furthest from the present water system, such as Gum Springs. These studies should include detailed fracture trace analyses, well installation, and hydrogeologic testing. The results of this testing will give more accurate estimates of yields that can be anticipated.

Recommendation #6 - Perform additional investigations in areas of historical mining activity, specifically within the Northeast Creek watershed and Contrary Creek Watershed. These studies should include the impacts of the mining activities on surface and groundwater resources and implications for stability of future building foundations.

Recommendation #7 - Develop a management plan for the Lake Anna area including more specific zoning within the area. Louisa County should work with the Lake Anna Civic Association and neighboring Counties to develop a comprehensive Lake Management plan that is consistent throughout the entire watershed.

Recommendation #8 - Encourage septic tank maintenance of all County residents. Proper septic system maintenance will reduce the risk of groundwater contamination and help to protect this valuable resource. The Louisa Regional wastewater treatment facility will be able to accept septage in 1998. The County should consider tax breaks or other incentives to promote this program.

Recommendation #9 - Develop a well head protection program for County in order to protect the public water supply wells. The program should include identification of recharge areas for public wells, and possibly land use restrictions and restrictions of the use of pesticides, nutrients or other pollutants within recharge areas.

Recommendation #10 - Pursue options to obtain water from neighboring jurisdictions such as Fluvanna County, Goochland County, the City of Charlottesville, the Rapidan Water and Sewer Authority, and the Town of Gordonsville in order to meet demands beyond the next 20 years.

1.0 INTRODUCTION

Draper Aden Associates was selected by the Thomas Jefferson Planning District Commission to work on the project team and develop a comprehensive Water Resource Study to address future growth that is expected to occur over the next 20 years. This Study was prepared by a project team consisting of the Thomas Jefferson Planning District Commission, the Virginia Division of Mineral Resources, the Louisa County Planning Department, the Louisa County Water Authority and Draper Aden Associates.

1.1 Objectives

Louisa County is experiencing significant growth pressures from growing urban population areas around Richmond, Charlottesville, and Fredericksburg. In addition, significant growth is expected along the Interstate 64 interchanges throughout Louisa County. Population growth in the County has already exceeded original projections for the year 2000. With increasing growth in the County, more and more pressure can be expected to be placed on the limited water and wastewater resources available within the County. This Study is a tool that can be used to assist Louisa County planners in ensuring that development occurs logically within the County, that appropriate public utilities are made available to facilitate growth in an orderly, planned manner, and that areas important to future water supplies are identified for recommended protection strategies.

The specific goals and objectives of this study are as follows:

- Assess existing facilities and needs, particularly in areas impacted by road corridor development.
- Identify potential for services based on factors such as population shifts.
- Evaluate availability of resources to meet existing and projected demands for the next 20 years in potential growth areas.
- Develop water and wastewater master plans that can be utilized to expand public water and wastewater services to all potential growth areas.
- Evaluate the continued use of groundwater resources and sanitary drain fields in areas that may not be available for public water and wastewater services.
- Consider growth management with consideration of the Present County Comprehensive Plan and other planning documents.
- Identify funding sources and administration options for implementation.

- Improve and maintain the water quality and environmental attributes of the North Anna River and South Anna River basins within Louisa County.
- Work with the Virginia Division of Mineral Resources to develop a work program to coordinate groundwater study components.

The service area for this Study includes the entire County, but concentrates on seven specific areas that have been identified by the County as potential growth areas over the next 20 years and beyond.

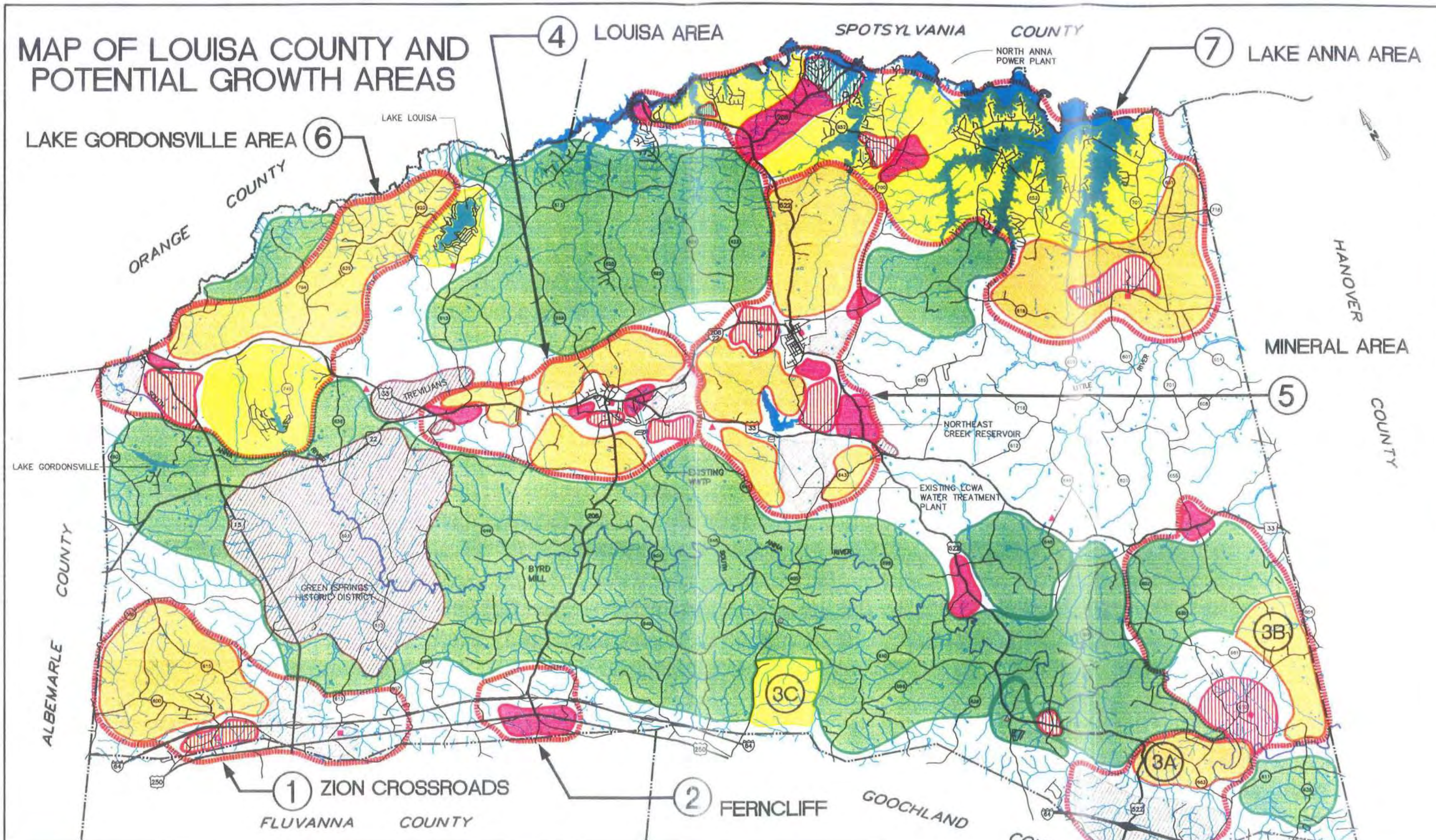
1.2 Potential Growth Areas

Based on the 1993 Louisa County Comprehensive Plan, seven potential growth areas have been identified in the County. These areas will be the primary areas considered for service by public water and sewer. However, this does not imply that other areas within the County cannot be served for public water and sewer in the future. That decision can be made by the County as further information and planning endeavors continue. The seven potential growth areas are Zion Crossroads, Ferncliff, Gum Springs, the Town of Louisa area, the Town of Mineral area, the Lake Gordonsville area, and the Lake Anna area. These areas are shown on Figure 1-1, which is an overall map of Louisa County which generally shows areas designated by the 1993 Comprehensive Plan for potential land use designation. For the purposes of this study, two (2) areas (Areas 3a and 3b) in the Gum Springs corridor are shown as residential in lieu of their original designation, agricultural/forestal. The reason for this adjustment is for potential future water projections only and does not necessary reflect recommended changes to the present Comprehensive Plan.

1.3 General Information

Louisa County is located approximately 20 miles east of Charlottesville and 50 miles northwest of Richmond (to the Town of Louisa). Louisa County lies within the Piedmont physiographic province of Virginia. The County is characterized by rolling topography with broad alluvial flood plains. The majority of the slopes are between 2-6% and between 6-12%. The majority of the County is forest land. Dominant forest types are hardwood. Other natural resources include geological deposits of limestone and dolomite near Gordonsville and granite near Mineral. Sulfide deposits were discovered near Mineral in the 1800's also yielding copper ore and a large tonnage of pyrite. Other minerals that have been mined in the County include iron, lead, zinc, gold, silver, manganese, mica, barite, soapstone, gneiss, vermiculite, sand, clay, and talc. The major rivers in the county are the South Anna River, the Little River and the North

MAP OF LOUISA COUNTY AND POTENTIAL GROWTH AREAS



RESIDENTIAL	AGRICULTURAL/FORESTAL	NON-DESIGNATED AREAS ARE RURAL RESIDENTIAL
MEDIUM DENSITY/RESIDENTIAL	RETAIL/SERVICE	LIMITS OF POTENTIAL GROWTH AREA
RESORT/MIXED USE	WATER RELATED COMMERCIAL	LCWA — LOUISA COUNTY WATER AUTHORITY
HISTORIC RESOURCES	COMMERCIAL/INDUSTRIAL	▲ EXISTING SCHOOL
		■ EXISTING FIRE STATION

NOTE: LAND USE DESIGNATIONS ARE BASED ON THE 1993 COMPREHENSIVE PLAN (EXCEPT AREA 3A, 3B AND 3C).

Draper Aden Associates
CONSULTING ENGINEERS

FIGURE 1-1

Anna River which was impounded in 1969-1970 to form Lake Anna on the Northern border of Louisa County.

The average annual precipitation for Louisa County as reported from the Piedmont Field Station in Orange County is 41 inches (York Water Supply Plan, Planning Bulletin 343, VWCB, 1988).

The average annual temperature in Louisa County is approximately 57 degrees Fahrenheit (York Water Supply Plan, Planning Bulletin 343, VWCB, 1988).

1.4 History/Background

Louisa County was formed in 1742 from Hanover County and named for Princess Louisa, Queen of Denmark and daughter of George II of England. The largest Cavalry action of the Civil War took place at Trevilians, just west of the Town of Louisa. Other historic sites include Boswell's Tavern, Providence Presbyterian Church, the Plantation Homes in the Green Springs Area, Byrd Mill, and the Louisa County Jail.

1.5 Previous Reports and Information

Several past studies have been performed in portions of the County (or neighboring jurisdictions) and have been reviewed for preparation of this Study. These reports include:

1. *"Water Resources Study for the Zion Crossroads Area"*, Timmons, June, 1996.
2. *"Water Supply and Storage Options for the Town of Gordonsville"*, Espey, Huston & Associates, Inc., 1995.
3. *"Feasibility Study Relating to a Central Water System for Louisa-Mineral Area"*, May-Hines & Associates, 1977.
4. *"Joint Water Study for Town of Louisa and Town of Mineral"*, R. Stuart Royer & Associates, 1963.
5. *"Louisa County 1993 Comprehensive Plan"*, adopted November, 15, 1993.
6. *"Build-Out Analysis of the Thomas Jefferson Planning District"*, prepared by the Thomas Jefferson Planning District Commission, October, 1996.

7. *"Louisa County DRASTIC - A Mapping Project to Delineate Groundwater Pollution Potential Areas with Associated Protection Strategies"*, prepared by the Thomas Jefferson Planning District Commission (TJPDC), 1991.

8. *"Prioritization of Third and Fourth Order Watersheds in the Thomas Jefferson Planning District"*, prepared by the TJPDC, 1993.

9. *"Identification of Nonpoint Source Pollution Potential to Groundwater from Pesticides in Albemarle and Louisa County"*, prepared by TJPDC and Virginia Tech, 1993.

10. *"Evaluation of Household Water Quality in Goochland County, Virginia"*, prepared by Virginia Tech, 1996.

11. *"Louisa County Water Testing Program"*, prepared by Virginia Tech and the TJPDC, 1992.

The first 4 water studies listed above were all performed for specific areas within or adjacent to Louisa County and their contents were useful in preparation of portions of this Study. However, this study represents the first comprehensive approach to water resource development and system planning undertaken for the entire County.

2.0 PRESENT WATER QUALITY IN LOUISA COUNTY

The water resources in Louisa County include impoundments (lakes), groundwater supplies, rivers and streams. These resources are utilized to provide drinking water, recreational activities, and aesthetic value to County residents. A review of many previous studies (as referenced in section 1) and available water quality data was performed and the general findings are presented.

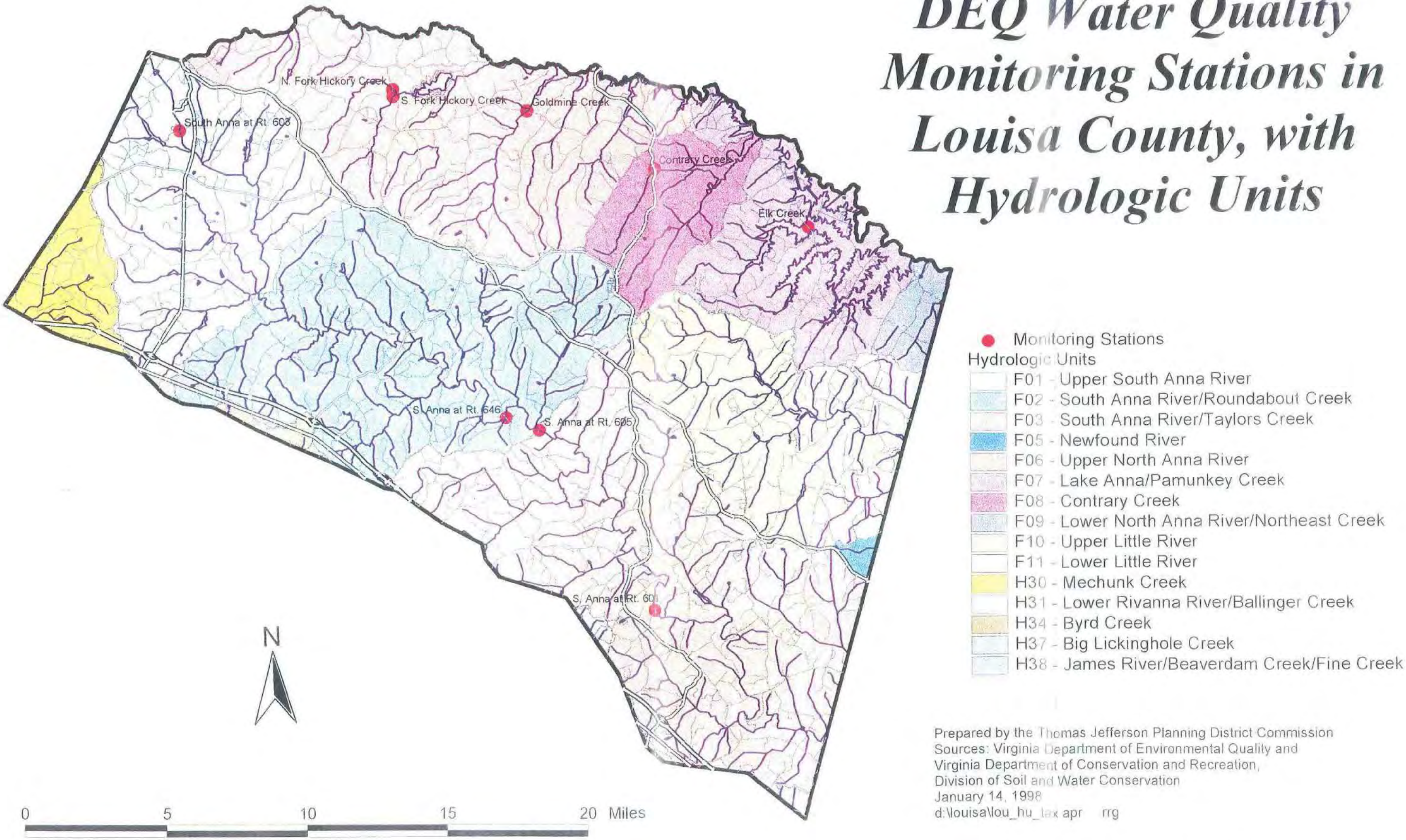
2.1 Watersheds

Louisa County contains 514 square miles and lies solely within the Piedmont Physiographic Province. The land is described as gently rolling with elevations varying from 200 feet to 600 feet above sea level. The County is drained primarily by the North Anna and South Anna Rivers and their tributaries, that are part of the York River watershed There are some small areas along the southern border of the County which are part of the James River Basin. Figure 2-1 shows all rivers, streams, and tributaries along with the hydrologic units of the entire County. The boundaries of the hydrologic units coincide with the specific watersheds of the County. Within Louisa County, the North Anna watershed is made up of the upper North Anna River basin, the Contrary Creek watershed, the Lake Anna/Pamunkey Creek watershed, and the Lower North Anna watershed. The Upper and Lower Little River watersheds along with the Newfound River watershed are also part of the North Anna River basin, but these rivers do not join the North Anna for many miles east of the Louisa County border. The South Anna (S.A.) River watershed is made up of the Upper S.A. watershed, the S.A./Roundabout Creek watershed, and the S.A./Taylors Creek watershed. The hydrologic basins that are part of the James River watershed include the Mechunk Creek watershed, the Byrd Creek watershed, the Big Lickinghole Creek watershed, and the James River/Beaverdam Creek watershed.

2.2 Groundwater Quality

The quality of groundwater appears to be good throughout most of Louisa County; however, a review of previous studies and available data indicate some areas of concern. A brief summary of the primary findings of these studies and data is presented in this section. A more detailed description of these findings is provided in Appendix A.

DEQ Water Quality Monitoring Stations in Louisa County, with Hydrologic Units



Prepared by the Thomas Jefferson Planning District Commission
Sources: Virginia Department of Environmental Quality and
Virginia Department of Conservation and Recreation,
Division of Soil and Water Conservation
January 14, 1998
d:\louisa\lou_hu_tax.apr rrg

FIGURE 2-1

2.2.1 Louisa County DRASTIC Study

The purpose of the Louisa County DRASTIC mapping project was to produce a map showing the areas of Louisa County that are most vulnerable to groundwater pollution and to propose stategies to protect groundwater in those areas. "DRASTIC" is an acronym for the seven parameters that were used to evaluate groundwater pollution potential: Depth (to groundwater), Recharge (net), Aquifer media, Soil media, Topographic position, Impact of vadose zone, and hydraulic Conductivity. A numerical value (index) was assigned to each of the three hydrogeological settings that exist in Louisa County. A higher index value represents a higher pollution potential.

Areas mapped as having high susceptibility to groundwater contamination were found to be associated with a higher incidence of contamination. Coliform bacteria were found in about 88% of the wells located in high DRASTIC areas, whereas 58% of the wells in low DRASTIC areas tested positive. Both high DRASTIC areas and low DRASTIC areas were tested in order to make a valid comparison. The results were:

DRASTIC RATING:	
low:	100-119
	120-139
	140-159
high	180-199

high DRASTIC:	81% total coliform contamination
	44% fecal coliform contamination
low DRASTIC:	58% total coliform contamination.
	23% fecal coliform contamination

Appendix A contains a description of all the DRASTIC evaluation parameters and more information on contamination findings.

2.2.2 Louisa County Water Testing Study (Virginia Tech)

This study reported that 60% of the wells sampled tested positive for total coliform bacteria, 25% contained fecal coliform bacteria, and 14% of the wells in agricultural areas were characterized by nitrate concentrations exceeding the drinking water standard (maximum contamination level = MCL). Of those areas associated with a high DRASTIC score for groundwater pollution potential, 81% of the wells contained coliform bacteria. Of those wells associated with septic systems more than 20 years old, 71% contained coliform bacteria. Coliform bacteria were observed in 100% of the sampled wells that were associated with a high DRASTIC score and located on a farm or high-density residential lot (< 1 acre).

Other findings and details of this study are presented in Appendix A.

2.2.3 Evaluation of Household Water Quality in Goochland County

The findings from this study differ somewhat from the study discussed in section 2.2.2; however, because of similarities in both demographics and geology between eastern Louisa County and western Goochland County, some of the results of the Goochland study appear to be relevant to Louisa County:

- 65% of the participants who indicated the depth of their well reported depths greater than 50 feet; 35% reported depths less than (or equal to) 50 feet. The average well depth was 151 feet.
- 14% of the participants have septic system drainfields within 100 feet of their water supply well, whereas total coliform bacteria were found in 58.4% of raw well water samples and *E. coli* (fecal coliform) was found in 9.5% of raw well water samples.
- 26% of the participants indicated that their water supply well was within 0.5 mile of a major farm animal operation, whereas total coliform bacteria (which may be derived from animals as well as humans) were found in 58.4% of raw well water samples and the concentration of nitrate was found to exceed its MCL in 2.9% of the samples.

2.2.4 Review of VDH Data

In order to further evaluate the potential quality of groundwater resources in Louisa County, data obtained from the Virginia Department of Health was reviewed for three important parameters: hardness, nitrate, and nitrite in public water supply wells. This data is provided in Appendix A.

Based upon a review of average hardness and nitrate concentrations, the quality of water obtained from the public wells appears to be acceptable throughout Louisa County. Two wells appear to have marginal problems with hardness: one well at Blue Ridge Shores (average total hardness = 155 mg/l = 86% of the drinking water standard of 180 mg/l), and one well at Kloeckner (average hardness = 180 mg/l = drinking water standard).

2.3 Surface Water Quality

The quality of surface water appears to be good throughout most of Louisa County according to previous studies conducted and the data reviewed. A brief summary of the primary findings of these studies and data are presented is this section. A more detailed description of these findings is provided in Appendix A.

2.3.1 Prioritization of Third and Fourth Order Watersheds

In this study, it was reported that 12 of the 145 third-order watersheds in Louisa County are classified as high priority. A high priority watershed means that the watershed is at a high level of environmental sensitivity. Another 57 watersheds discharge to the high priority areas and, therefore, may also be considered critical. Expressed in terms of area, about 53,416 acres of Louisa County are within high priority watersheds, whereas approximately 122,250 acres drain to such watersheds.

The South Anna River was ranked high-priority because of an abundance of associated wetlands. Similarly, wetlands are present in areas adjacent to the County sanitary landfill. The area near Northeast Creek Reservoir is ranked high-priority because it is a source of potable water. It should also be noted that at least some portions of the Northeast Creek Reservoir watershed appear to drain mining areas.

2.3.2 Chemical Data Analysis

Data available from nine surface water monitoring stations (shown on Figure 2-1) in Louisa County were reviewed and analyzed statistically. A table (presented in Appendix A) presents summary statistics (mean, standard deviation, sample size, maximum, minimum) for those parameters that appeared to have been measured during multiple sampling events. Among those parameters, several (pH, nitrate, hardness, chloride, sulfate) are associated with drinking water standards referred to as MCLs (maximum contaminant levels) or secondary MCLs. With the exception of Contrary Creek, the average concentrations of all regulated drinking water parameters lie far below those standards.

The average pH at the Contrary Creek station (3.76 standard units) is well below the drinking water standard (6.5 S.U.); the average total hardness (as $CaCO_3$; 114.8 mg/l) is nearly

65% of the drinking water standard (180 mg/l); and the average sulfate (about 184 mg/l) is almost 75% of the drinking water standard (250 mg/l). These data suggest that Contrary Creek has been significantly degraded by the mining activities that took place within the upper reaches of this watershed.

It should be noted that most of the parameters being monitored by the Virginia DEQ are <u>general</u> indicators of water quality (parameters that are generally of interest to those who are responsible for maintaining public supplies of potable water). There is a general paucity of surface water data for constituents that are relevant to the mining industry in the area (such as antimony, lead, zinc, mercury, and cyanide).

A statistical cluster analysis of the mean water quality parameter values was performed in order to help reveal similarities among different surface waters.. A summary of the statistical analysis and information concerning theory and computational methods is presented in Appendix A. Salient results of the cluster analyses are as follows:

- The surface water chemistry profile at South Anna Route 646 (SAR 646) is very similar to that observed at South Anna Route 601 (SAR 601). Conversely, the water chemistry profile at South Anna Route 605 (SAR 605) differs substantially from that observed at either SAR 646 or SAR 601 - even though SAR 605 is located between the other two stations. It is noted that SAR 605 is located just below the confluence of the South Anna River with Northeast creek(a stream whose watershed appears to include both a reservoir and a portion of the Mineral gold-mining district).

- Very little chemical data from the Northeast Creek watershed was available. During the summer of 1976, however, the USGS analyzed surface water samples from six stations located within the Northeast Creek watershed. Selected samples were analyzed for dissolved sulfate (5 samples among 4 stations; average = 6.4 ppm, median = 6.0 ppm), dissolved iron (5 samples among 4 stations; 2 highest values = 450 ppb and 600 ppb), copper (in sediment; 1 sample = 10 ppb), lead (in sediment - 1 sample = 10 ppb), silver (in sediment, 1 sample = <0 ppb), and zinc (in sediment, 1 sample = 80 ppb). These data reveal no evidence that any portions of Northeast Creek have been adversely affected by mining activities in the northeastern most reaches of the watershed; however, the paucity of data precludes any confidence in such a conclusion.

- Surface water chemistry profiles at Goldmine Creek Route 628 (GMC 628) and South Anna River Route 603 (SAR 603) are more similar to each other than they are to other stations within their respective watersheds. The reasons why this might be so are not understood, but may reflect similarities in dominant bedrock geology and/or land use.

- Surface water chemistry profiles at North Fork Hickory Creek (HNF) and South Fork Hickory Creek (HSF) are more similar to each other than that observed at any other stations. The similarity between water chemistry at these two stations is likely to reflect considerable similarity in bedrock geology and land use within their respective watersheds.
- The surface water chemistry profile at Contrary Creek is only weakly related to that observed at other stations in Louisa County. The apparent relationship between Contrary Creek and the Mineral gold-mining district is discussed above.

Also performed was a principal components analysis of mean water quality parameter values in order to help reveal relationships among different water quality parameters (provided in Appendix A). Salient results of the principal component analyses are as follows:

- NH3 + NH4 (ammonia), SO4 (sulfate), and hardness are highly inter-correlated
- NO3 (nitrate) and chloride are moderately inter-correlated
- NO2 (nitrite) and BOD (biochemical oxygen demand) are highly inter-correlated

It is difficult to explain the physical-chemical reasons for the observed correlations; however, such empirical relationships may have practical value. For example, increasing levels of nitrite may be associated with increases in treatment costs (as BOD increases with NO2).

It is recommended that the Contrary Creek-Freshwater Creek watersheds be removed from consideration for potential development of either groundwater or surface water resources until more detailed water quality studies have been conducted.

It is recommended that the County consider developing a modest program to evaluate the distributions of inorganic constituents that are likely to be derived from gold mine tailings, stamp mill tailings, and amalgamation plants (antimony, lead, zinc, mercury, cyanide) within the Contrary Creek-Freshwater Creek watersheds and the northeastern most portion of the Northeast Creek watershed.

2.3.3 Biological Data Analysis

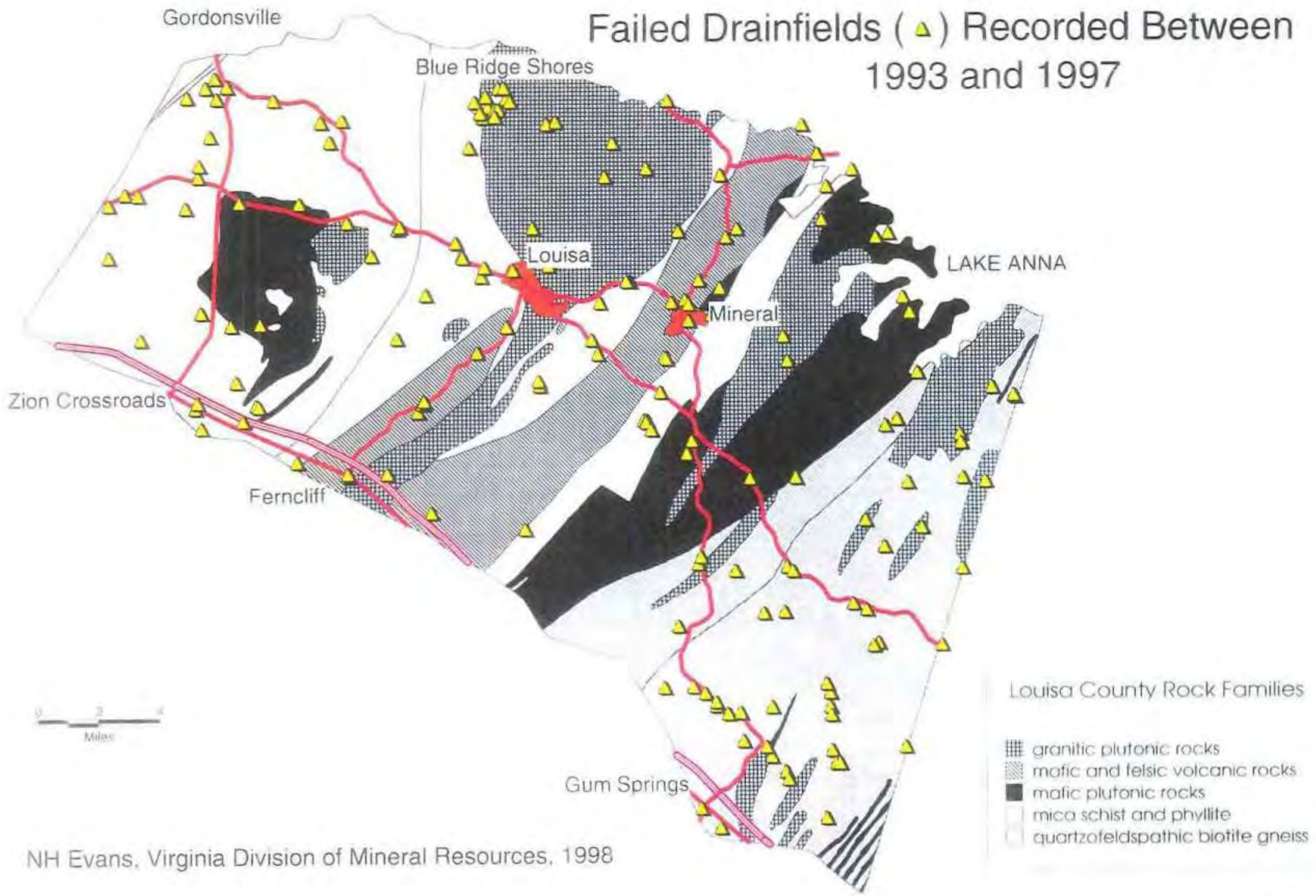
A rigorous analysis of fish diversity and population structure was not feasible because of the lack of data available for all observed fish species; however, using portions of the standard EPA methods (*Rapid Bioassessment Protocols [RBP] for Use in Streams and Rivers*; a non-intensive assessment of the overall water quality was performed.

Fish survey data was obtained from maps prepared by the Thomas Jefferson Planning District Commission (dated October 29, 1997), which was based on nine monitoring locations throughout Louisa County. The original source of the fish census information was the Virginia Department of Environmental Quality. The RBP analyses suggests that the water quality at all monitoring stations is not significantly degraded (except for the monitoring station on the South Anna River at State Route 601).

2.4 Sanitary Drainfields

When properly designed, installed and maintained, septic systems can provide cost-effective treatment of household sewage and certain wastes from small businesses. Unfortunately, septic systems that malfunction also can contaminate groundwater, surface water, and soils. According to the U.S. Environmental Protection Agency (EPA), septic systems are the most frequently reported sources of groundwater contamination in the nation. Malfunctioning septic systems often affect the drinking water of users of the system first; many people who rely on a septic system also rely on groundwater, tapped by a well on the same property, to meet their drinking, household, business, and farm water needs.

Even where operating properly, systems can be spaced so densely that their discharge exceeds the capacity of the soil to assimilate the pollutant loads. Because the design life of many septic systems built during the 1960s and 1970s is now being approached, groundwater contamination caused by septic system failure probably will increase in the future. This appears to be the situation around Lake Louisa (Blue Ridge Shores Subdivision), a relatively dense (3 lots/acre) residential community that began construction during this time period. As shown on Figure 2-2, which is a map of all reported drainfield failures between 1993 and 1997, the highest failure density in the County is around this development. The other reported failures appear to be spaced consistently throughout the County.



Failed Drainfields (▲) Recorded Between 1993 and 1997
Gordonsville
Blue Ridge Shores
Louisa
Mineral
LAKE ANNA
Zion Crossroads
Ferncliff
Gum Springs
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 2-2

3.0 GEOLOGY AND GROUNDWATER HYDROLOGY

The quantity and quality of water that can be pumped from the ground at a given location is determined by physical characteristics of the soil, weathered rock material (saprolite), and bedrock that underlie the area. Groundwater occurs in soil, saprolite, and bedrock, and water wells can be constructed to tap water in each of these zones.

3.1 General Overview

Hand-dug wells, and wells that are bored with an auger, penetrate soil and saprolite to maximum depths of about 75 feet, but not the hard bedrock beneath. These wells are vulnerable to seasonal fluctuations in the water table and to contamination from surface water sources. In general, shallow wells that do not penetrate bedrock are not viable for long-term domestic water supply.

Drilled water wells tap sources of high quality groundwater in the bedrock, at depths of up to several hundred feet. These wells are cased (or sealed) from the surface down through soils and saprolite to the top of the bedrock in order to prevent direct infiltration of surface water into the well. Ideally, the water that is pumped from a deep drilled well has spent a long time percolating downward through soils, saprolite, and the bedrock itself, and has been cleansed of biological and chemical impurities. These are the type of wells that are desirable to supply domestic and industrial water needs for long term applications.

The nature of the bedrock geology is critical to determining the quantity of groundwater that can be pumped from a drilled well in any given place. In some parts of the world, bedrock geology consists of porous sedimentary layers that form laterally extensive aquifers at predictable depths, from which seemingly unlimited quantities of high-quality groundwater can be pumped. In these areas, groundwater is the obvious solution for public water supply needs. Other parts of the world, Louisa County included, are underlain by crystalline igneous and metamorphic rocks that have little or no primary porosity. In these areas, laterally extensive aquifers are rare, and the quantity of water available at a given site, and the depth of the water-bearing zones, are highly variable and difficult to predict. Additionally, wide variation in mineralogy and chemistry of bedrock types in a geologically complex crystalline terrain such as Louisa County can lead to variations in groundwater chemistry, resulting in water quality problems in some areas. To evaluate groundwater quantity and quality questions in Louisa, we need detailed knowledge of bedrock types and structures, and a knowledge of the hydrologic characteristics of existing drilled wells.

3.2 Bedrock Geology

In undertaking this study, all available published geologic maps that include any portion of Louisa county have been digitized, attributed, and converted into *ArcView* shape files that will be compatible with the new Louisa County GIS (Geographical Information System) platform. This provides a framework not only for the present study, but also for working with a variety of other planning issues that may arise in the future. The coverage includes data compiled at 1:500,000 scale (100% of the county represented), 1:100,000 scale (80% of the county represented) and 1:24,000 scale (20% of the county represented). The digital files, which include explanatory text and references to source materials, are being incorporated into the County's new GIS system.

Louisa County is underlain by igneous and metamorphic rocks ranging in age from 300 million to more than one billion years. The western portion of the county is underlain predominantly by mica schist and phyllite that represent metamorphosed sandstone, siltstone and mudstone originally deposited in an Early Paleozoic (500 million years ago) ocean basin. The Green Springs area is underlain by a mafic-composition igneous pluton and associated granitic rocks. The Ellisville Granodiorite is a granitic igneous pluton that underlies the north-central portion of the county, extending southwestward through the town of Louisa to beyond Ferncliff. The east-central portion of the county is underlain by metamorphosed mafic and felsic composition volcanic rocks of the Cambrian-age (560 million years ago) Chopawamsic Formation, and the Ordovician-age (450 million years ago) Quantico Slate. The Chopawamsic contains a series of gold and sulfide mineral deposits that extend from north of the town of Mineral, southwestward to the Shannon Hill area and beyond. The southeastern portion of the county is underlain by billion-year-old garnet-biotite gneisses of the Maidens Formation, which appear to represent ancient sedimentary deposits that have been deeply buried and metamorphosed at high temperatures and pressures. The Maidens is intruded by a series of granitic plutonic rocks. Throughout Louisa County, many of the boundaries between individual rock formations are faults, some of which are regionally extensive and have histories of multiple movement.

For purposes of this report, the approximately 50 different bedrock mapping units represented in the digital database have been grouped into 5 rock families (which are shown on Figure 3-1):

1. quartzofeldspathic biotite gneiss
2. granitic plutonic rocks
3. mafic and felsic volcanic rocks
4. mafic plutonic rocks
5. mica schist and phyllite.

Fundamentally, all bedrock underlying Louisa County is crystalline rock that contains virtually no pore space between individual mineral grains. Groundwater occurs only within fractures in the rock. The density and geometry of bedrock fractures, and the ease with which groundwater can move through the fractures are critical to determining how much water can be extracted from wells penetrating bedrock. Fracture density and orientation varies among different rock types and from place to place within any one rock type. Fractures are geometrically related to structural features such as folds and faults. Surface observations on bedrock structures can be used to estimate fracture orientations in the subsurface; topographic lineaments defined on aerial photographs and topographic maps are also instructive.

In general, mica schist and phyllite contain fewer through-going fractures than do harder, less mica-rich rocks such as granitic or mafic plutonic rocks, mafic or felsic volcanic rocks, and quartzofeldspathic gneiss. However, within any of these rock types, there are likely to be some locations where geologic structures result in very low fracture densities and little or no groundwater productivity, and other areas where fracture geometry and density support substantial groundwater yields.

3.3 Saprolite

Water well yields in crystalline rock are determined not only by fracture density in the bedrock, but also by the effectiveness with which water is stored in the overlying saprolite and transmitted into fracture systems below. The physical properties of the saprolite that develops over a particular type of bedrock are determined by the ways in which the individual minerals that make up the rock behave in the weathering environment. Some common minerals such as quartz and muscovite are highly resistant to chemical weathering. Other common minerals such

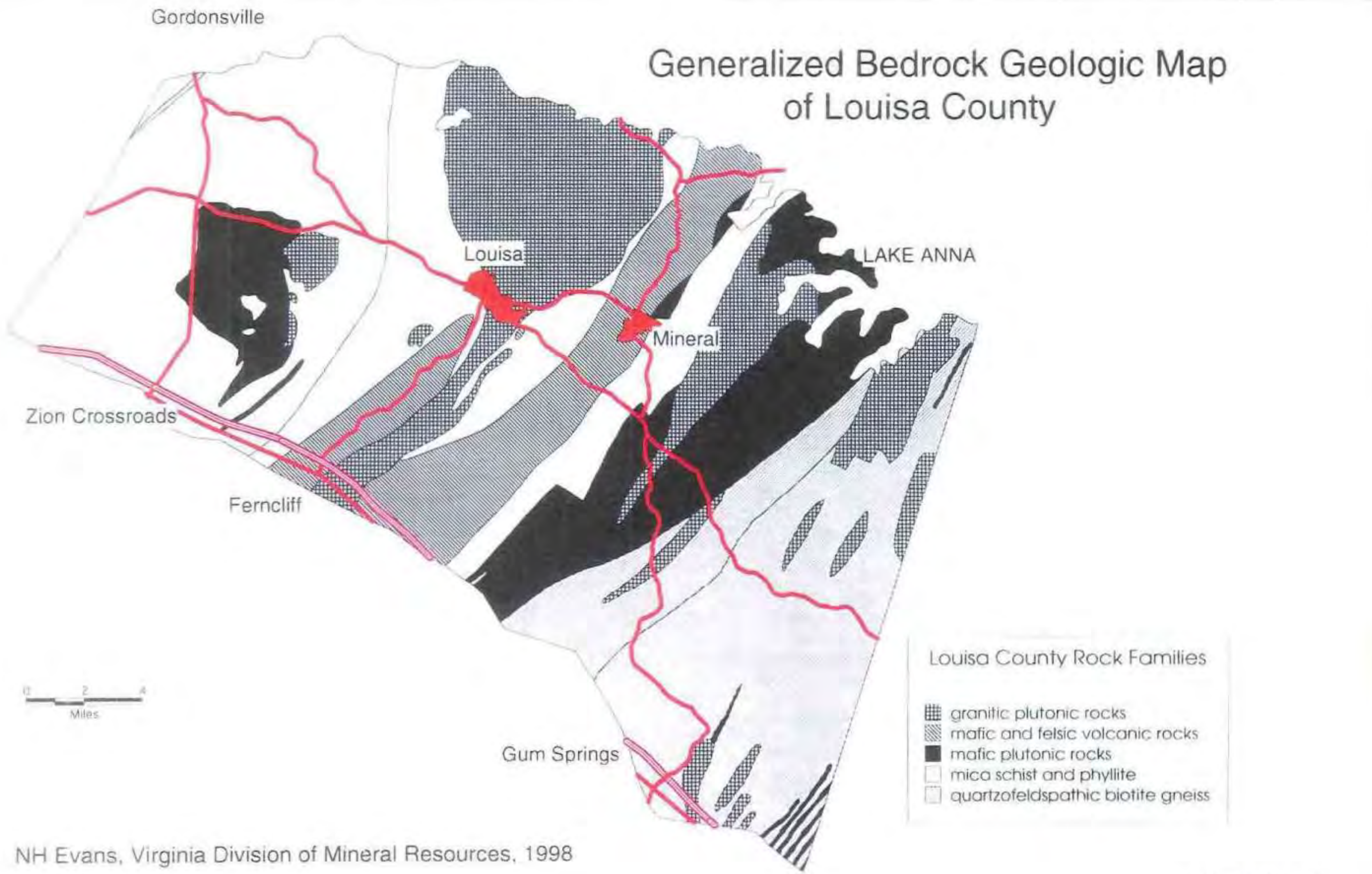

Generalized Bedrock Geologic Map of Louisa County
Gordonsville
Louisa
LAKE ANNA
Mineral
Zion Crossroads
Ferncliff
Gum Springs
0 2 4
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 3-1

as feldspar, biotite, and amphibole weather readily to form hydrated clays, and may be leached away to some extent, leaving void space in the saprolite residuum.

Granitic plutonic rocks and quartzofeldspathic gneisses that contain abundant quartz, muscovite, and feldspar commonly weather to thick saprolite in which quartz and muscovite form a porous lattice around voids left by leached feldspars. This type of saprolite can be highly permeable with respect to groundwater, if the orientation of the residual lattice is suitable. A thick layer of this material can provide excellent storage for groundwater recharge. In contrast, mafic composition igneous rocks, which contain little or no quartz or muscovite, commonly weather into relatively thin, clay-rich saprolite. This material can be relatively impermeable to groundwater, and consequently does not make good storage or recharge material.

Paradoxically, the highly permeable granitic and gneissic saprolites that function best in terms of groundwater storage and recharge are also most susceptible to contamination by infiltration of surface waters, particularly drainfield effluents. Clay-rich saprolite derived from mafic composition igneous rocks is a less efficient storage medium for groundwater recharge, but is also less vulnerable to contamination.

Saprolites are generally thickest in upland areas with gentle slopes, and thin to absent on steeper slopes adjoining stream drainages. Drainage bottoms commonly contain transported alluvial and terrace deposits sitting directly on bedrock. Casing lengths reported on drilled water wells are a reliable indicator of saprolite thickness. Casing length data in the water well database (Figure 3-2) indicate that most upland areas of Louisa County are underlain by more than 50 feet of saprolite. On average, saprolite is thickest over mica schist and phyllite, and thinnest over granitic plutonic rocks, although averages are within 20 percent of each other among all five rock families:

	average casing length (feet)	number of wells
mica schist and phyllite	74.3	389
mafic and felsic volcanic rocks	73.0	316
quartzofeldspathic biotite gneiss	72.8	217
mafic plutonic rocks	68.7	520
granitic plutonic rocks	60.9	439

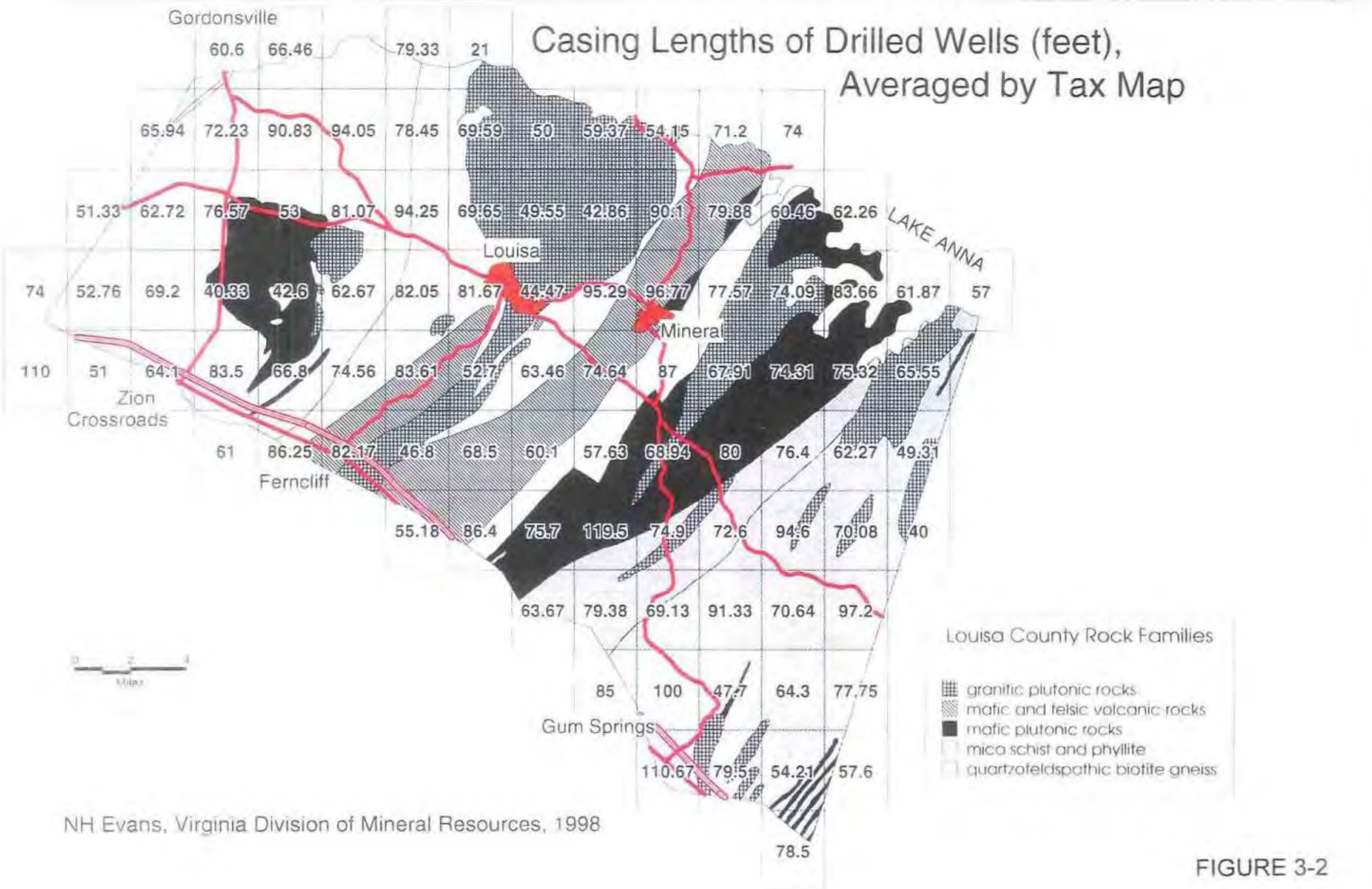

Casing Lengths of Drilled Wells (feet), Averaged by Tax Map
Gordonsville
Louisa
Mineral
Zion Crossroads
Ferncliff
Gum Springs
LAKE ANNA
60.6
66.46
79.33
21
65.94
72.23
90.83
94.05
78.45
69.59
50
59.37
54.15
71.2
74
51.33
62.72
76.57
53
81.07
94.25
69.65
49.55
42.86
90.1
79.88
60.46
62.26
74
52.76
69.2
40.33
42.6
62.67
82.05
81.67
44.47
95.29
96.77
77.57
74.09
83.66
61.87
57
110
51
64.1
83.5
66.8
74.56
83.61
52.7
63.46
74.64
87
67.91
74.31
75.32
65.55
61
86.25
82.17
46.8
68.5
60.1
57.63
68.94
80
76.4
62.27
49.31
55.18
86.4
75.7
119.5
74.9
72.6
94.6
70.08
40
63.67
79.38
69.13
91.33
70.64
97.2
85
100
47.7
64.3
77.75
110.67
79.5
54.21
57.6
78.5
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 3-2

3.4 Soils

Soil characteristics are critical in evaluating drain field suitability and effectiveness of groundwater recharge. In most parts of Louisa County, the soils are residual soils that formed *in situ* by weathering of parent saprolite, as opposed to transported soils that were carried in by wind or water from elsewhere and deposited. Consequently, the soil associations of Louisa County (Figure 3-3) are strongly correlated with the underlying saprolite and bedrock. The soil associations give a general idea of drainage, depth, and permeability:

Nason-Tatum-Manteo (mica schist and phyllite bedrock): deep, well-drained, moderately permeable.

Nason-Tatum (mafic and felsic volcanic rock bedrock): deep, well-drained, moderately permeable.

Zion-Poindexter-Iredell (mafic plutonic rock bedrock): moderately deep to deep, moderately well drained to somewhat poorly drained; slowly to moderately permeable.

Sekil-Iredell-Cullen (mafic plutonic rock bedrock): moderately deep to deep, well-drained to somewhat poorly drained, slowly to moderately rapidly permeable.

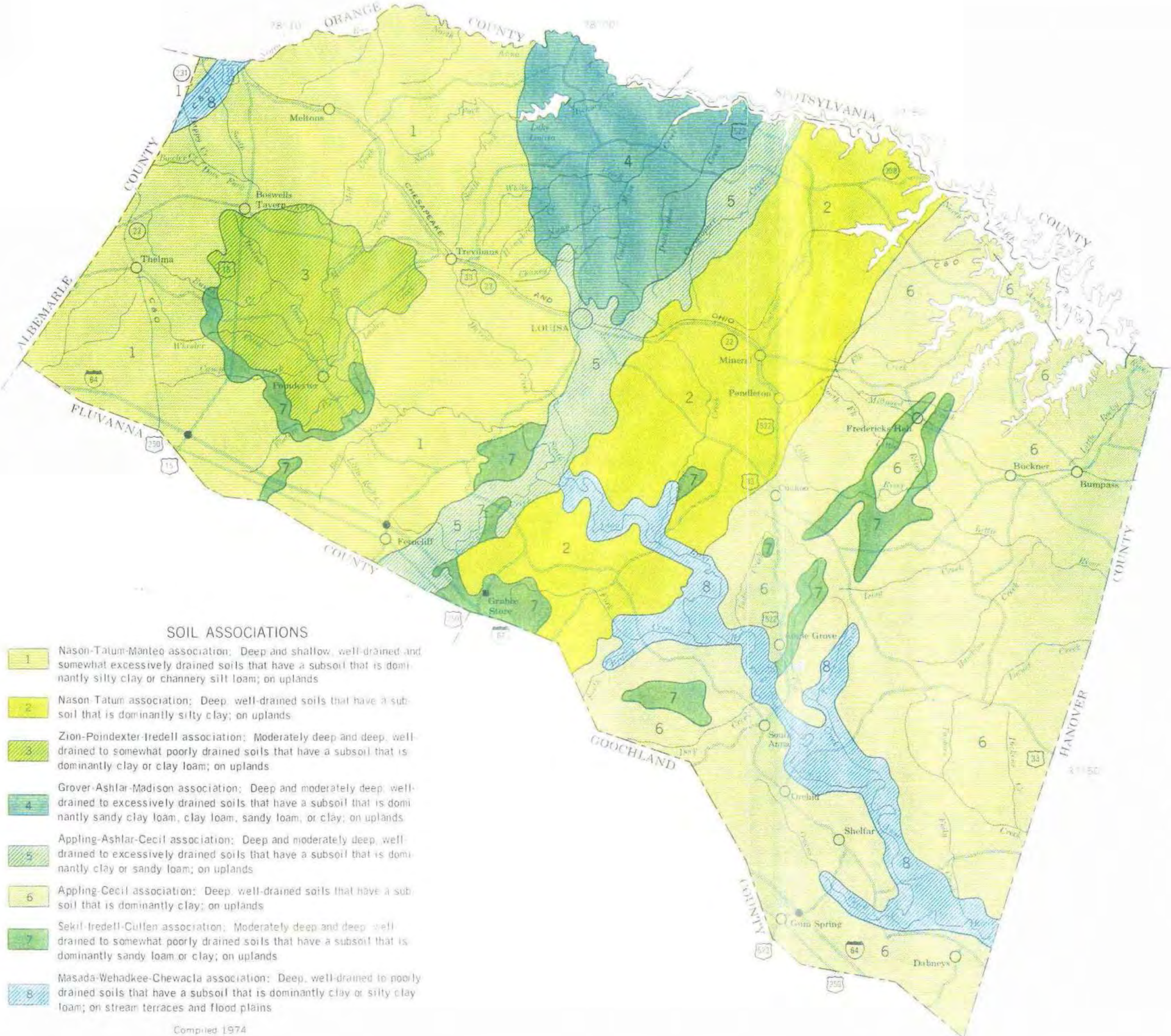
Grover-Ashlar-Madison (granitic plutonic rock bedrock): moderately deep to deep, well-drained to excessively-drained, moderately to moderately rapidly permeable.

Appling-Ashlar-Cecil (granitic plutonic rock bedrock): moderately deep to deep, well-drained to excessively-drained, moderately permeable.

Appling-Cecil (quartzofeldspathic biotite gneiss bedrock): deep, well-drained, moderately permeable.

Masada-Wehadkee-Chewacla (alluvium and terrace deposits): deep, well-drained to poorly-drained, moderately permeable.

The soil associations are too general to be used for purposes of evaluating specific sites, but they do serve to flag potential drainfield and groundwater problems in some parts of the county. Both highly permeable soils and low permeability soils can be unfavorable for drainfield siting. In order to make zoning decisions with respect to issues of lot size and drainfield



SOIL ASSOCIATIONS

1	Nason-Tatum-Manteo association: Deep and shallow, well-drained and somewhat excessively drained soils that have a subsoil that is dominantly silty clay or channery silt loam; on uplands
2	Nason-Tatum association: Deep, well-drained soils that have a subsoil that is dominantly silty clay; on uplands
3	Zion-Poindexter-Iredell association: Moderately deep and deep, well-drained to somewhat poorly drained soils that have a subsoil that is dominantly clay or clay loam; on uplands
4	Grover-Ashlar-Madison association: Deep and moderately deep, well-drained to excessively drained soils that have a subsoil that is dominantly sandy clay loam, clay loam, sandy loam, or clay; on uplands
5	Appling-Ashlar-Cecil association: Deep and moderately deep, well-drained to excessively drained soils that have a subsoil that is dominantly clay or sandy loam; on uplands
6	Appling-Cecil association: Deep, well-drained soils that have a subsoil that is dominantly clay; on uplands
7	Sekil-Iredell-Cullen association: Moderately deep and deep, well-drained to somewhat poorly drained soils that have a subsoil that is dominantly sandy loam or clay; on uplands
8	Masada-Wehadkee-Chewacla association: Deep, well-drained to poorly drained soils that have a subsoil that is dominantly clay or silty clay loam; on stream terraces and flood plains

Compiled 1974

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

GENERAL SOIL MAP

LOUISA COUNTY, VIRGINIA

Scale 1:190,080
1 0 1 2 3 4 Miles

FIGURE 3-3

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a b for decisions on the use of specific tracts.

suitability, planners need to utilize more detailed data contained in the 102 soil units mapped in the Louisa County soil survey of 1976. The detailed soil maps and attribute data are being incorporated in digital form into the new Louisa County GIS.

3.5 Water Well Database

In order to evaluate the relationship between geology and water well productivity in Louisa County, paper records of water well completion reports (GW2's) for all existing wells permitted by the Louisa County Health Department were scanned, and pertinent data was entered into a relational database. The database contained records for 2155 drilled wells and 1743 bored wells (Figure 3-4). Fields within the database included yield, total depth, depth to bedrock, static water level, and casing length.

Locational accuracy is crucial to correlating water well data with geologic formations and structures. At the time of this writing, wells in the database can only be located with respect to one of 105 county tax maps. Locating the wells with a higher degree of accuracy awaits resolution of issues related to translating tax map and parcel numbers into georeferenced locations using the Louisa County GIS and E-911 databases, which are under development. Sorting the data according to the 105 tax maps does not provide sufficient resolution to relate groundwater productivity to geology except in a very general way.

The water well yields (Figure 3-5) that are reported on water well completion reports are useful indicators of groundwater potential. These are initial yields, which are estimates made by drillers shortly after the well has been constructed. Initial yields are only an approximate indicator of how a well will perform under continuous pumping over time. The sustainable yield of a well is the amount of water that can be pumped on a continuous basis over time without exceeding local recharge. Generally the sustainable yield of a well is a smaller quantity than the reported initial yield.

Not withstanding uncertainties about how reported initial yields relate to sustainable yields, when the reported yields are averaged for wells occurring in a particular geologic formation, the resulting numbers do give an indication of groundwater productivity. However, it is important to consider these averages in relative rather than absolute terms. The Louisa County Health Department records contain very few reports of dry holes that were drilled and not completed. If all of the wells that have been drilled without producing any water were included in the calculations, the averages would be substantially lower.

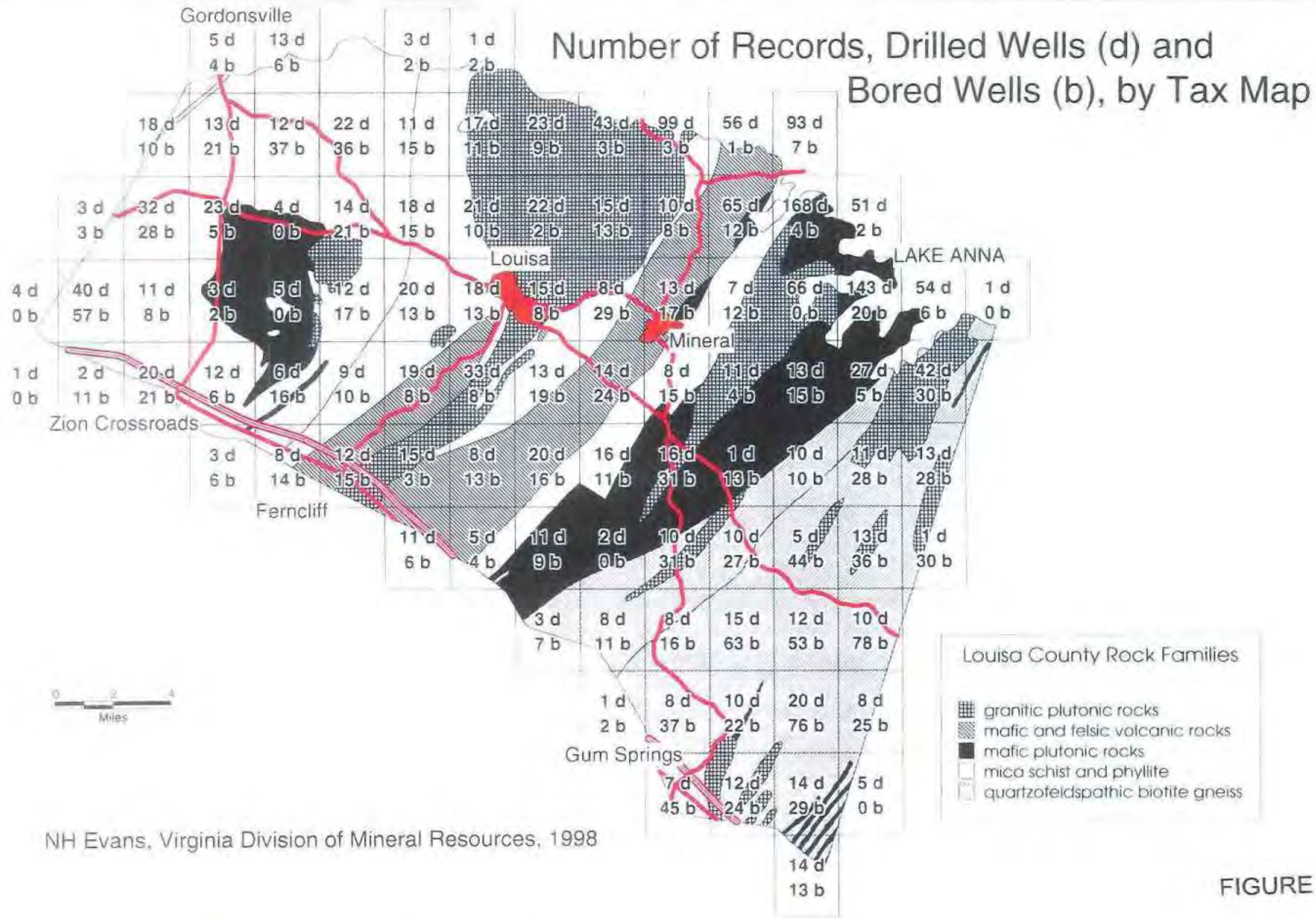

Number of Records, Drilled Wells (d) and Bored Wells (b), by Tax Map
Gordonsville
Louisa
Mineral
LAKE ANNA
Zion Crossroads
Ferncliff
Gum Springs
5 d 4 b
13 d 6 b
3 d 2 b
1 d 2 b
18 d 10 b
13 d 21 b
12 d 37 b
22 d 36 b
11 d 15 b
17 d 11 b
23 d 9 b
43 d 3 b
99 d 3 b
56 d 1 b
93 d 7 b
3 d 3 b
32 d 28 b
23 d 5 b
4 d 0 b
14 d 21 b
18 d 15 b
21 d 10 b
22 d 2 b
15 d 13 b
10 d 8 b
65 d 12 b
168 d 4 b
51 d 2 b
4 d 0 b
40 d 57 b
11 d 8 b
3 d 2 b
5 d 0 b
12 d 17 b
20 d 13 b
18 d 13 b
15 d 8 b
8 d 29 b
13 d 17 b
7 d 12 b
66 d 0 b
143 d 20 b
54 d 6 b
1 d 0 b
1 d 0 b
2 d 11 b
20 d 21 b
12 d 6 b
6 d 16 b
9 d 10 b
19 d 8 b
33 d 8 b
13 d 19 b
14 d 24 b
8 d 15 b
11 d 4 b
13 d 15 b
27 d 5 b
42 d 30 b
3 d 6 b
8 d 14 b
12 d 15 b
15 d 3 b
8 d 13 b
20 d 16 b
16 d 11 b
16 d 31 b
1 d 13 b
10 d 10 b
11 d 28 b
13 d 28 b
11 d 6 b
5 d 4 b
11 d 9 b
2 d 0 b
10 d 31 b
10 d 27 b
5 d 44 b
13 d 36 b
1 d 30 b
3 d 7 b
8 d 11 b
8 d 16 b
15 d 63 b
12 d 53 b
10 d 78 b
1 d 2 b
8 d 37 b
10 d 22 b
20 d 76 b
8 d 25 b
7 d 45 b
12 d 24 b
14 d 29 b
5 d 0 b
14 d 13 b
0 2 4
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 3-4

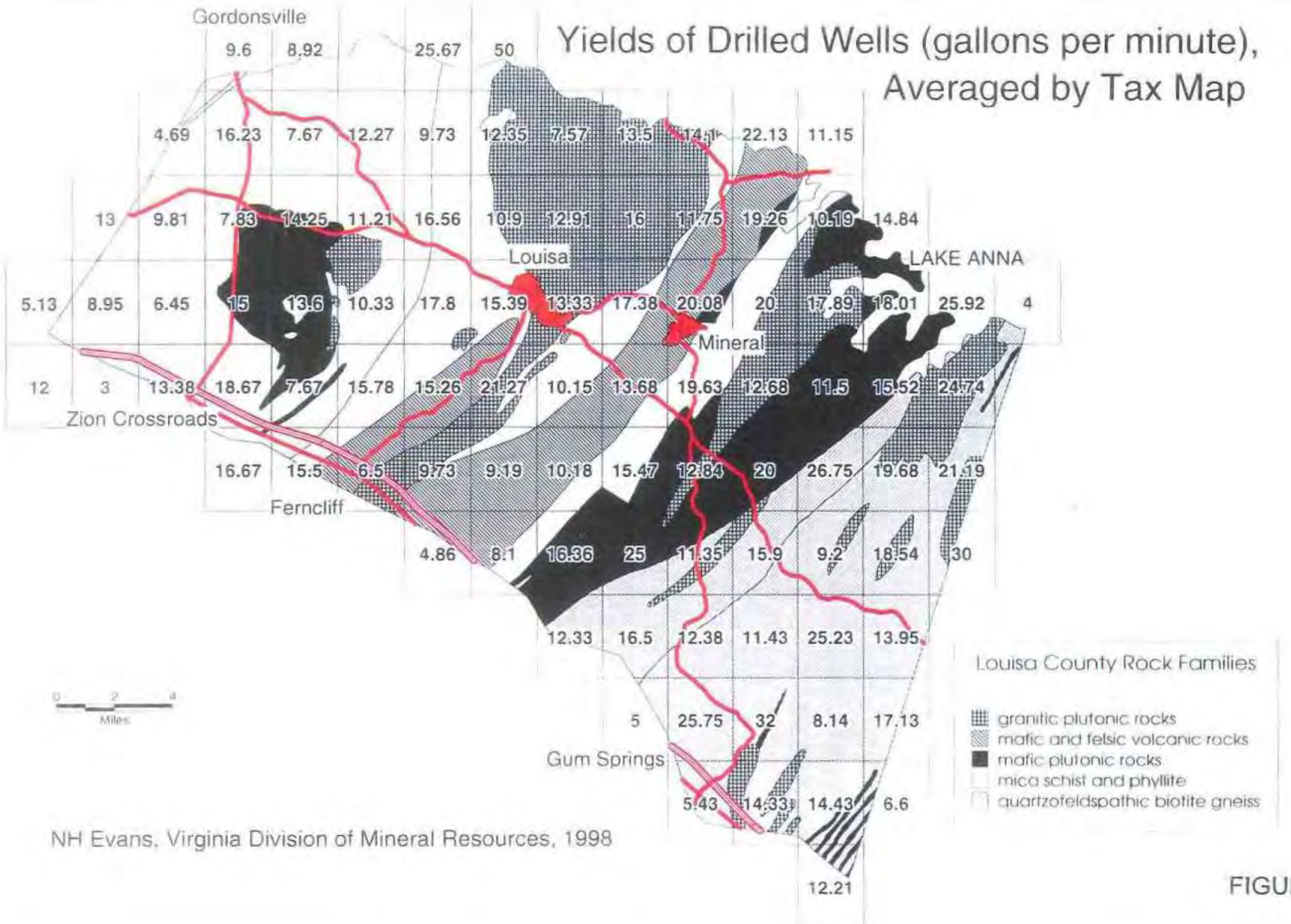

Yields of Drilled Wells (gallons per minute),
Averaged by Tax Map
Gordonsville
Louisa
Mineral
LAKE ANNA
Zion Crossroads
Ferncliff
Gum Springs
9.6 8.92 25.67 50
4.69 16.23 7.67 12.27 9.73 12.35 7.57 13.5 14.1 22.13 11.15
13 9.81 7.83 14.25 11.21 16.56 10.9 12.91 16 11.75 19.26 10.19 14.84
5.13 8.95 6.45 15 13.6 10.33 17.8 15.39 13.33 17.38 20.08 20 17.89 18.01 25.92 4
12 3 13.38 18.67 7.67 15.78 15.26 21.27 10.15 13.68 19.63 12.68 11.5 15.52 24.74
16.67 15.5 6.5 9.73 9.19 10.18 15.47 12.84 20 26.75 19.68 21.19
4.86 8.1 16.36 25 11.35 15.9 9.2 18.54 30
12.33 16.5 12.38 11.43 25.23 13.95
5 25.75 32 8.14 17.13
5.43 14.33 14.43 6.6
12.21
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 3-5

	Average yield (gpm)	number of wells
quartzofeldspathic biotite gneiss	16.2	217
granitic plutonic rocks	15.5	439
mafic plutonic rocks	15.3	520
mafic and felsic volcanic rocks	14.7	316
mica schist and phyllite	12.1	389

Differences among the average yields for volcanic, plutonic, and gneissic rocks do not appear to be statistically significant. Mica schist and phyllite have average yields that are 20 to 25 percent lower than the other rock families. This is consistent with geologic considerations in that the schists and phyllites have lower fracture densities than cyrstalline plutonic, volcanic, and gneissic rocks.

There are 82 drilled wells in the database for which reported initial yields are 50 gallons per minute or greater (Figure 3-6). Fifty of these wells are immediately adjacent to Lake Anna. This is not unexpected, given that a large body of water such as the lake has a strong effect on groundwater recharge in its immediate vicinity. Of the remaining 32 wells, 15 wells are in granitic igneous rocks, with the remainder distributed more or less evenly among the other four rock families. This is would imply that granitic plutonic rocks have more significant groundwater potential than the other four rock families in Louisa County, which is consistent with bedrock and saprolite characteristics, discussed above.

As discussed above, the VDMR well database reveals 82 drilled wells for which reported yields are 50 gallons per minute or greater, and that 61% of those wells are immediately adjacent to Lake Anna. Since a large number of wells have been drilled along the south bank of Lake Anna, one might suspect that the apparently higher average yield of wells located along Lake Anna might arise simply from the increased opportunity to encounter higher yields (viewing wells as "trials" in a statistical sense). In order to investigate this possibility, a data set composed of the information available for each Tax Map was evaluated based on average yield (and log average yield) and number of drilled wells (and log number of drilled wells).

As illustrated by a series of scatter plots (Appendix B), there is no obvious correlation between the average yield observed within a given Tax Map and the number of wells drilled in

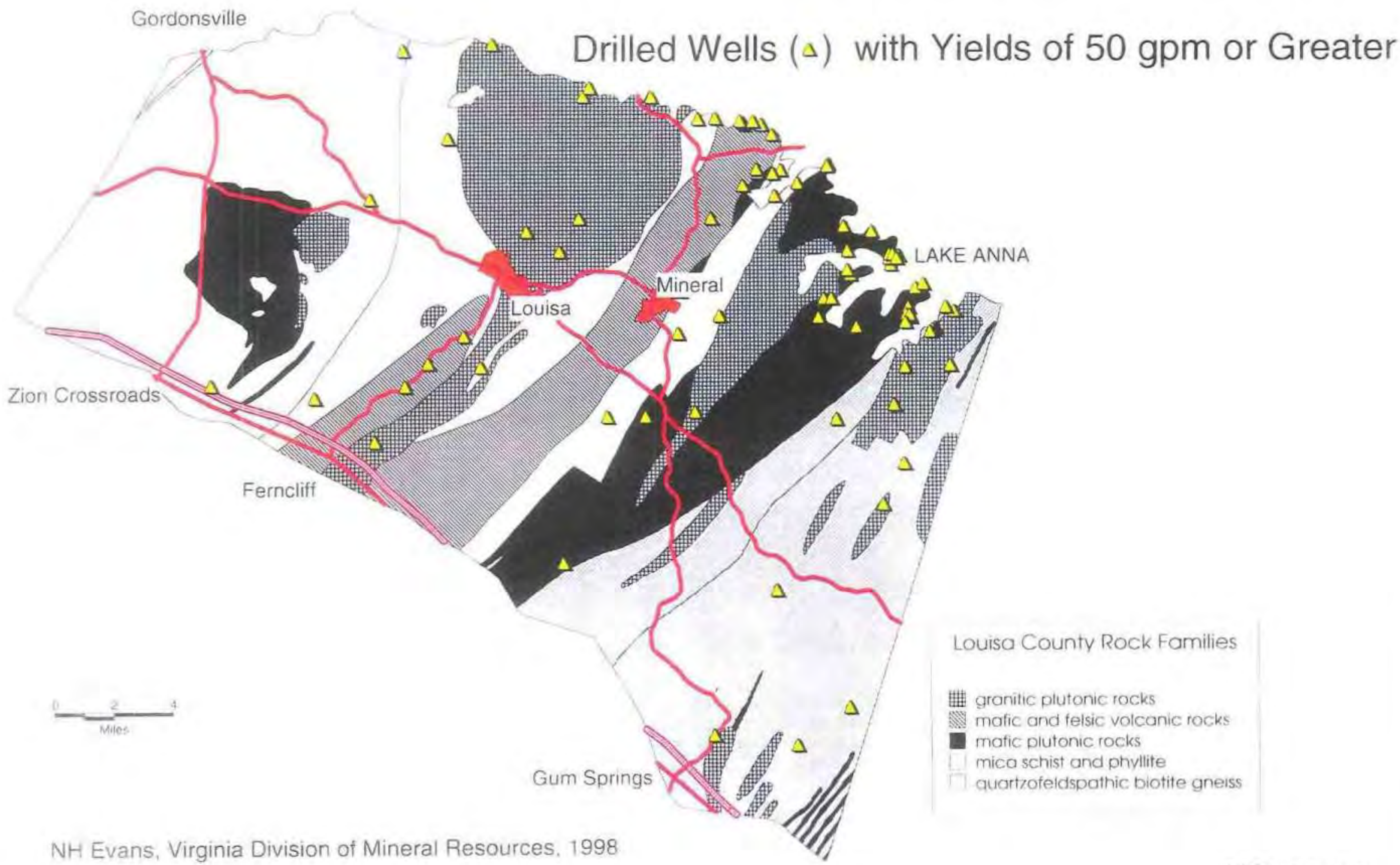

Drilled Wells (▲) with Yields of 50 gpm or Greater
Gordonsville
LAKE ANNA
Mineral
Louisa
Zion Crossroads
Ferncliff
Gum Springs
0 2 4
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 3-6

that area. Indeed, virtually all correlation coefficients are less than 0.1 (where a coefficient of 1.0 indicates perfect positive correlation) - although almost all are positive rather than negative. Nonetheless, it is concluded that average well yields are indeed higher in areas adjacent to Lake Anna, which probably results from a hydraulic head (lake level) that is nearly always much higher than the level to which the water table is drown down within the wells. Under such conditions (large hydraulic gradient), one would expect wells that are located adjacent to the Lake to recharge at a faster rate than those located at a greater distance from the Lake.

The manner in which wells have historically been sited and drilled in the Piedmont has led to stereotypical views of groundwater resources in these areas that are overly pessimistic:

- igneous and metamorphic rocks yield only small quantities of water
- well water is derived from vertical fractures pinching out at depths of around 300 feet.
- the only reason to drill a borehole larger than 6-inches in diameter is to increase storage capacity

These maxims arise from data that appear to be highly biased toward residential wells that are:

- only 100 to 200 feet in depth,
- 6 inches or less in diameter, and
- located on topographic highs (in close physical proximity to the homes that they serve)

The Piedmont presents a set of hydrogeologic constraints that differs greatly from those generally associated with the high-yield, confined aquifers of the Coastal Plain:

- The source of the water derived from any given well is precipitation in the general vicinity of that well - the water is not derived from some area that is remote from the well. This observation suggests that any wellhead protection program can be limited to that portion of the catchment area that is upgradient from the well field. At the same time, however, some level of protection should be afforded the entire catchment area that is upgradient from the well field.
- The water table consists of hills and valleys that generally conform to the surface topography; however, the water table is at a more level grade.
- Groundwater flows continuously toward the nearest perennial streams.

3.6 Impacts of Mining on Water Quality

An historically significant, northeast-trending belt of sulfide mineralization runs from the southernmost tip of Fauquier County, through western Spotsylvania County, central Louisa County, westernmost Goochland-easternmost Fluvanna Counties, and essentially terminates in Buckingham County. Gold was mined in this region from 1804 until 1947. The gold industry in Virginia never recovered after World War 2.

Mining activities are commonly associated with profound environmental impacts. More specifically, the mining and processing of sulfide ore bodies (in order to extract such metals as gold, silver, lead, and zinc) may be associated with:

- relatively high concentrations of metals in surface water and groundwater (antimony, copper, lead, zinc),
- reduced pH of surface water and groundwater, and
- mercury and cyanide contamination (as derived from amalgamation/cyanide processing).

Sweet and Trimble (1983) documented the prior existence of 24 gold mines in Louisa County. These mines are clustered along a very narrow, elongate, northeast trending belt within the Chopawamsic Formation. As suggested by its name, the Town of Mineral is centrally located within this historically important mining district. A map of showing the approximate locations of these mines is included as Figure 3-7.

Although the principal commodity of interest was native gold, the ore was processed for other commodities as well. For example, Boyd-Smith Mines, Inc., initiated lead and zinc mining at the Allah Cooper mine (3.65 miles west of Glenora) in 1915 (Watson, 1907).

Gold ore is processed by crushing (known as "stamping" or "milling") and amalgamating. Stamp mills were present at the Allah Cooper mine, Louisa mine (1.2 miles southwest of Pendleton; small stamp mill), Luce mine (0.3 miles southwest of Pendleton; 20-stamp mill, Slate Hill mine (0.8 miles southwest of Pendleton; 15-stamp mill), Walnut Grove mine (2.75 miles southwest of Pendleton; 16-stamp mill + 2 Chilian mills). Mines and stamp mills are associated with piles of waste material, which represent potential sources of heavy-metal leachate.

Gold is extracted from the milled ore by a process know as "amalgamation," whereby mercury forms an alloy with any gold and/or silver that may be present in the ore. Cyanide is also used in the process of extracting and refining the ore. There were fewer records encountered

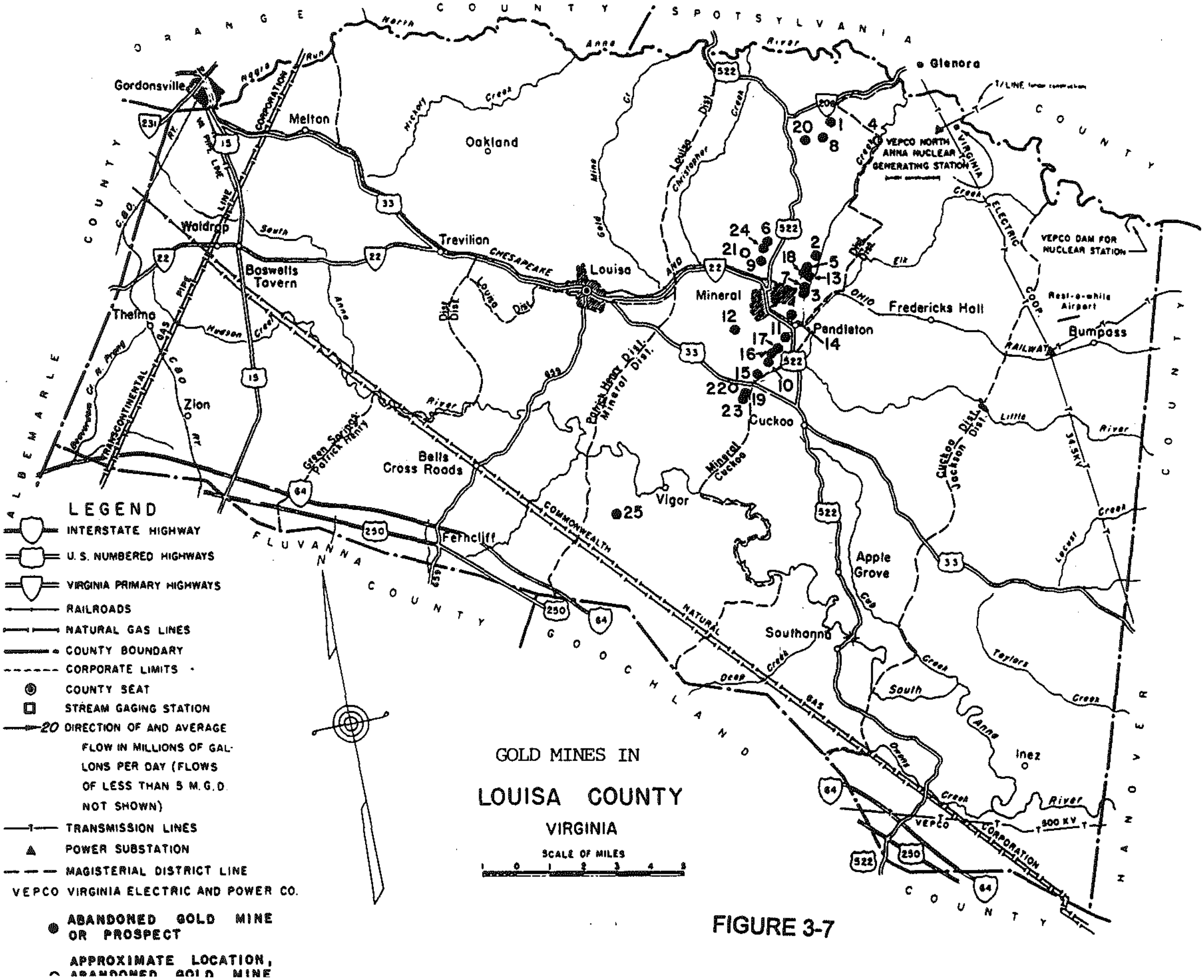
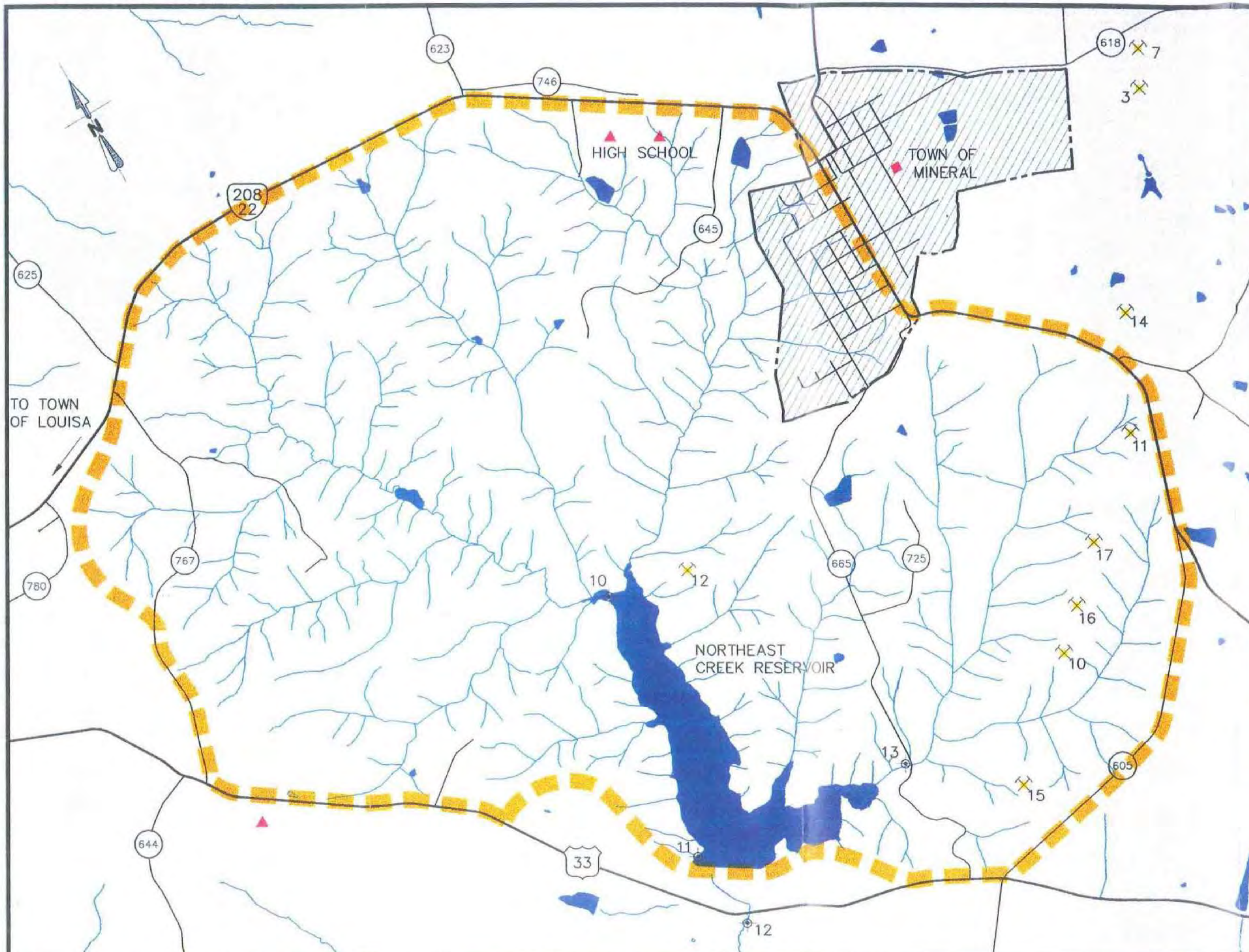

GOLD MINES IN
LOUISA COUNTY
VIRGINIA
SCALE OF MILES
1 0 1 2 3 4 5
LEGEND
INTERSTATE HIGHWAY
U. S. NUMBERED HIGHWAYS
VIRGINIA PRIMARY HIGHWAYS
RAILROADS
NATURAL GAS LINES
COUNTY BOUNDARY
CORPORATE LIMITS
COUNTY SEAT
STREAM GAGING STATION
20 DIRECTION OF AND AVERAGE FLOW IN MILLIONS OF GALLONS PER DAY (FLOWS OF LESS THAN 5 M.G.D. NOT SHOWN)
TRANSMISSION LINES
POWER SUBSTATION
MAGISTERIAL DISTRICT LINE
VEPCO VIRGINIA ELECTRIC AND POWER CO.
ABANDONED GOLD MINE OR PROSPECT
APPROXIMATE LOCATION, ABANDONED GOLD MINE
ORANGE COUNTY
SPOTSYLVANIA COUNTY
ALBEMARLE COUNTY
FLUVANNA COUNTY
GOOCHLAND COUNTY
HANOVER COUNTY
Gordonsville
Melton
Oakland
Trevilian
Louisa
Mineral
Waldrop
Boswells Tavern
Thelma
Zion
Bells Cross Roads
Ferncliff
Vigor
Cuckoo
Pendleton
Fredericks Hall
Bumpass
Glenora
Apple Grove
Southanna
Inez
VEPCO NORTH ANNA NUCLEAR GENERATING STATION
VEPCO DAM FOR NUCLEAR STATION
Rest-a-while Airport
CHESAPEAKE AND OHIO RAILWAY
COMMONWEALTH NATURAL GAS
TRANSCONTINENTAL GAS PIPE LINE
North Anna River
South Anna River
Little River
500 KV
VEPCO

FIGURE 3-7

regarding the locations of amalgamation /cyanide plants, and we are uncertain how much ore was shipped to such plants in other areas relative to the amount of ore processed within the Louisa County mining district. A small amalgamation plant was operated at Twin Vein Mine (2 to 3 miles south-southwest of Mineral; 1921 to 1925). In 1897, a cyanide plant was built at the Bertha and Edith mine in adjacent Goochland County (1.65 miles southwest of Caledonia) in order to process tailings from the stamping mill. Amalgamation / cyanide plants represent potential sources of mercury and cyanide contamination in addition to piles of waste material which, as mentioned above, represent potential sources of heavy-metal leachate.

Due to the close proximity of many gold mines to the Northeast Creek Reservoir, a more detailed map of the gold mines has been prepared (Figure 3-8)



MINE KEY

3	BIBB PROSPECT	LAT: 38°00'19" N LON: 77°53'16" W
7	HARRIS MINE	LAT: 35°00'25" N LON: 77°53'12" W
10	LOUISA MINE (SMALL STAMP MILL)	LAT: 37°58'51" N LON: 77°54'41" W
11	LUCE MINE (20-STAMP MILL)	LAT: 37°59'22" N LON: 77°54'02" W
12	MACDONALD MINE	LAT: 37°59'44" N LON: 77°55'54" W
14	NEW LUCE PROSPECT	LAT: 37°59'42" N LON: 77°53'46" W
15	PROFFIT MINE	LAT: 37°58'33" N LON: 77°55'06" W
16	RICSWAN MINE	LAT: 37°58'58" N LON: 77°54'33" W
17	SLATE HILL MINE	LAT: 37°59'06" N LON: 77°54'23" W

MAP LEGEND

WATERSHED BASIN BOUNDARY

SAMPLING STATION

OLD MINE LOCATION

Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, Virginia – Richmond, Virginia

NORTHEAST CREEK RESERVOIR WATERSHED

SCALE: 1"= 2000'

FIGURE: 3-8

4.0 EXISTING WATER SUPPLY AND WASTEWATER SYSTEMS

The existing public water and wastewater systems are presently limited to the Town of Louisa/Town of Mineral areas. Other areas of the County do have private systems with multiple users such as Zion Crossroads, Blue Ridge Shores, Shenandoah Crossings, and areas along Lake Anna.

4.1 Water Supply

4.1.1 Surface Water

The only surface water source presently being utilized in Louisa County for public drinking water is Northeast Creek Reservoir. This reservoir has a surface area of 185 acres and a watershed of 9.73 square miles. The water treatment plant was constructed in 1982 and has a rated production capacity of 1.0 MGD. The reservoir has been evaluated by the Department of Environmental Quality (DEQ) to have a safe yield of 2.77 MGD (attached in Appendix C). For surface water reservoirs, the DEQ defines the safe yield as the minimum withdrawal rate available during a day and recurring every 30 years.

The Louisa County Water Authority (LCWA) is presently treating approximately 200,000 gallons of water per day for distribution to customers in the Town of Louisa/Mineral service area. The water treatment plant is a conventional gravity filtration system and the treatment methods that can be performed include chemical addition, coagulation, sedimentation, high rate filtration, chlorination, and fluoridation.

4.1.2 Groundwater

In addition to serving the majority of individual homeowners throughout the County, groundwater serves as a drinking water source for many private residential developments and businesses throughout Louisa County. These residential developments and businesses include Blue Ridge Shores, Shenandoah Crossings, the North Anna Power Plant, and Crossings Pointe.

The Towns of Louisa and Mineral both have springs and several wells that have supplied drinking water to their localities. The Louisa County Water Authority (LCWA) maintains the Town of Louisa well system in case it is needed as a backup to the Northeast Creek reservoir supply. The Town of Louisa wells have not been significantly used for more than 10 years. In addition to a well that the LCWA owns and operates at the Louisa Industrial Park, the Town of Louisa system can provide at least an additional 100,000 gallons of water per day, if needed.

The Town of Mineral system includes 2 springs and several wells and presently provides approximately 90,000 gallons of water per day to its residents. The Town of Mineral supplements this supply by purchasing an additional 10,000 gallons of water per day from the LCWA. The Town of Mineral supply is not presently operated by the LCWA.

The majority of the 2155 wells included in the VDMR database serve single family residences. In order to help put the "residential well bias" in perspective, a review of the records obtained from the Virginia Department of Health was compiled on a smaller database that is restricted to public water supply wells. As summarized in Table 4-1, and as illustrated on the associated graphs, the average reported yield is approximately 42 gpm (60,000 gpd) with an average well depth of nearly 300 feet.

It is evident that the average yield of public wells (42 gpm) appears to be about three times greater than the average yield of all wells (public and private; single-family and multiple) located in the County (about 14.5 gpm). It is also noted that the higher average yield observed among public wells was achieved with wells that are almost all less than about 400 feet deep.

The results of the subject study, coupled with yield studies conducted by others in other Piedmont areas (LeGrand, 1967; Daniel, 1987) suggest a number of generalizations about expected yields under various conditions:

- Yields from individual wells vary greatly over distances as short as 100 feet.
- The yield from any single well cannot be predicted; however, one can assess the relative probabilities of achieving general ranges in yield under different topographic/geologic conditions.
- Yields tend to be most strongly correlated with topographic position and thickness of regolith (unconsolidated material overlying bedrock). High yield wells are associated with thick residual soils and relatively low topographic position.
- Prime well sites are located in broad draws with a relatively large catchment or recharge areas.
- Wells on concave slopes are commonly more productive than wells on convex slopes or straight slopes.
- Broad, slightly concave slopes near saddles in gently rolling upland areas are correlated with relatively higher yielding wells - avoid steep, V-shaped valleys.

TABLE 4-1
PUBLIC WATER SUPPLIES IN LOUISA COUNTY
SOURCE: VIRGINIA DEPARTMENT OF HEALTH

TY	LOCATION	WATER SOURCE	DEPTH / FT	YIELD (design) (gpd)	YIELD (measured) (gpd)	STORAGE CAPACITY (gallons)	COMMENTS
			SURFACE WATER SOURCES				
ouisa Water Authority	4.3 mi SE Rt 33 & 22	Northeast Creek	185 acre reservoir	1020000		1472 acre-ft	1472 acre-ft
Town of Louisa	0.2 mi N Rt 1008 & 522	spring	30K gal reservoir		38,880		
Town of Mineral	1.2 mi from Rt 618 & 703	2 springs	20K reservoir		57,600	60,000 gal	60,000 gal
			GROUNDWATER SOURCES				
Acorn West Trailer Park	0.6 mi W Rt 33 & 632	drilled well	120		8,640	2,350	None
Blue Ridge Shores	1 mi N Rt 613 & 669	drilled well	163	160,000	288,000	107,000	Chlorination
lue Ridge Shores	1 mi N Rt 613 & 669	drilled well	405				Corrosion control
lue Ridge Shores	1 mi N Rt 613 & 669	drilled well	300				
Blue Ridge Shores	1 mi N Rt 613 & 669	drilled well	239				
xpressions Learning Center	Rt 610 & 635	drilled well	205		17,280	11	None
lerdone Island	1 mi NE Rt 622 & 652	drilled well	200	19,600	83,520	20,000	Chlorination
Jouette Elementary School	0.3 mi N Rt 33 & 648	drilled well	345	19,600	61,920	15,000	Chlorination
lockner Barrier Films	Klockner Rd & Rt 213	drilled well	305	22,000	53,280	325	Chlorination
lockner-Pentaplast	Klockner Rd & Rt 213	drilled well	205	44,000	21,600	1,106	Chlorination
Klockner-Pentaplast	Klockner Rd & Rt 213	drilled well	280		57,600		
Louisa Water Authority	Industrial Airpark at Rt 22	drilled well	550		34,560	570,000	Full treatment
Town of Louisa	0.7 mi S Rt 33 & 522	drilled well (No 3)	200		43,200	175,000	2 ASTs
Town of Louisa	0.8 mi SW Rt 33 & 522	drilled well (No 4)	405		53,280		
Town of Louisa	0.2 mi E Rt 628 & 1014	drilled well (No 2)	301		46,080		
Town of Mineral	0.4 mi from Rt 618 & 703	drilled well (No 4)	200		165,600		Chlorination
own of Mineral	Richmond Ave & Sixth St	drilled well (No 5)	365		17,280		Chlorination
Town of Mineral	Rt 618 & 22	well (No 3)			14,400		Chlorination
f Mineral	1.2 mi S Rt 618 & 703	drilled well (No 6)	600		21,600		Chlorination
nna Nuclear Info Ctr	5 mi N Rt 618 & 700	drilled well	260	19,600	106,560	200	Calcite filtration
North Anna Power Station	5 mi N Rt 618 & 700	drilled well (No 2)	385	136,000	12,960	27,950	2000 gal + 25950 gal
lorth Anna Power Station	5 mi N Rt 618 & 700	drilled well (No 3A)	185		74,880	30,950	5000 gal + 25950 gal; chlorination
lorth Anna Power Station	5 mi N Rt 618 & 700	drilled well (No 4)	200		77,760	27,950	2000 gal + 25950 gal
North Anna Power Station	5 mi N Rt 618 & 700	drilled well (No 6)	375		79,200	30,950	5000 gal + 25950 gal
Shenandoah Crossing	end of Rt 749, 4 mi S Rt 33	drilled well	280	98,400	123,840	62,191	Chlorination
henandoah Crossing	end of Rt 749, 4 mi S Rt 33	drilled well	300		97,920		Chlorination
Six-o-Five Village	0.25 mi N Rt 33 & 605	drilled well	310	10,700	64,800	6,800	None
Six-o-Five Village	0.25 mi N Rt 33 & 605	drilled well	365		10,800		
revillians Elementary School	Rt 33 btwn Rt 636 & 22	drilled well	204	19,600	57,600	15,000	None
win Oaks Community	0.5 mi SW Rt 697 & 646	drilled well			7,200	5,000	pH adjusted
Crossing Pointe (Va Oil Co)	Rt 15 & I-64	drilled well	305	10,400	28,800	15,000	None
rossing Pointe (Va Oil Co)	Rt 15 & I-64	drilled well	305		21,600		None
Vest End Elementary School	0.2 mi SW Rt 33 & 749	drilled well	204	20,000	57,600	15,000	None
East End Elementary School	0.3 mi N Rt 33 & 648	drilled well	345	31,200	61,920	15,000	None
UM (groundwater only)			9,411	611,100	1,871,280	1,142,783	
VERAGE			294	47,008	60,364	54,418	
STD DEV			104	48,520	55,276	122,228	

- Yields from wells placed in valleys and draws are likely to be significantly higher than those placed on hills (where houses are typically located).
- Yields from wells placed in the most productive geologic units are likely to be higher than those placed in the least productive geologic units.
- Yield is positively correlated with thickness of regolith.
- Variation in yield is negatively correlated with thickness of regolith: the thicker the regolith, the more stable the yield.
- Maximum yields are commonly obtained from significantly greater depths (> 300 feet) than typically assumed (< 300 feet).
- Water that is available to a well at a given depth is rarely lost by drilling deeper; therefore, drilling deeper is not likely to produce less water, but is very likely to produce more water (although the increased yield may or may not be significant).

Studies of well yields in Piedmont areas (LeGrand, 1967; Daniel, 1987) also suggest generalizations about designing and managing well fields:

- The cone of depression associated with any given well, and the overlapping cones of depression (interference) that may be associated with a given cluster of wells, is local: pumping of the well field will not cause a regional lowering of the water table. By "local," we mean "within the watershed associated with that well." Since recharge to a well occurs within the watershed associated with that well, the effects of pumping are not likely to extend beyond the limits of that watershed.
- Where two heavily pumped wells are within several hundred feet of each other, the probability of measurable interference (overlapping cones of depression) is likely; however, the probability that such interference will significantly hinder the utility of the well field is low. In other words, the well field is not likely to go dry because of the relatively minor well interference: provided that the wells are not marginal to begin with, and in the absence of some unusual geologic condition (such as when all wells are located along a single fracture that is the only productive fracture in the area).
- If the yield from a well (or well field) is unstable, then it is probably being over pumped: decrease the pumping rate until a significant increase in stability is noted.

- Constant pumping at a moderate rate (one that does not cause unstable yields) does not damage a well.

4.2 Wastewater Treatment Systems

The majority of Louisa County is served by septic tanks and sanitary drainfields. There are some wastewater treatment facilities within the County, but most of these are relatively small systems (<40,000 gals/day). Table 4-2 summarizes all wastewater treatment facilities presently located in Louisa County. The only publicly operated wastewater treatment facilities are the Louisa regional WWTP and the Town of Louisa WWTP.

4.2.1 Louisa County Wastewater Treatment Plant

The existing 200,000 gallon/day Louisa County Wastewater Treatment Plant is presently in the process of being expanded to a 400,000 gallon/day plant (scheduled completion is spring of 1998). This facility presently treats approximately 200,000 gallons/day of wastewater from the southern portion of the Town of Louisa, most of the Town of Mineral and several schools within the service area. The VPDES (Virginia Pollution Discharge Effluent Limitations) permit for this facility includes the following limitations:

Item	**Limit**	
	Monthly Average	Weekly Average
BODs	10 mg/1	15 mg/1
Suspended Solids	30 mg/1	45 mg/1
Dissolved Oxygen		6.0 mg/1 minimum
pH		6.0-9.0
Ammonia (May-Nov.)	2.1 mg/l	2.1 mg/1 maximum
Ammonia (Dec.-Apr.)	3.5 mg/l	3.5 mg/l maximum
Fecal Coliform	200 n/100 ml	

Wastewater treatment consists of physical/biological functions to remove floating, suspended, dissolved, and settleable contaminants. The process consists of wastewater collection facilities, debris manhole, influent pumps, combined screening and septage receiving, an existing

Table 4-2
Permitted Wastewater Treatment Facilities
in Louisa County, Virginia

Facility Name	Location	Discharge Limits (BOD, TSS, ammonia)	Capacity
Louisa Regional WWTP	B/T Louisa/Mineral	10,30,2.1	400,000 gpd
Town of Louisa WWTP	Louisa		62,400 gpd
Shenandoah Crossings WWTP	Lake Gordonsville Area	10,10,3 (TKN)	100,000 gpd
Twin Oaks Community WWTP	Route 697/South Anna	30,30,nl	10,000 gpd
Virginia Oil WWTP	Zion Crossroads	15,30,2.1	39,500 gpd
Lake Anna Family Campground STP	Lake Anna	30,30,nl	20,000 gpd
Virginia Power WWTP	Lake Anna	30,30,nl	30,000 gpd

BOD - Biological Oxygen Demand (5 day) in mg/L
TSS - Total Suspended Solids in mg/L
TKN - Total Kjeldahl Nitrogen in mg/L
nl - no limit

barrier ditch converted to an oxidation ditch (#1), a new oxidation ditch (#2), a flow splitter, two secondary clarifiers, a new ultraviolet disinfection chamber, a cascade aerator, biosolids pumping facilities, existing tankage converted to a secondary aerobic digester (#1), and a new primary aerobic digester (#2).

The plant was designed to treat 0.4 million-gallons-per-day with an influent BOD of 300 mg/l, suspended solids of 250 mg/l, and ammonia levels of 30 mg/l, to effluent levels of BOD of 10 mg/l, suspended solids of 30 mg/l, and ammonia levels of 2.1 mg/l from May to November and 3.5 mg/l from December to April.

The system is a type of biological treatment for domestic level waste using the extended aeration modification of the activated-sludge process. Theoretically, the biological waste treatment is a process which uses microorganisms to consume dissolved organic contaminants in wastewater and convert them to additional microorganisms. In aerobic systems, microorganisms and water are conducted to a settling zone where the solid organic contaminants and microorganisms settle, allowing the water to be removed while leaving organics in the system as added cell growth.

Once the wastewater plant has been upgraded (1998), the plant will be permitted to receive up to two loads of septage per day from septic tank haulers.

4.2.2 Town of Louisa WWTP

The Town of Louisa presently owns and operates a trickling filter wastewater treatment facility with an average daily treatment capacity of approximately 60,000 gals/day. This facility discharges to a stream with very low flows and consequently relatively stringent discharge parameters for BOD, TSS, and ammonia must be achieved. At some point in the future, it may be desirable to abandon this facility and pump the generated wastewater to the Louisa Regional WWTP.

4.2.3 Private Wastewater Treatment Facilities

As indicated in Table 4-2, there are several wastewater treatment facilities located outside of the Louisa/Mineral service area. The largest facility is located at Shenandoah Crossings, which is a residential, golf community. The treatment plant at this location is a biological activated sludge plant and is a relatively new plant (less than 10 years old). The permit stipulations allow for a maximum of discharge of 100,000 gallons/day of treated sewage, which flows to a tributary that leads to the South Anna River.

4.2.4 Septic Tanks and Sanitary Drainfields

In reviewing the locations and capacities of the existing wastewater discharge permits shown in Table 4-2, it appears that less than 20 percent of the County's present population is on public or private wastewater treatment facilities. Accordingly, this means that more than 80 percent of the present population utilizes septic tanks and drainfields as their method of wastewater disposal/treatment. While septic tanks and drainfields are not usually intended to be the ultimate method of wastewater treatment for the environment, a properly sited, constructed, and maintained system can last between 30 and 50 years. Because most of these systems are operated and maintained by individual residents, unless a system has an obvious system failure, it is difficult to determine the percentage of drainfields that are operating properly and how many are truly not functioning up to the intended treatment standards. In Section 2, a discussion and figure was presented on the number of reported drainfields failures that has occurred between 1993 and 1997. As pointed out, the only area with a relatively high frequency of drainfield failures was along Lake Louisa. However, there are probably other areas in the County that have failing systems due to improper maintenance, bad soil conditions, or a high groundwater table.

One reason that many septic tank/drainfield systems fail or reach their design life early is because of improper maintenance, primarily not pumping out the septic tank often enough. The Virginia Department of Health recommends that homeowners pump out their septic tanks every 3 to 5 years to maintain the system integrity and reduce the release of untreated solids to the drainfield. Presently, Louisa County does not have a facility that can treat septage. As a result, septic haulers must transport septage to another jurisdiction such as Charlottesville. This increases the cost for disposal of the septage substantially and can be a deterrent for people to maintain their systems on the frequency that is needed. As discussed in section 4.2.1, the Louisa Regional WWTP will be able to accept septage from County residents (spring 1998).

4.3 Existing Water and Wastewater Infrastructure

The existing County infrastructure is presently limited to the Town of Louisa/Mineral areas. The water system includes watermains from 6 to 12 inch diameter leading from Northeast Creek Reservoir on Route 33 to the center of Louisa. The Louisa water system includes ground storage tanks of 600,000 gallons and 2 elevated storage tanks equaling 175,000 gallons of capacity. Fire protection is provided along the transmission mains. A 12 inch watermain also connects the Town of Louisa to the Town of Mineral by way of Route 208. This allows the transfer of water by the LCWA to the Town of Mineral and the schools along 208 from the surface water treatment plant. The primary transmission mains and water storage tanks are shown on the Proposed Water System Master Plan, Figure 9-1.

4.4 Existing Water and Wastewater Usage

The LCWA provides all water to the Town of Louisa and some residents and businesses outside of the Town of Louisa limits. The Town of Mineral presently provides most of its residents with drinking water obtained from their existing groundwater supply. In 1996, the LCWA provided approximately 220,000 gallons of water per day to approximately 630 residential and 200 non-residential customers. The LCWA also provided approximately 10,000 gallons of water per day to the Town of Mineral. The Town of Mineral provides approximately 100,000 gallons of water per day (including the 10,000 from LCWA) to its residential and non-residential customers.

The LCWA operates the Louisa Regional wastewater treatment facility for the Town of Louisa and the County. A network of pump stations, force mains, and gravity sewers transports sewage from the Town of Louisa/Mineral areas. The portion of Louisa located to the south of Route 208 is served by the Regional WWTP. The northern portion of Louisa (Town) is serviced by a trickling filter wastewater treatment facility. The Town of Mineral is now served by the Louisa Regional facility.

4.5 Existing User Fees

According to the *1997 Annual Water and Sewer Rate Survey Report* prepared by Draper Aden Associates, the average residential water rate in the state of Virginia has increased for the 8th consecutive year. Rates for water increased to a state average of $15.69 per billing cycle, an average rate increase of 36% since 1990.

The Louisa County Water Authority reported an average water rate of $12.25 per billing cycle and the Town of Louisa reported an average water rate of $13.00 per billing cycle. These rates are both below the state average.

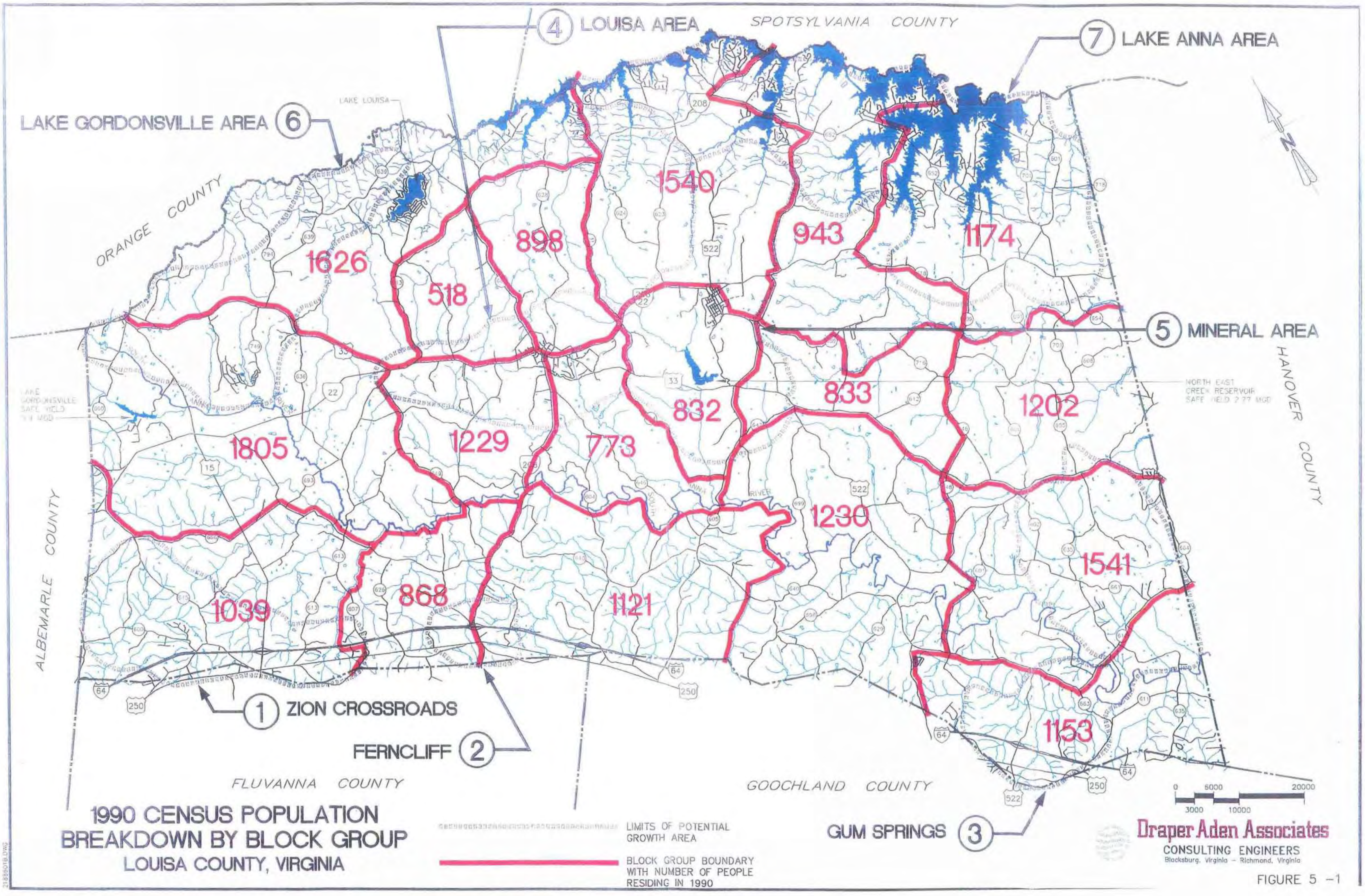
5.0 PROJECTED WATER AND WASTEWATER DEMANDS

There are several methods that can be utilized to estimate the future water and wastewater demands for future growth in an area. Zoning or comprehensive planning maps can be used to predict the required utility services that will be necessary at complete buildout of a particular growth area or for an entire County. Population growth projections for specific areas can also be used to determine the necessary water and wastewater services that will be needed in future years. Typically, the actual demand will be relatively proportional to the population served. However, areas that have industries with high water demands can increase the per capita usage substantially. Also, industries that are located near a County boundary (where employees may live in another locality and are not accounted for in the County population projections) can increase the actual demands significantly.

5.1 Projected 20 Year Demands Using Population Growth

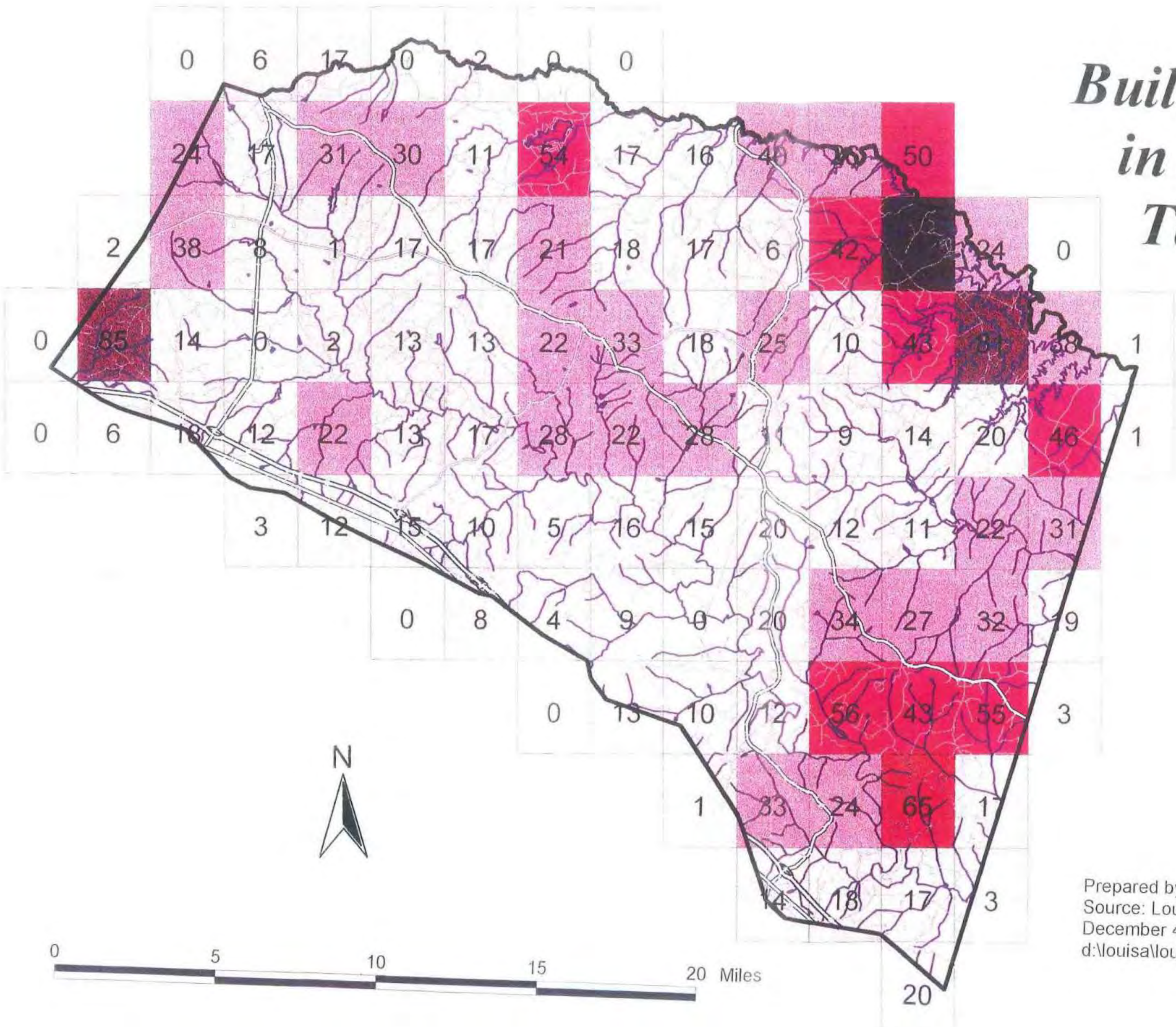
The Virginia Employment Commission (VEC) has projected population growth for all political subdivisions within the state. The census is performed in 10 year increments and is projected for the following 20 years. In 1990, there were 20,325 people that resided in Louisa County. Figure 5-1 presents a breakdown of population by group census block for the 1990 population. The information shown on this Figure was used as a starting point for projected growth in each of the seven potential growth areas. Annual growth rates were initially projected as 1.3% for 1990 to 1995, 1.1% for 1996 to 2000, and 0.8% for 2001 to 2010. However, these annual growth rates have recently been revised and will be published shortly. The new annual growth rates are projected as 1.9% for 1996 to 2000, and 1.7% for 2001 to 2010. These growth rates translate into a projected County population of 25,400 by the year 2000 and 30,000 by the year 2010. Continuing these projections at a growth rate of 1.7% brings the estimated County population to 32,638 by the year 2015.

Based on discussions with the Louisa County Planning Department, past building permit activity (Figure 5-2), and the private interest being expressed for new developments throughout the County, it is possible that Lousia County will grow at a significantly higher rate over the next 20 years than what has been projected by the VEC. Based on existing County information, it is believed that approximately 25,000 people resided in the County in 1995, already achieving close to the VEC projection for the year 2000. Therefore, the VEC population estimate has been used to estimate the lower range of the estimated public water and sewer demand that will be required in the year 2015. The higher range of the estimated public water and sewer demand is based on higher projected growth rates, primarily occurring in the seven potential growth areas



1990 CENSUS POPULATION
BREAKDOWN BY BLOCK GROUP
LOUISA COUNTY, VIRGINIA

FIGURE 5 –1



Building Permits Issued in Louisa County by Tax Map, 1990-97

Building Permits 1990-97

0

1 - 20

21 - 40

41 - 60

61 - 80

81 - 100

101 - 120

Prepared by the Thomas Jefferson Planning District Commission
Source: Louisa County Records
December 4, 1997
d:\louisa\lou_hu_tax.apr rrg

FIGURE 5-2

throughout the County. Using the higher projected growth rates brings the estimated population to approximately 46,000 by the year 2015. The actual population will probably be somewhere between 32,000 and 46,000, but it is possible that some of the potential growth areas may reach the high end projections by 2015. In any case, these population projections should provide a good planning tool and will be used to develop the water and wastewater master plan to serve the potential growth areas within the County over the next 20 years and beyond.

Based on the projected population growth for Louisa County, it is estimated that between 1.9 and 2.9 million gallons of water per day (MGD) of public water will be required to serve the seven potential growth areas on an average day. This estimate is based on a usage of 100 gallons per person per day for the population growth and assumes that a portion of the population in some of the growth areas will remain on private water. Including an additional 50% reserve for new commercial/industrial devevlopment to the County increases the required total to between **2.8 MGD and 4.1 MGD (average day).** This additional reserve is not intended to serve major industrial water users (>300,000 GPD), but it does allot up to 1.2 MGD for industrial users throughout the County. The estimated peak day demands are between **4.5 MGD and 6.6 MGD.** The projected water demands for each of the seven growth areas are shown in Table 5-1, Table 5-2, and Table 5-3.

5.2 Projected 20 Year Demands Using Present Comprehensive Plan

The projected water and wastewater demands for the year 2015 were also estimated for the 7 potential growth areas using the present County Comprehensive Plan (1993). The land use designations shown on the comprehensive plan include residential, medium density-residential, resort/mixed use, retail/service, commercial/industrial, historic resources, rural residential, and agricultural/forestal. It is assumed that historic areas, rural residential, and agricultural/forestal areas will be served by private wells and wastewater treatment systems and not public systems. For the land use designations, the following unit demands have been used:

Residential -	300 gals/day/dwelling @ avg. density of 2 units/acre
Medium Density -	200 gals/day/dwelling @ avg. density of 5 units/acre
Resort/Mixed Use-	200 gals/day/dwelling @ avg. density of 5 units/acre
Retail/Service-	600 gals/day/acre
Comm./Industrial-	750 gals/day/acre (not considered wet industry)

TABLE 5-1
20 YEAR PROJECTED WATER DEMANDS FOR LOUISA COUNTY
USING POPULATION GROWTH
LOWER LEVEL ESTIMATES

Potential Growth Area Location	1990 Census Population			1995 Estimated Population			2000 Estimated Growth			2015 Estimated Growth			Estimated Public Water Required			With Xtra for Industry (Add'l 50%)		
	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Average Day (gpd)	Add. 50% (gpd)	Peak Day (gpd)
1. Zion Crossroads	1,039	103,900	187,020	1,295	129,478	207,165	1,653	165,251	264,401	5,242	524,203	838,725	4,194	419,363	670,980	419,363	629,044	1,006,471
2. Ferncliff	400	40,000	72,000	498	49,847	79,756	578	57,787	92,459	1,201	120,134	192,215	961	96,107	153,772	96,107	144,161	230,658
3. Gum Springs	2,694	269,400	484,920	3,357	335,721	537,154	3,892	389,193	622,709	7,009	700,915	1,121,464	4,906	490,640	785,025	490,640	735,961	1,177,537
4. Louisa	2,279	227,900	410,220	2,840	284,005	454,408	3,136	313,564	501,703	5,647	564,712	903,539	5,082	508,240	813,185	508,240	762,361	1,219,777
5. Mineral	1,762	176,200	317,160	2,196	219,577	351,324	2,424	242,431	387,890	3,777	377,700	604,319	3,399	339,930	543,888	339,930	509,895	815,831
6. Lake Gordonsville	1,715	171,500	308,700	2,137	213,720	341,952	2,418	241,805	386,888	3,502	350,205	560,329	2,451	245,144	392,230	245,144	367,716	588,345
7. Lake Anna	2,316	231,600	416,880	2,886	288,616	461,785	3,684	368,355	589,368	7,658	765,783	1,225,254	5,360	536,048	857,677	536,048	804,073	1,286,516
8. Remaining Areas	8,120	812,000	1,461,600	10,119	1,011,900	1,619,040	10,635	1,063,517	1,701,627	11,461	1,146,134	1,833,814	1,146	114,613	183,381	114,613	171,920	275,072
TOTAL	20,325	2,032,500	3,252,000	25,329	2,532,865	4,052,584	28,419	2,841,902	4,547,044	45,498	4,549,786	7,279,658	27,501	2,750,086	4,400,138	2,750,086	4,125,129	6,600,207

POPULATION GROWTH RATES

Location	1990-1995	1996-2000	2001-2015
1. Zion Crossroads	4.5%	5.0%	8.0%
2. Ferncliff	4.5%	3.0%	5.0%
3. Gum Springs	4.5%	3.0%	4.0%
4. Louisa	4.5%	2.0%	4.0%
5. Mineral	4.5%	2.0%	3.0%
6. Lake Gordonsville	4.5%	2.5%	2.5%
7. Lake Anna	4.5%	5.0%	5.0%
8. Remaining Areas	4.5%	1.0%	0.5%

NOTES & ASSUMPTIONS:

1) Current average day demand based upon 1990 census data and assumes 100 gals/day use per person.

2) Growth Factor assumptions included input from Louisa County Planning Department.

3) Estimated Public Water Required = (2015 Population) - (Assumed % On Private Water) x 100 gpd/person
Assumed % On Private Water: Areas 1 & 2 - 20%, Areas 3, 6, & 7 - 30%, Areas 4 & 5 - 10%.

4) It is assumed that 10% of the population located outside of the 7 Potential Growth Areas will be served by Public Water.

5) Additional Water for Industrial does not include a major industrial user (>300,000 GPD).

6) Estimated Peak Day Flow = 1.6 x Average Day Flow

Table 5-1
Summary of 20 Year Flows
Upper Level Estimates

TABLE 5-2
20 YEAR PROJECTED WATER DEMANDS FOR LOUISA COUNTY
USING POPULATION GROWTH
UPPER LEVEL ESTIMATES

		1990 Census Population			1995 Estimated Population			2000 Estimated Growth		
	Potential Growth Area Location	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)
1.	Zion Crossroads	1,039	103,900	187,020	1,204	120,449	192,718	1,537	153,726	245,962
2.	Ferncliff	400	40,000	72,000	464	46,371	74,194	512	51,197	81,916
3.	Gum Springs	2,694	269,400	484,920	3,123	312,308	499,693	3,448	344,814	551,702
4.	Louisa	2,279	227,900	410,220	2,642	264,199	422,718	2,917	291,697	466,714
5.	Mineral	1,762	176,200	317,160	2,043	204,264	326,823	2,255	225,524	360,839
6.	Lake Gordonsville	1,715	171,500	308,700	1,988	198,816	318,105	2,195	219,508	351,213
7.	Lake Anna	2,316	231,600	416,880	2,685	268,488	429,581	3,113	311,251	498,002
8.	Remaining Areas	8,120	812,000	1,461,600	9,009	900,917	1,441,467	9,375	937,535	1,500,056
	TOTAL	20,325	2,032,500	3,252,000	23,158	2,315,811	3,705,297	25,353	2,535,252	4,056,403

		2015 Estimated Growth			Estimated Public Water Required			With Xtra for Industry (Add'l 50%)		
	Potential Growth Area Location	Population (people)	Average Day (gpd)	Peak Day (gpd)	Population (people)	Average Day (gpd)	Peak Day (gpd)	Average Day (gpd)	Add. 50% (gpd)	Peak Day (gpd)
1.	Zion Crossroads	3,684	368,414	589,462	2,947	294,731	471,570	294,731	442,097	707,355
2.	Ferncliff	689	68,905	110,248	551	55,124	88,198	55,124	82,686	132,297
3.	Gum Springs	4,641	464,074	742,518	3,249	324,852	519,763	324,852	487,278	779,644
4.	Louisa	3,926	392,585	628,136	3,533	353,327	565,323	353,327	529,990	847,984
5.	Mineral	3,035	303,526	485,641	2,732	273,173	437,077	273,173	409,760	655,616
6.	Lake Gordonsville	2,954	295,429	472,687	2,068	206,801	330,881	206,801	310,201	496,321
7.	Lake Anna	4,189	418,903	670,245	2,932	293,232	469,171	293,232	439,848	703,757
8.	Remaining Areas	9,661	966,058	1,545,693	966	96,606	154,569	96,606	144,909	231,854
	TOTAL	32,779	3,277,894	5,244,630	18,978	1,897,845	3,036,552	1,897,845	2,846,767	4,554,828

GROWTH RATES

Location	1990-1995	1996-2000	2001-2015
1. Zion Crossroads	3.0%	5.0%	6.0%
2. Ferncliff	3.0%	2.0%	2.0%
3. Gum Springs	3.0%	2.0%	2.0%
4. Louisa	3.0%	2.0%	2.0%
5. Mineral	3.0%	2.0%	2.0%
6. Lake Gordonsville	3.0%	2.0%	2.0%
7. Lake Anna	3.0%	3.0%	2.0%
8. Remaining Areas	2.1%	0.8%	0.2%

NOTES & ASSUMPTIONS:

1) Current average day demand based upon 1990 census data and assumes 100 gals/day use per person.
2) Growth factor percentages were selected to coincide with Va. Employment Commission estimates (see below).
3) Estimated Public Water Required = (2015 Population) - (Assumed % On Private Water) x 100 gpd/person
Assumed % On Private Water: Areas 1 & 2 - 20%, Areas 3, 6, & 7 - 30%, Areas 4 & 5 - 10%.
4) It is assumed that 10% of the population located outside of the 7 Potential Growth Areas will be served by Public Water.
5) Additional Water for Industrial does not include a major industrial user (>300,000 GPD).
6) Estimated Peak Day Flow = 1.6 x Average Day Flow

1990 Census Population:	20,325
1995 Proj. Census Pop:	23,100
2000 Proj. Census Pop:	25,400
2010 Proj. Census Pop:	30,000
2015 Proj. Census Pop:	32,640

Table 5-2
Summary of 20 Year Flows
Upper Level Estimates

TABLE 5-3
SUMMARY OF 20 YEAR PROJECTED FLOWS FOR LOUISA COUNTY USING POPULATION GROWTH

	Potential Growth Area Location	Projected Water Demand for Public Only		Projected Water Demand With Xtra for Industry	
		Lower	Upper	Lower	Upper
1.	Zion Crossroads	294,731	419,363	442,097	629,044
2.	Ferncliff	55,124	96,107	82,686	144,161
3.	Gum Springs	324,852	490,640	487,278	735,961
4.	Louisa	353,327	508,240	529,990	762,361
5.	Mineral	273,173	339,930	409,760	509,895
6.	Lake Gordonsville	206,801	245,144	310,201	367,716
7.	Lake Anna	293,232	536,048	439,848	804,073
8.	Remaining Areas	96,606	114,613	144,909	171,920
	TOTAL, AVG DAY	1,897,845	2,750,086	2,846,767	4,125,129
	TOTAL, PEAK DAY	3,036,552	4,400,138	4,554,828	6,600,207

Above flows are in Gallons/day.
Estimated Peak Day = 1.6 x Avg. Day

The dwelling densities were derived from the 1993 County Comprehensive Plan and the unit demands are based on typical design values recognized by the Virginia Health Department and are usually higher than the actual demands. Using these unit demands and the acreage shown for each of the land use designations, the projected water and wastewater demands were determined for each potential growth area. An assumption that significantly effects the projected demands is the percent buildout of each area by the year 2015. These percentages were assumed using projected growth patterns as a guideline. Table 5-4 presents the projected average and peak daily flows for each of the potential growth areas.

5.3 Build Out Demands Using Present Comprehensive Plan

In order to show the potential magnitude for ultimate water and wastewater demands, flow projections were made using the current Comprehensive Plan and complete buildout of the potential growth areas. These projections show that the County may ultimately need approximately 37 MGD (average day) of public water and sewer services to serve the County's potential growth areas. The peak day requirement at maximum buildout is estimated at just below 60 MGD. Table 5-5 presents the projected average and peak daily flows for each of the potential growth areas.

5.4 Ultimate Demands Based on Build-Out Housing Unit Density

In 1996, the Thomas Jefferson Planning District Commission (TJPDC) issued the Build-Out Housing Unit Density plan, which can also be used to calculate the maximum potential demands for public water and wastewater in Louisa County. Figure 5-3 presents the build-out housing unit density map for Louisa County. To obtain an approximate estimate, identified areas within each of the 7 potential growth areas were separated according to housing unit density projections. By using an average housing water demand of 250 gals/day/housing unit, it is estimated that Louisa County will require between 26 MGD and 54 MGD at ultimate build-out of the County. These estimates are consistent with the ultimate projections using the present Comprehensive Plan (section 5.3), in which it is estimated that approximately 37 MGD will be required.

It is important to note that ultimate build-out for Louisa County corresponds with a maximum build-out population for the County of approximately 255,000 persons

TABLE 5-4
20 YEAR PROJECTED WATER DEMANDS BASED ON PRESENT COMPREHENSIVE PLAN
LOUISA COUNTY

Zion Crossroads

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	1934	75%	20	n/a	n/a	750	GPD/ac.	217,575 GPD
Residential	6684	75%	20	2 unit/ac.	20	300	GPD/unit	601,560 GPD
Medium Density	612	50%	20	5 units/ac.	3	200	GPD/unit	61,200 GPD
Retail	n/a	60%	n/a	n/a	n/a	600	GPD/ac.	0 GPD
Study Area Total	**9230**							**880,335 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**1,408,536 GPD**

Ferncliff

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	n/a	75%	n/a	n/a	n/a	750	GPD/ac.	0 GPD
Residential	n/a	75%	n/a	n/a	n/a	300	GPD/unit	0 GPD
Medium Density	n/a	50%	n/a	n/a	n/a	200	GPD/unit	0 GPD
Retail	838	60%	40	n/a	n/a	600	GPD/ac.	120,672 GPD
Study Area Total	**838**							**120,672 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**193,075 GPD**

Gum Springs

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	3676	75%	10	n/a	n/a	750	GPD/ac.	206,775 GPD
Residential	4858	75%	15	2 unit/ac.	11	300	GPD/unit	327,915 GPD
Medium Density	1794	50%	10	5 units/ac.	4	200	GPD/unit	89,700 GPD
Retail	387	60%	20	n/a	n/a	600	GPD/ac.	27,864 GPD
Study Area Total	**10715**							**652,254 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**1,043,606 GPD**

Louisa Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	516	75%	20	n/a	n/a	750	GPD/ac.	58,050 GPD
Residential	5171	75%	20	2 unit/ac.	16	300	GPD/unit	465,390 GPD
Medium Density	596	50%	25	5 units/ac.	4	200	GPD/unit	74,500 GPD
Retail	629	60%	30	n/a	n/a	600	GPD/ac.	67,932 GPD
Study Area Total	**6912**							**665,872 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**1,065,395 GPD**

TABLE 5-4 (CONTINUED)
ULTIMATE WATER DEMANDS BASED ON PRESENT COMPREHENSIVE PLAN
LOUISA COUNTY

Mineral Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	1666	75%	10	n/a	n/a	750	GPD/ac.	93,713 GPD
Residential	4569	75%	10	2 unit/ac.	7	300	GPD/unit	205,605 GPD
Medium Density	1394	50%	15	5 units/ac.	5	200	GPD/unit	104,550 GPD
Retail	1111	60%	20	n/a	n/a	600	GPD/ac.	79,992 GPD
Study Area Total	**8740**							**483,860 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**774,175 GPD**

Lake Gordonsville Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	546	75%	10	n/a	n/a	750	GPD/ac.	30,713 GPD
Residential	12500	75%	5	2 unit/ac.	9	300	GPD/unit	281,250 GPD
Medium Density	964	50%	5	5 units/ac.	1	200	GPD/unit	24,100 GPD
Retail	105	60%	30	n/a	n/a	600	GPD/ac.	11,340 GPD
Study Area Total	**14115**							**347,403 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**555,844 GPD**

Lake Anna Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	870	75%	5	n/a	n/a	750	GPD/ac.	24,469 GPD
Residential	7775	75%	5	2 unit/ac.	6	300	GPD/unit	174,938 GPD
Resort/Mixed Use	13300	75%	5	3 units/ac.	15	250	GPD/unit	374,063 GPD
Medium Density	1378	50%	5	5 units/ac.	2	200	GPD/unit	34,450 GPD
Retail	2138	60%	5	n/a	n/a	600	GPD/ac.	38,484 GPD
Study Area Total	**25461**							**646,403 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**1,034,244 GPD**

Total Average Daily Demand for Potential Growth Areas	**3,796,798 GPD**
Peak Daily Demand for Potential Growth Areas	**6,074,876 GPD**

Notes:

1. **The land use and areas shown for each growth area are taken from the present Louisa County Comprehensive Plan (1993).**
2. **Portion developable accounts for open space and right of ways that are typically required for each type of land use.**
3. **Percent buildout is an estimate of how much of a particular land use may be developed in the next 20 years.**
4. **The unit flows shown are based on typical design values recognized by the Virgina Health Department and are usually higher than the actual demands.**
5. **The average demand is calculated as follows:**
   Area x Portion Developable (%) x Percent Buildout (%) x Dwelling Density x Unit Flow = GPD
   GPD = Gallons per day
6. **This table does not account for the use of private systems.**

TABLE 5-5
ULTIMATE WATER DEMANDS BASED ON PRESENT COMPREHENSIVE PLAN
LOUISA COUNTY
Page 1 of 2

Zion Crossroads

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	1934	75%	100	n/a	n/a	750	GPD/ac.	1,087,875 GPD
Residential	6684	75%	100	2 unit/ac.	100	300	GPD/unit	3,007,800 GPD
Medium Density	612	50%	100	5 units/ac.	15	200	GPD/unit	306,000 GPD
Retail	n/a	60%	n/a	n/a	n/a	600	GPD/ac.	0 GPD
Study Area Total	**9230**							**4,401,675 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**7,042,680 GPD**

Ferncliff

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	n/a	75%	n/a	n/a	n/a	750	GPD/ac.	0 GPD
Residential	n/a	75%	n/a	n/a	n/a	300	GPD/unit	0 GPD
Medium Density	n/a	50%	n/a	n/a	n/a	200	GPD/unit	0 GPD
Retail	838	60%	100	n/a	n/a	600	GPD/ac.	301,680 GPD
Study Area Total	**838**							**301,680 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**482,688 GPD**

Gum Springs

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	3676	75%	100	n/a	n/a	750	GPD/ac.	2,067,750 GPD
Residential	4858	75%	100	2 unit/ac.	73	300	GPD/unit	2,186,100 GPD
Medium Density	1794	50%	100	5 units/ac.	45	200	GPD/unit	897,000 GPD
Retail	387	60%	100	n/a	n/a	600	GPD/ac.	139,320 GPD
Study Area Total	**10715**							**5,290,170 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**8,464,272 GPD**

Louisa Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	516	75%	100	n/a	n/a	750	GPD/ac.	290,250 GPD
Residential	5171	75%	100	2 unit/ac.	78	300	GPD/unit	2,326,950 GPD
Medium Density	596	50%	100	5 units/ac.	15	200	GPD/unit	298,000 GPD
Retail	629	60%	100	n/a	n/a	600	GPD/ac.	226,440 GPD
Study Area Total	**6912**							**3,141,640 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**5,026,624 GPD**

TABLE 5-5 (CONTINUED)
ULTIMATE WATER DEMANDS BASED ON PRESENT COMPREHENSIVE PLAN
LOUISA COUNTY

Mineral Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	1666	75%	100	n/a	n/a	750	GPD/ac.	937,125 GPD
Residential	4569	75%	100	2 unit/ac.	69	300	GPD/unit	2,056,050 GPD
Medium Density	1394	50%	100	5 units/ac.	35	200	GPD/unit	697,000 GPD
Retail	1111	60%	100	n/a	n/a	600	GPD/ac.	399,960 GPD
Study Area Total	**8740**							**4,090,135 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**6,544,216 GPD**

Lake Gordonsville Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	546	75%	100	n/a	n/a	750	GPD/ac.	307,125 GPD
Residential	12500	75%	100	2 unit/ac.	188	300	GPD/unit	5,625,000 GPD
Medium Density	964	50%	100	5 units/ac.	24	200	GPD/unit	482,000 GPD
Retail	105	60%	100	n/a	n/a	600	GPD/ac.	37,800 GPD
Study Area Total	**14115**							**6,451,925 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**10,323,080 GPD**

Lake Anna Area

Land Use (1)	Area (1) (Acres)	Portion (2) Developable	Percent (3) Buildout	Dwelling (1) Density	Dwelling Units	Unit (4) Flows	Units	Average (5) Demand
Industrial/Commercial	870	75%	100	n/a	n/a	750	GPD/ac.	489,375 GPD
Residential	7775	75%	100	2 unit/ac.	117	300	GPD/unit	3,498,750 GPD
Resort/Mixed Use	13300	75%	100	3 units/ac.	299	250	GPD/unit	7,481,250 GPD
Medium Density	1378	50%	100	5 units/ac.	34	200	GPD/unit	689,000 GPD
Retail	2138	60%	100	n/a	n/a	600	GPD/ac.	769,680 GPD
Study Area Total	**25461**							**12,928,055 GPD**
Peak Daily Demand = Avg. Demand x 1.6								**20,684,888 GPD**

Total Average Daily Demand for Potential Growth Areas	**36,605,280 GPD**
Peak Daily Demand for Potential Growth Areas	**58,568,448 GPD**

Notes:

1. The land use and areas shown for each growth area are taken from the present Louisa County Comprehensive Plan (1993).
2. Portion developable accounts for open space and right of ways that are typically required for each type of land use.
3. Percent buildout is an estimate of how much of a particular land use may be developed.
4. The unit flows shown are based on typical design values recognized by the Virgina Health Department and are usually higher than the actual demands.
5. The average demand is calculated as follows:
   Area x Portion Developable (%) x Percent Buildout (%) x Dwelling Density x Unit Flow = GPD
   GPD = Gallons per day
6. This table does not account for the use of private systems.

TABLE 5-6
ULTIMATE WATER DEMANDS BASED ON BUILD-OUT HOUSING UNIT DENSITY
LOUISA COUNTY

Zion Crossroads

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre)		Average Demand		
		Lower	Upper	Lower	Upper	Units
Neighborhood 2	983	3.1 h.u./ac.	5.9 h.u./ac.	761,825	1,449,925	GPD
Suburban 2	3400	0.35 h.u./ac.	1 h.u./ac.	297,500	850,000	GPD
Suburban 1	880	0.2 h.u./ac.	0.33 h.u./ac.	44,000	72,600	GPD
Large Lot 2	670	0.1 h.u./ac.	0.2 h.u./ac.	16,750	33,500	GPD
Large Lot 1	200	0.05 h.u./ac.	0.1 h.u./ac.	2,500	5,000	GPD
Rural 2	3800	0.03 h.u./ac.	0.05 h.u./ac.	28,500	47,500	GPD
Remaining Areas	1100	0.01 h.u./ac.	0.03 h.u./ac.	2,750	8,250	GPD
Average Daily Demand				**1,153,825**	**2,466,775**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**1,846,120**	**3,946,840**	**GPD**

Ferncliff

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre)		Average Demand		
		Lower	Upper	Lower	Upper	Units
Neighborhood 2	0	3.1 h.u./ac.	5.9 h.u./ac.	0	0	GPD
Suburban 2	2700	0.35 h.u./ac.	1 h.u./ac.	236,250	675,000	GPD
Large Lot 2	180	0.1 h.u./ac.	0.2 h.u./ac.	4,500	9,000	GPD
Large Lot 1	70	0.05 h.u./ac.	0.1 h.u./ac.	875	1,750	GPD
Remaining Areas	35	0.01 h.u./ac.	0.03 h.u./ac.	88	263	GPD
Average Daily Demand				**241,713**	**686,013**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**386,740**	**1,097,620**	**GPD**

Gum Springs

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre)		Average Demand		
		Lower	Upper	Lower	Upper	Units
Neighborhood 2	3850	3.1 h.u./ac.	5.9 h.u./ac.	2,983,750	5,678,750	GPD
Suburban 2	9050	0.35 h.u./ac.	1 h.u./ac.	791,875	2,262,500	GPD
Suburban 1	100	0.2 h.u./ac.	0.33 h.u./ac.	5,000	8,250	GPD
Large Lot 2	240	0.1 h.u./ac.	0.2 h.u./ac.	6,000	12,000	GPD
Large Lot 1	350	0.05 h.u./ac.	0.1 h.u./ac.	4,375	8,750	GPD
Rural 2	3000	0.03 h.u./ac.	0.05 h.u./ac.	22,500	37,500	GPD
Remaining Areas	5000	0.01 h.u./ac.	0.03 h.u./ac.	12,500	37,500	GPD
Average Daily Demand				**3,826,000**	**8,045,250**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**6,121,600**	**12,872,400**	**GPD**

TABLE 5-6 (CONTINUED)
ULTIMATE WATER DEMANDS BASED ON BUILD-OUT HOUSING UNIT DENSITY
LOUISA COUNTY

Louisa Area

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre) Lower	Housing Unit Density (h.u./acre) Upper	Average Demand Lower	Average Demand Upper	Units
Neighborhood 2	1560	3.1 h.u./ac.	5.9 h.u./ac.	1,209,000	2,301,000	GPD
Suburban 2	3000	0.35 h.u.	1 h.u.	262,500	750,000	GPD
Suburban 1	3600	0.2 h.u.	0.33 h.u.	180,000	297,000	GPD
Large Lot 2	1660	0.1 h.u.	0.2 h.u.	41,500	83,000	GPD
Large Lot 1	40	0.05 h.u.	0.1 h.u.	500	1,000	GPD
Rural 2	1660	0.03 h.u.	0.05 h.u.	12,450	20,750	GPD
Remaining Areas	1500	0.01 h.u.	0.03 n/a	3,750	11,250	GPD
Average Daily Demand				**1,709,700**	**3,464,000**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**2,735,520**	**5,542,400**	**GPD**

Mineral Area

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre) Lower	Housing Unit Density (h.u./acre) Upper	Average Demand Lower	Average Demand Upper	Units
Neighborhood 2	6040	3.1 h.u./ac.	5.9 h.u./ac.	4,681,000	8,909,000	GPD
Suburban 2	10000	0.35 h.u./ac.	1 h.u./ac.	875,000	2,500,000	GPD
Suburban 1	900	0.2 h.u./ac.	0.33 h.u./ac.	45,000	74,250	GPD
Large Lot 2	800	0.1 h.u./ac.	0.2 h.u./ac.	20,000	40,000	GPD
Remaining Areas	370	0.01 h.u./ac.	0.03 h.u./ac.	925	2,775	GPD
Average Daily Demand				**5,621,925**	**11,526,025**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**8,995,080**	**18,441,640**	**GPD**

Lake Gordonsville Area

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre) Lower	Housing Unit Density (h.u./acre) Upper	Average Demand Lower	Average Demand Upper	Units
Neighborhood 2	5620	3.1 h.u./ac.	5.9 h.u./ac.	4,355,500	8,289,500	GPD
Large Lot 2	1470	0.1 h.u./ac.	0.2 h.u./ac.	36,750	73,500	GPD
Rural 2	8000	0.03 h.u./ac.	0.05 h.u./ac.	60,000	100,000	GPD
Remaining Areas	2000	0.01 h.u./ac.	0.03 h.u./ac.	5,000	15,000	GPD
Average Daily Demand				**4,457,250**	**8,478,000**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**7,131,600**	**13,564,800**	**GPD**

TABLE 5-6 (CONTINUED)
ULTIMATE WATER DEMANDS BASED ON BUILD-OUT HOUSING UNIT DENSITY
LOUISA COUNTY

Lake Anna Area

Housing Unit Description	Area (Acres)	Housing Unit Density (h.u./acre)		Average Demand		
		Lower	Upper	Lower	Upper	Units
Neighborhood 2	12150	3.1 h.u./ac.	5.9 h.u./ac.	9,416,250	17,921,250	GPD
Suburban 2	3600	0.35 h.u./ac.	1 h.u./ac.	315,000	900,000	GPD
Suburban 1	0	0.2 h.u./ac.	0.33 h.u./ac.	0	0	GPD
Large Lot 2	1500	0.1 h.u./ac.	0.2 h.u./ac.	37,500	75,000	GPD
Large Lot 1	0	0.05 h.u./ac.	0.1 h.u./ac.	0	0	GPD
Rural 2	0	0.03 h.u./ac.	0.05 h.u./ac.	0	0	GPD
Remaining Areas	3000	0.01 h.u./ac.	0.03 h.u./ac.	7,500	22,500	GPD
Average Daily Demand				**9,776,250**	**18,918,750**	**GPD**
Peak Daily Demand = Avg. Demand x 1.6				**15,642,000**	**30,270,000**	**GPD**
Total Average Daily Demand for Potential Growth Areas				**26,786,663**	**53,584,813**	**GPD**
Peak Daily Demand for Potential Growth Areas				**42,858,660**	**85,735,700**	**GPD**

Notes:

1. **The areas shown for each growth area are approximate and were taken from the Buildout Analysis for Louisa County prepared by the Thomas Jefferson Planning District Commission.**
2. **An average usage of 250 gallons/day/housing unit was used to estimate water demand.**
3. **This table does not account for the use of private systems.**

6.0 WATER SYSTEM EVALUATION FOR FUTURE GROWTH

Based upon development of the seven potential growth areas and the existing available water supply, an evaluation has been performed to address future water demands which includes additional water sources, primary water transmission lines, and storage tank requirements. As shown in Table 5-3, the water supply demands for public water in the year 2015 are estimated to be between 2.8 MGD and 4.1 MGD (average). The peak daily flow could reach up to 6.6 MGD. The Louisa County Water Authority (LCWA) is presently capable of producing up to 1.0 MGD of treated surface water from their Northeast Creek Reservoir facility. Additionally, public wells and springs that are presently owned and operated by the LCWA, the Town of Louisa, and the Town of Mineral, have cumulative reported yields of between 0.3 MGD and 0.4 MGD. Based on the projected 20 year demands and the present available water supply, Louisa County will require additional water in the near future.

6.1 Future Regulations and Water

The future emphasis of regulatory control over water will probably be on protection of groundwater and surface water resources that are currently available to Louisa County. Groundwater resources in Louisa County will probably be a significant component of the total supply of water available for the County for many years. Effort should be made in the evaluation of subdivisions and any other small lot development to ensure that sewage is adequately collected, treated and disposed of to minimize the potential impact on groundwater. Future State and Federal regulations will be concerned with improving and maintaining surface water quality and groundwater protection. New regulations will probably be coming out in the future to address bacterial quality of water and some of the associated viruses that can pass through conventional water treatment plants. The County can expect to potentially have to improve filtration and possibly disinfection processes at their treatment facilities.

6.2 Surface Water Sources

The best surface water sources for the immediate future are the 2 reservoirs that are already owned by the County, Northeast Creek Reservoir and Lake Gordonsville. The largest potential surface water source in Louisa County is Lake Anna. However, because the lake was constructed primarily as a cooling water supply source for Virginia Powers' nuclear power plant, it would be very difficult to obtain any significant allocation of water for drinking water purposes in the next 20 years. For long term planning (40 years+), Lake Anna may be a potential drinking water source, should deregulation of their nuclear power plant require termination of this facility.

6.2.1 Northeast Creek Reservoir

Northeast Creek reservoir has an estimated safe yield of 2.77 million gallons/day (MGD) of water that can be used for drinking water purposes. Although the actual safe yield may vary from this estimate, this reservoir offers the best option for significantly increasing the public water supply, primarily because there is already a water treatment plant and transmission main in place. The existing water treatment plant can provide up to 1 MGD to County residents. Expanding this plant to allow for treatment of up to 2.5 MGD should be less expensive than construction of a new 1.5 MGD plant because some of the existing plant infrastructure will reduce overall project costs. As discussed in Section 2, the quality of this water source is presently very good. However, a reservoir watershed management plan will need to be developed (discussed in section 8) to preserve the water quality.

6.2.2 Lake Gordonsville

Lake Gordonsville is presently used for flood control and does not have a water treatment plant. It appears to have very good water quality. Lake Gordonsville has an estimated safe yield of 0.9 MGD of water that can be used for drinking water purposes. Although Louisa County owns Lake Gordonsville, the Town of Gordonsville owns 10 percent of the Lake's usable yield. In a recent study prepared for the Town of Gordonsville by Espey, Huston & Associates, Inc., it was recommended that the Town of Gordonsville seek to purchase water from Louisa County to meet future water demands. Although in the long term, it may not be desirable for Louisa County to allocate their water supply to another entity, providing some water to the Town initially is a good way of generating immediate revenue to offset new water plant construction costs. Additionally, an agreement with the Town of Gordonsville could include a portion of the capital construction costs.

6.2.3 Direct Withdrawal from South Anna River

If the County grows faster than estimated, or if larger industrial water users decide to locate in Louisa County, it may be necessary to obtain an additional surface water source in the County.

In order to insure a continuous water supply, the State regulations require that direct withdrawals be limited to the "1Q30", which is defined as the lowest rate of flow which statistically occurs for 1 day every 30 years. Additionally, a minimum instream flow (MIF) will be established by the State, which limits the amount of water that can be withdrawn from a river when it is flowing below the MIF. The result is that only very large sources (like the James River and Rivanna River) are permitted for direct withdrawal.

The largest, free flowing river in Louisa County is the South Anna River. This river is not large enough to allow for any significant withdrawal without the benefit of some type of storage impoundment.

6.2.4 New Surface Water Impoundments

Due to the present environmental impacts and associated permitting requirements, it is very difficult to develop a surface water impoundment directly on a free flowing stream or river such as the South Anna River or some of its larger tributaries. However, from a permitting standpoint, it is possible to develop an impoundment on a smaller tributary that may not contain significant wetlands or endangered plant and animal species. If an impoundment can be constructed near the South Anna River, it would be possible to pump water from the South Anna River during periods of flow above the MIF to provide a continuous water supply during low flow conditions. This is a very expensive option because it will require property acquisition, a large impoundment, a water treatment plant, at least 2 pumping stations, and probably several miles of transmission mains.

6.3 Groundwater Resources in Potential Growth Areas

The averages of reported initial yields help to characterize groundwater potential in different parts of Louisa County, but do not provide absolute criteria with which to evaluate groundwater availability on specific sites. The averages do not, for example, guarantee that every 200-acre subdivision on granitic plutonic rocks can expect to obtain a sustainable 15.5 GPM yield from each of 200 individual domestic wells. In fractured rock aquifer terrain, groundwater storage, recharge, and transmissivity in one area may be quite different from the aquifer parameters a short distance away, even within the same geologic formation. Somewhere in Louisa County there undoubtedly exist 200-acre parcels on granitic rocks for which little or no groundwater is available.

The following is a general overview of groundwater potential in each of the potential growth areas:

1. Zion Crossroads

Bedrock geology: mica schist and phyllite.

Average of reported yields: 10.9 GPM (n = 85).

High yield wells: One 50 GPM well is reported within area.

Groundwater potential: low. Bedrock fracture densities are relatively low, and much of the potential growth area is on a topographic interfluve that likely corresponds to a groundwater divide in the subsurface. Prospects are not good for developing multiple high-yield wells that are sustainable over time.

2. Ferncliff

Bedrock geology: mafic and felsic volcanic rocks; granite.

Average of reported yields: 6.5 GPM (n = 12).

High yield wells: One 60 GPM well is located in granite just east of the area.

Groundwater potential: low. Designated growth area is on topographic interfluve; this may account for relatively low reported yields in rocks that elsewhere have shown higher productivity.

3. Gum Springs

Bedrock Geology: quartzofeldspathic biotite gneiss; mafic plutonic rocks; granitic plutonic rocks.

Average of reported yields within area: 16 GPM (n = 79).

High yield wells: Three high yield wells are within the area (60, 100, and 150).

Groundwater potential: low to moderate. The growth area is extensive, and contains a variety of topographic and geologic settings. The area likely contains sufficient groundwater to sustain moderate densities of residential development. Hydrologic testing is recommended to evaluate groundwater availability in sites of potential cluster or high-density development.

4 and 5. Louisa and Mineral Areas

Bedrock geology: granitic plutonic rocks; mafic and felsic volcanic rocks.

Average of reported yields within area: 14.7 GPM (n = 91).

High yield wells: Three high yield wells are within the area (50, 60, 80 GPM).

Groundwater potential: low to moderate.

6. Lake Gordonsville Area

Bedrock geology: mica schist and phyllite.

Average of reported yields within area: 11.5 GPM (n = 72).

High yield wells: Two high yield wells are within the area (50, 60 GPM).

Groundwater potential: low. Low bedrock fracture density in most of the area; potential for high-yield wells exists in the Everona Limestone near the Albemarle-Orange-Louisa County boundary intersection southwest of Gordonsville.

7. Lake Anna Area

Bedrock geology: All five rock families represented.

Average of reported yields within area: 15.8 GPM (n = 970).

High yield wells within area: 50 wells have yields of 50 GPM or greater.

Groundwater potential: low to good. Groundwater recharge is buffered by the lake for much of the area; yields are nonetheless governed by bedrock fracture density and geometry.

The only way to evaluate with some degree of certainty the hydrogeologic regime of a particular site is to conduct hydrologic testing using existing or new wells. Hydrologic tests are designed to measure groundwater flow and storage characteristics; tests can be designed using single wells, or multiple wells on adjacent sites. Typically, electronic devices are installed in the well or wells to monitor water levels, and a well is pumped at a known rate for a period of time. Changes in water levels in the wells over time are charted through the test, and mathematical formulae are then applied to define the aquifer parameters. Hydrologic testing is the only way one can accurately assess the sustainable yield of a given well, or what effect, if any, introduction of a new pumping well will have on water availability in existing nearby wells.

It is recommended that serious consideration be given to developing groundwater resources in selected areas for the following reasons:

- Development of new well fields is likely to cost significantly less than developing new surface water sources or extending long transmission mains (at least initially).
- The quality of groundwater is generally higher than that of surface waters (requiring less treatment prior to distribution).
- The volume of groundwater in storage (because of the thick residual soils through much of the County) is large (such that adequate yields are more likely during droughts).
- The footprint of a well field is trivial when compared to the footprint of a surface water impoundment, such that well fields permit additional uses of the land (as deemed appropriate with respect to well-head protection). Well-head protection areas should be considered in addition to the sum of the footprints of the individual well sites.

In the absence of site-specific data concerning the fundamental hydrogeologic properties of the various rock units, several guidelines (as opposed to recommendations) are offered for consideration when planning the development of groundwater resources in Louisa County:

- Give somewhat higher priority to areas underlain by quartzofeldspathic rocks (gneiss, granite, granodiorite), followed by more mafic plutonic rocks and volcanic rocks: give lowest priority to areas underlain by mica schist and phyllite.
- Give higher priority to areas associated with the thickest regolith (as measured by casing length of existing wells).
- Give lowest priority to headwaters areas in close proximity to the Mineral gold-mining district until further studies show that groundwater resources have not been impacted by

contaminants associated with such mining (Contrary Creek watershed, northeastern most portion of South Anna-Roundabout Creek hydrologic unit, northernmost portion of South Anna - Tailors Creek hydrologic unit).

- Place well fields close to the contacts between major rock types (where the probability of encountering fault zones may be maximized).
- Place individual wells in broad draws having relatively large catchment areas.
- Since a significant number of borings will not yield commercially significant quantitites of groundwater, the number of proposed drill sites should be at least three, and as much as five, times the number of wells that are ultimately planned for the well field.
- More single-family residential units can be served by communal well networks than can be served by individual (private) wells because the former (1) makes a larger geographic area available for consideration as potential well sites and (2) pools resources (which permits the construction of deeper wells of larger diameter than any single resident could afford).

6.3 Obtaining Water From Adjoining Counties

Although most of the neighboring Towns and Counties are not presently in the position to provide water to Louisa County, it is possible that at some point in the future arrangements from one or more jurisdictions could be made. The most promising areas are probably Fluvanna and Goochland Counties because several I-64 interchanges (Zion Crossroads, Ferncliff, Gum Springs) are closely related to these County boundaries and it may be in both parties interest to join supplies to promote strong growth around these corridors. Additionally, the Town of Gordonsville may be an option for additional water in the future if a larger supply is provided to them by Orange County or the Rapidan Service Authority.

6.4 Water Storage Requirements

Storage is an essential part of any water system. It is important to maintain adequate system pressures and flows during peak demands and also provides fire protection. In order to evaluate water storage needs in the service area, four parameters were considered:

1. Flow Equalization

   Over the course of a 24 hour day, demand for water changes significantly. During the day, it is common for tanks to be emptying; while at night, the tanks refill again for the next day's peaks. If water is not available from storage, pumps have to be large enough to meet peak hour demands. For a typical domestic demand, storage necessary to meet peak hour flows usually amounts to 25% of the total demand for that day.

2. Fire Flows

One of the major purposes for distribution system storage is meeting fire demands. Although fire demands may not occur very often or last very long, they are much greater than consumer peak demands. For the potential growth areas, water storage capacity has been reserved in order to provide a minimum of 1,000 gallons per minute of fireflow for a 2 hour period.

3. Emergency Storage

In water distribution design, it is good practice to provide emergency storage in case of pump failure and other potential problems. This analysis allowed 25% of the peak day flows for emergency reserve capacity.

4. VDH Requirements

The Virginia Department of Health requires a minimum of 200 gallons of "effective" storage per equivalent residential connection. This requirement is usually met or exceeded by the above design criteria.

An analysis of the storage requirements for the 7 potential growth areas has been performed and is summarized in Table 6-1. These storage requirements were estimated based on the projected 2015 water demands that are summarized in Tables 5-1 and 5-2.

TABLE 6-1
PROJECTED WATER STORAGE REQUIREMENTS FOR YEAR 2015
LOUISA COUNTY, VIRGINIA

Potential Growth Area	Projected Peak Day Flow (gpd)	Required Storage (gallons)	Existing Storage (Gals)	Additional Storage Recommended (Gals)
1. Zion Crossroads	700,000 to 1,000,000	470,000 to 620,000	0	600,000
2. Ferncliff	130,000 to 230,000	185,000 to 235,000	0	250,000
3. Gum Springs	780,000 to 1,200,000	510,000 to 720,000	0	600,000
4. Louisa Area	850,000 to 1,200,000	550,000 to 720,000	700,000	None
5. Mineral Area	650,000 to 820,000	450,000 to 530,000	60,000	500,000
6. Lake Gordonsville Area	500,000 to 600,000	370,000 to 420,000	0	500,000
7. Lake Anna Area	700,000 to 1,300,000	470,000 to 770,000	0	600,000

Required Storage Calculations (sum of a thru c below):

a. Fireflow = 2 hrs x 1,000 gal/min.
b. Equalization = .25 x peak flow
c. Emergency = .25 x peak flow

7.0 WASTEWATER SYSTEM EVALUATION FOR FUTURE GROWTH

Based upon development of the seven potential growth areas, an evaluation has been performed to address future wastewater needs. Outside of the potential growth areas, the continued use of septic tanks and drainfields in addition to alternative systems are discussed. As shown in Table 5-3, the water supply demands for public water in the year 2015 are estimated to be between 2.8 MGD and 4.1 MGD (average). The peak daily flow could reach up to 6.6 MGD. The projected wastewater demands should be relatively consistent with the projected water demands. The Louisa County Water Authority (LCWA) is presently capable of treating up to 200,000 gallons of wastewater per day at the Louisa Regional facility and is presently expanding to accommodate a flow of 400,000 gals/day. The Town of Louisa also operates a 60,000 gal/day trickling filter plant. Based on the projected 20 year demands and the present available water supply, Louisa County will require several additional wastewater treatment facilities in future years.

7.1 Future Regulations and Wastewater Treatment

Existing and future regulations will have a significant impact on the treatment of wastewater for the residents of Louisa County. Treatment standards for wastewater will become more strict in the future years as long as the additional pressure to provide protection for both, groundwater resources and surface water resources within the County should continue.

Louisa County is located in a headwaters area of the York River. Stream flow in the County is relatively low, especially in the dry periods of the year. Most streams are relatively small and during the summer time have flows just a fraction of what they are during the wetter periods of the year. Typically from Virginia water outlets, the river flows under low-flow conditions can be as low as one tenth (10^{th}) of a cfs (cubic foot per second per square mile of drainage area within the basin. The fact that Louisa County is located in a headwater area with relatively low flow in their streams and rivers throughout the County, has a significant impact on permitting of wastewater treatment plants and wastewater discharges within the county.

The majority of plant sites available for wastewater treatment within Louisa County will be permitted based on the Virginia Water Quality Regulations because the reaches of streams in all likelihood will be termed water quality limited and will require a high level of treatment to meet the appropriate criteria. Virginia recently upgraded its water quality standards in 1997. These standards are reviewed on a three year cycle and are usually amended at each renewal point. For the next ten to twelve years (or longer), it appears that the water quality standards will be stable with no major shifts in the present water quality standards. Key areas in the water quality standards for Virginia will directly impact wastewater treatment in Louisa County. The key areas are the development of an ammonia standard of 2.5 mg/l for chronic toxicity and streams of average pH. By the time the appropriate permitting factors are applied, the maximum allowable ammonia discharge will probably be less than 1 mg/l in many locations in. As new permits are applied for, or old permits come up for renewal, it can be expected that imposition of ammonia standards at low levels for those treatment facilities will apply. In addition to ammonia, the water quality standards also have criteria for heavy metals. Heavy metals can also have a significant influence on Louisa County, but the actual impact is not as clear as it is for the ammonia standards. Currently the wastewater discharges that we have evaluated either do not have a permit limit for metals or have very little metals in them. In the future, it is probable that metals limits may be placed on wastewater treatment facilities.

The State of Virginia, and other states that surround the Chesapeake Bay, are currently in the process of evaluating the Chesapeake Bay to find out what appropriate steps are necessary to preserve this very important resource. The Chesapeake Bay Act (Chesapeake Bay Tributary Studies) is attempting to establish discharge criteria (nutrients, metals, BOD, suspended solids) that will be more protective of the Chesapeake Bay and enhance the ultimate recovery of the Bay to less polluted levels. The Tributary study for the York River has not been completed to date. The only Tributary Study that is near the final stage of completion is the Tributary Study for the Potomac River Basin. This could have a significant impact on the York River Basin in that after a thorough evaluation of the Bay, it was concluded that controlling nitrogen input is a key factor in the control of algal blooms, to enhance water quality, that phosphorus was significant. The net result is the Potomac River Basin currently will have a total nitrogen limit of 8 mg/l in wastewater discharges that ultimately end up in the Bay. It is anticipated that the York River Basin will have similar criteria set if it proves that nitrogen is limiting algal blooms in the lower part of the Chesapeake Bay.

In the design of any wastewater treatment plant for Louisa County, it is anticipated that along with issuance of the permit or renewal of the permit, facilities will require features to allow for nitrification and denitrification processes in order to achieve the low ammonia standards that are anticipated. Additionally, phosphorus removal may also be required for wastewater treatment in the near future.

7.2 Anticipated WWTP Discharge Requirements

As discussed in Section 7.1, the Virginia Water Quality Standards and the Chesapeake Bay Act will probably establish very stringent limits for nitrogen. Water quality standards (chronic ammonia critical for freshwater) will define permit limits. Ammonia limits will likely be set below 2 mg/l for ammonia. This limitation will establish the performance criteria for new plants in Louisa County. The typical permit limits are anticipated to be: BOD 10 to 20 mg/l, suspended solids 10 mg/l, and ammonia nitrogen less than 2 mg/l. A plant site located on a larger stream may have as high as a 20 mg/l suspended solids limit, which may reduce the treatment cost, but probably only slightly.

7.3 Typical Wastewater Treatment Facility

The combination of low stream discharges in the river and very stringent water quality criteria will require most of the wastewater treatment plants in Louisa County, both existing and new ones, in the near future to have quite stringent treatment discharge limits. The typical wastewater treatment plant in Louisa County will consist of the following unit operations;

- Preliminary Treatment. Wastewater Treatment Facilities will typically incorporate fine screening to remove non-degradable solid objects in the wastewater along with an aerated grit chamber to initiate treatment of the wastewater at the treatment facility.

- Secondary Treatment. The high level of treatment required for all discharges in Louisa County, will dictate some type of biological nutrient removal process to be utilized in the County for nitrogen and possibly phosphorus control. The typical treatment facility will consist of a secondary treatment unit, that consists of aeration and solids separation operated in such a fashion to enhance nitrification and phosphorus removal biologically from the wastewater. The future requirements from Tributary Studies to reduce the total amount of nitrogen will also force the design of treatment facilities to provide at least the ability to add de-nitrification to the treatment train at some future time.

- Wastewater Filtration. Nearly all of the facilities will have to include some form of filtration to reliable reduce the suspended solids to below permit conditions. The result of water coming out of the wastewater treatment facility will be of excellent quality and should not cause any environmental degradation to the streams that they discharge to.

- Disinfection. Disinfection will be provided to ensure that there is good bacterial quality of the effluent prior to discharge. Typical disinfection can be accomplished with chlorination followed by dechlorination or by ultra-violet disinfection.

- Post Aeration. All facilities in Louisa County (because of the low stream flows) can be expected to have to provide post aeration to resaturate the water with dissolved oxygen prior to discharge to a stream or river.

- Sludge Digestion and Disposal. Typical sludge handling for wastewater treatment facilities in Louisa County will consist of aerobic sludge digestion followed by land application of the sludge. This particular method works well with the biological nutrient removal plants and as a natural extension of the facilities to manage the bio-solids generated in the wastewater treatment process.

The typical wastewater treatment facility located in Louisa County (for all areas except for Lake Anna) will probably consist of the previously delineated unit operations. For cost estimating purposes (presented in Section 10), it has been assumed that the permit limits will be relatively stringent (as discussed in Section 7.2).

This assumption should apply to the larger size wastewater treatment plants (>300,000 gpd) to be located within Louisa County. However, some smaller wastewater treatment facilities may be able to obtain wastewater discharge permits with more generous limits and can possibly eliminate one or two of the aforementioned unit operations.

7.4 Wastewater Treatment for the Lake Anna Area

The Lake Anna Area is a very unique area within Louisa County as far as wastewater discharges are concerned. A wastewater discharge to the lake would have to meet wastewater quality standards essentially with no dilution. In other words, the discharge would have to meet water quality standards without considering any dilution by the volume of water in the lake. This will result in extremely low discharge standards for BOD (less than 10 mg/l), suspended solids (less than 10 mg/l), ammonia nitrogen (probably less than 1 mg/l), with some concern of phosphorus removal for discharge to the lake. In addition to the extreme level of treatment, the aesthetics of discharging to the lake would probably become an issue with the County residents and civic organizations. Lake discharge is possible because the high level of treatment would ensure that no degradation of the lake would occur. However, there are other options available, that will provide a good level of treatment and may eliminate the necessity for direct discharge to the lake.

For those areas to be served by wastewater treatment near the lake, it is suggested that land application of the treated wastewater through spray irrigation in nearby rural fields be utilized. The typical wastewater treatment system for a spray irrigation package involves some type of preliminary treatment, followed by secondary treatment for organic and suspended solids removal, followed by spray irrigation of the effluent on land. The typical wastewater treatment portion of this plant will produce an effluent that is below 60 mg/l suspended solids, below 60 mg/l BOD, and ready to be land applied. In this part of Virginia, it is anticipated that up to 90 days storage of wastewater be provided for winter time conditions when the wastewater cannot be adequately land applied. A typical design for this facility consists of a secondary wastewater treatment plant to produce a reasonable quality effluent of below 60 mg/l BOD and suspended solids, followed by an aerated holding lagoon to store the wastewater until it can be appropriately applied to land. Wastewater can be applied to both crop land and forest land and would require approximately 200 acres of active application area per million gallons of wastewater treated. Wastewater treatment utilizing this alternative, although probably more expensive than a wastewater treatment plant with stringent limits for direct discharge, will probably be more desirable in the Lake Anna areas of Louisa County.

Another option for wastewater treatment for Lake Anna is to discharge just south of the dam, where the North Anna River becomes free flowing again. However, the length of force main and number of pump stations that would be required would probably make this option more costly than utilizing spray fields. The treatment facility would need to achieve the more stringent standards discussed in Section 7.2.

7.5 Upgrade of Louisa County Wastewater Treatment Plant

Although the existing regional Louisa wastewater treatment plant is presently being expanded to a capacity of 400,000 gals/day, due to its location this facility should be evaluated for additional expansion due to anticipated growth in the central portion of Louisa County. It is possible that an additional 750,000 gallons per day of capacity will be needed to serve this area in the next 20 years. The biological process presently being utilized (oxidation ditch) should be able to meet future anticipated limits. This should reduce the cost for plant expansion as compared to construction of a new facility.

7.6 Centralized WWTP for Louisa County

A centralized Regional wastewater treatment plant for Louisa County has been evaluated. The cost of long force mains and pump stations make this alternative less cost effective than localized wastewater treatment in individual growth areas.

7.7 Alternative Wastewater Treatment Systems

Alternative waste disposal systems have been developed for sites that are unsuitable for septic systems. The successful operation of alternative disposal systems generally requires more careful attention to siting, design, installation, and maintenance than for conventional septic systems. The site and soil conditions where they are used are often less favorable for wastewater absorption. These systems are usually more mechanically complex and require regular maintenance. While it is not presently normal policy in Loiusa County to allow alternative wastewater treatment methods when property is not suitable for septic systems, there are alternatives that can be utilized. The Louisa County Health Department will need to review alternative systems and operation requirements prior to issuance of these type of permits.

Some of these alternative systems are similar to conventional septic systems in that they discharge effluent to the ground through a soil absorption area. These include mound systems, low-pressure distribution systems, and enhanced-flow systems. Other alternatives discharge treated wastewater into a stream or a ditch that leads to a stream instead of to a soil absorption area. They include sand filters and aerobic treatment units.

7.7.1 Cluster Systems

In the cluster septic system, one large drainfield is used for several septic tanks. Each home or unit has an onsite septic tank to settle solids. Wastewater flows from the individual tanks to the community drainfield. These systems have been used in planned residential developments and in neighborhoods where drainfields have failed. If soil and site conditions permit, one mass drainfield may be more effective for several residences. For clusters of homes or commercial/institutional flows, a two-compartment septic tank provides for more efficient removal of suspended solids. The second compartment receives the clarified liquid from the first compartment at a slower rate and with less turbulence, providing more settling area and more favorable conditions for settling the remaining solids. The additional compartment also reduces the effect of periodic high wastewater flows. Two single-compartment tanks in a series can work in a similar fashion. A reduction of suspended solids and a longer retention period improves the quality of the effluent, which helps improve the performance and extended the life of soil absorption areas.

7.7.2 Enhanced-Flow Systems

Enhanced-flow systems are conventional septic systems with the addition of a pump to distribute effluent to a larger portion of the drain field. In a conventional septic system, less than 15 percent of the drainfield is dosed with effluent at any time and parts of the system, usually areas close to the distribution box, never have a chance to dry out. An enhanced-flow system used a pump to improve wastewater distribution throughout the drainfield. Pumping the effluent periodically wets the entire drainfield. The drainfield dries out between dosing, which is beneficial to soil clogging. Maintenance of enhanced-flow systems is basically the some as for a conventional septic system, but pump maintenance and replacement must also be considered.

7.7.3 Low-Pressure Distribution Systems

Approximately 1,000 of these alternatives to conventional septic systems have been permitted by the Virginia Department of Health. These systems, like the enhanced-flow systems, use a pump to distribute the effluent through pipes in controlled doses to the drainfield. Unlike the enhanced-flow systems, there is no distribution box. The pump is housed in a dosing tank adjacent to the septic tank, and the effluent is pumped directly from the dosing tank to a set of perforated small-diameter plastic pipes that are buried in trenches. Site conditions and soils determine the pipe layout and the number and size f the holes in the pipe. These systems may include a second septic tank in series with the first or a two-compartment tank to provide more opportunity for solids to settle before effluent is pumped out. The drainfield area may be the same size as a conventional system, but can be reduced by up to 50 percent with proper soil conditions. Low-pressure distribution systems can cost twice as much as a conventional septic system. The system also requires more maintenance and energy, so the operating costs are higher.

7.7.4 Sand Filters

Sand filters discharge treated wastewater to a stream or ditch leading to a stream instead of to a soil absorption area; such systems are regulated by the Virginia Water Control Board, but permitting for residential systems can be handled through a local health department. Sand filters are used for small flows from residences and small commercial establishments where a soil absorption field is not possible, and are the most commonly used alternative system in Virginia.

Wastewater passes through a pretreatment unit (a septic tank or an aerobic treatment unit) before being applied intermittently to a bed of granular material (and, activated carbon, mineral tailings, anthracite, and other materials have been used) that is underlain by graded gravel and collecting tile. Bacteria living in the filter materials are responsible for much of the treatment of the wastewater. The effluent must be disinfected (usually chlorination also may be required. Site conditions determine the design and type of sand filter, which can be either ground level or a buried sand pit. Sand filters cost al least twice as much as conventional septic systems, with higher operating costs adding to the expense.

8.0 WATER RESOURCE PROTECTION

Water resources in Louisa County are somewhat limited. In order to maximize the potential of long-term water resources, certain areas should be protected from the adverse effects of human activity. Such resources include current and future impoundments, groundwater supplies, rivers and streams. Protection of these resources will rely on control of point and non-point sources of pollution, either from development or other ground-disturbing activities.

Based on information available about Louisa County, the following three goals are set forth:

1. Protect and maintain the water quality in present and future Louisa County impoundments;
2. Protect and maintain the water quality in Louisa County's groundwater supply areas; and
3. Protect and maintain the water quality of Louisa County's streams and rivers.

Strategies more fully described in following sections of this chapter include:

- Decreasing run-off
- Decreasing nutrient loading
- Continuing Geographic Information Systems (GIS) mapping of land characteristics, well and septic locations
- Additional examination of old mining sites and underground storage tanks (USTs) located upstream from water impoundments
- Increasing water quality testing
- Increasing use of Best Management Practices (BMPs) in specific areas
- Developing site-based zoning and delineation of areas suitable for various development types
- Use of natural vegetative buffers
- Improving septic system management
- Instituting a wellhead protection program
- Enhancing partnerships with agencies responsible for developing and educating the public about strategies for water protection
- Encouraging public involvement

8.1 GOAL ONE: Protect and maintain the water quality in present and future Louisa County impoundments

The primary surface water impoundments for water supplies over the next twenty years have been identified as the Northeast Creek Reservoir and Lake Gordonsville. While these lakes presently demonstrate good water quality, as development continues within each watershed, the potential for pollutants in the form of sediment, nitrogen, phosphorus, pesticides, and other contaminants may jeopardize the water quality if not protected.

In accordance with the watershed management strategies presented in this section, a watershed management program should be implemented as soon as possible for both of the County's water sources. Because Northeast Creek Reservoir is the primary surface water source for Louisa County for many years and the entire watershed is within the County, a more detailed analysis of this reservoir is presented and the approach used in this watershed will be transferable to Lake Gordonsville or any other yet unidentified public water supply impoundment.

However, the time to develop a watershed management plan for Lake Gordonsville is soon. This will require a more detailed analysis of this drainage basin, which lies primarily in Albemarle County. Albemarle County has protected the South Fork Rivanna Reservoir for many years and is familiar with watershed protection strategies. Albemarle County has also designated much of this drainage basin as rural in its Comprehensive Plan.

To undertake watershed management planning for Lake Gordonsville, Louisa County should:

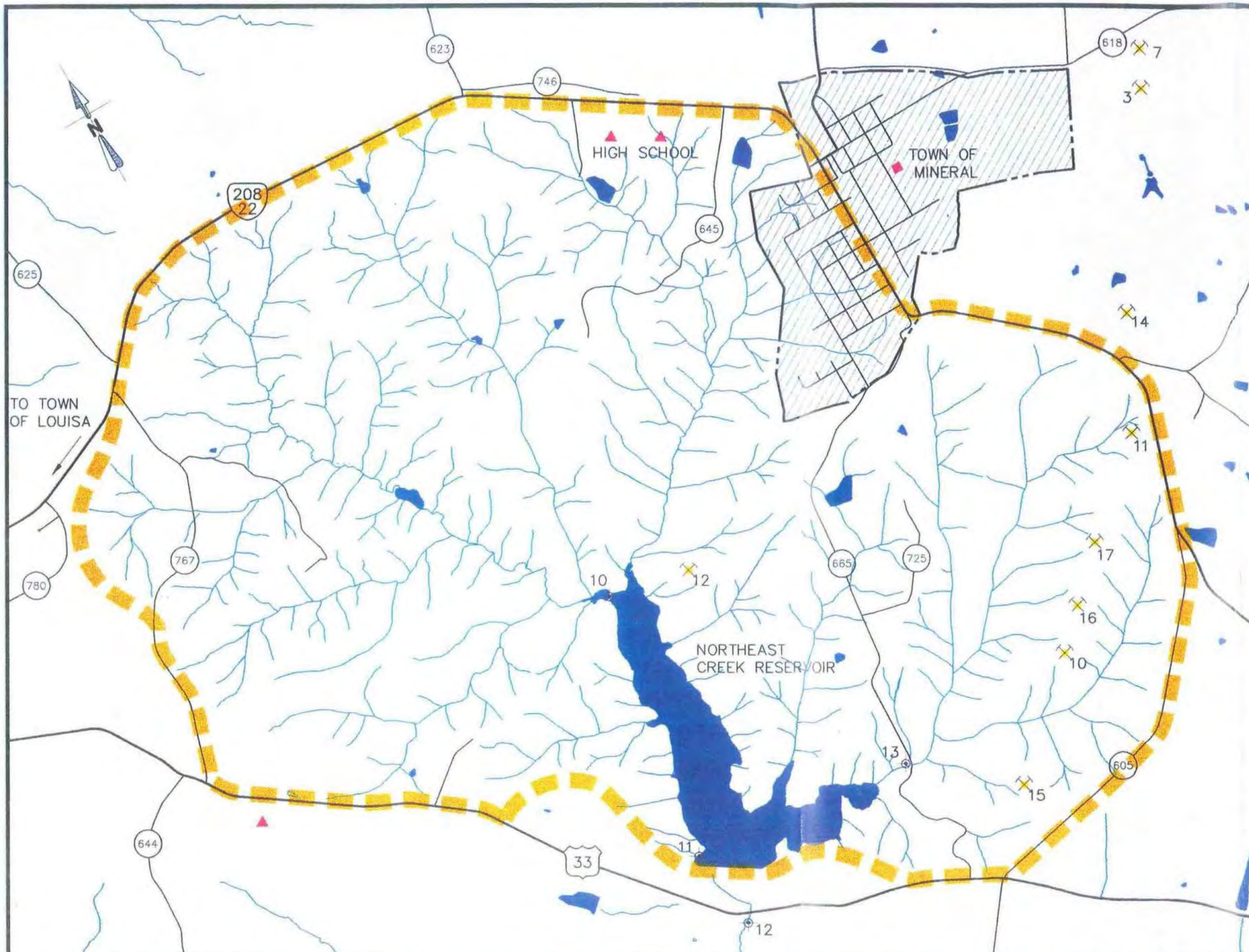
- *research the existing components of the Lake Gordonsville watershed,*
- *prepare a general management plan utilizing the techniques discussed in this section, and*
- *meet with Albemarle County to develop a cooperative watershed management plan that both Counties are willing to enforce.*

Because the Lake Anna area is in the midst of a great deal of development activity, *the County should undertake a more detailed study of Lake Anna and the effects of that activity in the watershed.*

8.1.1 Strategy: Delineate drainage basins of existing and future public water supplies (Watershed Management Areas)

A map of the existing Northeast Creek Reservoir watershed is presented in Figure 3-8. This watershed encompasses a drainage basin of approximately 9.7 square miles. The upper reaches of the watershed are bounded by Route 208/22. The western reaches are bound primarily by Route 767. However, a portion of the basin extends further west of Route 767 into the existing Louisa Industrial Park. Routes 522 and 605 run along the eastern boundary of the watershed. Approximately 40 percent of the Town of Mineral lies within the upper reaches of the watershed.

In addition to all stream tributaries, the map also shows locations of several past mines. There appear to be at least seven mines located within the reservoir basin. The previous mining activities and resulting possible water contamination issues that may result from these activities were discussed in Section 2.



MINE KEY

3	BIBB PROSPECT	LAT: LON:	38°00'19" N 77°53'16" W
7	HARRIS MINE	LAT: LON:	35°00'25" N 77°53'12" W
10	LOUISA MINE (SMALL STAMP MILL)	LAT: LON:	37°58'51" N 77°54'41" W
11	LUCE MINE (20-STAMP MILL)	LAT: LON:	37°59'22" N 77°54'02" W
12	MACDONALD MINE	LAT: LON:	37°59'44" N 77°55'54" W
14	NEW LUCE PROSPECT	LAT: LON:	37°59'42" N 77°53'46" W
15	PROFFIT MINE	LAT: LON:	37°58'33" N 77°55'06" W
16	RICSWAN MINE	LAT: LON:	37°58'58" N 77°54'33" W
17	SLATE HILL MINE	LAT: LON:	37°59'06" N 77°54'23" W

MAP LEGEND

WATERSHED BASIN BOUNDARY

SAMPLING STATION

OLD MINE LOCATION

Draper Aden Associates
CONSULTING ENGINEERS
Blacksburg, Virginia – Richmond, Virginia

NORTHEAST CREEK RESERVOIR WATERSHED

SCALE: 1"= 2000'

FIGURE: 3-8

8.1.2 Strategy: Evaluate and revise as appropriate the Potential Land Use Designations within Watershed Management Areas.

Comparison of the Northeast Creek Reservoir watershed map with the map contained in Figure 1-1, which shows possible future land use designations, indicates:

- approximately 50 percent of the basin is projected for residential development (average 2 units/acre),
- approximately 20 percent is projected for medium density development (average 5 units/acre),
- approximately 15 percent is projected for retail, and
- approximately 15 percent includes the Town of Mineral and a portion of the Louisa Industrial Park.

It appears that the present land use designations (per 1993 Comprehensive Plan) will make it very difficult to adequately protect the primary drinking water source for Louisa County in future years. *Louisa County should consider minimizing growth immediately around the lake,* primarily that slated for residential use at densities of two units per acre. A possible suggestion is to revise these areas to an agricultural/forestal designation in future comprehensive plans. Some more dense residential development, commercial and retail may still be viable for the upper reaches of the basin provided that adequate BMPs are implemented and enforced.

8.1.3 Strategy: Evaluate current and past land uses in the Watershed Management Area.

Old mines and underground storage tanks should be located and mapped on the County's GIS (Geographic Information System).

Detailed investigations should be undertaken to assess the extent to which the old mines could diminish the water quality of feeder streams.

Additional stream monitoring stations should be put in place following the investigation and monitoring for heavy metals and other identified contaminants carried out on a regular basis. Include testing for pesticides, herbicides, and nitrates in water testing program. Such monitoring was beyond the scope of this study, but should be undertaken beyond the required annual sampling.

8.1.4 Strategy: Promote forestal uses within the Watershed Management Area.

Forestal uses have been shown to provide the best buffering for water resources. These may be promoted through designated land uses and the use of land use taxation.

Continued support of Louisa County's commitment to land use taxation is recommended to protect water quality provided Best Management Practices are used.

Conservation easements in the Watershed Management Areas should be encouraged.

8.1.5 Strategy: Implement a septic tank management program within the Watershed Management Area.

Because septic tank management affects both surface water and groundwater, but has a greater impact on groundwater, this topic is covered in Section 8.2.3. The recommendations in that section apply to Watershed Management Areas as well.

8.1.6 Strategy: Decrease non-point sources of pollution

A. Land disturbing activities:

Land disturbing activities are major causes of soil erosion and provide opportunities for increased non-point source pollution. Most land disturbing activity requires a permit from the County.

When seeking approval of a project which disturbs land, the applicant should demonstrate that:

1. *No more land shall be disturbed than is necessary to provide for the desired use or development;*
2. *Indigenous vegetation shall be preserved to the maximum extent possible consistent with the use and development allowed.*

Funding of the Soil Erosion and Control Program in Louisa County should be continued.

Prior to a subdivision receiving approval, the applicant should demonstrate sustainable water yields consistent with the proposed use.

B. Stormwater Management

Runoff is that portion of the rainfall that does not infiltrate the soil (and become groundwater) or become captured in local depressions. It is a key component in the local and regional water budget. Stormwater runoff in urbanized or urbanizing areas is a significant source of non-point source pollution. Contaminants introduced into state waters from diffuse activities and locations are collectively called "non-point" source (NPS) pollution.

Runoff also has implications for groundwater. The greater the percentage of rainfall that flows away as runoff, the less groundwater recharge occurs in a given area. In naturally vegetated areas, stormwater gets trapped by vegetation and slowly soaks into the ground. In contrast, in areas intensively affected by human activities, stormwater travels preferentially by overland flow, becomes channelized by drains and ditches, and it rapidly discharged into streams and impoundments. Such channelized flows have high velocities which entrain (take along with the flow) sediment and pollutants, increase erosion and siltation, and have a negative effect on aquatic ecology, particularly native fish populations. For example, in a neighboring locality, coliform bacteria levels show a strong positive correlation with times of high runoff.

As development occurs, stormwater management programs have handled the increased rate and volume, velocity and flow rate of runoff by requiring developers to construct in-site ponds and drainage systems that control one or more of the runoff characteristics. In some cases, localities have conducted regional stormwater management studies and publicly funded stormwater improvements including elaborate drainage systems, channeled watercourses, dams, and reservoirs.

In 1989, the General Assembly passed the Stormwater Management Act (10.1-603.1 et seq., *Code of Virginia*) that provides localities authority to adopt local stormwater management ordinances consistent with minimum state regulations. Most localities have required stormwater management for years to control flow volume and velocity through erosion and sediment control ordinances and flood plain regulations. Until passage of the Stormwater Management Act, and subsequent amendments, no clear authority for localities to protect water quality was available.

Experience with what has become "conventional" stormwater retention pond design throughout the Commonwealth has shown them to be both aesthetically objectionable and somewhat hazardous to health and safety. As Louisa County works to develop effective methods of stormwater management, significant consideration should be given to alternative techniques, such as temporary retention in parking lots, improved designs for drainage structure, and regional stormwater basins.

The County should begin the development of a stormwater management program in the growth areas where the post development non-point source pollution load should not be allowed to exceed existing non-point source pollution loads.

Such calculations should be on the site as a whole, not an individual lot. Pre-development calculations should reflect the load from the entire unplatted parcel. Post-development calculations should reflect the total of impervious surfaces for all platted parcels assuming a complete build out of the project. BMPs will be designed and implemented to mitigate the increased load for the entire development.

A promising mechanism of funding a stormwater management program is the concept of a local stormwater utility. Such a utility functions like any other public service district and its existence reinforces the concept that control of non-pont source pollution is fundamentally no different than the services provided by other public utilities.

Utility fees may be based on the extent of impervious cover on a parcel, since problems with stormwater quantity and quality are directly proportional to the amount of impervious cover. Typical charges to the landowner might average $2.00 to $5.00 per month, with higher rates for industrial and commercial sites.

Most importantly, when BMPs are approached as a public utility, fees can be directed toward watershed-wide stormwater management planning, purchase of land for regional stormwater management facilities, construction and maintenance of such facilities, and staffing the local stormwater management program.

C. Impervious Surfaces

In urban and suburban areas, studies have shown that runoff increases in direct proportion to the percentage of impervious surface within the drainage sub-basin. Furthermore, studies in more rural areas have shown that agricultural land uses can have similar impact on runoff as do urban land use. Regional studies encompassing multiple basins have shown that where impervious surfaces reach ten percent or more of the land area, significant degradation of the ecology of local streams becomes apparent. The table below shows estimated impervious surface percentage for various land uses based on large number of EPA studies. The values given for agricultural lands are "equivalent" values based on empirical runoff measurements as a function of soil type.

Land Cover	Percent Impervious Surface
Forest	0%
Ungrazed grass/shrubland	2%
5+ acre residences in woodlands	3%
2-5 acre residences in woodlands	5%
Mowed lawns, moderately grazed pasture, golf courses	8%
1 acre residences	10%
Orchards	12.5%
Grazed pasture lands	15%
Croplands	18%
0.5 acre residences	25%
0.33 acre residences	30%
0.25 acre residences	35%
Townhouses	50%
Apartments	70%
Light commercial/industrial, schools, universities	70%
Heavy commercial/industrial	90%
Pavement, quarries	100%

It is likely that all drainage basins within Louisa County contain less than ten percent impervious surface or equivalent for agricultural land. However, as development proceeds, the combined effect of urban and agricultural land uses may rapidly lead to significant increases in local runoff and associated environmental problems.

The County should consider including the following Best Management Practices (BMPs) in developing a runoff control program or integrating specific actions in existing ordinances or programs such as the Soil Erosion and Control program to counteract the effect of impervious surfaces:

- protection of existing natural areas in urban and suburban areas
- use of drip hoses, not sprinklers for watering lawns
- reduction of paved areas
- minimized road widths
- vegetated swales
- use of porous block or gravel
- creation of artificial wetlands to capture runoff
- use of sand filters in stormwater detention facilities
- developing a cost/benefit analysis for controlling runoff
- use of vegetation as buffers, catchment areas, ground cover on steep banks
- use of gravel or sand to trap roof runoff
- use of BMPs associated with agriculture that reduce runoff
- citizen involvement as educators concerning use of BMPs

D. Pesticide-Herbicide-Nitrate Management

Several legal and educational initiatives may be used to support local government programs to regulate pesticides in order to protect groundwater:

- The 1987 report, *Ground Water Protection Strategy for Virginia*, noted that local governments have the greatest impact on groundwater and that there is a need for local governments to take groundwater vulnerability into account when dealing with land uses that have potential groundwater consequences.

- The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA) contain provisions that provide both EPA and the states the power to restrict the use of certain pesticides and fertilizers in particular geographic areas.

- The 1990 report, *Supplement to the Ground Water Protection Strategy,* found pesticides and fertilizers to be one of the five pollution potential sources listed as priorities for action. The supplement recommended that an *ad-hoc* committee be established to find additional ways to use local government land use authority to protect groundwater.

- In response to the *Ground Water Protection Strategy*, the Ad Hoc Wellhead Protection Advisory committee issued a report in June, 1991, recommending that localities "play the lead role in setting groundwater protection goals and priorities, in determining areas to be protected, and in designating the type of protection to be implemented." The Ad Hoc Wellhead Advisory Committee subsequently prepared a wellhead protection handbook: "Wellhead Protection: Tools for Local Governments in Virginia". The handbook recommends operating standards as a regulatory technique to "limit the threat to the environment posed by ongoing processes, such as pesticide application".

- The 1989 Chesapeake Bay Local Assistance Department Local Assistance Manual recommends performance standards within Chesapeake Bay Preservation Areas which includes a reduction in the land application of nutrients and toxins. The purpose of this requirement is to prevent a net increase in nonpoint source pollution from new development, and achieve a 40% reduction in nonpoint source pollution from agricultural uses. The manual defines nonpoint source pollution as pollution consisting of constituents such as sediment, nutrients, and organic and toxic substances from diffuse sources, such as runoff from agriculture and urban land development and use.

- The Code of Virginia clearly supports groundwater protection as a goal of the comprehensive plan.

- The policy statements, recommended programs and laws indicate that local government can use planning and zoning techniques as means to control land uses to protect groundwater within sensitive or vulnerable areas. It seems, then, that local governments could limit the application of pesticides within such areas through a control of certain land uses generally linked with specific pesticides. It may also be possible for a locality to go so far as to use operating standards and source prohibitions to limit pesticide use itself within vulnerable areas. However, these types of local controls seem to conflict with a recent decision by the General Assembly to control pesticide use at the state level.

When land uses are proposed within an area vulnerable to pesticides used with the proposed land use, Extension Agents can consult with landowners about the risk of pesticides in the area, and if appropriate, recommend alternative pesticides to protect groundwater.

With discretionary land uses, the locality can use pesticide vulnerability as one of the criteria used to approve the land use. If necessary, when the proposed land use is within a vulnerable area and there are no pesticide alternatives, the locality could use groundwater protection as a criteria to deny the approval of the proposed land use. Specific recommendations for pesticide management are presented in the Appendices.

8.2 GOAL TWO: Protect the Groundwater Quality in Louisa County.

8.2.1 Strategy: Delineate areas where residents rely on groundwater, particularly in higher density areas.

GIS mapping is underway to pinpoint well locations, failed wells, septic systems, and failed septic systems. This mapping will be available to the County in the near future.

8.2.2 Strategy: Institute a wellhead protection program

To maintain a reliable supply of well water, public or private, it is important to institute good practices and protection in the area surrounding the well to minimize the potential for pollution. Programs such as this are known as wellhead protection programs. The area designated for protection depends on the nature of the soils, the rates of withdrawal, existing land use, future land use, and the consequences of contaminating the subject well.

If adequate information is not available, estimates of the area to be protected may be used. The Lord Fairfax Planning District Commission has proposed radii of 300 feet to 1500 feet, the smaller areas being associated with the most restrictive institutional controls.

A wellhead protection program should be instituted that:

- *identifies public wells*
- *restricts development within a reasonable area (either further research or estimate)*
- *restricts the use of pesticides, nutrients, or other pollutants*

8.2.3 Strategy: Develop a septic system management program in Groundwater Protection Areas.

Septic systems have been identified by EPA as the most frequently reported sources of groundwater contamination in the United States. A properly designed, installed, maintained, and utilized septic system, however, should function well for many years.

Septic systems function by providing both anaerobic (without oxygen) and aerobic (with oxygen) treatment of biological wastes. This treatment is provided by micro-organisms. Solids are transferred from commodes to the septic tank via household plumbing. Within the septic tank the solids are combined with all other household wastewater from the kitchen, bath, and laundry. The solids are partially liquefied and digested within the anaerobic environment of the septic tank. Lighter materials float on top of the liquid in the tank and form a scum layer. Each time the septic tank fills up the overflow goes first into a distribution box and than into parallel lines of perforated pipe or open-jointed tile. These "lines" are placed in trenches partially filled with gravel and completely surrounded by soil. These trenches make up the drain field of a conventional septic system.

Aerobic treatment of the wastewater takes place in the soil of the drain field. If the septic tank is not pumped out, it will eventually fill up with solids. Solids will begin to be transported into the trenches and, over time, will clog the soil pores. Septic system "failure" will occur when sufficient solids have infiltrated into the soil pores to cause sewage to leach out onto the surface or back up into the residence that the system serves. Rehabilitation of a drain field which has failed due to solids infiltration is often either impossible or ineffective, and is extremely expensive even where it can be done. In addition, long before this type of failure occurs, inefficient treatment of the wastewater may have occurred for a number of years. The EPA recommends an average pump our frequency of three to five years for conventional septic systems in order to maintain efficient effluent treatment.

The County should require that septic fields within the groundwater protection and watershed management areas be pumped every five years.

Tanks should be inspected every four years. If sludge equals 1/3 of the volume of the tank, the tank should be pumped at that time. If it is greater than 1/3 of the volume, it should be pumped and re-inspected in two years. Contractors should provide a letter of inspection to the public health sanitarian.

The ability of the Authority's system to accept septage on a rotational basis throughout the year should be ensured.

Private septic fields should be identified and mapped on the GIS.

Water quality data should be gathered and analyzed in areas where septic systems are known to fail.

Pump-out alone will dramatically extend the life of a sewage disposal site. Nevertheless, failure will take place eventually although with very different consequences. In conventional drain fields, a biological mat builds up at the gravel/soil interface in the drain field trench. After many years, this mat, which is very important for providing treatment of the effluent wastewater, becomes too thick for water to pass through it. System failure will occur in this situation as with a system which has not been regularly pumped out.

System failure caused by biological mat buildup alone is not permanent. If solids have not infiltrated into a disposal site or if components of the on-site sewage treatment system have not been damaged, the disposal site can often be reclaimed merely by temporary cessation of use, allowing the biological mat time to break down. The amount of time necessary to reclaim a sewage disposal site in this manner may be very brief or as long as several years, depending on the amount of biological mat buildup. For this reason, a reserve area should be available in order to continue the use of a given system and maintain residency on an affected property.

Alternate drain fields for septic systems should be required.

8.2.4 Strategy: Implement site-specific carrying capacity residential zoning in Watershed Management Areas.

The carrying capacity of a tract of land, in terms of dwellings per acre relying on individual water wells and drain fields, is determined by the nature of local soils, saprolite, and bedrock geology. For each set of conditions, there exists a minimum lot size, or maximum density for residential development, beyond which problems of drain field failure, water well contamination, or declining water well yields may occur.

The locations of drain field failures on record at the Louisa County Health Department are shown on Figure 2-1. The Blue Ridge Shores subdivision shows up as a cluster of data points. This is an example of a residential development where lot sizes are too small to adequately support individual drain fields.

Locations of water well abandonments, due either to contamination or to lack of water, are shown on Figure 8-1. It is clear from these two figures that problems with drain field and water well failures are not restricted to one area, but occur throughout Louisa County.

The principal goal of residential zoning is to protect the health, safety, and welfare of the citizens. Protection of groundwater supplies falls under this statutory requirement. Often this protection is realized through lot sizes.

It is suggested here that allowable lot sizes be decided based on the carrying capacity of the land in order to protect the groundwater supplies.

This goes beyond the minimum requirement for percolation and takes into consideration the ability of the land to filter out contaminants before reaching the groundwater levels. Ground that percs well may allow such rapid absorption of the wastewater that it is not cleansed before reaching the groundwater.

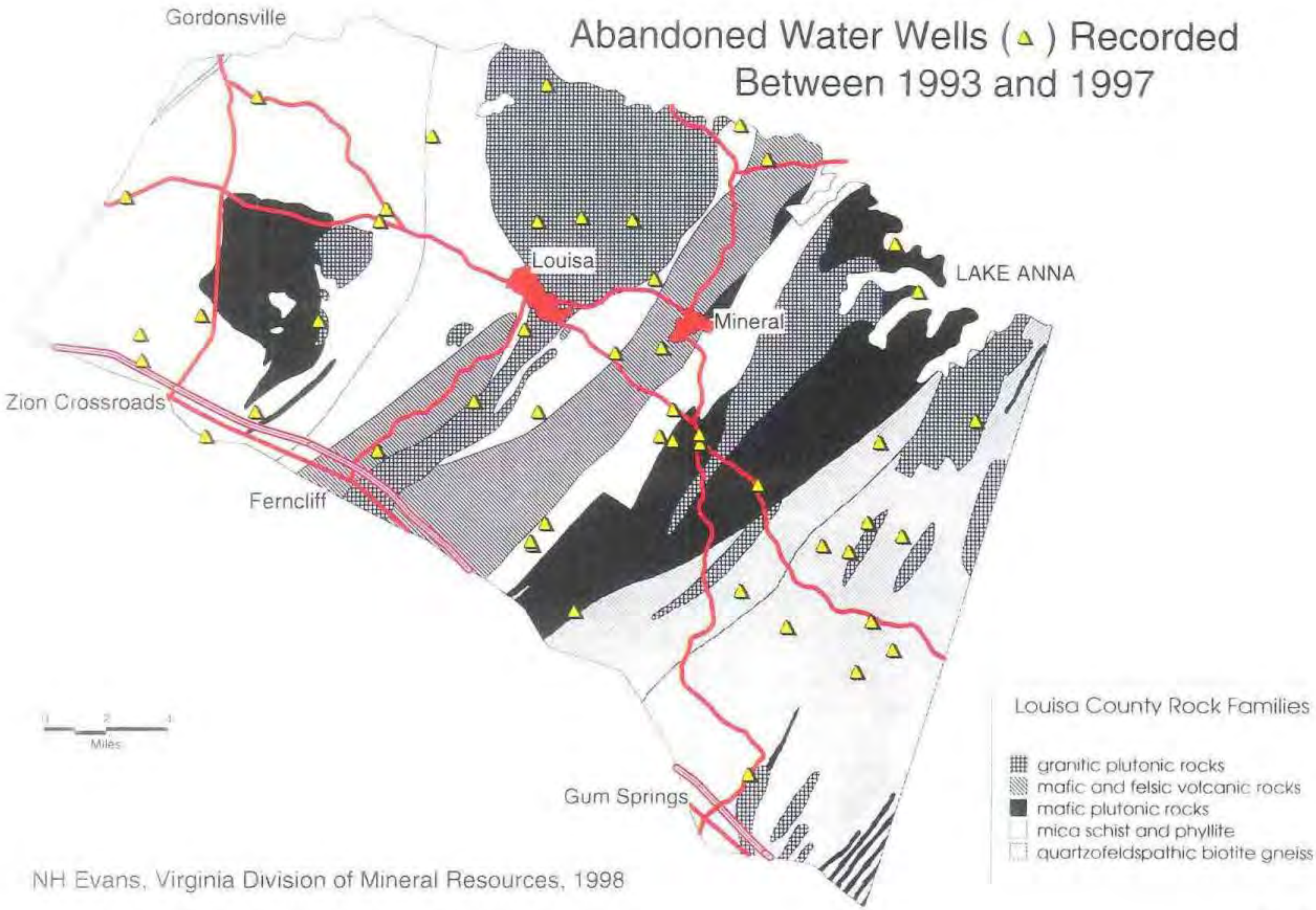
Minimum lot sizes should be determined based on careful consideration of factors such as soil type, saprolite type and thickness, bedrock geology, and slope that pertain to specific parcels of land. The complex distribution of different soils, saprolite, and bedrock in Louisa County means that the minimum lot size appropriate in one part of the county is not necessarily appropriate in other parts of the county.

The new Louisa County GIS, including a soils layer and elevation data, makes it possible to accurately overlay the spatial data in the preceding paragraph. Included in this study are a geologic map, water well database, and septic field failures. This is critical to developing a site-specific carrying capacity zoning ordinance to protect groundwater supplies and which is consistent with the protection of health, safety, and welfare requirement.

A Site-Specific Carrying Capacity-based Zoning Ordinance should be developed by:

A. Assigning values to individual mapping units pertaining to the following attributes for the purpose of identifying drain field suitability:

1. Evaluate individual soils units with respect to drain field suitability
Consider physical properties that affect the ability of soils to clean wastewater as it passes through. These properties include permeability, cation exchange capacity, oxygenation potential.



Abandoned Water Wells (▲) Recorded Between 1993 and 1997
Gordonsville
Louisa
Mineral
LAKE ANNA
Zion Crossroads
Ferncliff
Gum Springs
Miles
Louisa County Rock Families
granitic plutonic rocks
mafic and felsic volcanic rocks
mafic plutonic rocks
mica schist and phyllite
quartzofeldspathic biotite gneiss
NH Evans, Virginia Division of Mineral Resources, 1998

FIGURE 8-2

2. *Evaluate bedrock geologic formations with respect to aquifer suitability.* Consider factors such as fracture density and rock chemistry that affect groundwater productivity, groundwater chemistry.

3. *Evaluate saprolites related to bedrock types in terms of groundwater storage/recharge suitability.*
Consider physical and chemical factors that affect the ability of different saprolites to transmit groundwater; create derivative digital layers based on saprolite types. Contour casing length data from water well database to create a saprolite thickness map.

4. *Create slope map from digital elevation data. Evaluate water well and drain field suitabilities in terms of slope.*

B. *Refine suitability values through investigation of known cases of domestic drain field and water well failure to determine causal relationship to soil type, saprolite, and geology.*

C. *Flag high-risk sets of conditions.*

D. *Assign appropriate minimum lot sizes to ranges of aggregate "drain field stability" values, requiring larger lots where high-risk sets of conditions are present.*

8.3 GOAL THREE: Protect water quality of the rivers and streams flowing though Louisa County.

In recognition of the value of trees in controlling site runoff and the need for vegetated buffers, the Virginia Department of Forestry's Forestry Best Management Practices for Water Quality in Virginia handbook recommends Stream Management Zones (SMZ) on both sides of the banks of perennial streams and bodies of open water in order to protect bank edges and water quality. The guidelines state that the purpose of the SMZ is to provide a relatively undisturbed zone to trap and filter out suspended sediments before these particulates reach the stream.

Programs implementing BMPs which decrease runoff of nutrients should be supported.

The County should seek partnerships with other agencies to ensure water quality monitoring is conducted in the County.

Stream Management Zones should include establishing vegetative buffers along the stream banks.

The continuation of buffers should be ensured where they naturally exist; buffers should be developed where non-existing.

8.4 <u>GENERAL: strategies which cut across protecting rivers and streams, groundwater, and streams.</u>

8.4.1 Use Best Management Practices

Best Management Practices, BMPs, have been developed for forestry, stream protection, agriculture, and wellhead protection. These are referenced in the appendix. Use and implementation of these BMPs would go a long way to preventing pollution in Louisa County. To do so, may in some cases, require plan adoption and implementation. It is recommended Louisa County use the already developed or suggested BMPs.

Partnerships with agencies such as the Soil and Water Conservation District, the Farm Bureau, the Health Department, the State Water Control Board and others will provide needed assistance and support for the County in implementing BMPs.

Where the BMPs require on-going maintenance in order to function properly, such maintenance should be ensure by the County through maintenance agreements with the owner. Such agreements are consistent with a requirement in the state Erosion and Sediment Control Program concerning maintenance of stormwater management structures. Maintenance agreements with commercial, industrial, and industrial property owners are fairly straightforward and easily enforced. Conversely, the County must exercise caution in accepting agreements that assign ultimate maintenance responsibility to homeowner organizations. Statewide experience demonstrates that such organizations are often not capable of following through with these responsibilities, such that local governments are often asked to assume the long term maintenance of the facilities.

8.4.2 Citizen Involvement

The importance of an educated citizenry in any pollution prevention programs can't be understated. Citizen involvement should be sought in developing the plans outlined in this chapter as well as to be educated and educate. The Louisa County Extension Service is well-suited to partnering with the County in educating citizens about the benefits of protecting the water supplies in Louisa County.

9.0 WATER AND WASTEWATER MASTER PLAN DEVELOPMENT

Based on the estimated 20 year demands for public water and wastewater that were presented in Section 5.1 and are summarized in Table 5-3, proposed water and wastewater system master plans have been developed. The purpose of these master plans is to show approximate locations of the major components that will be necessary to provide a significant supply of public water and wastewater services to each of the seven potential growth areas. These major components include water/wastewater treatment plants, reservoirs, water storage tanks, pump stations, spray irrigation fields, and primary transmission mains. All locations of these components are approximate only. The master plans do not show proposed secondary trunk sewers, pump stations, or water mains within each particular growth area (except for recommended loops).

It is important to mention that the groundwater sources have not been included on the Water System Master plan, but that does not mean it is not important for the County to continue using and pursuing additional wells. In fact, additional hydrogeological field studies may indicate that groundwater may not only supplement the primary public water supplies, but in certain potential growth areas may actually provide the majority of the water.

9.1 Water System Master Plan

The Water System Master (WSM) Plan has been developed around the two (2) existing surface water reservoirs in Louisa County. Northeast Creek Reservoir, located in the Louisa/Mineral area, is presently being utilized to provide treated water to nearby residents and businesses. This plant can produce up to 1.0 million gallons of water per day and present demands are only about 220,000 gallons/day (average daily). Hence, there is presently an 800,000 gallon per day surplus that can be distributed elsewhere in the County. Unfortunately, the most promising supply areas are not nearby and transmission mains to these areas will be a major expense. Additional water storage tanks, booster pump stations and re-chlorination points (due to long transmission mains) will be necessary in many instances and will further increase initial capital costs. Nevertheless, this is probably the County's best option for providing a significant amount of water to a growing area.

Once Northeast Creak Reservoir begins to approach its design capacity, it is recommended that a second water treatment plant (WTP) be constructed on Lake Gordonsville. Lake Gordonsville is owned by the County and is presently used for flood control only. The DEQ has recently estimated that a specific yield of up to 0.9 MGD could be realized from this source. The County should investigate further methods of increasing the specific yield of this reservoir and possibly raising the water level in this lake. This would involve some dam modifications and in all likelihood, the purchase of some lake front properties. Lake Gordonsville will probably be a very important component of the public water system in future years.

Once the Lake Gordonsville WTP has begun distributing water and begins to reach its initial design capacity, it will probably be most cost effective to upgrade the Northeast Creek WTP.

When both of these surface water sources have been utilized near their maximum potential, it will probably be necessary to construct an additional reservoir, unless a source from a neighboring County is available, or if a significant supplement of ground water sources can be established. Due to permitting and environmental issues, it will probably be extremely difficult to construct a reservoir directly on the South Anna River or one of its primary tributaries. Therefore, an off-stream storage facility has been shown in the Gum Springs area. In using this, water would be pumped from the South Anna to the new impoundment, where a new water treatment plant would need to be constructed. The capital cost for this option will be much higher than utilizing the existing reservoirs, but will provide a third reliable surface water source and provide a balanced system to the County.

Primary water transmission mains have been shown to provide a network that will ultimately provide at least two (2) routes to each potential growth area. This is important in crisis situations (line breaks, water shortages) and will also help to improve fire protection. Water storage tanks are shown at approximate locations throughout the County and will provide fire protection, equalize system pressures, and support requirements for industrial/commercial development.

9.2 Wastewater System Master Plan

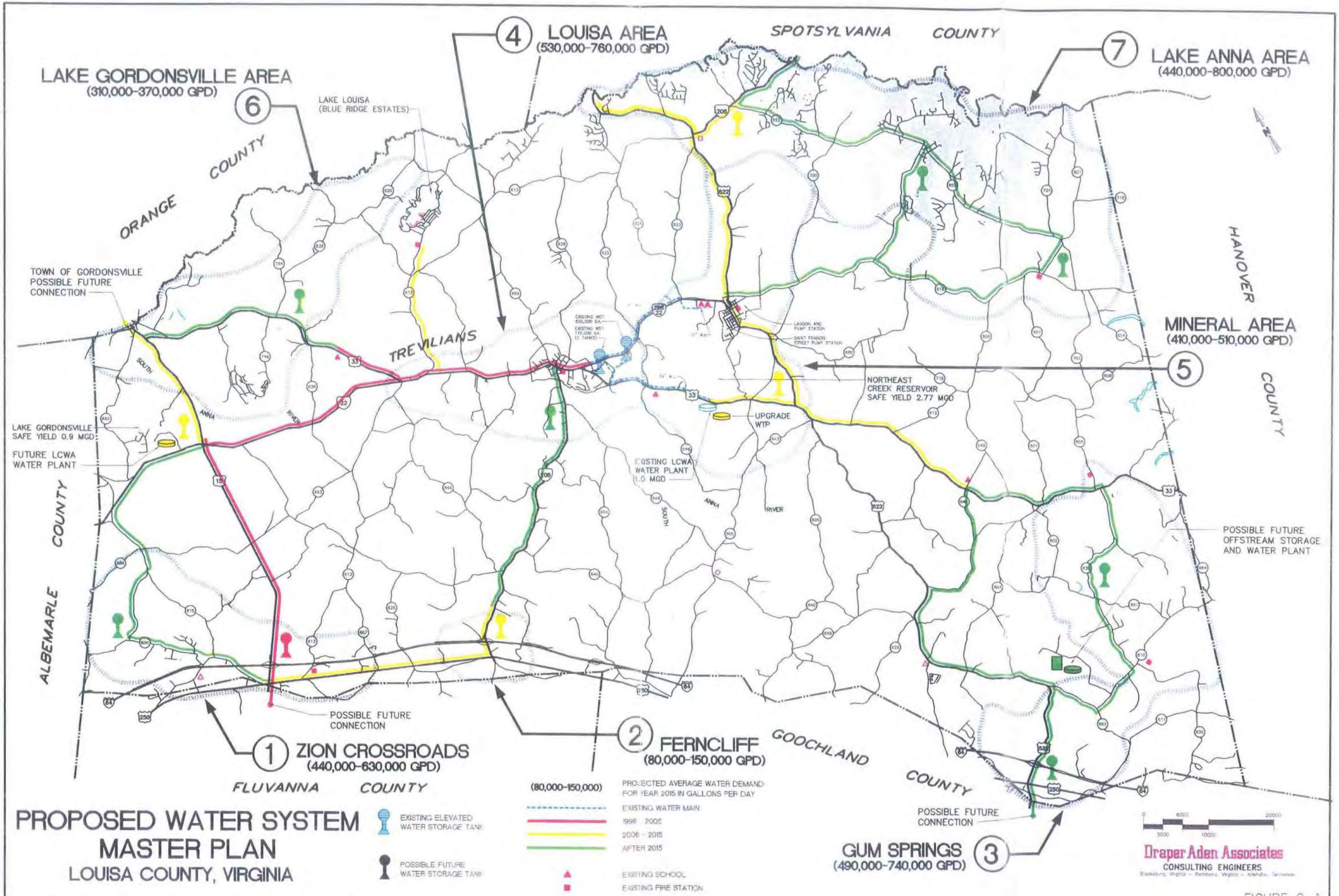
Unlike the Water System Master Plan, the proposed Wastewater System Master Plan has been prepared around the concept of providing multiple wastewater treatment plants (WWTP's) throughout the County. Proposed wastewater treatment plants are shown to serve the Zion Crossroads area, the Gum Springs area, the Lake Gordonsville area, and the Lake Anna area. The Louisa and Mineral areas are shown to continue to use the Louisa Regional WWTP, which will eventually require another expansion. Service to the Ferncliff area is shown to be provided by pumping to the Zion Crossroads WWTP. With the exception of the Lake Anna area, the WWTP's are shown to discharge to the South Anna River or one of its tributaries.

9.3 Phases of Implementation

Each of the Master Plans has been developed around a phased approach for expansion of utility infrastructure to serve potential growth areas. The recommended phasing is 1997 to 2005, 2006 to 2015, and after 2015. For the Water System Master Plan, it is believed that the Zion Crossroads area will require extension of a watermain from Louisa, an elevated water storage tank, and a wastewater treatment plant by the year 2005. It is estimated that most of the other potential growth areas will begin major utility construction between 2006 and 2015. Because the Gum Springs area is located the furthest from Northeast Creek Reservoir, construction of public water and wastewater services has been shown to occur after the year 2015. Complete system loops and additional plant expansions will probably occur after 2015.

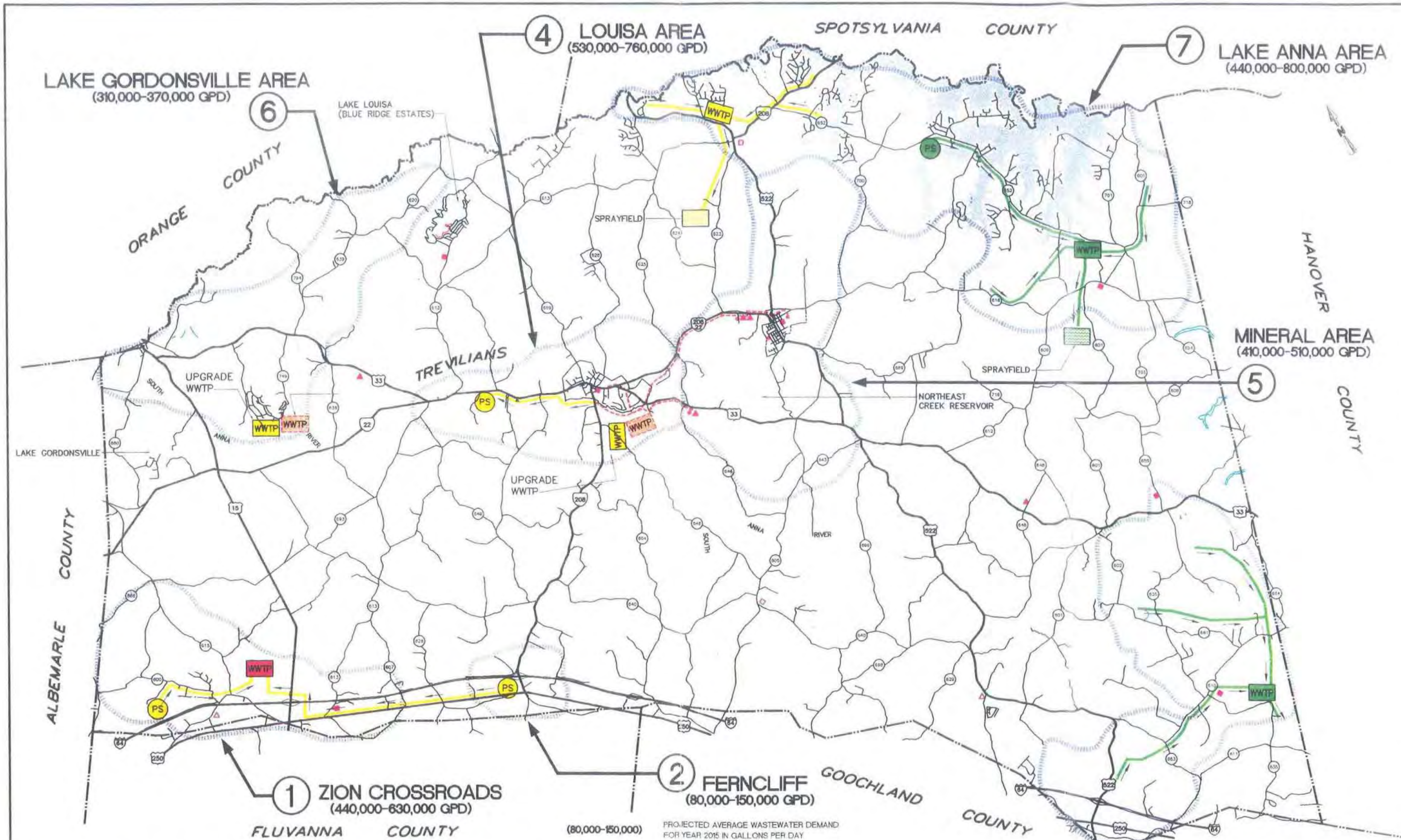
9.4 Modifications to Master Plans

These Master Plans are presented as working tools for Louisa County utility planners and should be observed as base templates that can be modified as future growth continues. Locations, elevations, and sizing of all utilities will need to be confirmed by a specific design analysis for the County.



PROPOSED WATER SYSTEM MASTER PLAN
LOUISA COUNTY, VIRGINIA
1 ZION CROSSROADS (440,000-630,000 GPD)
2 FERNCLIFF (80,000-150,000 GPD)
3 GUM SPRINGS (490,000-740,000 GPD)
4 LOUISA AREA (530,000-760,000 GPD)
5 MINERAL AREA (410,000-510,000 GPD)
6 LAKE GORDONSVILLE AREA (310,000-370,000 GPD)
7 LAKE ANNA AREA (440,000-800,000 GPD)
SPOTSYLVANIA COUNTY
ORANGE COUNTY
HANOVER COUNTY
ALBEMARLE COUNTY
FLUVANNA COUNTY
GOOCHLAND COUNTY
LAKE LOUISA (BLUE RIDGE ESTATES)
TOWN OF GORDONSVILLE POSSIBLE FUTURE CONNECTION
LAKE GORDONSVILLE SAFE YIELD 0.9 MGD
FUTURE LCWA WATER PLANT
TREVILIANS
SOUTH ANNA RIVER
NORTHEAST CREEK RESERVOIR SAFE YIELD 2.77 MGD
UPGRADE WTP
EXISTING LCWA WATER PLANT 1.0 MGD
POSSIBLE FUTURE OFFSTREAM STORAGE AND WATER PLANT
POSSIBLE FUTURE CONNECTION
POSSIBLE FUTURE CONNECTION
(80,000-150,000) PROJECTED AVERAGE WATER DEMAND FOR YEAR 2015 IN GALLONS PER DAY
EXISTING WATER MAIN
1998 - 2005
2006 - 2015
AFTER 2015
EXISTING SCHOOL
EXISTING FIRE STATION
EXISTING ELEVATED WATER STORAGE TANK
POSSIBLE FUTURE WATER STORAGE TANK
Draper Aden Associates
CONSULTING ENGINEERS

FIGURE 9-1



PROPOSED WASTEWATER SYSTEM MASTER PLAN

LOUISA COUNTY, VIRGINIA

WWTP EXISTING WASTEWATER TREATMENT PLANT

WWTP PROPOSED WASTEWATER TREATMENT PLANT

(PS) PROPOSED PUMP STATION

(80,000-150,000) PROJECTED AVERAGE WASTEWATER DEMAND FOR YEAR 2015 IN GALLONS PER DAY

EXISTING SANITARY SEWER

1998 - 2005

2006 - 2015

AFTER 2015

EXISTING SCHOOL

EXISTING FIRE STATION

Draper Aden Associates
CONSULTING ENGINEERS

FIGURE 9-2

10.0 COST ESTIMATES FOR PUBLIC WATER AND WASTEWATER

Based on the Water and Wastewater System Master Plans presented in Sections 9.1 and 9.2, capital cost estimates have been performed for providing public utilities to all potential growth areas. With the exception of the Gum Springs area, the cost estimates were not included for utility expansions expected to occur after 2015. The cost estimates also do not include acquisition of additional well sources.

In order to get an idea as to how many customers are required to overcome initial capital expenditures, a budget analysis was performed for the Zion Crossroads improvements. A similar type of analysis can be performed for each improvement project.

10.1 Zion Crossroads

In order to provide public water and sewer to this area, it will probably require a watermain extension from the Louisa system (approximately 18 miles), a booster pump station, a re-chlorination station, an elevated water storage tank, and a wastewater treatment plant. As shown in Table 10-1, the estimated project cost is approximately $7.7 million. It is anticipated that this will be the first potential growth area to require public water and wastewater services, which should occur in the next seven years. The proposed Edgemar development (a 300 lot residential golf community) has been recently rezoned for this area and will be providing a portion of the wastewater treatment facility costs.

10.1.1 Zion Crossroads Budget Analysis

A general budget analysis was performed for this expansion using the initial capital cost estimate projected above ($7.7 million). This analysis shows that it will require between 800 and 1650 connections to reach a break even point for capital expenditures financed over 40 years (Figure 10-1). If the capital cost is financed over 20 years, this analysis shows that it will require between 1100 and 2300 connections to reach a break even point (Figure 10-2). The assumptions for this analysis are listed below:

- The capital construction cost ($7.68 million) was financed over periods of 20 and 40 years at an interest rate of 5 percent.

- Annual operations and maintenance costs were assumed to be $250,000, which include operation of the wastewater treatment plant, additional water treatment costs, and maintenance of the water storage tank.
- The average water bill is presently $12.25/month and the average sewer bill is $12.00/month.
- Connection fees are $1000 each for water and sewer connection ($2000 total).
- An average of 100 new customers per year is assumed.
- Annual operations and maintenance costs do not increase.

10.2 Ferncliff

In order to provide public water and sewer to this area, it will probably require a watermain extension from the Zion Crossroads area (approximately 4 miles), an elevated water storage tank, and a pump station/force main to the Zion Crossroads WWTP. As shown in Table 10-2, the estimated project cost is approximately $2.5 million and assumes that Zion Crossroads will have public water and sewer available. It is anticipated that this project may occur by the year 2015.

10.3 Gum Springs

In order to provide public water and sewer to this area, it will probably require a watermain extension from the Louisa system (approximately 20 miles), a booster pump station, a re-chlorination station, an elevated water storage tank, and a wastewater treatment facility. As shown in Table 10-3, the estimated project cost is approximately $9.7 million. It is anticipated that public water and wastewater service will occur after the year 2015 due to the long distance to the Louisa/Mineral areas. However, the marketplace may require that this area provide water and wastewater services prior to the year 2015.

10.4 Louisa/Mineral Areas

The cost estimates for the Louisa/Mineral areas were combined because many of the recommended improvements will benefit both locales since they are presently connected. It is anticipated that the Northeast Creek water treatment plant will need to be upgraded within the next 20 years, so the cost for this upgrade has been included in the cost estimate. It is also anticipated that the existing Louisa Regional Wastewater Treatment Plant will require another upgrade within the next 20 years, which is also reflected in the cost estimate. Since some of the primary transmission mains between these two areas are already in place, watermain extensions are shown for the eastern Mineral corridor (approximately 3.5 miles) and an extension to the Blue Ridge Shores development is shown (approximately 3.5 miles) due to the sanitary drainfield problems that presently exist. Construction of a water tank in the Mineral area is also anticipated and is included in the cost estimae. As shown in Table 10-4, the estimated project cost is approximately $9.5 million. It is anticipated that these improvements may be necessary by the year 2015.

10.5 Lake Gordonsville Area

In order to provide public water and sewer to this area, it will at a minimum require some water transmission main, an elevated water storage tank, and a wastewater treatment facility. Also included in this estimate is the construction of a new water treatment plant on Lake Gordonsville. As shown in Table 10-5, the estimated project cost is approximately $8 million. It is anticipated that these improvements may be necessary by the year 2015.

10.6 Lake Anna Area

In order to provide public water and sewer to this area, it will probably require a watermain extension from the Mineral area (approximately 6.5 miles), a booster pump station, a re-chlorination station, an elevated water storage tank, a wastewater treatment facility and spray field irrigation for effluent application. As shown in Table 10-6, the estimated project cost is approximately $7.4 million. It is anticipated that these improvements may be necessary by the year 2015.

TABLE 10-1

PRELIMINARY COST ESTIMATE

FOR PROVIDING WATER/SEWER TO ZION CROSSROADS GROWTH AREA

FROM NORTHEAST CREEK RESERVOIR

Item	Quantity	Units	Unit Cost	Total Cost
A. Water Main Extension from Louisa Area (along Rte 22 and Rte 15)				
1. 12-inch Water Main	96,000	LF	$25.00	$2,400,000.00
2. Booster Pump Station	1	EA	$250,000.00	$250,000.00
3. Re-chlorination Station	1	EA	$100,000.00	$100,000.00
4. Fire Hydrant Assemblies	96	EA	$2,000.00	$192,000.00
5. 12-inch Gate Valves	48	EA	$1,000.00	$48,000.00
			Subtotal	$2,990,000.00
B. 600,000 Gal. Elevated Storage Tank near Zion Crossroads				
1. Property Acquisition (1 acre)	1	LS	$25,000.00	$25,000.00
2. Tank	1	LS	$670,000.00	$670,000.00
3. Foundation	200	CY	$250.00	$50,000.00
4. Site Work/Misc. Piping	1	LS	$30,000.00	$30,000.00
			Subtotal	$775,000.00
C. 500,000 GPD Wastewater Treatment Plant Expansion for Zion Crossroads				
1. Wastewater Treatment Plant	1	LS	$2,700,000.00	$2,700,000.00
2. Discharge Outfall, Access Road	1	LS	$0.00	$0.00
			Subtotal	$2,700,000.00
			Subtotal, Items A thru C	$6,465,000.00
			Contingency (10%)	*$646,500.00*
			Total Construction Cost	$7,111,500.00
			Engineering/Admin. (8%)	*$568,920.00*
			Total Project Cost	**$7,680,420.00**

Notes and Assumptions:

1) Other than for water tank, easement acquisition costs have not been included above.

2) For Item B, the water main price is for PVC pressure pipe.

3) Item C assumes the Edgemar development will construct a portion of the wastewater treatment plant.

4) The above estimates are based on 1997 dollars.

5) The actual project costs will be based on competitive bids and will be effected by market conditions and available work for utility contractors at the time of bidding.

FIGURE 10-1

Water & Sewer Utility Budget Analysis
Zion Crossroads

Assuming a 20 Year Debt Repayment Schedule

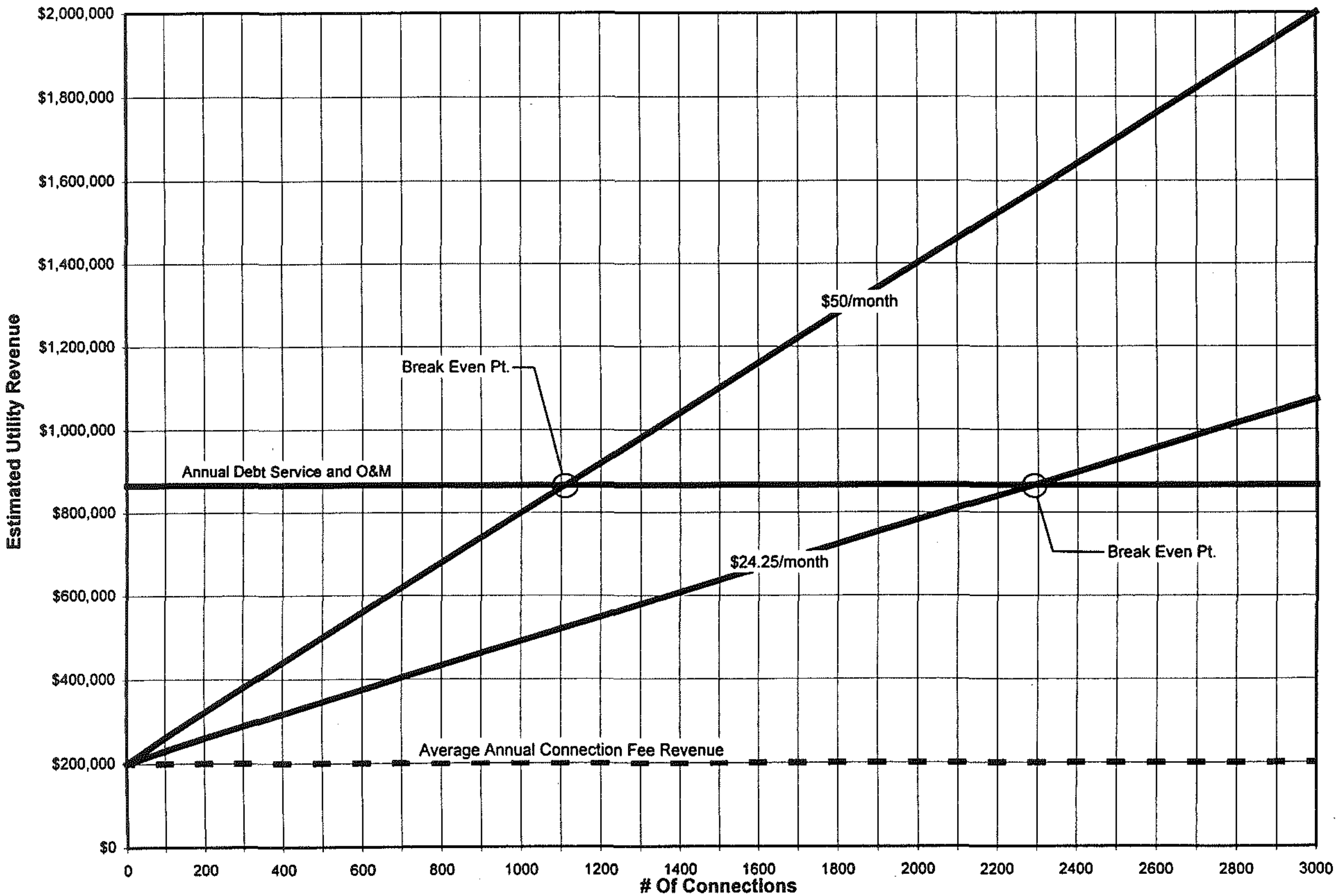


FIGURE 10-2

Water & Sewer Utility Budget Analysis
Zion Crossroads
Assuming a 40 Year Debt Repayment Schedule

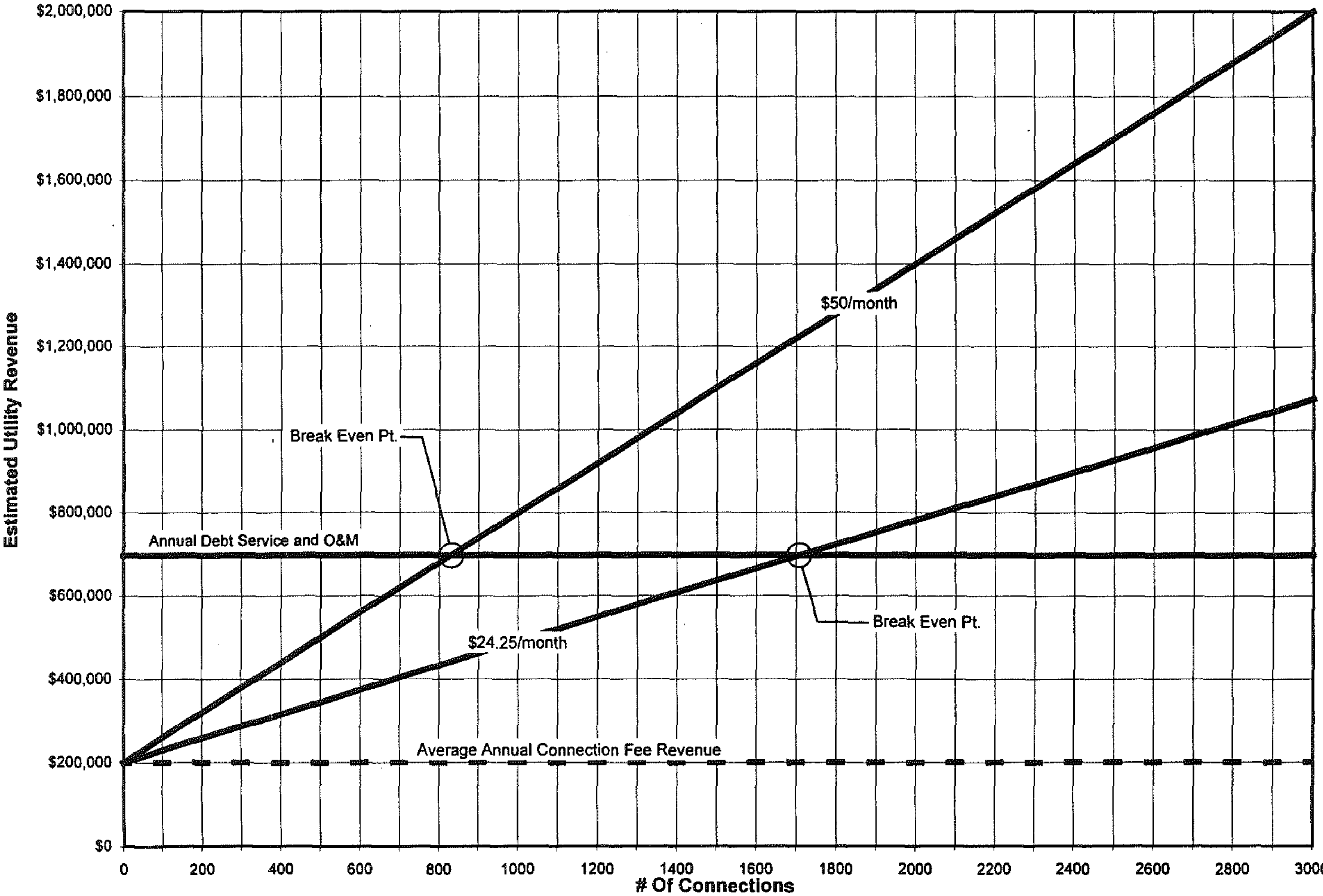


TABLE 10-2
PRELIMINARY COST ESTIMATE
FOR PROVIDING WATER/SEWER TO FERNCLIFF GROWTH AREA
FROM ZION CROSSROADS

Item	Quantity	Units	Unit Cost	Total Cost
A. Water Main Extension from Zion Crossroads (along Rte 250)				
1. 12-inch Water Main	40,000	LF	$25.00	$1,000,000.00
2. Fire Hydrant Assemblies	40	EA	$2,000.00	$80,000.00
3. 12-inch Gate Valves	20	EA	$1,000.00	$20,000.00
			Subtotal	$1,100,000.00
B. 250,000 Gal. Elevated Storage Tank near I-64				
1. Property Acquisition (1 acre)	1	LS	$25,000.00	$25,000.00
2. Tank	1	LS	$400,000.00	$400,000.00
3. Foundation	100	CY	$250.00	$25,000.00
4. Site Work/Misc. Piping	1	LS	$30,000.00	$30,000.00
			Subtotal	$480,000.00
C. Wastewater Treatment Infrastructure				
1. 150,000 GPD Pump Station	1	LS	$150,000.00	$150,000.00
2. 8 Inch PVC Sanitary Force Main	40,000	LF	$22.00	$880,000.00
3. Miscellaneous Valves	1	LS	$40,000.00	$40,000.00
			Subtotal	$1,030,000.00
			Subtotal, Items A thru C	$2,610,000.00
			Contingency (10%)	*$261,000.00*
			Total Construction Cost	$2,871,000.00
			Engineering/Admin. (8%)	*$229,680.00*
			Total Project Cost	**$3,100,680.00**

Notes and Assumptions:

1) Easement acquisition costs have not been included above.

2) For Item A, the water main price is for PVC pressure pipe.

3) The above estimates are based on 1997 dollars.

4) The actual project costs will be based on competitive bidding and could vary by 10%.

5) The actual project costs will be based on competitive bids and will be effected by market conditions and available work for utility contractors at the time of bidding.

TABLE 10-3

PRELIMINARY COST ESTIMATE

FOR PROVIDING WATER/SEWER TO GUM SPRINGS GROWTH AREA

FROM NORTHEAST CREEK RESERVOIR

Item	Quantity	Units	Unit Cost	Total Cost
A. Water Main Extension along Rte 33 and Rte 522				
1. 12-inch Water Main	106,000	LF	$25.00	$2,650,000.00
2. Booster Pump Station	1	EA	$250,000.00	$250,000.00
3. Re-chlorination Station	1	EA	$100,000.00	$100,000.00
4. Fire Hydrant Assemblies	90	EA	$2,000.00	$180,000.00
5. 12-inch Gate Valves	45	EA	$1,000.00	$45,000.00
			Subtotal	$3,225,000.00
B. 600,000 Gal. Elevated Storage Tank near I-64				
1. Property Acquisition (1 acre)	1	LS	$25,000.00	$25,000.00
2. Tank	1	LS	$670,000.00	$670,000.00
3. Foundation	200	CY	$250.00	$50,000.00
4. Site Work	1	LS	$30,000.00	$30,000.00
			Subtotal	$775,000.00
C. 600,000 GPD Wastewater Treatment Plant for Gum Springs				
1. Wastewater Treatment Plant	1	LS	$4,000,000.00	$4,000,000.00
2. Discharge Outfall, Access Road	1	LS	$200,000.00	$200,000.00
			Subtotal	$4,200,000.00
			Subtotal, Items A thru C	$8,200,000.00
			Contingency (10%)	*$820,000.00*
			Total Construction Cost	$9,020,000.00
			Engineering/Admin. (8%)	*$721,600.00*
			Total Project Cost	**$9,741,600.00**

Notes and Assumptions:

1) Other than for water tank, easement acquisition costs have not been included above.

2) For Item B, the water main price is for PVC pressure pipe.

3) The above estimates are based on 1997 dollars.

4) The actual project costs will be based on competitive bids and will be effected by market conditions and available work for utility contractors at the time of bidding.

TABLE 10-4
PRELIMINARY COST ESTIMATE
FOR EXPANDING WATER/SEWER IN LOUISA/MINERAL GROWTH AREAS

Item	Quantity	Units	Unit Cost	Total Cost
A. Upgrade Existing Water Plant to 2.5 MGD				
1. Water Treatment Plant	1	LS	$2,500,000.00	$2,500,000.00
2. Upgrade Pump Station	1	LS	$250,000.00	$250,000.00
			Subtotal	$2,750,000.00
B. Water Main Extensions in Louisa Area (along Rte 613 and Rte 208)				
1. 12-inch Water Main	20,000	LF	$25.00	$500,000.00
2. 8-inch Water Main	20,000	LF	$22.00	$440,000.00
3. Fire Hydrant Assemblies	40	EA	$2,000.00	$80,000.00
4. 12-inch Gate Valves	20	EA	$1,000.00	$20,000.00
			Subtotal	$1,040,000.00
C. 500,000 Gal. Elevated Storage Tank				
1. Property Acquisition	1	LS	$25,000.00	$25,000.00
2. Tank	1	LS	$600,000.00	$600,000.00
3. Foundation	160	CY	$250.00	$40,000.00
4. Site Work	1	LS	$30,000.00	$30,000.00
			Subtotal	$695,000.00
D. 750,000 GPD Wastewater Treatment Plant Expansion for Existing WWTP				
1. Wastewater Treatment Plant	1	LS	$3,500,000.00	$3,500,000.00
2. Discharge Outfall, Access Road	1	LS	$50,000.00	$50,000.00
			Subtotal	$3,550,000.00
			Subtotal, Items A thru D	$8,035,000.00
			Contingency (10%)	*$803,500.00*
			Total Construction Cost	$8,838,500.00
			Engineering/Admin. (8%)	*$707,080.00*
			Total Project Cost	**$9,545,580.00**

Notes and Assumptions:

1) Other than for water tanks, easement acquisition costs have not been included above.
2) For Item B, the water main price is for PVC pressure pipe.
3) The above estimates are based on 1997 dollars.
4) The actual project costs will be based on competitive bidding and could vary by 10%.
5) The actual project costs will be based on competitive bids and will be effected by market conditions and available work for utility contractors at the time of bidding.

TABLE 10-5

PRELIMINARY COST ESTIMATE

FOR PROVIDING WATER/SEWER TO LAKE GORDONSVILLE AREA

Item	Quantity	Units	Unit Cost	Total Cost
A. 800,000 GPD Water Plant @ Lake Gordonsville				
1. Intake Structure & Pumping Station	1	LS	$400,000.00	$400,000.00
2. Water Treatment Plant	1	LS	$2,000,000.00	$2,000,000.00
			Subtotal	$2,400,000.00
B. Water Main Extension along Route 15 from North Limits to Route 22				
1. 12-inch Water Main	21,000	LF	$25.00	$525,000.00
2. Booster Pump Station	1	EA	$250,000.00	$250,000.00
3. Fire Hydrant Assemblies	21	EA	$2,000.00	$42,000.00
4. 12-inch Gate Valves	11	EA	$1,000.00	$11,000.00
			Subtotal	$828,000.00
C. 500,000 Gal. Elevated Storage Tank near Water Plant				
1. Property Acquisition	1	LS	$40,000.00	$40,000.00
2. Tank	1	LS	$600,000.00	$600,000.00
3. Foundation	160	CY	$250.00	$40,000.00
4. Altitude Valve	1	EA	$25,000.00	$25,000.00
5. Site Work	1	LS	$30,000.00	$30,000.00
			Subtotal	$735,000.00
D. 350,000 GPD Wastewater Treatment Plant Near Shenandoah Crossings				
1. Wastewater Treatment Plant	1	LS	$2,600,000.00	$2,600,000.00
2. Discharge Outfall, Access Road	1	LS	$100,000.00	$100,000.00
			Subtotal	$2,700,000.00
			Subtotal, Items A thru D	$6,663,000.00
			Contingency (10%)	*$666,300.00*
			Total Construction Cost	$7,329,300.00
			Engineering/Admin. (8%)	*$586,344.00*
			Total Project Cost	**$7,915,644.00**

<u>*Notes and Assumptions:*</u>

1) Other than for water tank, easement acquisition costs have not been included above.

2) For Item B, the water main price is for PVC pressure pipe.

3) The above estimates are based on 1997 dollars.

4) The actual project costs will be based on competitive bidding and could vary by 10%.

TABLE 10-6
PRELIMINARY COST ESTIMATE
FOR EXPANDING WATER/SEWER SERVICE TO LAKE ANNA AREA

Item	Quantity	Units	Unit Cost	Total Cost
A. Water Main Extension from Mineral along Rte 522				
1. 12-inch Water Main	35,000	LF	$25.00	$875,000.00
2. Booster Pump Station	1	EA	$250,000.00	$250,000.00
3. Re-chlorination Station	1	EA	$100,000.00	$100,000.00
4. Fire Hydrant Assemblies	35	EA	$2,000.00	$70,000.00
5. 12-inch Gate Valves	18	EA	$1,000.00	$18,000.00
			Subtotal	$1,313,000.00
B. 600,000 Gal. Elevated Storage Tank				
1. Property Acquisition	1	LS	$25,000.00	$25,000.00
2. Tank	1	LS	$670,000.00	$670,000.00
3. Foundation	200	CY	$250.00	$50,000.00
4. Site Work	1	LS	$30,000.00	$30,000.00
			Subtotal	$775,000.00
C. 500,000 GPD Wastewater Treatment Plant to Spray Fields				
1. Wastewater Treatment Plant	1	LS	$2,000,000.00	$2,000,000.00
2. Access Road	1	LS	$150,000.00	$150,000.00
3. Holding Lagoons (10 Acres)	1	LS	$1,000,000.00	$1,000,000.00
4. Spray Fields (300 Acres)	1	LS	$1,000,000.00	$1,000,000.00
			Subtotal	$4,150,000.00
			Subtotal, Items A thru C	$6,238,000.00
			Contingency (10%)	*$623,800.00*
			Total Construction Cost	$6,861,800.00
			Engineering/Admin. (8%)	*$548,944.00*
			Total Project Cost	**$7,410,744.00**

Notes and Assumptions:

1) Other than for water tanks, easement acquisition costs have not been included above.
2) For Item B, the water main price is for PVC pressure pipe.
3) The above estimates are based on 1997 dollars.
4) The actual project costs will be based on competitive bidding and could vary by 10%.
5) The actual project costs will be based on competitive bids and will be effected by market conditions and available work for utility contractors at the time of bidding.

TABLE 10-7
PRELIMINARY COST ESTIMATES
FOR VARIOUS SIZE RANGES OF WWTPs IN LOUISA COUNTY

Wastewater Plant Component	250,000 gpd	500,000 gpd	750,000 gpd
Pump Station	$250,000	$312,500	$390,000
Screening and Grit Removal	$170,000	$255,000	$350,000
Biological Treatment Unit	$350,000	$455,000	$550,000
Tankage	$340,000	$510,000	$690,000
Sludge Digestor/Holding tank	$200,000	$300,000	$450,000
Disinfection	$180,000	$216,000	$260,000
Building/Laboratory	$160,000	$176,000	$200,000
Mechanical	$350,000	$437,500	$550,000
Electrical	$300,000	$330,000	$380,000
Site Work	$60,000	$90,000	$120,000
Miscellaneous Piping	$40,000	$52,000	$80,000
Total Construction Cost	**$2,400,000**	**$3,134,000**	**$4,020,000**
Contingency (10%)	*$240,000*	*$313,400*	*$402,000*
Engineering (8%)	*$192,000*	*$250,720*	*$321,600*
Total Project Costs	**$2,832,000**	**$3,698,120**	**$4,743,600**
Cost/gallon	***$11.33***	***$7.40***	***$6.32***

11.0 FUNDING OPTIONS

In order to provide affordable user fees to the customers of the proposed system, low interest loans and grants will be required. Competition for funding in today's market is extremely competitive. Projects similar to that proposed in this report require several sources of funding. The following is a list of funding options that are available followed by a brief description:

- Virginia Resource Authority
- Virginia Revolving Loan Fund
- Rural Utilities Service (RUS)
- Virginia Water Projects
- Community Development Block Grants
- Connection Fees
- County Contributions
- Private Sector Contributions
- Governor's Opportunity Fund

11.1 Community Development Block Grants (CDBG)

Block grants are awarded on an annual basis through the Virginia Department of Housing and Community Development. Applications are submitted in March and selections are announced in June of each year. A maximum of $700,000 is available for a water or wastewater project. The project must address the needs of low and moderate income (LMI) households. At least 51% of the homes served by a projects must be LMI households. To be competitive in the grant process, the effect on LMI's should be much higher. In addition, addressing housing needs along with water or wastewater needs help in receiving grants. Grants are also available for Industrial Development Projects and are usually awarded in September.

11.2 Virginia Water Projects, Inc. (VWP)

The Virginia Water Project, Inc. works with Community Action Agencies, local governments, and Planning District Commissions in helping rural and low income Virginians obtain adequate, affordable and safe water/sanitary services. VWP provides both low interest loans and grants. Grants can be used for preliminary engineering studies and a maximum of $600 per hookup is available for connection fees.

11.3 Connection Fees

Connection fees are a very important part of funding a new project as well as establishing a reserve fund for future system improvements. The amount of the connection fee depends on the value of the system. Most utilities charge a lower connection fee when the system is first constructed to encourage connections.

11.4 Virginia Resource Authority (VRA)

The Virginia Resource Authority provides funds through the sale of bonds for financing projects for water, wastewater, and solid waste.

11.5 Rural Utilities Service (RUS)

Formerly known as the Farmers Home Administration, the Rural Utilities Service (RUS), in cooperation with the United States Department of Agriculture, provides financial assistance for water and wastewater projects to rural areas serving up to a population of 10,000. Louisa County is eligible for a 5% loan over a 40 year period. Grant funds up to 75% are also available for facilities serving the most financially needy communities to reduce user fees for customers of the project.

11.6 Governor's Opportunity Fund

The Governor's Opportunity Fund is administered through the Virginia Department of Economic Development. This fund is used to assist localities attach industries to the State of Virginia and their locality. The funds can be used for water, sewer, and site improvements. The amount of funding is on a case-by-case basis.

12.0 FINDINGS AND RECOMMENDATIONS

The purpose of this section is to provide an overview of the Water Quality Management Plan findings along with the most important recommendations for Louisa County to prepare for future growth. Additional, more comprehensive recommendations are found in the referenced sections of the Study report. In general, Louisa County's water supplies are in good condition, though limited in quantity. This leads to a plan that meets growth demands and includes expanding existing systems, developing new systems, and implementing a plan to protect the surface and groundwater supplies.

12.1 Findings

A summary of the findings from the previous sections of the Study is as follows:

Future Water and Wastewater Demands

- The existing population of Louisa County is approximately 25,000. Population projections for the County range from 32,000 to 46,000 by the year 2015. **(Section 5)**

- The **average daily demands** for public water and wastewater to accommodate growth in the seven growth areas will be between **2.8 MGD** (million gallons per day) **and 4.1 MGD.** Estimated peak day demands are **between 4.5 MGD and 6.6 MGD.** The seven potential growth areas are Zion Crossroads, Ferncliff, Gum Springs, the Town of Louisa area, the Town of Mineral area, the Lake Gordonsville area, and Lake Anna. **(Section 5)**

- At full build out of the present County Comprehensive Plan, the **build out demand** for public water and wastewater in the seven potential growth areas is estimated to be approximately **37 MGD** for the average daily demand and approximately **60 MGD** for the peak daily demand. **(Section 5)**

Water Resources - Surface Water and Groundwater

- The overall water quality of Louisa County's lakes, rivers, streams and groundwater supplies appears to be good at the present time but will need to be protected as future growth occurs. **(Section 2)**

- The only surface water impoundment presently being utilized for public drinking water is Northeast Creek Reservoir. The Louisa County Water Authority (LCWA) is presently treating approximately 220,000 gallons of water per day for distribution to customers in the Town of Louisa/Mineral service area. **(Section 4)**

- Past mining activities have affected the water quality of Contrary Creek, which flows into Lake Anna. There may be other water quality issues as a result of past mining activities **(Section 3)**

- A database of 2155 drilled wells in Louisa County was evaluated for yield, total depth, depth to bedrock, static water level, and casing length. Of the drilled wells, average yields in 5 rock families ranged between 12 gpm (gallons per minute) and 16 gpm. The average casing length of the drilled wells ranged from 60 feet to 74 feet in the 5 rock families. Of the 2155 drilled wells, 82 wells had reported initial yields greater than 50 gpm. Fifty of these wells are located immediately adjacent to Lake Anna. **(Section 3)**

- Thirty four of the 2155 drilled wells in Louisa County serve multiple users, both public and private systems. The remainder serve single family residences. Of the multiple user wells, the average yield was 42 gpm, almost three times greater than the average yield of all drilled wells (14.5 gpm). **(Section 4)**

- There are some areas of the County where groundwater has been affected by fecal coliform bacteria and increased nitrate levels which may be caused by failing septic systems. The Blue Ridge Shores subdivision at Lake Louisa has a high incidence of reported septic failures. **(Section 2)**

- The only public water system is found in the Town of Louisa/Town of Mineral areas. Areas of the County with private systems with multiple users include Zion Crossroads, Blue Ridge Shores, Shenandoah Crossings, and areas along Lake Anna. **(Section 4)**

- Groundwater serves as the primary drinking water source for most areas of the County. Groundwater also continues to provide or supplement the water supplies within the Towns of Louisa and Mineral. The Town of Mineral currently provides their residents with approximately 90,000 gallons of water per day from their existing groundwater wells and springs. **(Section 4)**

- The best water supply options to meet the projected demand are expansion of the **Northeast Creek Reservoir and development of Lake Gordonsville,** supplemented by the available groundwater supply. **(Section 6)**

- The LCWA water treatment plant at Northeast Creek Reservoir can presently provide up to **1 MGD** of drinking water. Based on a Department of Environmental Quality (DEQ) safe yield analysis, the water treatment plant can be expanded to a capacity of **2.8 MGD** for future demands. Lake Gordonsville is presently used for flood control and does not have a water treatment plant. Based on a DEQ analysis, approximately **1 MGD** of water can be used for drinking water purposes. There may be a potential for groundwater supply. This must be ascertained with further study. **(Section 6)**

- To meet water demands beyond the next 20 years or for heavy industrial water users will probably require either locating a large groundwater supply, constructing a new surface water impoundment, or developing an agreement to purchase water from a neighboring jurisdiction. **(Section 6)**

- Due to the limited water resources in Louisa County, it is very important to protect the long term use of the lakes, rivers, streams, and groundwater supply. Specific management plans should be developed for Northeast Creek Reservoir, Lake Gordonsville, and Lake Anna. **(Section 8)**

Wastewater

- Approximately 80 percent of wastewater treatment in Louisa County is provided by individual septic tanks and sanitary drainfields. The only publicly operated wastewater treatment plants (WWTPs) are the Louisa regional WWTP and the Town of Louisa WWTP. Other areas of the County do have private wastewater treatment systems with multiple users such as Zion Crossroads, Shenandoah Crossings, and the North Anna Power Plant. **(Section 4)**

- The existing Louisa County Wastewater Treatment Plant presently treats approximately 200,000 gallons/day of wastewater from the southern portion of the Town of Louisa, most of the Town of Mineral and several schools within the service area. This facility is presently in the process of being expanded to a 400,000 gallon/day plant. The Town of Louisa presently owns and operates a trickling filter wastewater treatment facility with an average daily treatment capacity of approximately 60,000 gallons/day that serves the northern portion of the Town of Louisa. **(Section 4)**

- To meet wastewater demands over the next 20 years, it appears that several wastewater treatment plants will need to be constructed in different areas of the County. The combination of low summer flows in the South Anna River and its tributaries and very stringent water quality criteria will require most of the wastewater treatment plants in Louisa County to have stringent treatment discharge limits. **(Section 7)**

- In the Lake Anna area, it may be difficult to obtain a permit or too costly for a direct discharge to the Lake. To serve this area may require wastewater treatment combined with discharging the treated effluent to nearby spray irrigation fields. **(Section 7)**

- For wastewater treatment outside of potential growth areas, the use of septic systems for individual homeowners should be developed in a manner consistent with ground/surface water protection and County requirements. **(Section 7)**

Water and Wastewater System Master Plans

- Based on the estimated 20 year demands for public water and wastewater, proposed water system and wastewater system master plans have been developed. These master plans show approximate locations of the major components that will be necessary to provide a significant supply of public water and wastewater services to each of the seven potential growth areas. **(Section 9)**

- The Water System Master Plan (Figure 9-1) has been developed around the Northeast Creek Reservoir and Lake Gordonsville and includes a network of long transmission mains and water storage tanks. A possible future off-stream storage impoundment has been shown in the Gum Springs area. Primary water transmission mains have been shown to provide at least two routes to each growth area in order to improve system reliability and fire protection. **(Section 9)**

- The Wastewater System Master Plan (Figure 9-2) has been developed around the concept of providing individual wastewater treatment plants to serve the Zion Crossroads area, the Gum Springs area, the Lake Gordonsville area, and the Lake Anna area. The Louisa and Mineral areas are shown to continue to use the Louisa Regional WWTP. Service to the Ferncliff area is shown to be provided by pumping to the Zion Crossroads WWTP. **(Section 9)**
- Based on the Water and Wastewater System Master Plans, capital cost estimates have been performed for providing initial public utilities to all potential growth areas. **(Section 10)** A summary of these cost estimates is provided on the next page.
- Some of the funding options that may be available to Louisa County for providing public water and wastewater services include Community Development Block Grants, the Virginia Revolving Loan Fund, and the Rural Utilities Service, and the Governor's Opportunity Fund. **(Section 11)**

WATER AND WASTEWATER SYSTEM MASTER PLAN
PRELIMINARY COST SUMMARY OF PROJECTS

Zion Crossroads

A. Water Main Extension from Louisa Area (along Rte 22 and Rte 15)	$3,552,120
B. 600,000 Gal. Elevated Storage Tank near Zion Crossroads	$920,700
C. 500,000 GPD Wastewater Treatment Plant Expansion for Zion Crossroads	$3,207,600
Total For Projects In Zions Crossroads	**$7,680,420**

Lake Gordonsville

A. 800,000 GPD Water Plant @ Lake Gordonsville	$2,851,200
B. Water Main Extension along Route 15 from North Limits to Route 22	$983,664
C. 500,000 Gal. Elevated Storage Tank near Water Plant	$873,180
D. 350,000 GPD Wastewater Treatment Plant Near Shenandoah Crossings	$3,207,600
Total For Projects In Lake Gordonsville	**$7,915,644**

Ferncliff

A. Water Main Extension from Zion Crossroads (along Rte 250)	$1,306,800
B. 250,000 Gal. Elevated Storage Tank near I-64	$570,240
C. Wastewater Treatment Infrastructure	$1,223,640
Total For Projects In Ferncliff	**$3,100,680**

Louisa/Mineral

A. Upgrade Existing Water Plant to 2.5 MGD	$3,267,000
B. Water Main Extensions in Louisa Area (along Rte 613 and Rte 208)	$1,235,520
C. 500,000 Gal. Elevated Storage Tank	$825,660
D. 750,000 GPD Wastewater Treatment Plant Expansion for Existing WWTP	$4,217,400
Total For Projects In Louisa/Mineral	**$9,545,580**

Lake Anna

A. Water Main Extension from Mineral along Rte 522	$1,559,844
B. 600,000 Gal. Elevated Storage Tank	$920,700
C. 500,000 GPD Wastewater Treatment Plant to Spray Fields	$4,930,200
Total For Projects In Lake Anna	**$7,410,744**

Gum Springs

A. Water Main Extension along Rte 33 and Rte 522	$3,831,300
B. 600,000 Gal. Elevated Storage Tank near I-64	$920,700
C. 600,000 GPD Wastewater Treatment Plant for Gum Springs	$4,989,600
Total For Projects In Gum Springs	**$9,741,600**

12.2 Recommendations

This Water Quality Management Plan is a three pronged approach: water resources (ground and surface), wastewater treatment, and non-point source protection. There are ten overall recommendations that are presented in this section to enhance the Plan. Other, more specific recommendations are presented throughout the Study.

Recommendation #1 - Utilize the proposed Water and Wastewater System Master Plans as a baseline for providing public services to Potential Growth Areas. Develop a "Phased approach" for implementation, which should be based on anticipated revenue and growth control.

Recommendation #2 - Revise the present Louisa County Comprehensive Plan based on water resource protection, growth control strategies, and detailed mapping of the County (soils, geology, etc. on the new GIS).

Recommendation #3 - Develop specific watershed protection plans for both of the Countys' present and future drinking water supplies, the Northeast Creek Reservoir and Lake Gordonsville.

Recommendation #4 - Using the new County mapping system, work with the Virginia Division of Mineral Resources to develop a more accurate groundwater potential yield map and septic system favorability map. These maps will be useful for potential development throughout the County.

Recommendation #5 - Conduct detailed field studies for groundwater resource development in potential growth areas, especially areas located furthest from the present water system, such as Gum Springs. These studies should include detailed fracture trace analyses, well installation, and hydrogeologic testing. The results of this testing will give more accurate estimates of yields that can be anticipated.

Recommendation #6 - Perform additional investigations in areas of historical mining activity, specifically within the Northeast Creek watershed and Contrary Creek Watershed. These studies should include the impacts of the mining activities on surface and groundwater resources and implications for stability of future building foundations.

Recommendation #7 - Develop a management plan for the Lake Anna area including more specific zoning within the area. Louisa County should work with the Lake Anna Civic Association and neighboring Counties to develop a comprehensive Lake Management plan that is consistent throughout the entire watershed.

Recommendation #8 - Encourage septic tank maintenance of all County residents. Proper septic system maintenance will reduce the risk of groundwater contamination and help to protect this valuable resource. The Louisa Regional wastewater treatment facility will be able to accept septage in 1998. The County should consider tax breaks or other incentives to promote this program.

Recommendation #9 - Develop a well head protection program for County in order to protect the public water supply wells. The program should include identification of recharge areas for public wells, and possibly land use restrictions and restrictions of the use of pesticides, nutrients or other pollutants within recharge areas.

Recommendation #10 - Pursue options to obtain water from neighboring jurisdictions such as Fluvanna County, Goochland County, the City of Charlottesville, the Rapidan Water and Sewer Authority, and the Town of Gordonsville in order to meet demands beyond the next 20 years.

APPENDIX H-1-2-2
FLUVANNA COUNTY GEOLOGY AND WATER WELL PRODUCTIVITY

FLUVANNA COUNTY GEOLOGY AND WATER WELL PRODUCTIVITY

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Overview

The quantity and quality of water that can be pumped from the ground at a given location is determined by physical characteristics of the soils, weathered rock material (saprolite), and bedrock that underlie the area (Figure 1). Groundwater occurs in soils, saprolite, and bedrock, and water wells can be constructed to tap water in each of these zones.

Hand-dug wells, and wells that are bored with an auger, penetrate soil and saprolite to maximum depths of about 75 feet, but not the hard bedrock beneath. These wells are vulnerable to seasonal fluctuations in the water table, and to contamination from surface waters. In general, shallow wells that do not penetrate bedrock are not viable for long-term domestic water supply.

Drilled water wells (Figure 1) tap sources of high quality groundwater in the bedrock, at depths of up to several hundred feet. These wells are cased, or sealed, from the surface downward through soils and saprolite to the top of the bedrock, in order to prevent direct infiltration of surface waters into the well. Ideally, the water that is pumped from a deep drilled well has spent a long time percolating downward through soils, saprolite, and the bedrock itself, and has been cleansed of biological and chemical impurities. Drilled wells are the best type of well for supplying domestic and industrial water needs.

Understanding the nature of the subsurface bedrock is critical to determining the quantity of groundwater that can be pumped from a drilled well at a given place. In some parts of the world, bedrock consists of sedimentary layers which have abundant pore spaces between individual mineral grains. These layers can form laterally extensive aquifers, or conduits for groundwater movement, that are at predictable depths, and from which seemingly unlimited quantities of high-quality groundwater can be pumped. In these areas, groundwater is the obvious solution for public water supply needs.

Original citation
Water Resources in Fluvanna: Present Conditions and Recommendations for Preservation and Restoration
Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999

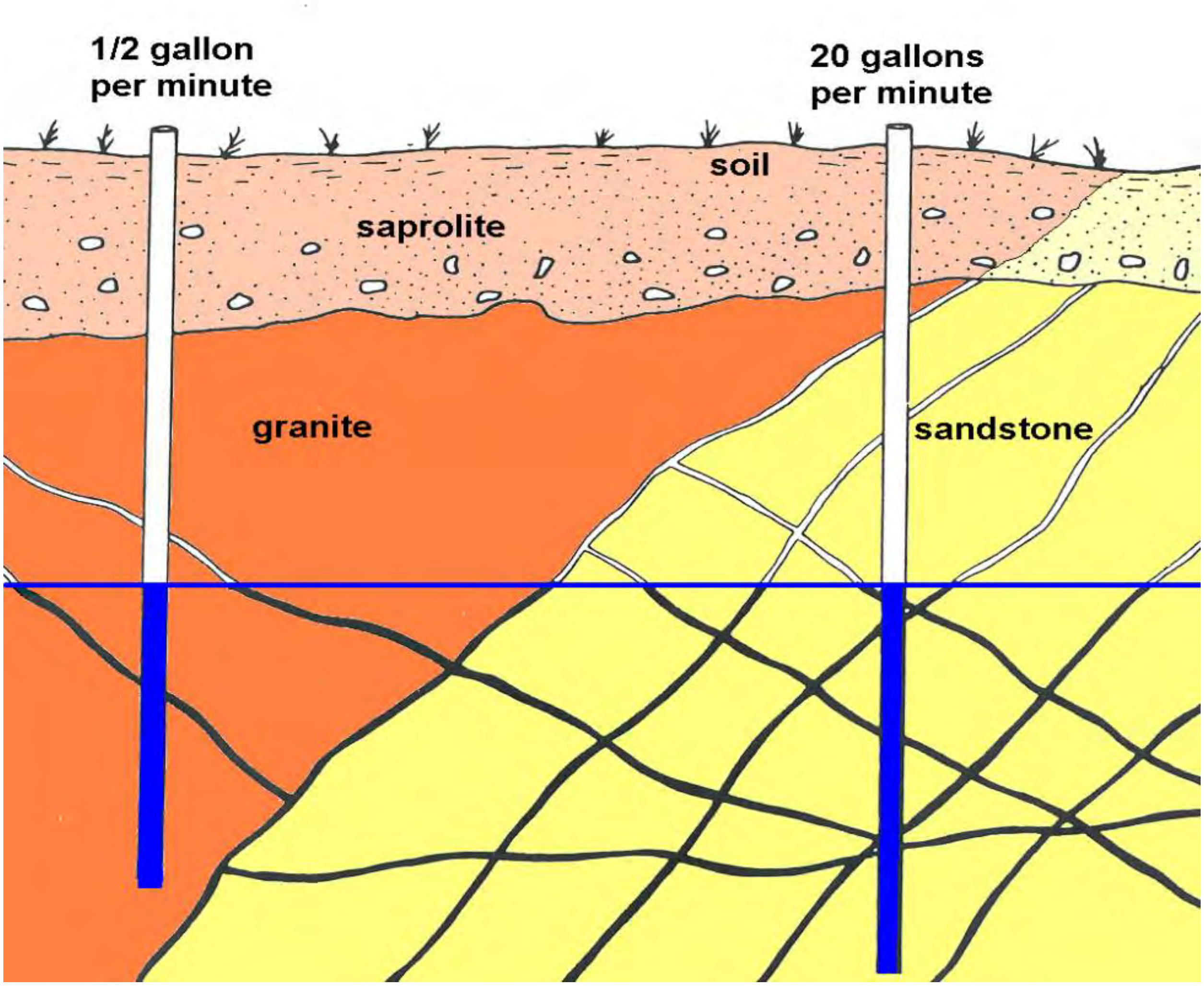

Figure 1: Soil, saprolite and fractured bedrock control groundwater flow.

In contrast, the bedrock beneath Fluvanna County is very complex, and contains relatively few open spaces to conduct groundwater. In Fluvanna, extensive subsurface aquifers are rare, and both the quantity of water available at a given site, and the depth of the water-bearing zones, are highly variable and difficult to predict. Also, the wide variety of mineralogy and rock chemistry in a geologically complex area such as Fluvanna County can cause variations in groundwater chemistry that lead to water quality problems in some areas. Water well productivity and groundwater quality in Fluvanna are determined by a complex interplay among the bedrock aquifer, which supplies water to the drilled well, and the local soils and saprolite, which provide recharge and storage for the bedrock aquifer.

To evaluate groundwater availability and groundwater quality questions in Fluvanna County, we need detailed knowledge of the geologic formations that underlie the county, and knowledge of the hydrologic characteristics of water wells located in the particular rock formations. We also need knowledge of the thickness and character of saprolite and soils layers throughout the county. The Fluvanna County hydrogeologic database has been developed in this project as a tool with which to manage multiple types of data related to groundwater on a desktop computer. This database will be an invaluable tool for evaluating site-specific groundwater questions throughout the County in the years to come.

At this writing, the database incorporates hydrologic data from 1326 domestic and 16 public water supply wells, of which 1008 wells have been precisely located in terms of latitude and longitude, and can thus be used in analysis of spatial relations (Figure 2). These include all water well records on file at the Fluvanna County Health Department in Palmyra, at the DMR in Charlottesville, and at the Virginia Department of Health, Office of Water Programs in Lexington. In addition to water well data, the hydrogeologic database incorporates bedrock geology and topographic map data. Water well construction data in the database provides information on saprolite thicknesses throughout the county. With additional future work, the database could include hydrologic testing data, water chemistry data, and soils mapping.

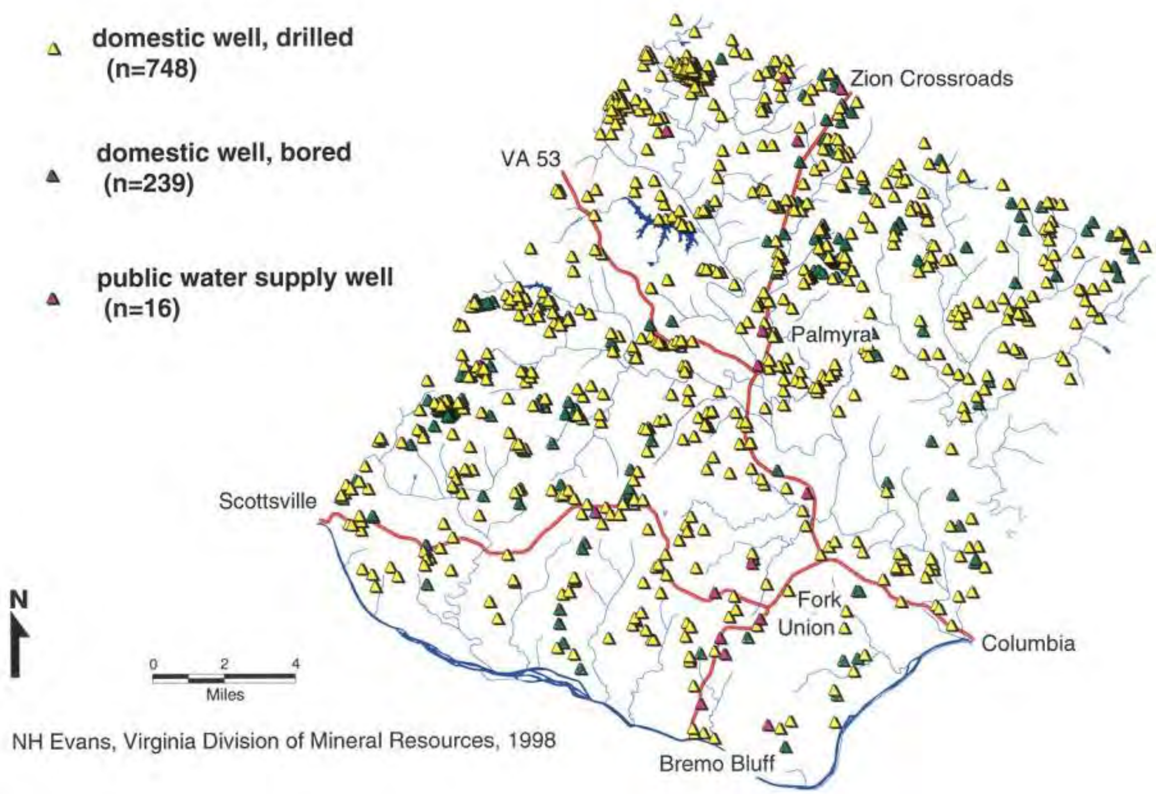

Figure 2: Distribution of water wells in the Fluvanna county hydrogeologic database.

Original citation
Water Resources in Fluvanna: Present Conditions and Recommendations for Preservation and Restoration
Thomas Jefferson Planning District Commission and VA DMME Division of Mineral Resources: January, 1999

Bedrock Geology

The Geologic Map of Fluvanna County (scale: 1:62,500, or 1 inch = 1 mile; Smith, J.W. and Milici, R.C., 1964, Virginia Division of Mineral Resources Bulletin 79, Plate 1) has been used as a geologic base for this study. This map was converted to a digital format, and can be used to subdivide the bedrock beneath the county into 18 unique geologic mapping units (Figure 3). Some of the rock unit names and descriptions have been modified from the original published map to reflect more recent mapping.

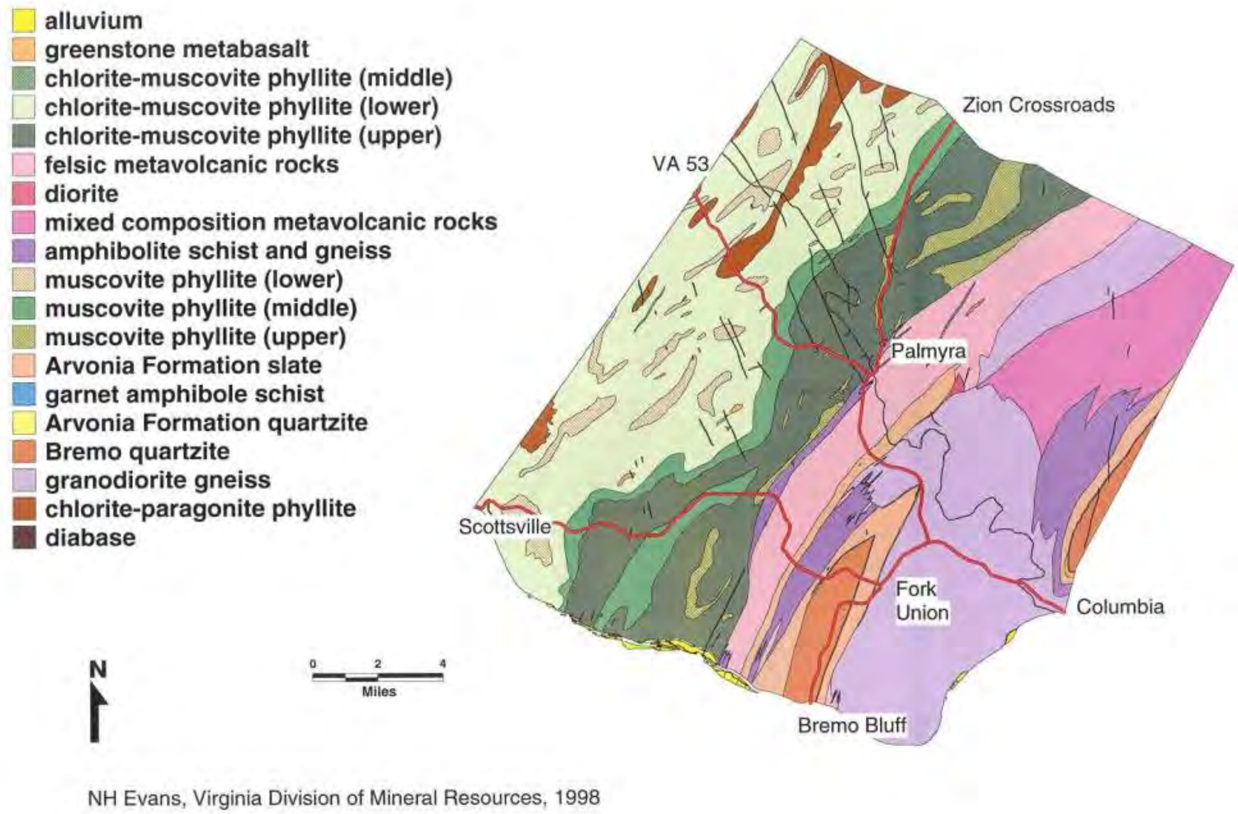

Figure 3: Bedrock mapping units in the Fluvanna County hydrogeologic database.

Detailed synopsis of Fluvanna County bedrock geology:

Fluvanna County is underlain by igneous and metamorphic rocks ranging in age from 300 million to more than one billion years. Bedrock in the western portion of the county consists of mica schist and phyllite that represent metamorphosed sandstone, siltstone and mudstone originally deposited in an Early Paleozoic (500 million years ago) ocean basin. East of Cunningham, phyllite and schist grade into quartz-mica schist and gneiss. The central portion of the County is underlain by metamorphosed volcanic rocks of the Cambrian-age (560 million years ago) Chopawamsic Formation. The southeastern portion of the County from Carysbrook to Columbia is underlain by Cambrian- to Ordovician-age granodiorite, granite, and related gneisses. These rocks, and the Chopawamsic volcanic rocks, are overlain by Ordovician-age (450 million years ago) slate and quartzite of the Arvonia Formation. Chopawamsic volcanic rocks and the slates of the Arvonia Formation contain a series of gold and sulfide mineral deposits that were mined during the nineteenth and early twentieth centuries. These historic mine sites have implications for water quality.

For purposes of studying county-wide trends in groundwater availability, the 18 different bedrock mapping units can be grouped into 6 rock families (Figure 4). Each of these has distinct characteristics with respect to groundwater movement, water well productivity, water quality, and suitability of groundwater recharge.

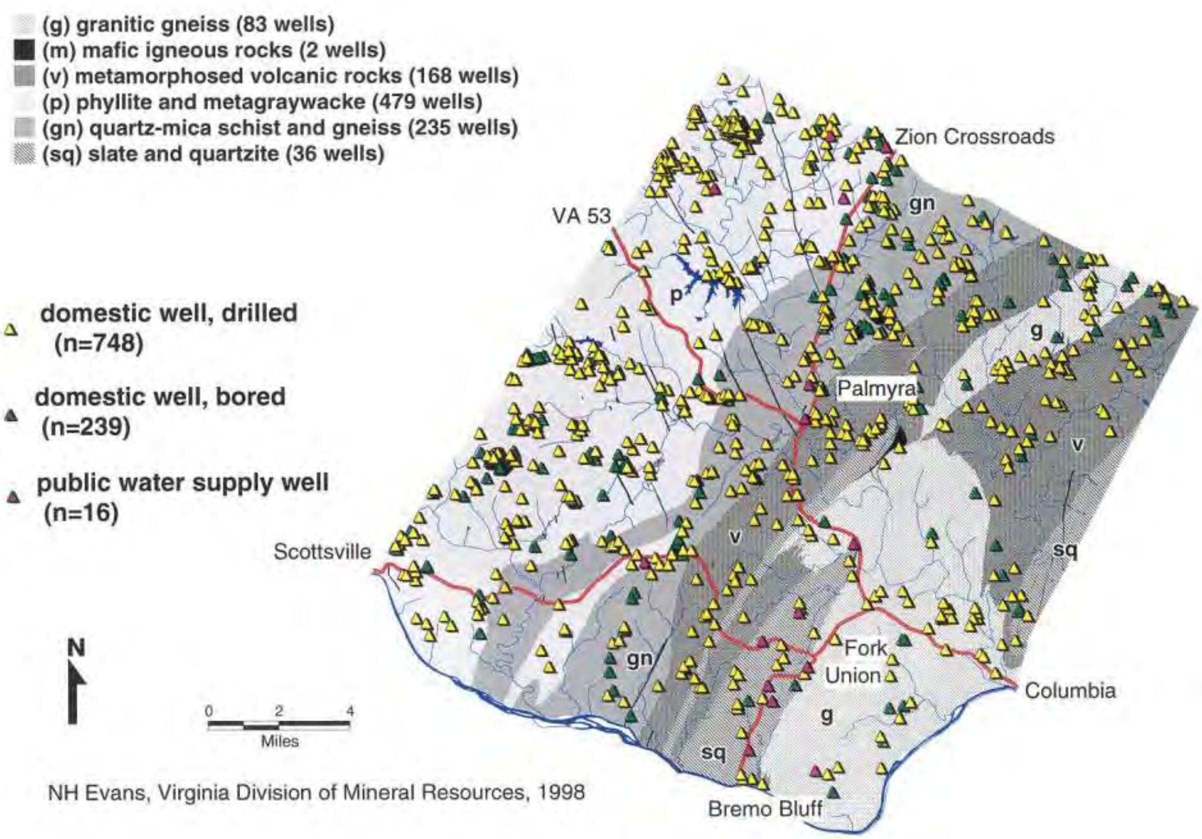

Figure 4: Bedrock families Fluvanna County and the distribution of water wells in the hydrogeologic database.

Fundamentally, all of the bedrock underlying Fluvanna County is crystalline rock that contains virtually no pore space between individual mineral grains. Groundwater occurs only within fractures in the rock (Figure 1). The density and geometry of bedrock fractures, and the ease with which groundwater can move through the fractures are critical to determining how much water can be extracted from wells penetrating bedrock. Fracture density and orientation varies among different rock types and from place to place within any one rock type.

Fractures are geometrically related to structural features is the bedrock such as folds, where the rocks have been crumpled by regional tectonic forces, and faults, which are abrupt discontinuities between blocks of bedrock. Surface observations of bedrock structures can be used to estimate fracture orientations in the subsurface; topographic lineaments defined on aerial photographs and topographic maps are also instructive. Throughout Fluvanna County, many of the boundaries between individual rock formations are faults, some of which are regionally extensive and have histories of multiple movement. In addition, the rocks have been tightly folded into a series of northeast-trending map-scale folds. The outcrop belts of the Arvonia Formation define three major folds in the central and eastern part of the county. In the western part of the county, the map pattern defines another series of folds. Folds and faults can coincide with increased fracture densities relative to surrounding rocks; this can be a useful tool for targeting areas favorable to groundwater productivity.

The phyllite and metagraywacke rock family contains fewer through-going fractures than do harder rocks such as quartzites, metamorphosed volcanic rocks and granite gneisses. However, within any of the individual bedrock families, there are locations where geologic structures, topography, and other factors relating to groundwater recharge result in little or no groundwater productivity, and other areas where fracture density and a combination of other factors support substantial groundwater yields.

Saprolite

Saprolite is thoroughly decomposed rock material that exists beneath near-surface soil horizons, and above solid, unweathered bedrock at depth (Figure 1). Most groundwater that flows into water wells from bedrock fractures was derived from surface water percolating downward through soils and saprolite. Water well yields in crystalline rock are determined not only by fracture density in the bedrock, but also by the effectiveness with which water is stored in the saprolite and transmitted into fracture networks below.

The physical properties of saprolite that develops over a particular type of bedrock are determined by the manner in which the individual minerals that make up the rock behave in the weathering environment. Some common minerals such as quartz and muscovite are highly resistant to chemical weathering. Other common minerals such as feldspar, biotite, and amphibole weather readily to form hydrated clays. The nature and thickness of saprolite in a particular area controls not only that material's ability transmit groundwater into underlying bedrock fractures, but also the ability of the saprolite layer to cleanse groundwater of contaminants from surface waters such as drainfield effluents.

Granitic gneisses contain abundant quartz, muscovite, and feldspar. These rocks commonly weather to thick saprolite in which quartz and muscovite form a porous lattice around voids left by leached feldspars. This type of saprolite can be highly permeable with respect to groundwater, if the orientation of the residual lattice is suitable. A thick layer of this material can provide excellent storage for groundwater recharge. In contrast, some mafic composition volcanic rocks, which contain little or no quartz or muscovite, weather into relatively thin, clay-rich saprolite. This material can be relatively impermeable to groundwater, and does not make good storage or recharge material.

Paradoxically, the highly permeable granitic and gneissic saprolites that function best in terms of groundwater storage and recharge are also most susceptible to contamination by infiltration of surface waters, particularly drain field effluents. Clay-rich saprolite derived from mafic composition igneous rocks is a less efficient storage medium for groundwater recharge, but is also less vulnerable to contamination.

Saprolites are generally thickest in upland areas with gentle slopes, and thin to absent on steeper slopes adjoining stream drainages. Drainage bottoms commonly contain transported alluvial and terrace deposits sitting directly on bedrock. Depth-to-bedrock data in the water well database are a reliable indicator of saprolite thickness. These data indicate that on average, upland areas of Fluvanna County are underlain by at least 50 feet of saprolite. While average saprolite thicknesses are within about 20 percent of each other among the six rock families, the saprolites above quartz-mica schists and gneisses are thickest, averaging 58.4 feet. The significance of these numbers is that on average, there is ample thickness of saprolite in Fluvanna County for purposes of groundwater storage, and sanitary drainfield siting. However, planners need to be aware that variations in the type of saprolite can affect viability both in terms of groundwater recharge potential and in terms of the ability of the material to cleanse drainfield effluents.

Rock Family	Average Depth to Bedrock
Granitic gneiss	54.6 feet (n=71)
Mafic igneous rocks	53.0 feet (n=2)
Metamorphosed volcanic rocks	51.1 feet (n=138)
Phyllite and metagraywacke	48.1 feet (n=439)
Quartz-mica schist and gneiss	58.4 feet (n=217)
Slate and quartzite	53.3 feet (n=23)

Soils

The Fluvanna County Soil Survey maps of 1958 have not been rectified such that they can readily be incorporated into the hydrogeologic database. This severely limits evaluation of the relationship of Fluvanna soils to groundwater recharge, and groundwater vulnerability to contamination by drainfield effluents. It is strongly recommended that the County undertake to render the Fluvanna Soil Survey into a digital format such that in the future, soils data can be interfaced with the other data layers in the hydrogeologic database.

Water Well Database

The hydrogeologic database contains a total of 1342 records from water wells drilled in Fluvanna County. Locational accuracy is crucial to correlating water well data with geologic and other map data. At the time of this writing, 1003, or about 75 percent of these records have been located with sufficient precision to assign latitude and longitude values, and thereby include the records in spatial analysis. The process of incorporating future records into the database would be greatly enhanced if the well locations were precisely determined during the permitting process using Global Positioning System (GPS) technologies.

The water well database contains 40 discrete data fields; of interest in the present discussion are fields for well yield, total depth, and depth to bedrock. The yields that are reported on water well completion reports are initial yields, which are estimates made by drillers shortly after the well has been constructed. These initial yields are only an approximate indicator of how a well will perform under continuous pumping over periods of months or years. The sustainable yield of a well is the amount of water that can be pumped on a continuous basis over time without exceeding local recharge. Generally the sustainable yield of a well is a smaller quantity than the reported initial yield.

One of the problems in working with the yield data is that relatively few “dry holes”, or failed attempts to find water, are reported by drillers to the Health Department. The database contains only 13 records for which the reported yield is zero. This does not represent a statistically valid sample set for purposes of this study. There undoubtedly have been far more than 13 dry holes drilled in Fluvanna County over the past 25 years or so during which records have been kept. Notwithstanding the under-representation of “dry holes”, when reported yields are averaged for all wells occurring in various geologic formations or rock families, the resulting numbers do give an indication of the relative groundwater productivity. Average yields for domestic wells drilled in the six Fluvanna rock families are a general indication of relative groundwater potential in different parts of the county:

Rock Family	Average Yield, Domestic Drilled Wells
granitic gneiss	14.1gpm (n=64)
Mafic igneous rocks	10.0gpm (n=1)
metamorphosed volcanic rocks	12.3gpm (n=133)
phyllite and metagraywacke	8.0gpm (n=368)
quartz-mica schist and gneiss	12.0gpm (n=157)
slate and quartzite	17.0gpm (n=25)

These average yields are consistent with geological considerations. Slates and quartzites have tended to fracture in a brittle manner in response to regional tectonic stress over time; consequently these rocks have significant potential for maintaining open fracture systems to serve as conduits for groundwater. On the other hand, phyllites and metagraywackes have tended to bend or fold rather than break under the influence of regional tectonic stress; these rocks have lower fracture densities than any of the crystalline plutonic, volcanic, and gneissic rock families.

There are a total of 22 drilled wells in the database for which reported initial yields are 50 gallons per minute or greater (Figure 5). The distribution of these wells with respect to rock family displays a trend similar to that of averages of reported yields, where the greatest percentage of high-yield wells occur in slate and quartzite, granitic gneiss, and metavolcanic rocks. The distribution of high-yield wells is a good indication that substantial groundwater resources do occur in locations that are scattered across Fluvanna County. Further detailed investigations of the geologic settings and recharge characteristics of these wells would be very helpful in locating other areas of the county where groundwater potential is favorable.

Three of the high-yield wells within slate and quartzite are public water supply wells operated by the Fork Union Sanitary District. These wells have larger diameters than most domestic wells, which enhances productivity. Nonetheless, the relatively high percentage of high-yield wells within the slate and quartzite rock family is an indication that groundwater potential is favorable is these rocks. A reported decline in productivity of some of the FUSD wells in recent years is likely related to pumping in excess of recharge rates. Unfortunately, the relatively high manganese content of several of these wells is probably related to manganese oxides in the quartzite bedrock, and other wells drilled in these rocks are likely to produce similar groundwater.

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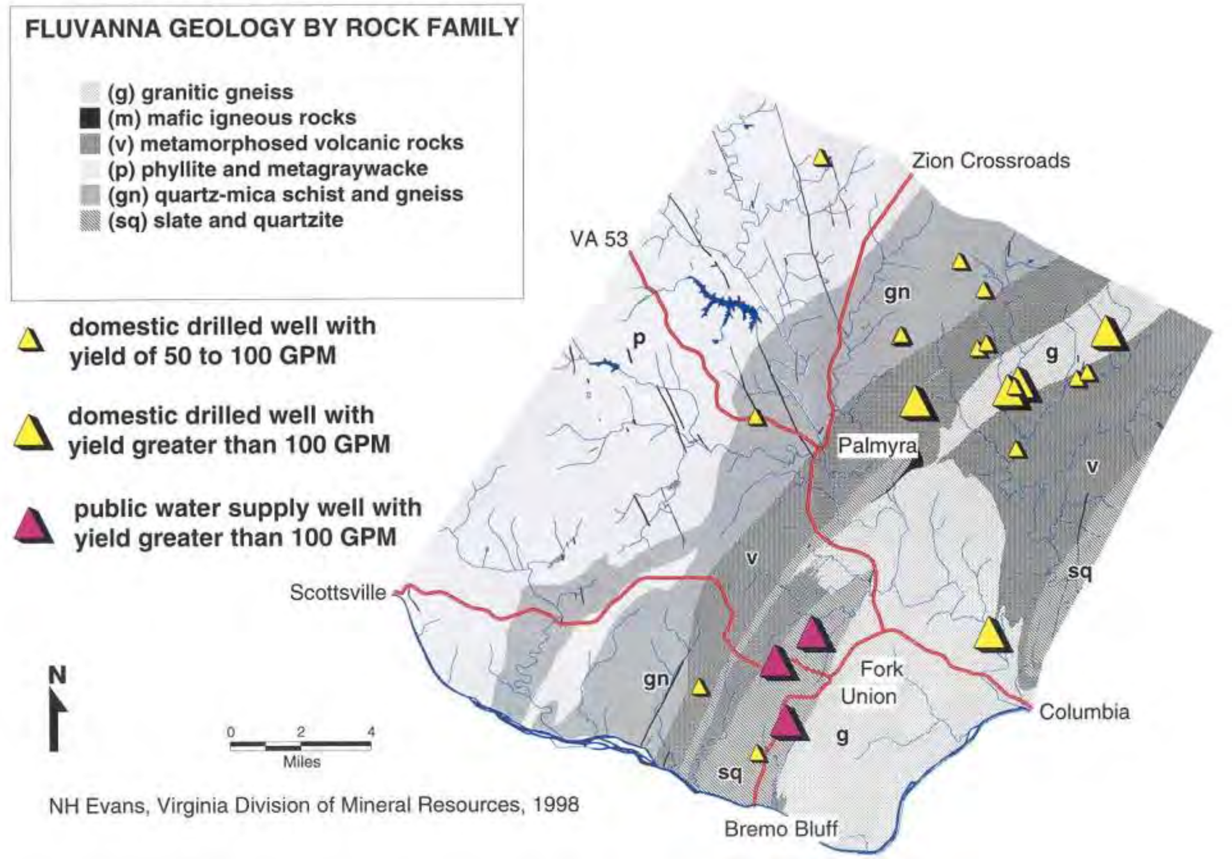


Figure 5: Distribution of high-yield wells in the Fluvanna County hydrogeologic database

Total depths of drilled wells in the database range 65 feet to 1101 feet; the median depth is 170 feet. High-yield wells range in depth from 105 feet to 505 feet. The relationships between well yield and total depth are displayed in the table below. With the exception of the phyllite and metagraywacke rock family, maximum average yields occur at depths greater than 100 feet. The slate and quartzite family shows a trend of increasing yield with depth, and maximum yields occur in wells drilled deeper than 300 feet. Five of the wells drilled deeper than 300 feet in slate and quartzite were developed as public water supply wells. The remaining rock families show maximum average yields for well depths between 100 and 300 feet.

Rock Family	Avg Yields, TD <100 FT	Avg Yields, TD 100-200 FT	Avg Yields, TD 200-300 FT	Avg Yields, TD >300 FT
Granitic gneiss	4.0 (n=3)	19.4 (n=23)	11.0 (n=25)	13.0 (n=16)
Mafic igneous rocks		10.0 (n=1)		
Metamorphosed volcanic rocks	6.0 (n=9	13.7 (n=53)	16.8 (n=44)	4.4 (n=28)
Phyllite and metagraywacke	12.4 (n=50)	10.1 (n=173)	5.7 (n=90)	2.9 (n=61)
quartz-mica schist and gneiss	11.8 (n=32)	16.2 (n=77)	7.3 (n=32)	3.9 (n=18)
Slate and quartzite	5.0 (n=3)	18.5 (n=14)	24.4 (n=5)	89.0 (n=8)

It is commonly believed that there are diminishing returns from drilling wells to depths greater than about 400 feet because theoretically, the confining pressures that increase with depth, tend to close bedrock fractures supplying groundwater to the well. While this may be true in the case of relatively soft rocks such as phyllite and metagraywacke (as evidenced by this study), harder rocks such as slate, quartzite, and granitic gneiss can maintain open fractures at depths considerably deeper than 400 feet. There may be substantial groundwater resources in some areas of the County that could be accessed at depths of 800 or more feet. Any groundwater exploration program undertaken in the future should include one or more deep test wells.

Evaluating Groundwater Resources in Potential Development Areas

The averages of reported initial yields help to characterize groundwater potential in different parts of Fluvanna County, but do not provide absolute criteria with which to evaluate groundwater availability on specific sites. The averages do not, for example, guarantee that every 200-acre subdivision on slate and quartzite bedrock can expect to obtain a sustainable 24.4 GPM yield from each of 200 individual domestic wells drilled to a depth of 300 feet. In fractured rock aquifer terrain, groundwater storage, recharge, and transmissivity in one area may be quite different from the aquifer parameters a short distance away, even within the same geologic formation. Somewhere in Fluvanna County there undoubtedly exist 200-acre parcels on slate and quartzite bedrock for which little or no groundwater is available.

Evaluating groundwater potential for a given parcel of land, and choosing the best well site on that parcel is not a matter of guesswork. Groundwater availability is in part a function of the local bedrock's ability to efficiently transmit groundwater from the recharge area to a well site. However, the size of the recharge area, and thickness and permeability of the local saprolite layer as a storage medium are also critical in determining how much of a sustainable yield can be anticipated from a given well site.

In fractured rock aquifer media, which pertains to all of Fluvanna County, the down gradient or “down hill” direction of groundwater flow is roughly consistent with surface topography. This means that the recharge area for a given well site generally corresponds to the surface drainage area topographically “upstream” from the well site. Wells that are sited on the tops of hills or ridges can be predicted to have far less extensive recharge areas than wells sited in valleys.

Saprolite thickness and character can be evaluated by studying casing-length data in the hydrogeologic database, and by examining soils mapping data for estimates of permeability. Obviously, bedrock exposures at the surface are evidence that saprolite is locally absent, with the implication that the saprolite layer may be very thin in those areas where bedrock is not exposed. The type of surface cover also has a profound effect on the accessibility of rainwater striking the surface to groundwater recharge. Rainfall hitting an asphalt parking lot has no access to the subsurface; clearly, asphalt is not an ideal surface cover medium for a groundwater recharge area. Cleared and closely cropped farmland, where topographic relief is high, can also promote rapid runoff of rainwater, and limited infiltration for groundwater recharge. A mature forest represents the optimal land cover for a groundwater recharge area.

The only way to evaluate with some degree of certainty the hydrogeologic regime of a particular site is to conduct hydrologic testing using existing or new wells. Hydrologic tests are designed to measure groundwater flow and storage characteristics; tests can be designed using single wells, or multiple wells on adjacent sites. Typically, electronic devices are installed in the well or wells to monitor water levels, and a well is pumped at a known rate for a period of time. Changes in water levels in the wells over time are charted through the test, and mathematical formulae are then applied to define the aquifer parameters. Hydrologic testing is the only way one can accurately assess the sustainable yield of a given well, or what effect, if any, introduction of a new pumping well will have on water availability in existing nearby wells. In the future, the County should consider requiring hydrologic tests prior to approving applications for high-density subdivisions dependant on groundwater.

APPENDIX H-1-3
RWSA LETTER

RIVANNA
WATER & SEWER AUTHORITY
695 Moores Creek Lane | Charlottesville, Virginia 22902-9016
434.977.2970
434.293.8858
www.rivanna.org

March 11, 2020

Mr. Joseph C. Hines, P.E., MBA
Principal, Timmons Group
1001 Boulders Parkway, Suite 300
Richmond, VA 23225

Re: James River Water Authority Water Request

Dear Joe,

Thank you for your recent inquiry about the Rivanna Water and Sewer Authority's (RWSA) ability to provide water to the James River Water Authority (JRWA). You indicated that JRWA is evaluating alternatives to a proposed raw water withdrawal from the James River to serve Louisa and Fluvanna Counties, with a required capacity of up to 12 mgd.

RWSA's core mission is to provide safe, high-quality drinking water, and environmentally responsible wastewater treatment services for the City of Charlottesville and areas served by the Albemarle County Service Authority. We do not presently have the water supply, treatment, or conveyance infrastructure in place to provide the requested volume of raw water, or a comparable volume of finished water, to JRWA. RWSA has planned and constructed its system to meet the projected 50-year water supply needs of its member communities. Providing the requested volume of raw water you referenced, or a corresponding volume of finished water, would be inconsistent with RWSA's core mission and long-term strategic and capital asset plans.

Please let me know if we may provide assistance otherwise.

Sincerely,

William I. Mawyer, Jr. P.E., MBA
Executive Director
Rivanna Water and Sewer Authority

APPENDIX H-2
PUMP STATION DETAILS

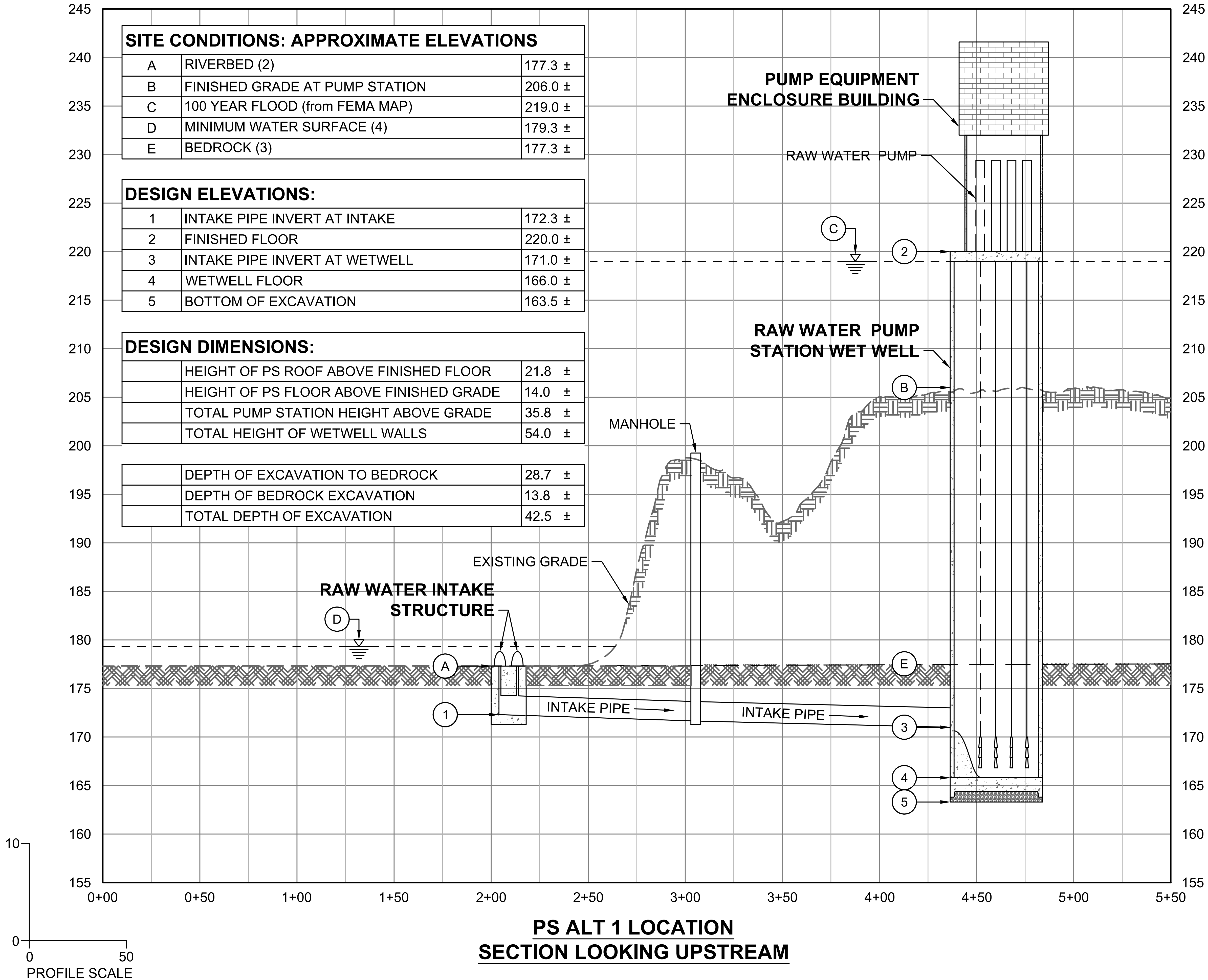
PS ALT 1

SITE CONDITIONS: APPROXIMATE ELEVATIONS		
A	RIVERBED (2)	177.3 ±
B	FINISHED GRADE AT PUMP STATION	206.0 ±
C	100 YEAR FLOOD (from FEMA MAP)	219.0 ±
D	MINIMUM WATER SURFACE (4)	179.3 ±
E	BEDROCK (3)	177.3 ±

DESIGN ELEVATIONS:		
1	INTAKE PIPE INVERT AT INTAKE	172.3 ±
2	FINISHED FLOOR	220.0 ±
3	INTAKE PIPE INVERT AT WETWELL	171.0 ±
4	WETWELL FLOOR	166.0 ±
5	BOTTOM OF EXCAVATION	163.5 ±

DESIGN DIMENSIONS:		
	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	14.0 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	35.8 ±
	TOTAL HEIGHT OF WETWELL WALLS	54.0 ±

	DEPTH OF EXCAVATION TO BEDROCK	28.7 ±
	DEPTH OF BEDROCK EXCAVATION	13.8 ±
	TOTAL DEPTH OF EXCAVATION	42.5 ±



PS ALT 1 LOCATION
SECTION LOOKING UPSTREAM

NOTES:

(1) PROFILE ELEVATION DATA IS BASED ON AVAILABLE FLUVANNA COUNTY LIDAR DATA DATED 2015. DETAILED FIELD OBTAINED ELEVATION DATA MAY DIFFER FROM THOSE INDICATED ON THIS EXHIBIT.

(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON INTERPOLATION OF DATA INDICATED ON VDOT BRIDGE GEOTECHNICAL REPORTS FOR THE ROUTE 15 BRIDGE AT BREMO BLUFF AND ALTERNATE SITE 6.

(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS ASSUMED TO BE SAME AS RIVER BOTTOM.

(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

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REVISION DESCRIPTION | DATE

DATE | DRAWN BY | DESIGNED BY | CHECKED BY

SCALE H: 1" = 50' V: 1" = 10'

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA

PS ALT 1 - RIVER SECTION

JOB NO. 34967

SHEET NO. ----

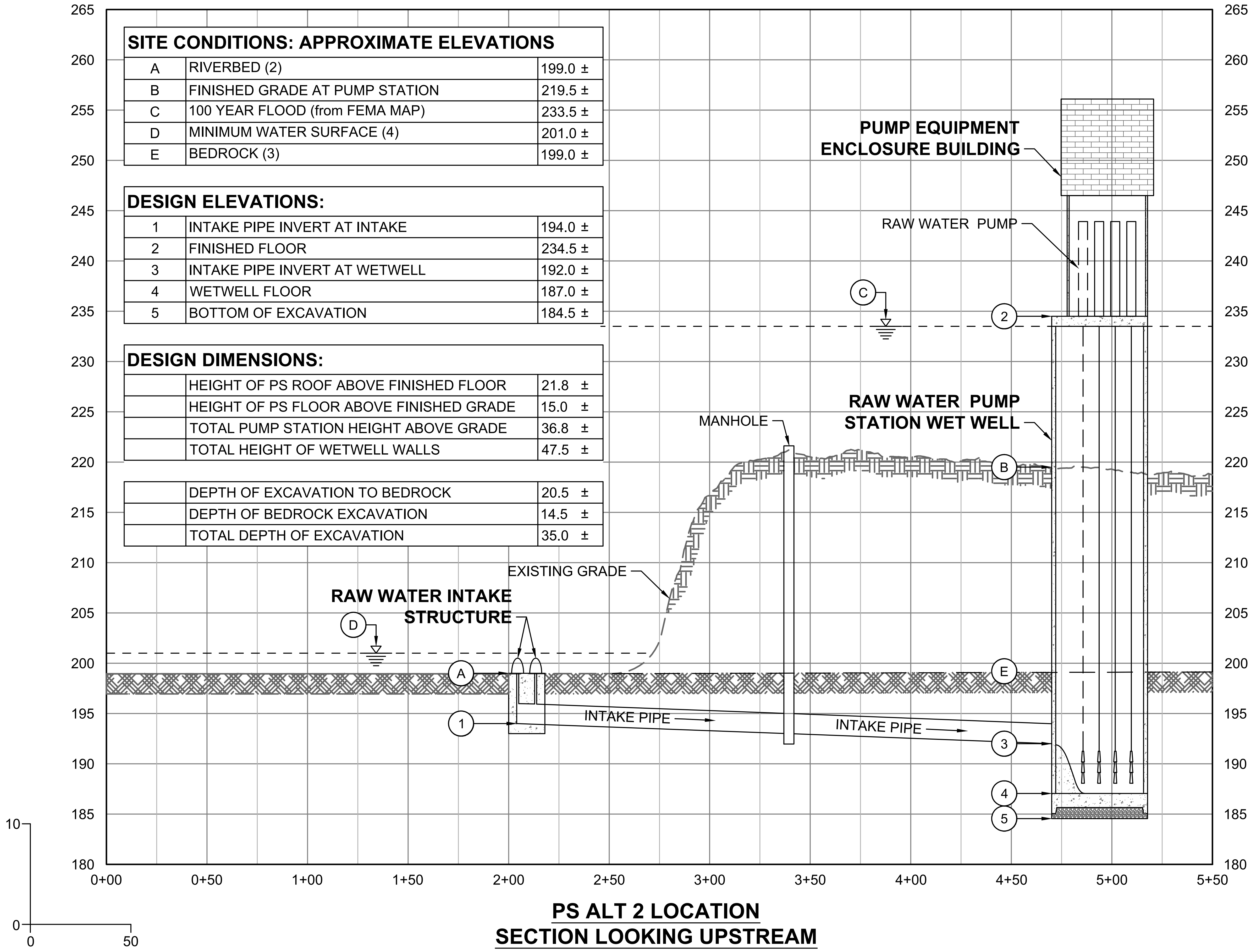
PS ALT 2

SITE CONDITIONS: APPROXIMATE ELEVATIONS		
A	RIVERBED (2)	199.0 ±
B	FINISHED GRADE AT PUMP STATION	219.5 ±
C	100 YEAR FLOOD (from FEMA MAP)	233.5 ±
D	MINIMUM WATER SURFACE (4)	201.0 ±
E	BEDROCK (3)	199.0 ±

DESIGN ELEVATIONS:		
1	INTAKE PIPE INVERT AT INTAKE	194.0 ±
2	FINISHED FLOOR	234.5 ±
3	INTAKE PIPE INVERT AT WETWELL	192.0 ±
4	WETWELL FLOOR	187.0 ±
5	BOTTOM OF EXCAVATION	184.5 ±

DESIGN DIMENSIONS:		
	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	15.0 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	36.8 ±
	TOTAL HEIGHT OF WETWELL WALLS	47.5 ±

	DEPTH OF EXCAVATION TO BEDROCK	20.5 ±
	DEPTH OF BEDROCK EXCAVATION	14.5 ±
	TOTAL DEPTH OF EXCAVATION	35.0 ±



PS ALT 2 LOCATION
SECTION LOOKING UPSTREAM

NOTES:

(1) PROFILE ELEVATION DATA IS BASED ON AVAILABLE FLUVANNA COUNTY LIDAR DATA DATED 2015. DETAILED FIELD OBTAINED ELEVATION DATA MAY DIFFER FROM THOSE INDICATED ON THIS EXHIBIT.

(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON DATA INDICATED ON VDOT BRIDGE GEOTECHNICAL REPORTS FOR THE ROUTE 15 BRIDGE AT BREMO BLUFF.

(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS ASSUMED TO BE SAME AS RIVER BOTTOM.

(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

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JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
PS ALT 2 - RIVER SECTION

JOB NO. 34967

SHEET NO. ----

PS ALT 3

SITE CONDITIONS: APPROXIMATE ELEVATIONS

A	RIVERBED (2)	170.6 ±
B	FINISHED GRADE AT PUMP STATION	199.0 ±
C	100 YEAR FLOOD (from FEMA MAP)	213.0 ±
D	MINIMUM WATER SURFACE (4)	172.6 ±
E	BEDROCK (3)	170.6 ±

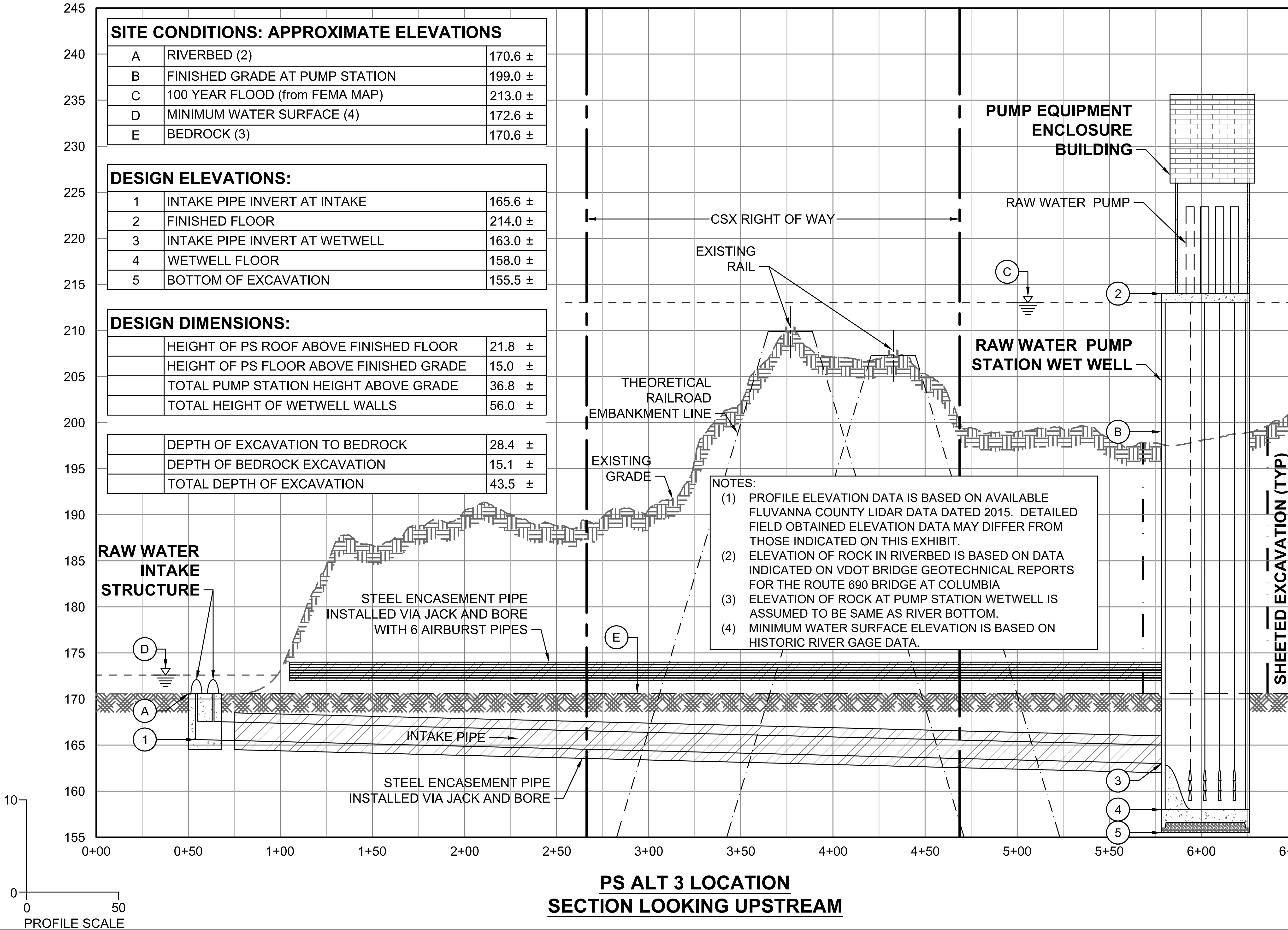
DESIGN ELEVATIONS:

1	INTAKE PIPE INVERT AT INTAKE	165.6 ±
2	FINISHED FLOOR	214.0 ±
3	INTAKE PIPE INVERT AT WETWELL	163.0 ±
4	WETWELL FLOOR	158.0 ±
5	BOTTOM OF EXCAVATION	155.5 ±

DESIGN DIMENSIONS:

	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	15.0 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	36.8 ±
	TOTAL HEIGHT OF WETWELL WALLS	56.0 ±

	DEPTH OF EXCAVATION TO BEDROCK	28.4 ±
	DEPTH OF BEDROCK EXCAVATION	15.1 ±
	TOTAL DEPTH OF EXCAVATION	43.5 ±



NOTES:

(1) PROFILE ELEVATION DATA IS BASED ON AVAILABLE FLUVANNA COUNTY LIDAR DATA DATED 2015. DETAILED FIELD OBTAINED ELEVATION DATA MAY DIFFER FROM THOSE INDICATED ON THIS EXHIBIT.

(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON DATA INDICATED ON VDOT BRIDGE GEOTECHNICAL REPORTS FOR THE ROUTE 690 BRIDGE AT COLUMBIA

(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS ASSUMED TO BE SAME AS RIVER BOTTOM.

(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

PS ALT 3 LOCATION
SECTION LOOKING UPSTREAM

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V: 1" = 10'

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FLUVANNA COUNTY, VIRGINIA
PS ALT 3 - RIVER SECTION

JOB NO.
34967

SHEET NO.

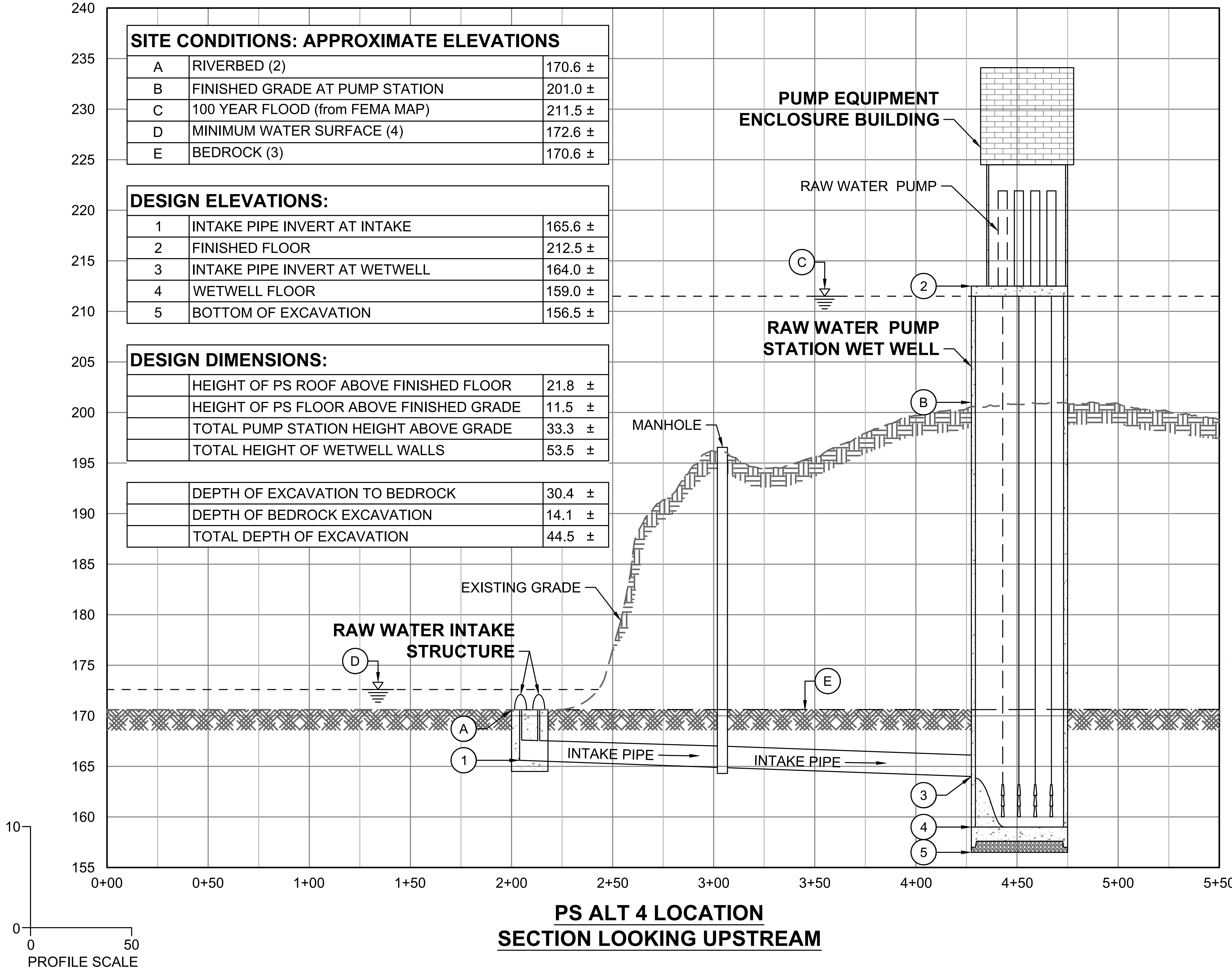
PS ALT 4

SITE CONDITIONS: APPROXIMATE ELEVATIONS		
A	RIVERBED (2)	170.6 ±
B	FINISHED GRADE AT PUMP STATION	201.0 ±
C	100 YEAR FLOOD (from FEMA MAP)	211.5 ±
D	MINIMUM WATER SURFACE (4)	172.6 ±
E	BEDROCK (3)	170.6 ±

DESIGN ELEVATIONS:		
1	INTAKE PIPE INVERT AT INTAKE	165.6 ±
2	FINISHED FLOOR	212.5 ±
3	INTAKE PIPE INVERT AT WETWELL	164.0 ±
4	WETWELL FLOOR	159.0 ±
5	BOTTOM OF EXCAVATION	156.5 ±

DESIGN DIMENSIONS:		
	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	11.5 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	33.3 ±
	TOTAL HEIGHT OF WETWELL WALLS	53.5 ±

	DEPTH OF EXCAVATION TO BEDROCK	30.4 ±
	DEPTH OF BEDROCK EXCAVATION	14.1 ±
	TOTAL DEPTH OF EXCAVATION	44.5 ±



PS ALT 4 LOCATION
SECTION LOOKING UPSTREAM

NOTES:
(1) PROFILE ELEVATION DATA IS BASED ON AVAILABLE GOOCHLAND COUNTY LIDAR DATA DATED 2015. DETAILED FIELD OBTAINED ELEVATION DATA MAY DIFFER FROM THOSE INDICATED ON THIS EXHIBIT.
(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON DATA INDICATED ON VDOT BRIDGE GEOTECHNICAL REPORTS FOR THE ROUTE 690 BRIDGE AT COLUMBIA
(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS ASSUMED TO BE SAME AS RIVER BOTTOM.
(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

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V: 1" = 10'

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
PS ALT 4 - RIVER SECTION

JOB NO.
34967
SHEET NO.

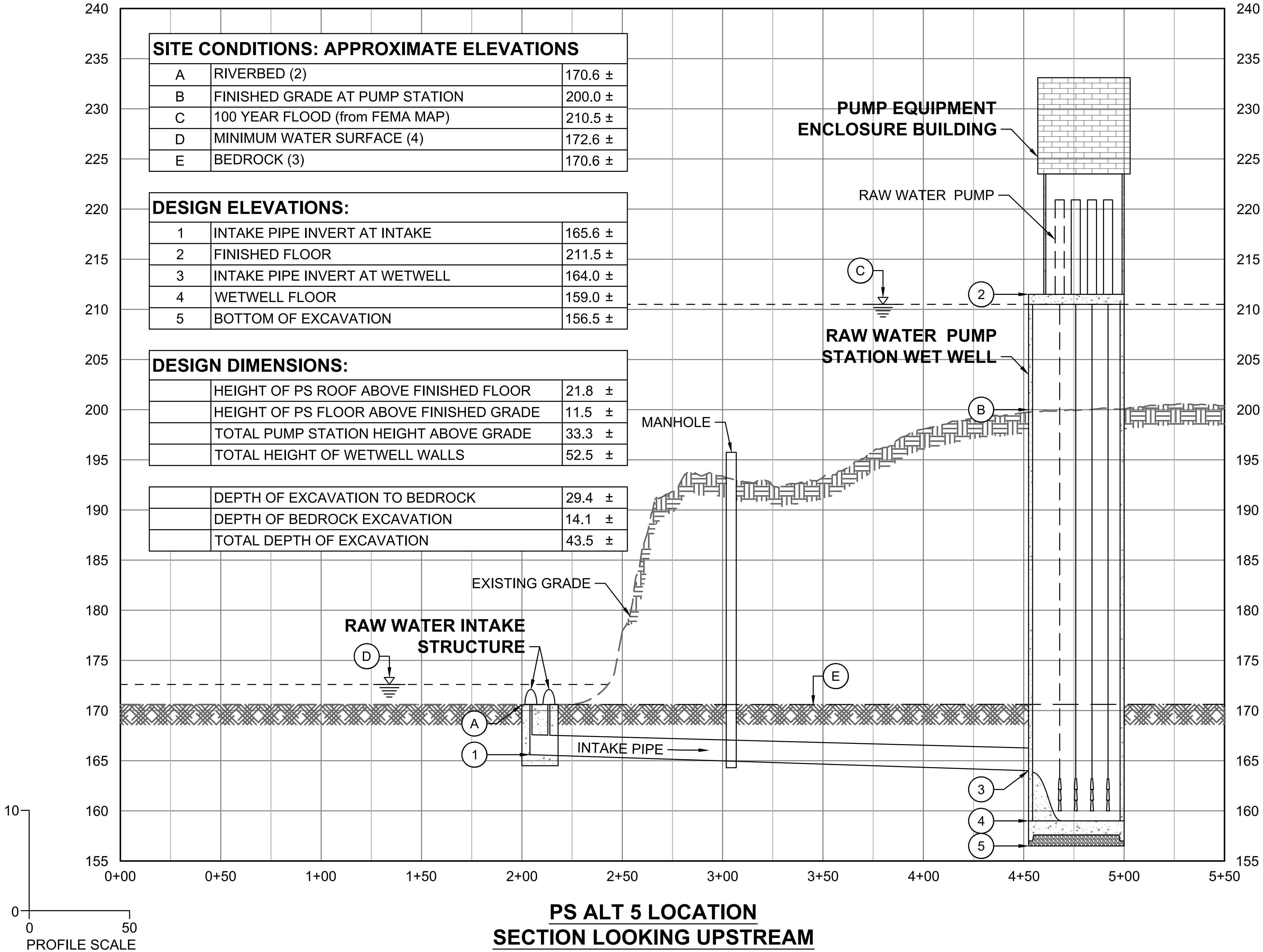
PS ALT 5

SITE CONDITIONS: APPROXIMATE ELEVATIONS		
A	RIVERBED (2)	170.6 ±
B	FINISHED GRADE AT PUMP STATION	200.0 ±
C	100 YEAR FLOOD (from FEMA MAP)	210.5 ±
D	MINIMUM WATER SURFACE (4)	172.6 ±
E	BEDROCK (3)	170.6 ±

DESIGN ELEVATIONS:		
1	INTAKE PIPE INVERT AT INTAKE	165.6 ±
2	FINISHED FLOOR	211.5 ±
3	INTAKE PIPE INVERT AT WETWELL	164.0 ±
4	WETWELL FLOOR	159.0 ±
5	BOTTOM OF EXCAVATION	156.5 ±

DESIGN DIMENSIONS:		
	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	11.5 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	33.3 ±
	TOTAL HEIGHT OF WETWELL WALLS	52.5 ±

	DEPTH OF EXCAVATION TO BEDROCK	29.4 ±
	DEPTH OF BEDROCK EXCAVATION	14.1 ±
	TOTAL DEPTH OF EXCAVATION	43.5 ±



PS ALT 5 LOCATION
SECTION LOOKING UPSTREAM

NOTES:
(1) PROFILE ELEVATION DATA IS BASED ON AVAILABLE GOOCHLAND COUNTY LIDAR DATA DATED 2015. DETAILED FIELD OBTAINED ELEVATION DATA MAY DIFFER FROM THOSE INDICATED ON THIS EXHIBIT.
(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON DATA INDICATED ON VDOT BRIDGE GEOTECHNICAL REPORTS FOR THE ROUTE 690 BRIDGE AT COLUMBIA
(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS ASSUMED TO BE SAME AS RIVER BOTTOM.
(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

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1001 Boulders Parkway, Suite 300 | Richmond, VA 23225
TEL 804.200.6500 FAX 804.560.1016 www.timmons.com

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TIMMONS GROUP

REVISION DESCRIPTION | DATE

DATE | DRAWN BY | DESIGNED BY | CHECKED BY | SCALE H: 1" = 50' V: 1" = 10'

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
PS ALT 5 - RIVER SECTION

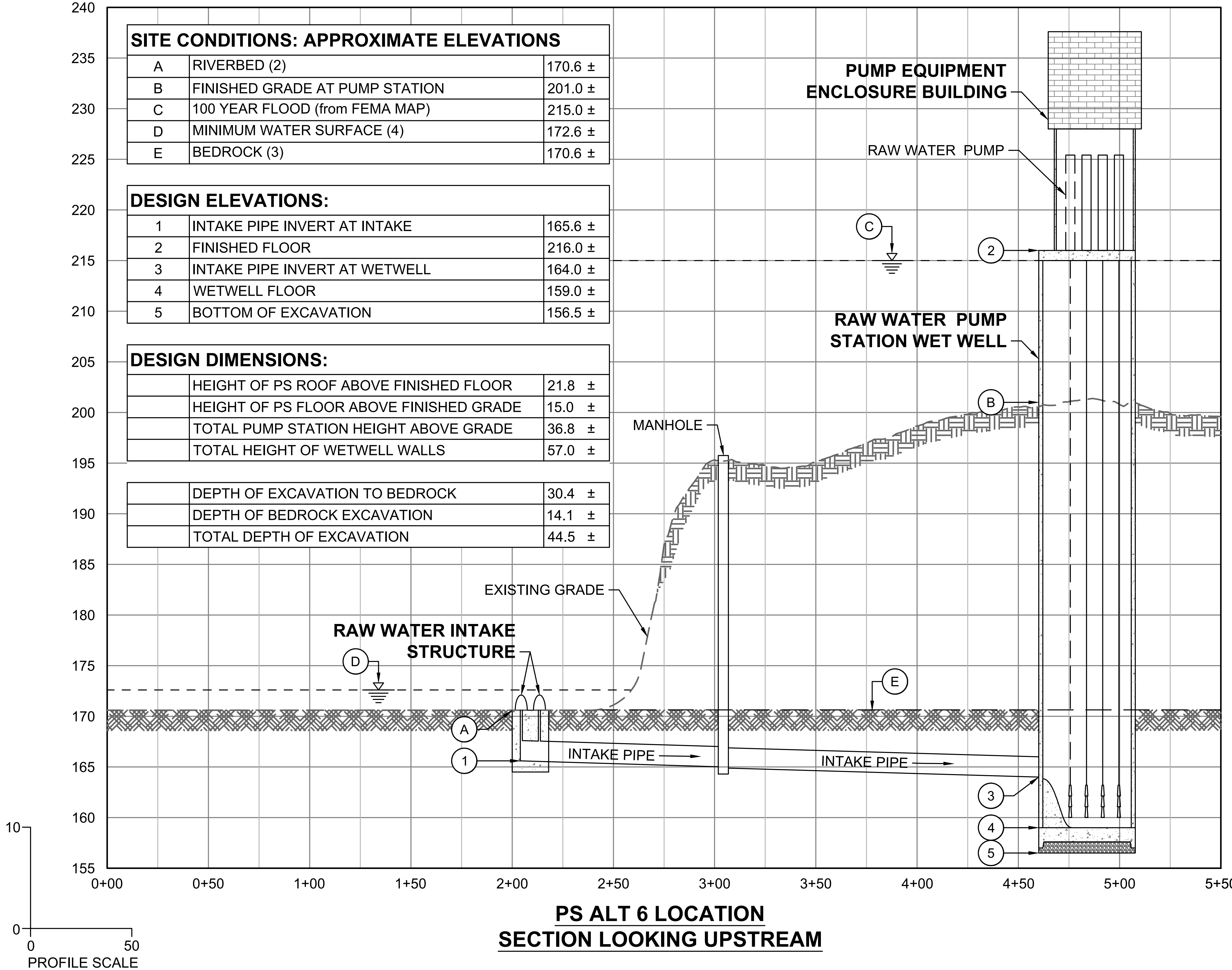
JOB NO. 34967
SHEET NO. ----

PS ALT 6

SITE CONDITIONS: APPROXIMATE ELEVATIONS		
A	RIVERBED (2)	170.6 ±
B	FINISHED GRADE AT PUMP STATION	201.0 ±
C	100 YEAR FLOOD (from FEMA MAP)	215.0 ±
D	MINIMUM WATER SURFACE (4)	172.6 ±
E	BEDROCK (3)	170.6 ±

DESIGN ELEVATIONS:		
1	INTAKE PIPE INVERT AT INTAKE	165.6 ±
2	FINISHED FLOOR	216.0 ±
3	INTAKE PIPE INVERT AT WETWELL	164.0 ±
4	WETWELL FLOOR	159.0 ±
5	BOTTOM OF EXCAVATION	156.5 ±

DESIGN DIMENSIONS:		
	HEIGHT OF PS ROOF ABOVE FINISHED FLOOR	21.8 ±
	HEIGHT OF PS FLOOR ABOVE FINISHED GRADE	15.0 ±
	TOTAL PUMP STATION HEIGHT ABOVE GRADE	36.8 ±
	TOTAL HEIGHT OF WETWELL WALLS	57.0 ±
	DEPTH OF EXCAVATION TO BEDROCK	30.4 ±
	DEPTH OF BEDROCK EXCAVATION	14.1 ±
	TOTAL DEPTH OF EXCAVATION	44.5 ±



PS ALT 6 LOCATION
SECTION LOOKING UPSTREAM

NOTES:

(1) PROFILE ELEVATION DATA IS BASED ON FIELD RUN TOPOGRAPHIC SURVEY DATA DATED MARCH, 2015.

(2) ELEVATION OF ROCK IN RIVERBED IS BASED ON DATA OBTAINED DURING GEOTECHNICAL INVESTIGATIONS AND BATHOMETRIC SURVEYS AT THIS SITE.

(3) ELEVATION OF ROCK AT PUMP STATION WETWELL IS BASED ON DATA OBTAINED DURING GEOTECHNICAL INVESTIGATIONS AT THIS SITE.

(4) MINIMUM WATER SURFACE ELEVATION IS BASED ON HISTORIC RIVER GAGE DATA.

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DRAWN BY
DESIGNED BY
CHECKED BY
SCALE
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V: 1" = 10'

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
PS ALT 6 - RIVER SECTION

JOB NO.
34967
SHEET NO.

APPENDIX H-3

MEMORANDUM REGARDING MEETING WITH MATHEW W. REYNOLDS, VDOT STATE UTILITIES & PROPERTY MANAGER RIGHT OF WAY & UTILITIES DIVISION

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MEMORANDUM

TO: Project File – James River Water Authority

FROM: David J. Saunders, PE

DATE: December 19, 2019

RE: Meeting December 18, 2019 with Mathew W. Reynolds, VDOT State Utilities & Property Manager Right of Way & Utilities Division

On December 18, David Saunders of Timmons Group and Greg Krystyniak of Faulconer Construction met with Mathew Reynolds of VDOT to discuss design considerations for analyzing pipe routing alternatives for the James River Water Authority project in Fluvanna County.

The following items were discussed:

1. It was explained the JRWA proposes to construct water supply facilities in Fluvanna County that include the construction of a raw water pipeline between the raw water pump station and a connection point at Route 6 to Louisa County facilities.

2. The JRWA is analyzing numerous potential pump station site alternatives. Each alternative has one or more potential pipeline routes, some of which would follow or cross existing VDOT routes to include: Route 6, Route 656 Bremo Road, Route 624 Point of Fork Road.

3. A review of the attached map exhibit indicating potential pipeline construction corridors and photographs indicating site constraints such as visible rock slopes at edge of roads, proximity of buildings to edge of road in Bremo Bluff and Columbia, and adjacent environmental features.

4. It was explained that the least impactful pipeline route is for the site as currently proposed on property formerly owned by Hammond near the Point of Fork. This route will only require a routine jack & bore crossing of Route 6, thus resulting in minimal to no disruption of traffic, and minimizes concerns to public safety during construction and future maintenance of the pipeline. This crossing at Route 6 has already been permitted by VDOT.

5. Discussion of VDOT policy regarding potential pipeline routing alternatives fell into four main categories as follows:

   a. Construction adjacent to but not in VDOT Right of Way (R/W).

   b. Construction inside VDOT R/W but outside of vehicular travel lanes.

c. Construction inside VDOT R/W and inside vehicular travel lanes.

d. A variation of b and c where VDOT facilities are located within prescriptive R/W.

6. In the case of construction adjacent to but not in VDOT R/W; VDOT would limit their involvement to typical Maintenance of Traffic (MOT) coordination for construction vehicles entering and exiting R/W during construction. Otherwise local County land disturbance permits would be required.

7. In the case of construction inside of VDOT R/W but outside of vehicular travel lanes; in addition to the above, VDOT would be involved in the review of construction documents (drawings, MOT plans, details and specifications) for compliance with VDOT design criteria. Upon final approval of the construction documents, VDOT would issue a Land Use Permit for the project.

8. In the case of construction inside of VDOT R/W but inside vehicular travel lanes; VDOT would require the same level of permitting as above. However, VDOT will only allow the placement of utilities within a vehicular travel lane when it is demonstrated that there is no other practicable alternative. Mr. Reynolds did agree that placing the pipeline in the travel lanes at Bremo Bluff and Columbia met the threshold of no other practicable alternative.

9. In the case of VDOT facilities located within prescriptive R/W; VDOT would require the same level of permitting as if they owned the R/W.

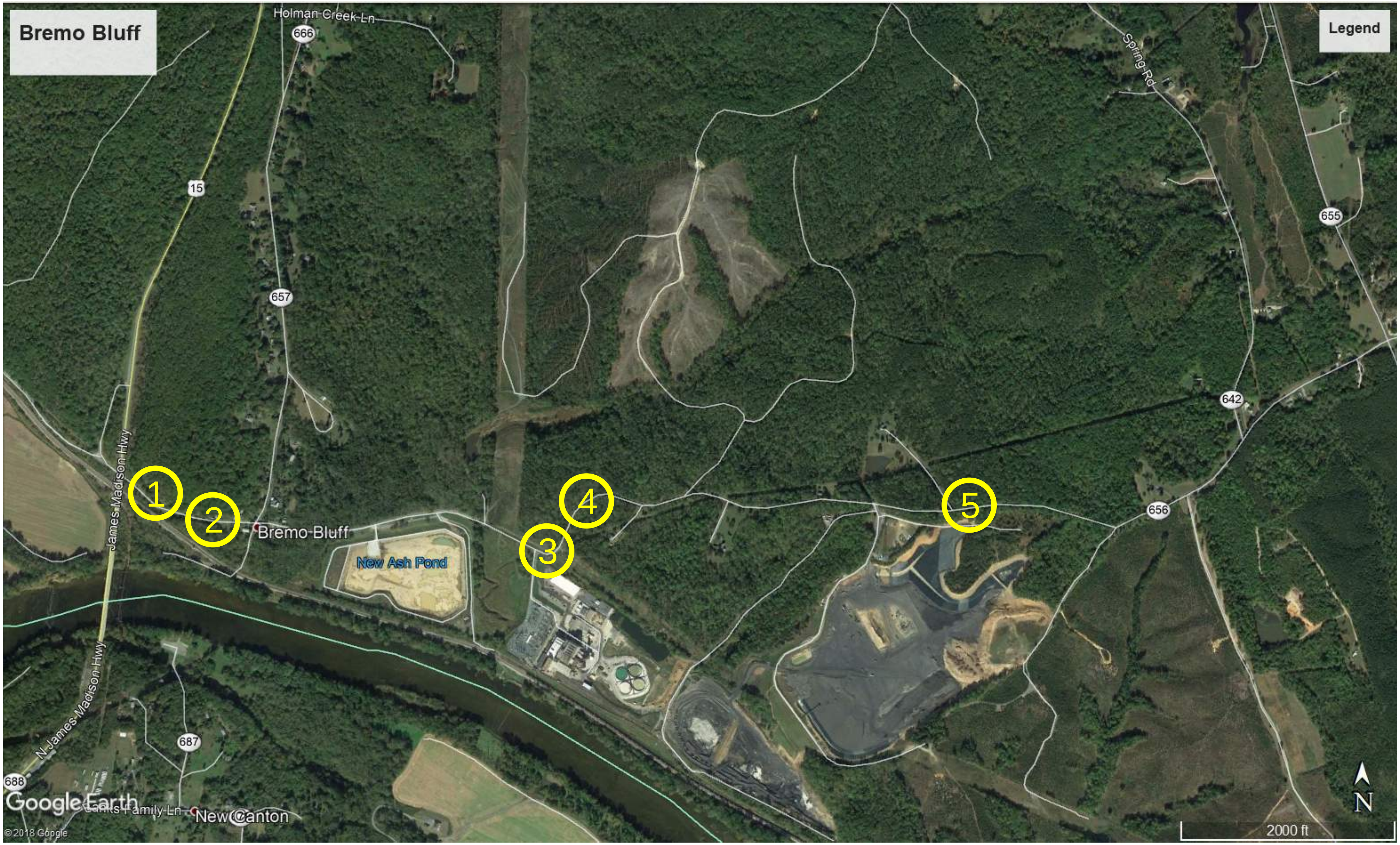
10. It was confirmed that depth of cover required over pipelines is 36 inches.

11. It was confirmed that construction within vehicular travel lanes and shoulder requires trenches to be backfilled with VDOT densely graded aggregate such as 21A stone.

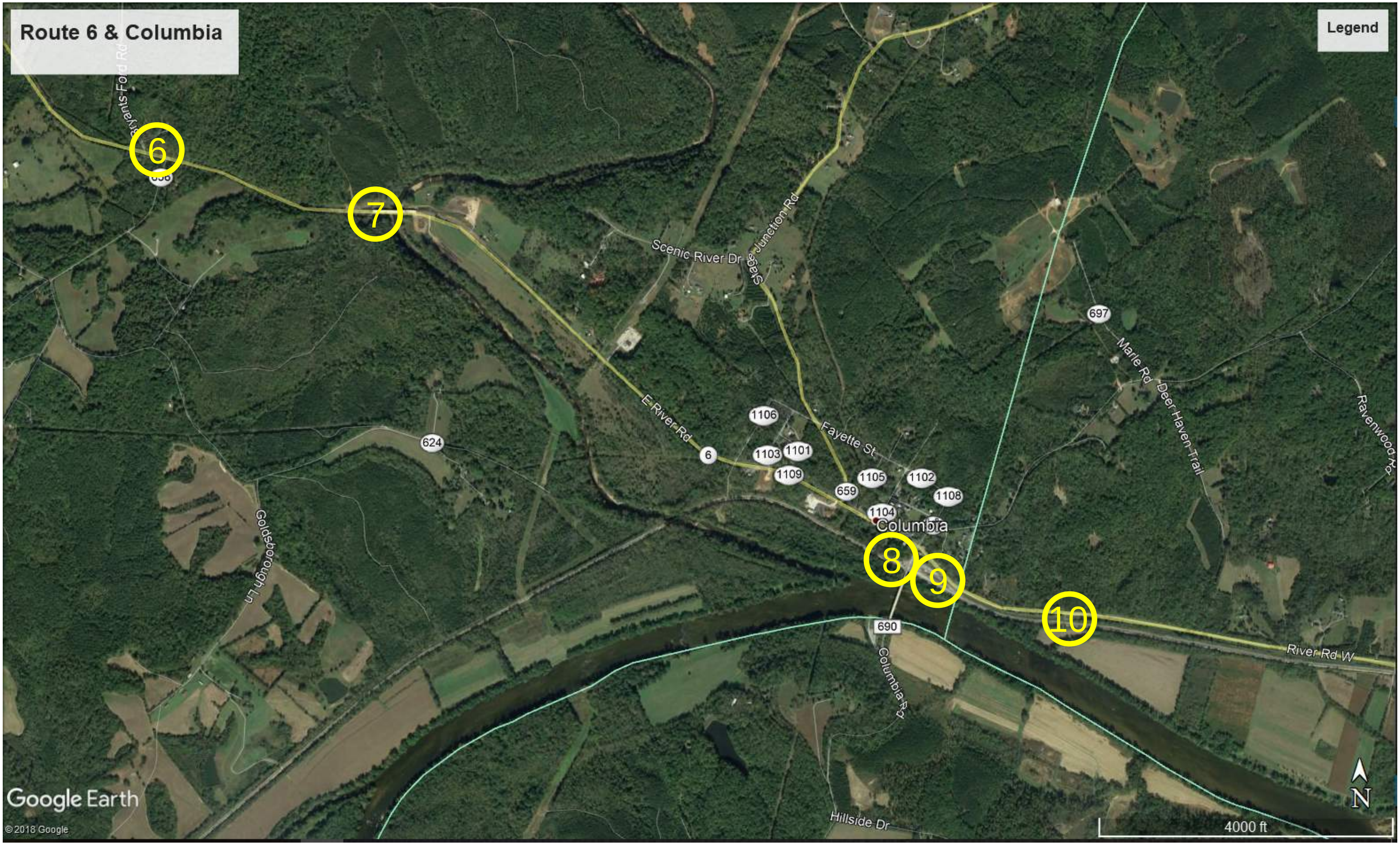
12. It was confirmed that in locations of guardrail, placement of pipelines is required to be outside the zone of influence for guardrail posts to avoid compromise to guardrail integrity and potential damage to pipeline if the rail is struck by a vehicle.

In summary, Mr. Reynolds was receptive to placement of pipelines within or adjacent to VDOT R/W provided that proper design considerations and approval protocols are adhered to.

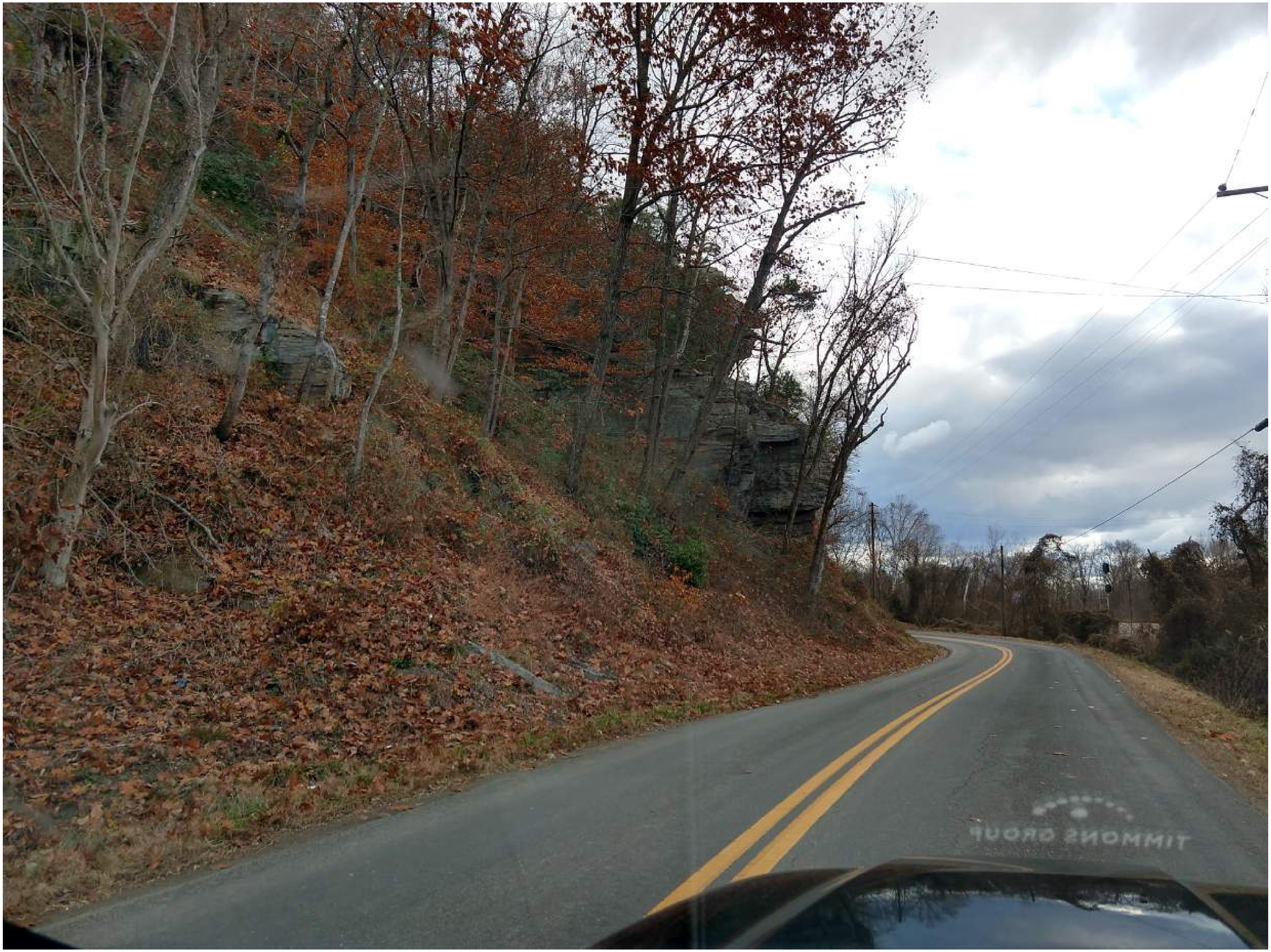
Attachments: Map exhibit and photos of existing site conditions.



Bremo Bluff and Route 656



Route 6 and Town of Columbia



PHOTOGRAPH #1

PHOTOGRAPH #2

PHOTOGRAPH #3

PHOTOGRAPH #4

PHOTOGRAPH #5

PHOTOGRAPH #6

PHOTOGRAPH #7

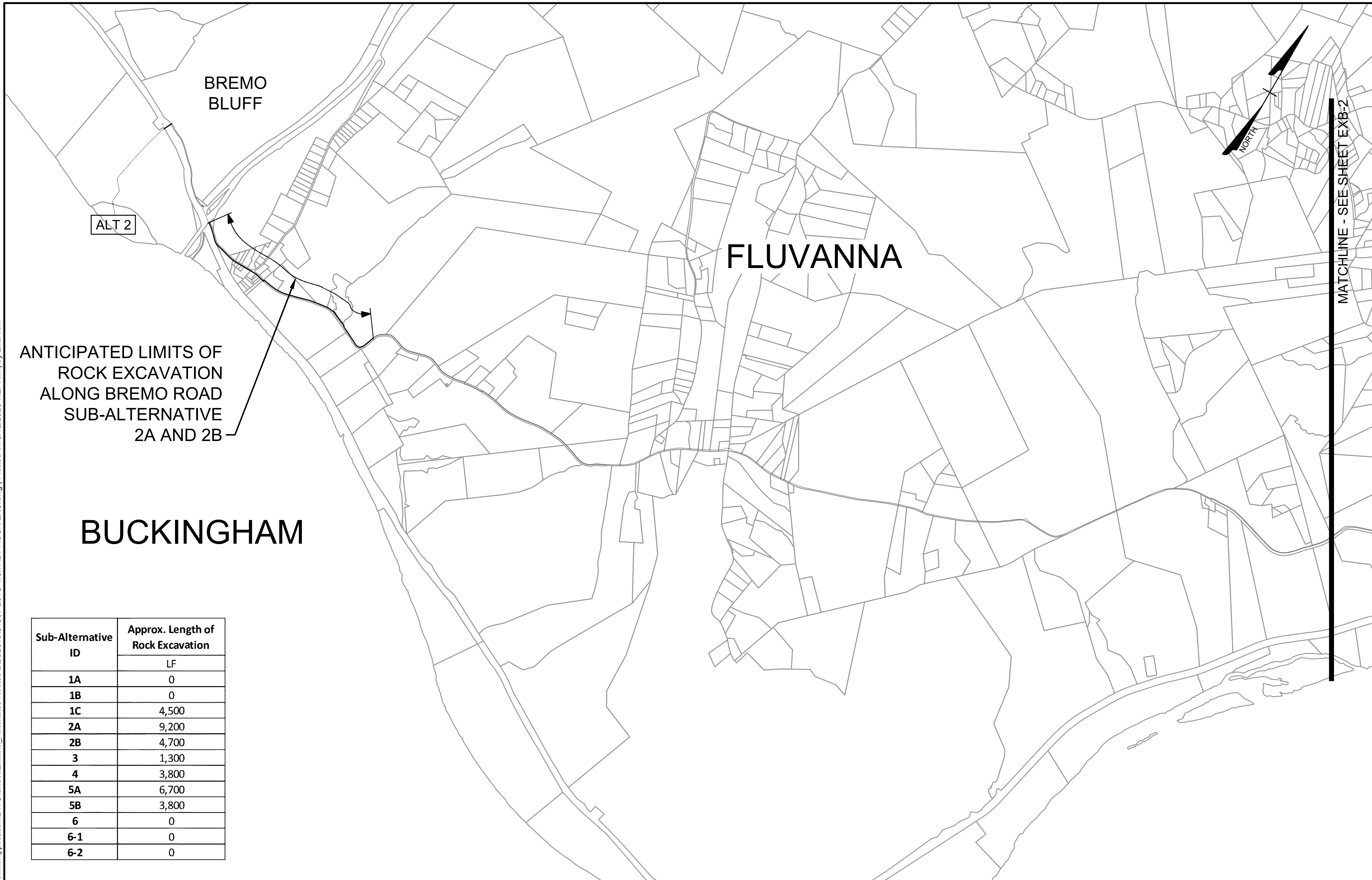
PHOTOGRAPH #8

PHOTOGRAPH #9

PHOTOGRAPH #10

APPENDIX H-4

ALTERNATIVE WATER MAIN ROCK EXCAVATION EXHIBIT



Sub-Alternative ID	Approx. Length of Rock Excavation
	LF
1A	0
1B	0
1C	4,500
2A	9,200
2B	4,700
3	1,300
4	3,800
5A	6,700
5B	3,800
6	0
6-1	0
6-2	0

JAMES RIVER WATER AUTHORITY ALTERNATIVE WATER MAIN ROCK EXCAVATION

L:\2019\34967 - JRWA Joint Permit Application\DWG\Sheet\Exhibit_Alternates Routes DEC2019\34967-201C-1.0x-ALT-ROCK-EXC.dwg | Plotted on 3/12/2020 7:27 AM | by Lina Kim

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				1"= 5,000'

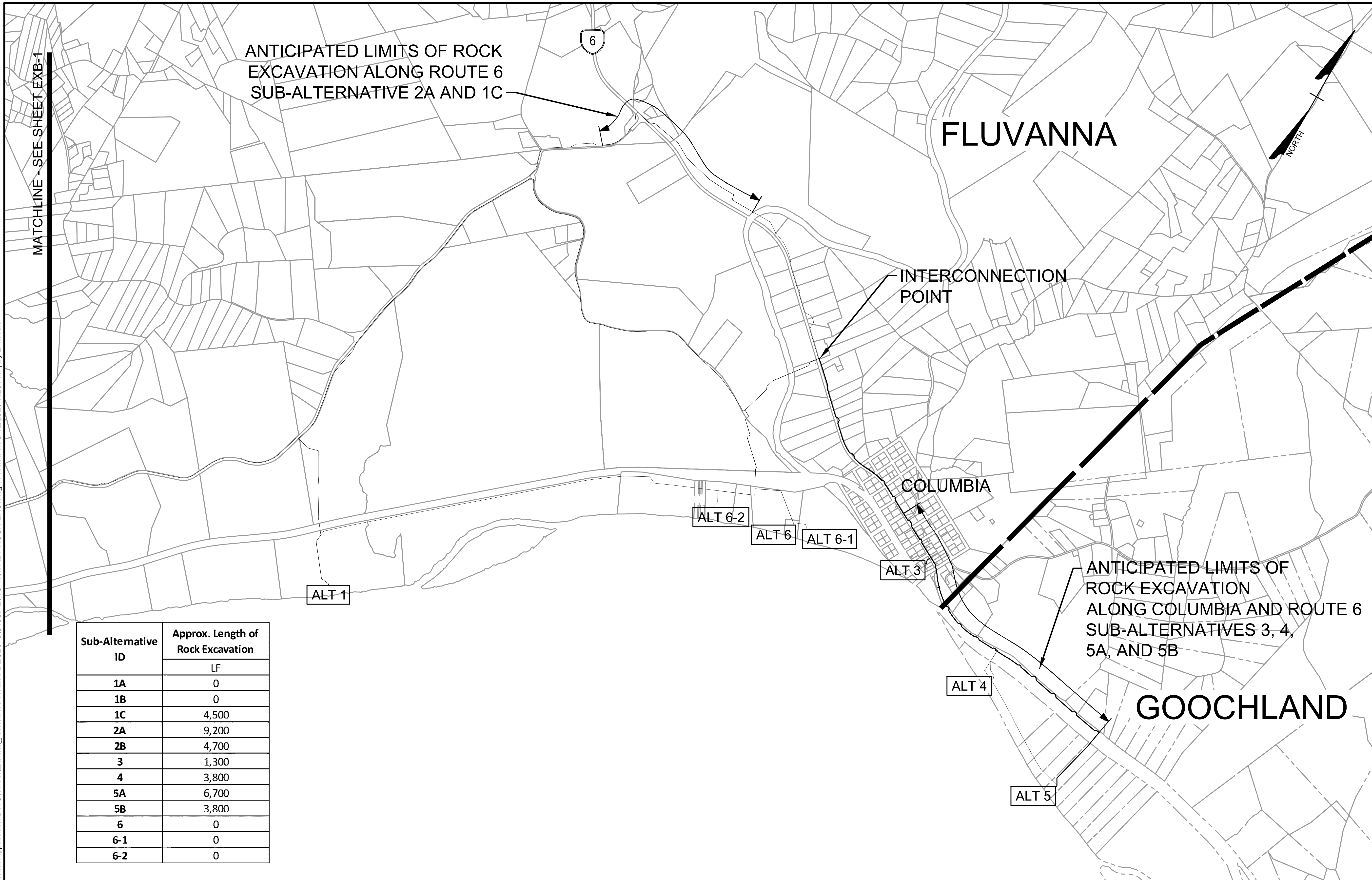
JAMES RIVER WATER AUTHORITY PROJECT

FORK UNION DISTRICT, FLUVANNA COUNTY, VIRGINIA

ALTERNATIVE WATER MAIN ROCK EXCAVATION

JOB NO. *33927*

SHEET NO. *EXB-1*



Sub-Alternative ID	Approx. Length of Rock Excavation
	LF
1A	0
1B	0
1C	4,500
2A	9,200
2B	4,700
3	1,300
4	3,800
5A	6,700
5B	3,800
6	0
6-1	0
6-2	0

JAMES RIVER WATER AUTHORITY ALTERNATIVE WATER MAIN ROCK EXCAVATION

L:\2019\34967 - JRWA Joint Permit Application\DWG\Sheet\Exhibit_Alternates Routes DEC2019\34967-201C-1.0x-ALT-ROCK-EXC.dwg | Plotted on 3/12/2020 7:26 AM | by Lina Kim

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DATE

DATE

DRAWN BY

DESIGNED BY

CHECKED BY

SCALE
1"= 5,000'

JAMES RIVER WATER AUTHORITY PROJECT
FORK UNION DISTRICT, FLUVANNA COUNTY, VIRGINIA
ALTERNATIVE WATER MAIN ROCK EXCAVATION

JOB NO.
33927

SHEET NO.
EXB-2

APPENDIX H-5
CSX CROSSINGS AND DOCUMENTS

APPENDIX H-5-1
FACILITY ENCROACHMENT AGREEMENT

ROPERTY

ies Services
outhpoint Drive South
ville, FL 32216

Presort
First Class Mail
ComBasPrice

U.S. POSTAGE PITNEY BOWES
ZIP 32202 $ 001.40⁰
02 4W
0000338249 SEP 20 2017

Mr. James C. Carter
Timmons Group
1001 Boulders Parkway
Richmond, VA 23225

4 HMFYNB3 23225

FACILITY ENCROACHMENT AGREEMENT

THIS AGREEMENT, made and effective as of August 4, 2017, by and between CSX TRANSPORTATION, INC., a Virginia corporation, whose mailing address is 500 Water Street, Jacksonville, Florida 32202, hereinafter called "Licensor," and JAMES RIVER WATER AUTHORITY, a municipal corporation, political subdivision or state agency, under the laws of the Commonwealth of Virginia, whose mailing address is 132 Main Street, Virginia 22963, hereinafter called "Licensee," WITNESSETH:

WHEREAS, Licensee desires to construct (unless previously constructed and designated as existing herein), use and maintain the below described facility(ies), hereinafter called "Facilities," over, under or across property owned or controlled by Licensor, at the below described location(s):

1. One (1) twenty-four inch (24") diameter sub-grade pipeline crossing, solely for the conveyance of reclaimed/non-potable water, located at or near Columbia, Fluvanna County, Virginia, Florence Division, Rivanna Subdivision, Milepost CAB-57.39, Latitude N37:45:05., Longitude W78:10:31.;

hereinafter, called the "Encroachment," as shown on print(s) labeled Exhibit "A," attached hereto and made a part hereof;

NOW, THEREFORE, in consideration of the mutual covenants, conditions, terms and agreements herein contained, the parties hereto agree and covenant as follows:

1. LICENSE:

1.1 Subject to Article 17, Licensor, insofar as it has the legal right, power and authority to do so, and its present title permits, and subject to:

(A) Licensor's present and future right to occupy, possess and use its property within the area of the Encroachment for any and all purposes;

(B) All encumbrances, conditions, covenants, easements, and limitations applicable to Licensor's title to or rights in the subject property; and

(C) Compliance by Licensee with the terms and conditions herein contained;

does hereby license and permit Licensee to construct, maintain, repair, renew, operate, use, alter or change the Facilities at the Encroachment above for the term herein stated, and to remove same upon termination.

1.2 The term Facilities, as used herein, shall include only those structures and ancillary facilities devoted exclusively to the transmission usage above within the Encroachment, and as shown on attached Exhibit A.

1.3 No additional structures or other facilities shall be placed, allowed, or maintained by Licensee in, upon or on the Encroachment except upon prior separate written consent of Licensor.

2. ENCROACHMENT FEE; TERM:

2.1 Licensee shall pay Licensor a one-time nonrefundable Encroachment Fee of FIVE THOUSAND ONE HUNDRED AND 00/100 U.S. DOLLARS ($5,100.00) upon execution of this Agreement. Licensee agrees that the Encroachment Fee applies only to the original Licensee under this Agreement. In the event of a successor (by merger, consolidation, reorganization and/or assignment) or if the original Licensee changes its name, then Licensee shall be subject to payment of Licensor's current administrative and document preparation fees for the cost incurred by Licensor in preparing and maintaining this Agreement on a current basis.

2.2 However, Licensee assumes sole responsibility for, and shall pay directly (or reimburse Licensor), any additional annual taxes and/or periodic assessments levied against Licensor or Licensor's property solely on account of said Facilities or Encroachment.

2.3 This Agreement shall terminate as herein provided, but shall also terminate upon: (a) Licensee's cessation of use of the Facilities or Encroachment for the purpose(s) above; (b) removal of the Facilities; (c) subsequent mutual consent; and/or (d) failure of Licensee to complete installation within five (5) years from the effective date of this Agreement.

2.4 In further consideration for the license or right hereby granted, Licensee hereby agrees that Licensor shall not be charged or assessed, directly or indirectly, with any part of the cost of the installation of said Facilities and appurtenances, and/or maintenance thereof, or for any public works project of which said Facilities is a part.

3. CONSTRUCTION, MAINTENANCE AND REPAIRS:

3.1 Licensee shall construct, maintain, relocate, repair, renew, alter, and/or remove the Facilities, in a prudent, workmanlike manner, using quality materials and complying with any applicable standard(s) or regulation(s) of Licensor (CSXT Specifications), or Licensee's particular industry, National Electrical Safety Code, or any governmental or regulatory body having jurisdiction over the Encroachment.

3.2 Location and construction of Facilities shall be made strictly in accordance with design(s) and specifications furnished to and approved by Licensor and of material(s) and size(s) appropriate for the purpose(s) above recited.

3.3 All of Licensee's work, and exercise of rights hereunder, shall be undertaken at time(s) satisfactory to Licensor, and so as to eliminate or minimize any impact on or interference with the safe use and operation of Licensor's property and appurtenances thereto.

3.4 In the installation, maintenance, repair and/or removal of said Facilities, Licensee shall not use explosives of any type or perform or cause any blasting without the separate express written consent of Licensor. As a condition to such consent, a representative will be assigned by Licensor to monitor blasting, and Licensee shall reimburse Licensor for the entire cost and/or expense of furnishing said monitor.

3.5 Any repairs or maintenance to the Facilities, whether resulting from acts of Licensee, or natural or weather events, which are necessary to protect or facilitate Licensor's use of its property, shall be made by Licensee promptly, but in no event later than thirty (30) days after Licensee has notice as to the need for such repairs or maintenance.

3.6 Licensor, in order to protect or safeguard its property, rail operations, equipment and/or employees from damage or injury, may request immediate repair or renewal of the Facilities, and if the same is not performed, may make or contract to make such repairs or renewals, at the sole risk, cost and expense of Licensee.

3.7 Neither the failure of Licensor to object to any work done, material used, or method of construction or maintenance of said Encroachment, nor any approval given or supervision exercised by Licensor, shall be construed as an admission of liability or responsibility by Licensor, or as a waiver by Licensor of any of the obligations, liability and/or responsibility of Licensee under this Agreement.

3.8 All work on the Encroachment shall be conducted in accordance with Licensor's safety rules and regulations.

3.9 Licensee hereby agrees to reimburse Licensor any loss, cost or expense (including losses resulting from train delays and/or inability to meet train schedules) arising from any failure of Licensee to make repairs or conduct maintenance as required by Section 3.5 above or from improper or incomplete repairs or maintenance to the Facilities or Encroachment.

3.10 In the event it becomes necessary for the Licensee to deviate from the approved Exhibit, Licensee shall seek prior approval from CSXT, or when applicable, an official field representative of CSXT permitted to approve changes, authorizing the necessary field changes and Licensee shall provide CSXT with complete As-Built Drawings of the completed work. As-Built Drawings shall be submitted to Licensor in either electronic or hard copy form upon the substantial completion of the project and upon Licensor's request.

4. PERMITS, LICENSES:

4.1 Before any work hereunder is performed, or before use of the Encroachment for the contracted purpose, Licensee, at its sole cost and expense, shall obtain all necessary permit(s) (including but not limited to zoning, building, construction, health, safety or environmental matters), letter(s) or certificate(s) of approval. Licensee expressly agrees and warrants that it shall conform and limit its activities to the terms of such permit(s), approval(s) and authorization(s), and shall comply with all applicable ordinances, rules, regulations, requirements and laws of any governmental authority (State, Federal or Local) having jurisdiction over Licensee's activities, including the location, contact, excavation and protection regulations of the Occupational Safety and Health Act (OSHA) (29 CFR 1926.651(b)), et al., and State "One Call" - "Call Before You Dig" requirements.

4.2 Licensee assumes sole responsibility for failure to obtain such permit(s) or approval(s), for any violations thereof, or for costs or expenses of compliance or remedy.

5. MARKING AND SUPPORT:

5.1 With respect to any subsurface installation or maintenance upon Licensor's property, Licensee, at its sole cost and expense, shall:

(A) support track(s) and roadbed in a manner satisfactory to Licensor;

(B) backfill with satisfactory material and thoroughly tamp all trenches to prevent settling of surface of land and roadbed of Licensor; and

(C) either remove any surplus earth or material from Licensor's property or cause said surplus earth or material to be placed and distributed at location(s) and in such manner Licensor may approve.

5.2 After construction or maintenance of the Facilities, Licensee shall:

(A) Restore any track(s), roadbed and other disturbed property; and

(B) Erect, maintain and periodically verify the accuracy of aboveground markers, in a form approved by Licensor, indicating the location, depth and ownership of any underground Facilities or related facilities.

5.3 Licensee shall be solely responsible for any subsidence or failure of lateral or subjacent support in the Encroachment area for a period of three (3) years after completion of installation.

6. TRACK CHANGES:

6.1 In the event that rail operations and/or track maintenance result in changes in grade or alignment of, additions to, or relocation of track(s) or other facilities, or in the event future use of Licensor's rail corridor or property necessitate any change of location, height or depth in the Facilities or Encroachment, Licensee, at its sole cost and expense and within thirty (30) days after notice in writing from Licensor, shall make changes in the Facilities or Encroachment to accommodate such track(s) or operations.

6.2 If Licensee fails to do so, Licensor may make or contract to make such changes at Licensee's cost.

7. FACILITY CHANGES:

7.1 Licensee shall periodically monitor and verify the depth or height of the Facilities or Encroachment in relation to the existing tracks and facilities, and shall relocate the Facilities or change the Encroachment, at Licensee's expense, should such relocation or change be necessary to comply with the minimum clearance requirements of Licensor.

7.2 If Licensee undertakes to revise, renew, relocate or change in any manner whatsoever all or any part of the Facilities (including any change in voltage or gauge of wire or any change in circumference, diameter or radius of pipe or change in materials transmitted in and through said pipe), or is required by any public agency or court order to do so, plans therefor shall be submitted to Licensor for approval before such change. After approval, the terms and conditions of this Agreement shall apply thereto.

8. INTERFERENCE WITH RAIL FACILITIES:

8.1 Although the Facilities/Encroachment herein permitted may not presently interfere with Licensor's railroad or facilities, in the event that the operation, existence or maintenance of said Facilities, in the sole judgment of Licensor, causes: (a) interference (including, but not limited to, physical or interference from an electromagnetic induction, or interference from stray or other currents) with Licensor's power lines, communication, signal or other wires, train control system, or electrical or electronic apparatus; or (b) interference in any manner, with the operation, maintenance or use of the rail corridor, track(s), structures, pole line(s), devices, other property, or any appurtenances thereto; then and in either event, Licensee, upon receipt of written notice from Licensor of any such interference, and at Licensee's sole risk, cost and expense, shall promptly make such changes in its Facilities or installation, as may be required in the reasonable judgment of the Licensor to eliminate all such interference. Upon Licensee's failure to remedy or change, Licensor may do so or contract to do so at Licensee's sole cost.

8.2 Without assuming any duty hereunder to inspect the Facilities, Licensor hereby reserves the right to inspect same and to require Licensee to undertake repairs, maintenance or adjustments to the Facilities, which Licensee hereby agrees to make promptly, at Licensee's sole cost and expense.

9. RISK, LIABILITY, INDEMNITY:

With respect to the relative risk and liabilities of the parties, it is hereby agreed that:

9.1 To the fullest extent permitted by State Law (constitutional or statutory, as amended), Licensee hereby agrees to, defend, indemnify, and hold Licensor harmless from and against any and all liability, loss, claim, suit, damage, charge or expense which Licensor may suffer, sustain, incur or in any way be subjected to, on account of death of or injury to any person whomsoever (including officers, agents, employees or invitees of Licensor), and for damage to or loss of or destruction of any property whatsoever, arising out of, resulting from, or in any way connected with the construction, repair, maintenance, replacement, presence, existence, operations, use or removal of the Facilities or any structure in connection therewith, or restoration of premises of Licensor to good order or condition after removal, EXCEPT when proven to have been caused solely by the willful misconduct or gross negligence of Licensor. HOWEVER, to the fullest extent permitted by State Law (constitutional or statutory, as amended), during any period of actual construction, repair, maintenance, replacement or removal of the Facilities, wherein agents, equipment or personnel of Licensee are on the railroad rail corridor, Licensee's liability hereunder shall be absolute, irrespective of any joint, sole or contributory fault or negligence of Licensor.

9.2 Use of Licensor's rail corridor involves certain risks of loss or damage as a result of the rail operations. Notwithstanding Section 9.1, Licensee expressly assumes all risk of loss and damage to Licensee's Property or the Facilities in, on, over or under the Encroachment, including loss of or any interference with use or service thereof, regardless of cause, including electrical field creation, fire or derailment resulting from rail operations. For this Section, the term "Licensee's Property" shall include property of third parties situated or placed upon Licensor's rail corridor by Licensee or by such third parties at request of or for benefit of Licensee.

9.3 To the fullest extent permitted by State Law (constitutional or statutory, as amended), Licensee assumes all responsibility for, and agrees to defend, indemnify and hold Licensor harmless from: (a) all claims, costs and expenses, including reasonable attorneys' fees, as a consequence of any sudden or nonsudden pollution of air, water, land and/or ground water on or off the Encroachment area, arising from or in connection with the use of this Encroachment or resulting from leaking, bursting, spilling, or any escape of the material transmitted in or through the Facilities; (b) any claim or liability arising under federal or state law dealing with either such sudden or nonsudden pollution of air, water, land and/or ground water arising therefrom or the remedy thereof; and (c) any subsidence or failure of lateral or subjacent support of the tracks arising from such Facilities leakage.

9.4 Notwithstanding Section 9.1, Licensee also expressly assumes all risk of loss which in any way may result from Licensee's failure to maintain either required clearances for any overhead Facilities or the required depth and encasement for any underground Facilities, whether or not such loss(es) result(s) in whole or part from Licensor's contributory negligence or joint fault.

9.5 Obligations of Licensee hereunder to release, indemnify and hold Licensor harmless shall also extend to companies and other legal entities that control, are controlled by, subsidiaries of, or are affiliated with Licensor, as well as any railroad that operates over the rail corridor on which the Encroachment is located, and the officers, employees and agents of each.

9.6 If a claim is made or action is brought against Licensor, and/or its opcrating lessee, for which Licensee may be responsible hereunder, in whole or in part, Licensee shall be notified to assume the handling or defense of such claim or action; but Licensor may participate in such handling or defense.

10. INSURANCE:

10.1 Prior to commencement of surveys, installation or occupation of premises pursuant to this Agreement, Licensee shall procure and shall maintain during the continuance of this Agreement, at its sole cost and expense, a policy of

(i) Statutory Worker's Compensation and Employers Liability Insurance with available limits of not less than ONE MILLION AND 00/100 U.S. DOLLARS ($1,000,000.00), which must contain a waiver of subrogation against CSXT and its Affiliates;

(ii) Commercial General Liability coverage (inclusive of contractual liability) with available limits of not less than FIVE MILLION AND 00/100 U.S. DOLLARS ($5,000,000.00), naming Licensor, and/or its designee, as additional insured and in combined single limits for bodily injury and property damage and covering the contractual liabilities assumed under this Agreement. The evidence of insurance coverage shall be endorsed to provide for thirty (30) days' notice to Licensor, or its designee, prior to cancellation or modification of any policy. Mail CGL certificate, along with agreement, to CSX Transportation, Inc., Speed Code J180, 500 Water Street, Jacksonville, FL 32202. On each successive year, send certificate to RenewalCOI@csx.com.

(iii) Business automobile liability insurance with available limits of not less than ONE MILLION AND 00/100 U.S. DOLLARS ($1,000,000.00) combined single limit for bodily injury and/or property damage per occurrence;

(iv) Such other insurance as Licensor may reasonably require.

10.2 If Licensee's existing CGL policy(ies) do(es) not automatically cover Licensee's contractual liability during periods of survey, installation, maintenance and continued occupation, a specific endorsement adding such coverage shall be purchased by Licensee. If said CGL policy is written on a "claims made" basis instead of a "per occurrence" basis, Licensee shall arrange for adequate time for reporting losses. Failure to do so shall be at Licensee's sole risk.

10.3 Licensor, or its designee, may at any time request evidence of insurance purchased by Licensee to comply with this Agreement. Failure of Licensee to comply with Licensor's request shall be considered a default by Licensee.

10.4 Securing such insurance shall not limit Licensee's liability under this Agreement, but shall be security therefor.

10.5 (A) In the event Licensee finds it necessary to perform construction or demolition operations within fifty feet (50') of any operated railroad track(s) or affecting any railroad bridge, trestle, tunnel, track(s), roadbed, overpass or underpass, Licensee shall: (a) notify Licensor; and (b) require its contractor(s) performing such operations to procure and maintain during the period of construction or demolition operations, at no cost to Licensor, Railroad Protective Liability (RPL) Insurance, naming Licensor, and/or its designee, as Named Insured, written on the current ISO/RIMA Form (ISO Form No. CG 00 35 01 96) with limits of FIVE MILLION AND 00/100 U.S. DOLLARS ($5,000,000.00) per occurrence for bodily injury and property damage, with at least TEN MILLION AND 00/100 U.S. DOLLARS ($10,000,000.00) aggregate limit per annual policy period, with Pollution Exclusion Amendment (ISO CG 28 31 11 85) if an older ISO Form CG 00 35 is used. The original of such RPL policy shall be sent to and approved by Licensor prior to commencement of such construction or demolition. Licensor reserves the right to demand higher limits.

(B) At Licensor's option, in lieu of purchasing RPL insurance from an insurance company (but not CGL insurance), Licensee may pay Licensor, at Licensor's current rate at time of request, the cost of adding this Encroachment, or additional construction and/or demolition activities, to Licensor's Railroad Protective Liability (RPL) Policy for the period of actual construction. This coverage is offered at Licensor's discretion and may not be available under all circumstances.

11. GRADE CROSSINGS; FLAGGING:

11.1 Nothing herein contained shall be construed to permit Licensee or Licensee's contractor to move any vehicles or equipment over the track(s), except at public road crossing(s), without separate prior written approval of Licensor.

11.2 If Licensor deems it advisable, during any construction, maintenance, repair, renewal, alteration, change or removal of said Facilities, to place watchmen, flagmen, inspectors or supervisors for protection of operations of Licensor or others on Licensor's rail corridor at the Encroachment, and to keep persons, equipment or materials away from the track(s), Licensor shall have the right to do so at the expense of Licensee, but Licensor shall not be liable for failure to do so.

12. LICENSOR'S COSTS:

12.1 Any additional or alternative costs or expenses incurred by Licensor to accommodate Licensee's continued use of Licensor's property as a result of track changes or wire changes shall also be paid by Licensee.

12.2 Licensor's expense for wages ("force account" charges) and materials for any work performed at the expense of Licensee pursuant hereto shall be paid by Licensee within thirty (30) days after receipt of Licensor's bill therefor. Licensor may, at its discretion, request an advance deposit for estimated Licensor costs and expenses.

12.3 Such expense shall include, but not be limited to, cost of railroad labor and supervision under "force account" rules, plus current applicable overhead percentages, the actual cost of materials, and insurance, freight and handling charges on all material used. Equipment rentals shall be in accordance with Licensor's applicable fixed rate. Licensor may, at its discretion, require advance deposits for estimated costs of such expenses and costs.

13. DEFAULT, BREACH, WAIVER:

13.1 The proper and complete performance of each covenant of this Agreement shall be deemed of the essence thereof, and in the event Licensee fails or refuses to fully and completely perform any of said covenants or remedy any breach within thirty (30) days after receiving written notice from Licensor to do so (or within forty-eight (48) hours in the event of notice of a railroad emergency), Licensor shall have the option of immediately revoking this Agreement and the privileges and powers hereby conferred, regardless of encroachment fee(s) having been paid in advance for any annual or other period. Upon such revocation, Licensee shall make removal in accordance with Article 14.

13.2 No waiver by Licensor of its rights as to any breach of covenant or condition herein contained shall be construed as a permanent waiver of such covenant or condition, or any subsequent breach thereof, unless such covenant or condition is permanently waived in writing by Licensor.

13.3 Neither the failure of Licensor to object to any work done, material used, or method of construction or maintenance of said Encroachment, nor any approval given or supervision exercised by Licensor, shall be construed as an admission of liability or responsibility by Licensor, or as a waiver by Licensor of any of the obligations, liability and/or responsibility of Licensee under this Agreement.

14. TERMINATION, REMOVAL:

14.1 All rights which Licensee may have hereunder shall cease upon the date of (a) termination, (b) revocation, or (c) subsequent agreement, or (d) Licensee's removal of the Facility from the Encroachment. However, neither termination nor revocation of this Agreement shall affect any claims and liabilities which have arisen or accrued hereunder, and which at the time of termination or revocation have not been satisfied; neither party, however, waiving any third party defenses or actions.

14.2 Within thirty (30) days after revocation or termination, Licensee, at its sole risk and expense, shall (a) remove the Facilities from the rail corridor of Licensor, unless the parties hereto agree otherwise, (b) restore the rail corridor of Licensor in a manner satisfactory to Licensor, and (c) reimburse Licensor any loss, cost or expense of Licensor resulting from such removal.

15. NOTICE:

15.1 Licensee shall give Licensor at least thirty (30) days written notice before doing <u>any</u> work on Licensor's rail corridor, cxccpt that in cascs of cmcrgcncy shortcr noticc may be given. Licensee shall provide proper notification as follows:

a. For non-emergencies, Licensee shall submit online via the CSX Property Portal from Licensor's web site, via web link:
https://propertyportal.csx.com/pub_ps_res/ps_res/jsf/public/index.faces

b. For emergencies, Licensee shall complete all of the steps outlined in Section 15.1 a. above, and shall also include detailed information of the emergency. Licensee shall also call and report details of the emergency to Licensor's Rail Operations Emergency Telephone Number: 1-800-232-0144. In the event Licensor needs to contact Licensee concerning an emergency involving Licensee's Facility(ies), the emergency phone number for Licensee is: 434-591-1910.

15.2 All other notices and communications concerning this Agreement shall be addressed to Licensee at the address above, and to Licensor at the address shown on Page 1, c/o CSXT Contract Management, J180; or at such other address as either party may designate in writing to the other.

15.3 Unless otherwise expressly stated herein, all such notices shall be in writing and sent via Certified or Registered Mail, Return Receipt Requested, or by courier, and shall be considered delivered upon: (a) actual receipt, or (b) date of refusal of such delivery.

16. ASSIGNMENT:

16.1 The rights herein conferred are the privileges of Licensee only, and Licensee shall obtain Licensor's prior written consent to any assignment of Licensee's interest herein; said consent shall not be unreasonably withheld.

16.2 Subject to Sections 2 and 16.1, this Agreement shall be binding upon and inure to the benefit of the parties hereto and their respective successors or assigns.

16.3 Licensee shall give Licensor written notice of any legal succession (by merger, consolidation, reorganization, etc.) or other change of legal existence or status of Licensee, with a copy of all documents attesting to such change or legal succession, within thirty (30) days thereof.

16.4 Licensor expressly reserves the right to assign this Agreement, in whole or in part, to any grantee, lessee, or vendee of Licensor's underlying property interests in the Encroachment, upon written notice thereof to Licensee.

16.5 In the event of any unauthorized sale, transfer, assignment, sublicense or encumbrance of this Agreement, or any of the rights and privileges hereunder, Licensor, at its option, may revoke this Agreement by giving Licensee or any such assignee written notice of such revocation; and Licensee shall reimburse Licensor for any loss, cost or expense Licensor may incur as a result of Licensee's failure to obtain said consent.

17. TITLE:

17.1 Licensee understands that Licensor occupies, uses and possesses lands, rights-of-way and rail corridors under all forms and qualities of ownership rights or facts, from full fee simple absolute to bare occupation. Accordingly, nothing in this Agreement shall act as or be deemed to act as any warranty, guaranty or representation of the quality of Licensor's title for any particular Encroachment or segment of Rail Corridor occupied, used or enjoyed in any manner by Licensee under any rights created in this Agreement. It is expressly understood that Licensor does not warrant title to any Rail Corridor and Licensee will accept the grants and privileges contained herein, subject to all lawful outstanding existing liens, mortgages and superior rights in and to the Rail Corridor, and all leases, licenses and easements or other interests previously granted to others therein.

17.2 The term "license," as used herein, shall mean with regard to any portion of the Rail Corridor which is owned by Licensor in fee simple absolute, or where the applicable law of the State where the Encroachment is located otherwise permits Licensor to make such grants to Licensee, a "permission to use" the Rail Corridor, with dominion and control over such portion of the Rail Corridor remaining with Licensor, and no interest in or exclusive right to possess being otherwise granted to Licensee. With regard to any other portion of Rail Corridor occupied, used or controlled by Licensor under any other facts or rights, Licensor merely waives its exclusive right to occupy the Rail Corridor and grants no other rights whatsoever under this Agreement, such waiver continuing only so long as Licensor continues its own occupation, use or control. Licensor does not warrant or guarantee that the license granted hereunder provides Licensee with all of the rights necessary to occupy any portion of the Rail Corridor. Licensee further acknowledges that it does not have the right to occupy any portion of the Rail Corridor held by Licensor in less than fee simple absolute without also receiving the consent of the owner(s) of the fee simple absolute estate. Further, Licensee shall not obtain, exercise or claim any interest in the Rail Corridor that would impair Licensor's existing rights therein.

17.3 Licensee agrees it shall not have nor shall it make, and hereby completely and absolutely waives its right to, any claim against Licensor for damages on account of any deficiencies in title to the Rail Corridor in the event of failure or insufficiency of Licensor's title to any portion thereof arising from Licensee's use or occupancy thereof.

17.4 To the fullest extent permitted by State Law (constitutional or statutory, as amended), Licensee agrees to fully and completely indemnify and defend all claims or litigation for slander of title, overburden of easement, or similar claims arising out of or based upon the Facilities placement, or the presence of the Facilities in, on or along any Encroachment(s), including claims for punitive or special damages.

17.5 Licensee shall not at any time own or claim any right, title or interest in or to Licensor's property occupied by the Encroachments, nor shall the exercise of this Agreement for any length of time give rise to any right, title or interest in Licensee to said property other than the license herein created.

17.6 Nothing in this Agreement shall bc dccmcd to givc, and Liccnsor hcrcby expressly waives, any claim of ownership in and to any part of the Facilities.

17.7 Licensee shall not create or permit any mortgage, pledge, security, interest, lien or encumbrances, including without limitation, tax liens and liens or encumbrances with respect to work performed or equipment furnished in connection with the construction, installation, repair, maintenance or operation of the Facilities in or on any portion of the Encroachment (collectively, "Liens or Encumbrances"), to be established or remain against the Encroachment or any portion thereof or any other Licensor property.

17.8 In the event that any property of Licensor becomes subject to such Liens or Encumbrances, Licensee agrees to pay, discharge or remove the same promptly upon Licensee's receipt of notice that such Liens or Encumbrances have been filed or docketed against the Encroachment or any other property of Licensor; however, Licensee reserves the right to challenge, at its sole expense, the validity and/or enforceability of any such Liens or Encumbrances.

18. GENERAL PROVISIONS:

18.1 This Agreement, and the attached specifications, contains the entire understanding between the parties hereto.

18.2 Neither this Agreement, any provision hereof, nor any agreement or provision included herein by reference, shall operate or be construed as being for the benefit of any third person.

18.3 Except as otherwise provided herein, or in any Rider attached hereto, neither the form of this Agreement, nor any language herein, shall be interpreted or construed in favor of or against either party hereto as the sole drafter thereof.

18.4 This Agreement is executed under current interpretation of applicable Federal, State, County, Municipal or other local statute, ordinance or law(s). However, each separate division (paragraph, clause, item, term, condition, covenant or agreement) herein shall have independent and severable status for the determination of legality, so that if any separate division is determined to be void or unenforceable for any reason, such determination shall have no effect upon the validity or enforceability of each other separate division, or any combination thereof.

18.5 This Agreement shall be construed and governed by the laws of the state in which the Facilities and Encroachment are located.

18.6 If any amount due pursuant to the terms of this Agreement is not paid by the due date, it will be subject to Licensor's standard late charge and will also accrue interest at eighteen percent (18%) per annum, unless limited by local law, and then at the highest rate so permitted.

18.7 Licensee agrees to reimburse Licensor for all reasonable costs (including attorney's fees) incurred by Licensor for collecting any amount due under the Agreement.

18.8 The provisions of this License are considered confidential and may not be disclosed to a third party without the consent of the other party(s), except: (a) as required by statute, regulation or court order, (b) to a parent, affiliate or subsidiary company, (c) to an auditing firm or legal counsel that are agreeable to the confidentiality provisions, or (d) to Lessees of Licensor's land and/or track who are affected by the terms and conditions of this Agreement and will maintain the confidentiality of this Agreement.

18.9 Licensor shall refund to Licensee any overpayments collected, plus any taxes paid in advance; PROVIDED, however, such refund shall not be made when the cumulative total involved is less than One Hundred Dollars ($100.00).

[Signatures on the following page]

IN WITNESS WHEREOF, the parties hereto have executed this Agreement in duplicate (each of which shall constitute an original) as of the effective date of this Agreement.

Witness for Licensor:

____

CSX TRANSPORTATION, INC.

By: ______________________________

Print/Type Name: Donna Sabin

Print/Type Title: Manager Real Estate Services

Witness for Licensee:

____

JAMES RIVER WATER AUTHORITY

By: ______________________________

Who, by the execution hereof, affirms that he/she has the authority to do so and to bind the Licensee to the terms and conditions of this Agreement.

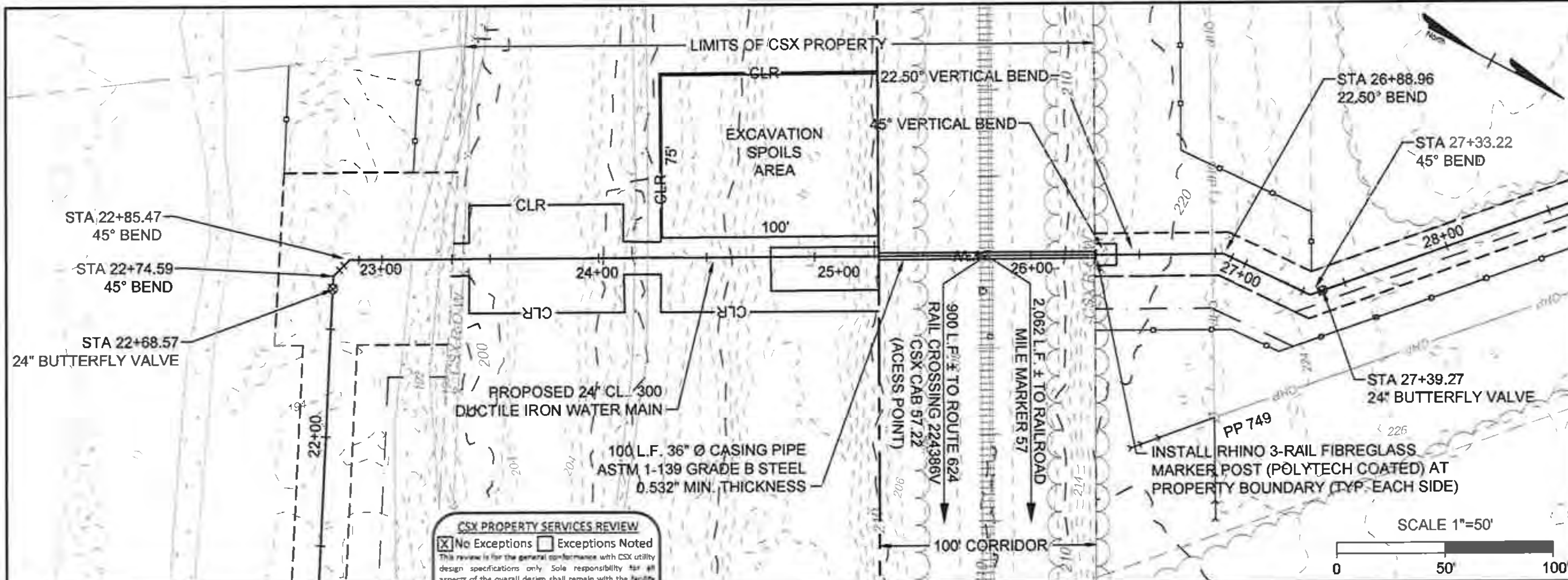
Print/Type Name: Goodman B. Duke

Print/Type Title: Chair, JRWA Board

Tax ID No.: 27-0317733

CSX845004

EXHIBIT A



CSX PROPERTY SERVICES REVIEW

☒ No Exceptions ☐ Exceptions Noted

This review is for the general conformance with CSX utility design specifications only. Sole responsibility for all aspects of the overall design shall remain with the facility owner. This review does not constitute approval to proceed without meeting all of CSX's safety and contractual requirements.

By: [signature]

CSX RAILROAD UNDERGROUND UTILITY CROSSING NOTES

1. THE FRONT OF THE CASING PIPE SHALL BE PROVIDED WITH MECHANICAL ARRANGEMENTS OR DEVICES THAT WILL POSITIVELY PREVENT THE AUGER FROM LEADING THE PIPE SO THAT NO UNSUPPORTED EXCAVATION IS AHEAD OF THE PIPE.
2. CASING PIPE ENDS TO BE SEALED IN ACCORDANCE WITH CURRENT CSXT SPECIFICATIONS.
3. RESTRAIN ALL PIPE JOINTS AND FITTINGS WITHIN CSX RIGHT OF WAY.
4. ALL DISTURBED AREAS WITHIN THE CSX RIGHT OF WAY ARE TO BE RESTORED TO PRE CONSTRUCTION CONDITIONS WITH RESPECT TO GRADE AND ELEVATION AND HAVE SEED AND STRAW MULCH APPLIED PER VESCH REQUIREMENTS.

CSXT Pipeline Spec. Reference	PIPELINE CONTENT DETAILS		
	Commodity Description:	NON POTABLE WATER	
	Maximum Operating Pressure:	240 PSI	
	Is Commodity Flammable:	☐ Yes ☒ No	
	CARRIER/CASING PIPE DETAILS		
		Carrier Pipe	Casing Pipe
Page 13, C); & 17, D)	Pipe Material:	DUCTILE IRON	WELDED STEEL
Page 13, C); & 17, D)	Material Specifications & Grade:	AWWA C151/ANSI A21.51	ASTM 1-139 GRADE B
Page 13, C); & 17, D)	Specified Minimum Yield Strength:	42,000 PSI	35,000 PSI
	Nominal Size Outside Diameter (Inches):	25.80 INCHES	37.06 INCHES
Page 14, ii), (d)	Wall Thickness (Inches):	0.40 INCHES	0.532 INCHES
Page 13, C); & 17, D)	Type of Seam:	N/A	WELDED
Page 13, C); & 17, D)	Type of Joints:	PUSH ON W/ RESTRAINT	N/A
Page 16, v)	Tunnel Liner Plates Required:	☐ Yes ☒ No	
	Cathodic Protection:	☐ Yes ☒ No	Type:
	Protective Coating:	☐ Yes ☒ No	Type:
	Temp. Track Support or Rip-Rap Req.:	☐ Yes ☒ No	Must Describe & Show on Dwg.

Location:	2,062' West of Rail Mile Marker 57 at the Town of Columbia, Va.
Latitude:	N 37° : 45' : 5 . 40"
Longitude:	W -78° : 10' : 31 . 01"
Drawing No.:	33927-CSX-UTIL Sheet: 1 of 3
Drawing Date:	05 / 26 / 2017 Revised: __/__/__
Drawing Scale:	V 1 Inches = 5 Feet
Drawing Scale:	H 1 Inches = 50 Feet

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YOUR VISION ACHIEVED THROUGH OURS.

REVISION DESCRIPTION | DATE

DATE 06-07-17 | DRAWN BY J. CARTER | DESIGNED BY J. CARTER | CHECKED BY D. SAUNDERS | SCALE 1" = 50'

TIMMONS GROUP

JAMES RIVER WATER AUTHORITY RAW WATER MAIN

FLUVANNA COUNTY - VIRGINIA

CSX RAILWAY CROSSING PERMIT - PLAN VIEW

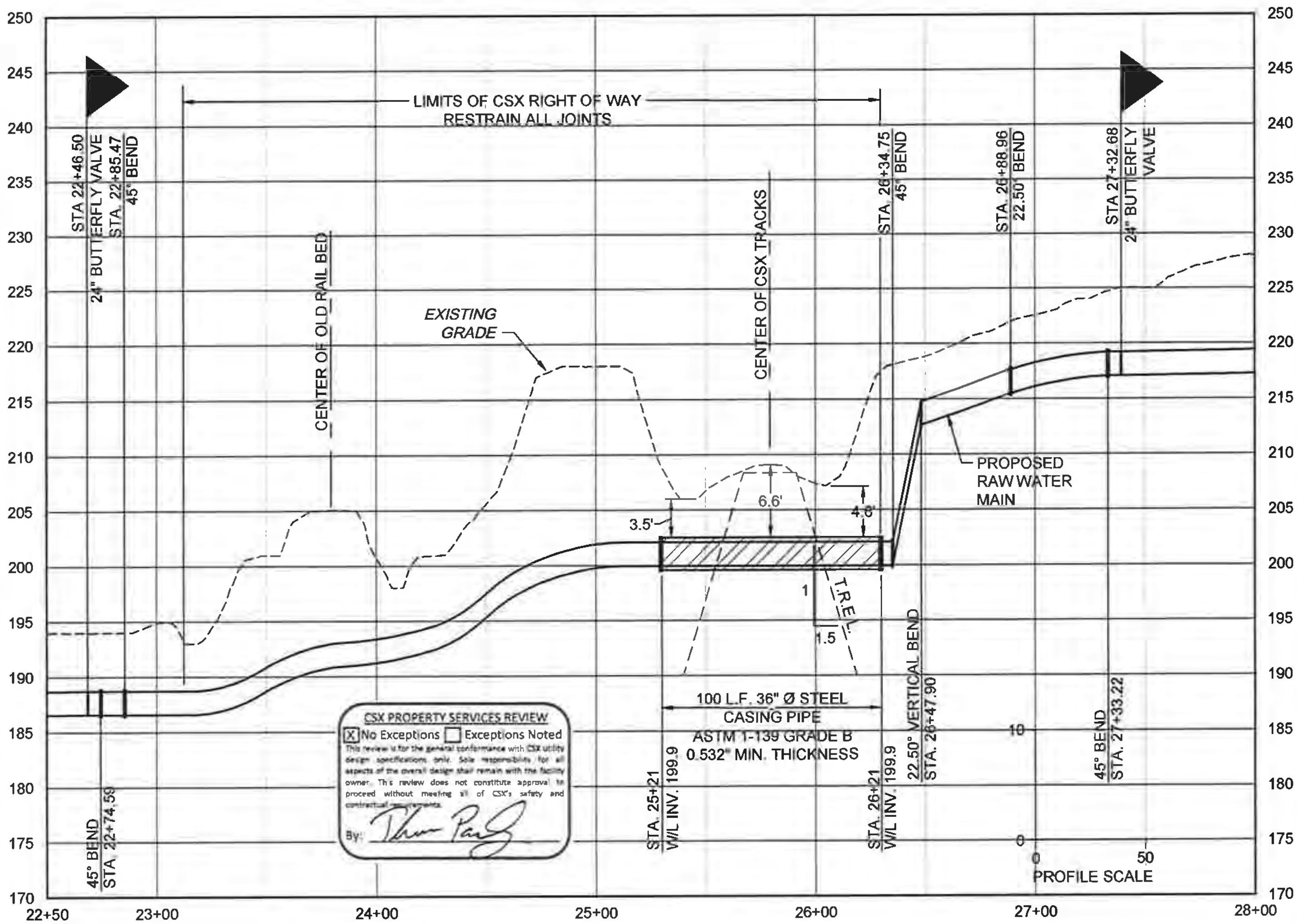
JOB NO. 33927

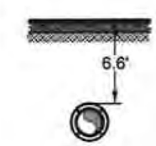
SHEET NO. CSX 1 of 2

L:\201\33927 - James River Water Project\DWG\Sheet\CD\33927-CSX-UTIL.dwg | Plotted on 6/9/2017 4:46 PM | by James Carter

8/3/2017

EXHIBIT A





CROSS SECTION
STA 25+80

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JAMES RIVER WATER AUTHORITY RAW WATER MAIN

FLUVANNA COUNTY - VIRGINIA

CSX RAILWAY CROSSING PERMIT - PROFILE AND SECTION VIEW

DATE	DRAWN BY	DESIGNED BY	CHECKED BY	SCALE	JOB NO.	SHEET NO.
06-07-17	J. CARTER	J. CARTER	D. SAUNDERS	H: 1" = 50' V: 1" = 5'	33927	CSX 2 of 2

8/3/2017

APPENDIX H-5-2
CSX PREFERRED ALTERNATIVE LETTER

Troy J. Creasy
Project Manager II – Public Projects
4900 Old Osborne Tpke., Suite 200
Richmond, VA 23231
804-226-7718
Troy_Creasy@csx.com

February 28, 2020

Dear Mr. Hines,

Thank you for allowing CSX Transportation (CSX) an opportunity to review the alternatives under consideration by the James River Water Authority. Based upon our preliminary review of the information, we have the following to offer:

1. Any utility crossing of CSX right-of-way and rail lines will require the JRWA to meet all CSX Safety Requirements and Pipeline Design and Construction Specifications and would need to be submitted through the CSX online portal for CSX review and approval. Please refer to CSX's Public Project Information for Construction and Improvement Projects That May Involve the Railroad manual for an overview of the review and approval process and associated costs.
2. This section of our rail line, from Goochland to Bremo, is an active core route. CSX maintains significant operations in this area. Any alternative that could negatively impact CSX operations would need to be closely evaluated.
3. Alternative 3 is located adjacent to the CSX switching yard in Columbia. This is an active switching yard that has a significant amount of electrical infrastructure above the proposed pipeline crossing. CSX would need to closely evaluate the potential impact of the pipeline crossing and pump station construction in addition to long-term impact to daily operations. Based upon our preliminary review of this alternative, we would discourage the JRWA from locating a pump station and intake at this location.
4. CSX currently has permitted Alternative 6 for a pipeline crossing. The current access to this pump station site is a single track at-grade crossing access via Old Columbia Road. This crossing location will not require an upgrade to the road and rail crossing in CSX Right-of-Way. As such this is CSX's preferred alternative.

Again, we appreciate the opportunity to review these alternatives and provide our input.

Best regards,

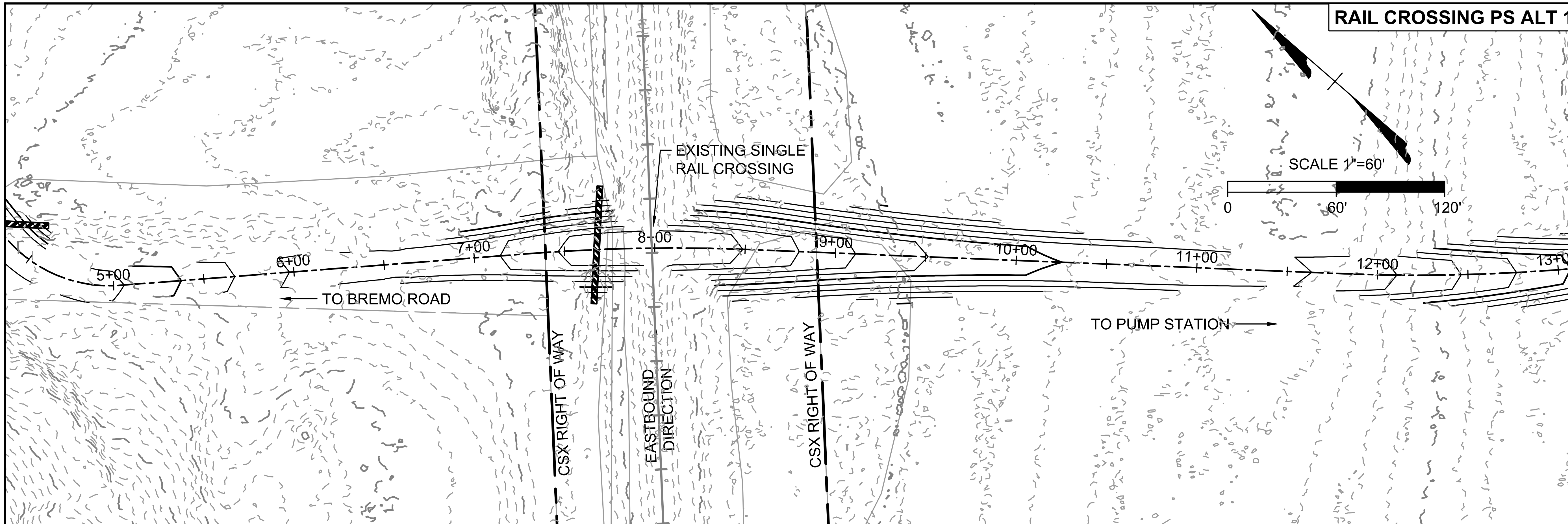
Troy Creasy

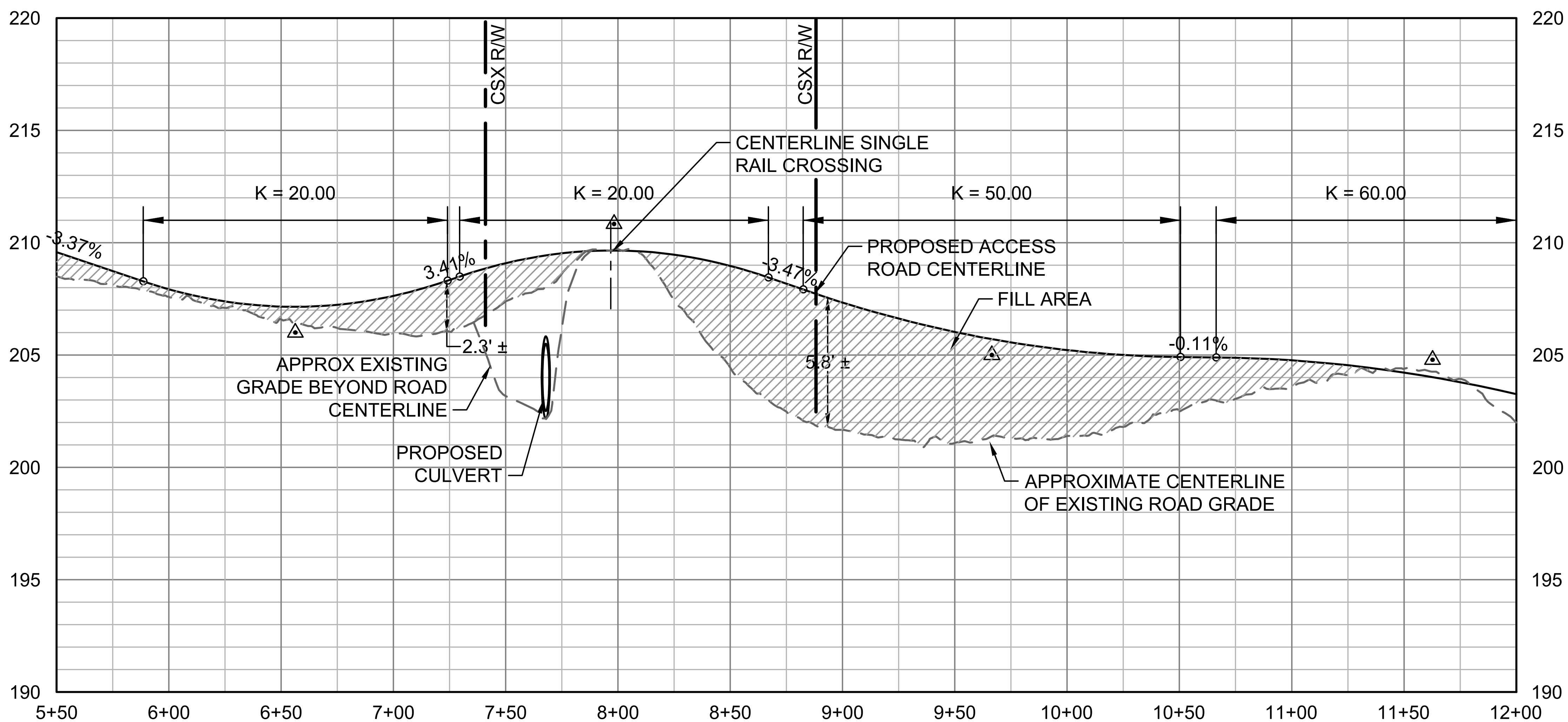
Troy J. Creasy
Project Manager II – Public Projects

APPENDIX H-5-3

PROPOSED ACCESS ROAD AND RAIL LINE CROSSING PROFILES

RAIL CROSSING PS ALT 1





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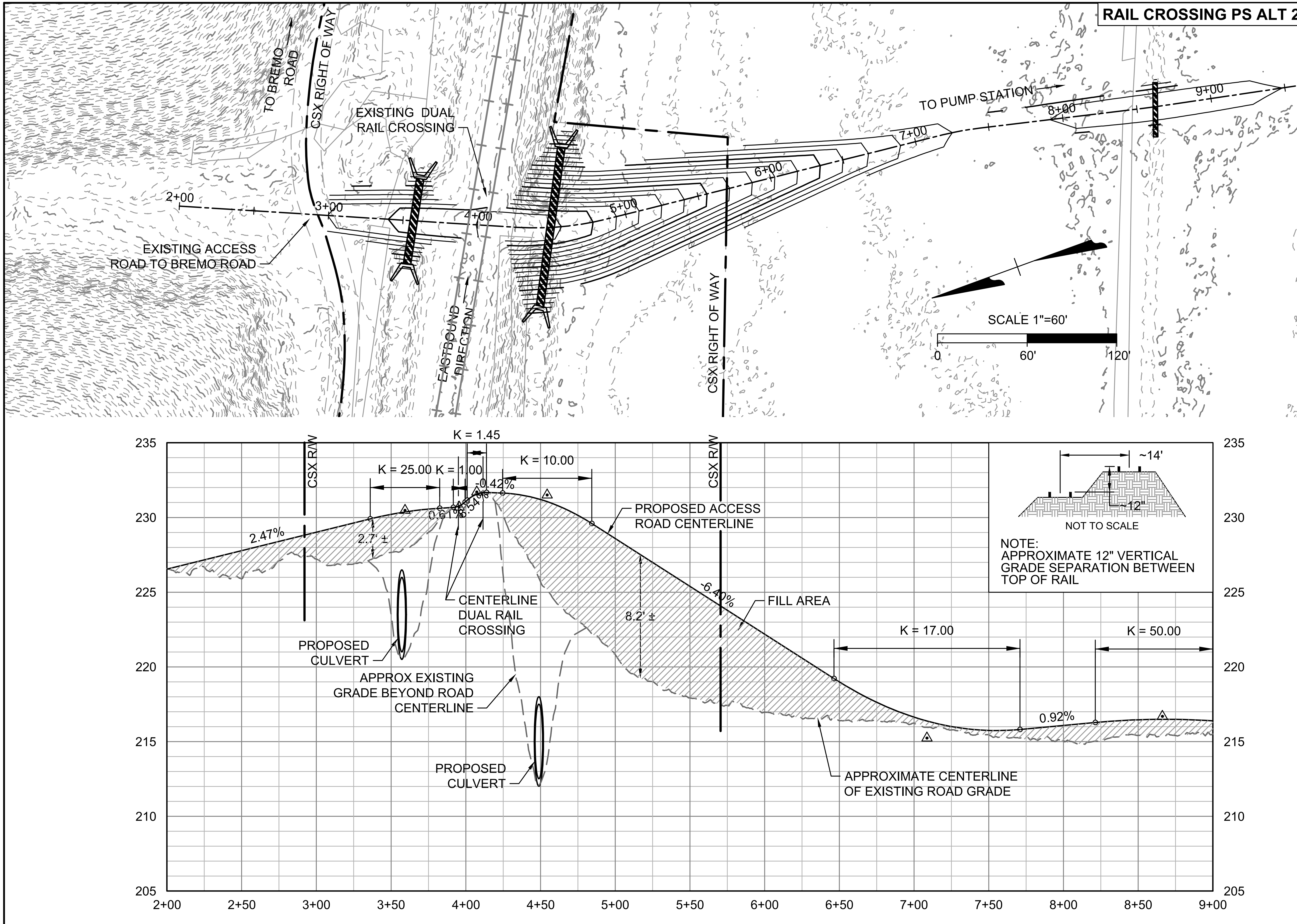
DESIGNED BY:
CHECKED BY:
SCALE: AS SHOWN

TIMMONS GROUP

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA

ALTERNATIVE 1 PROPOSED ACCESS ROAD PROFILE

JOB NO. 34967
SHEET NO. ----



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DATE: FEB. 2020

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DESIGNED BY

CHECKED BY

SCALE: AS SHOWN

JAMES RIVER WATER AUTHORITY

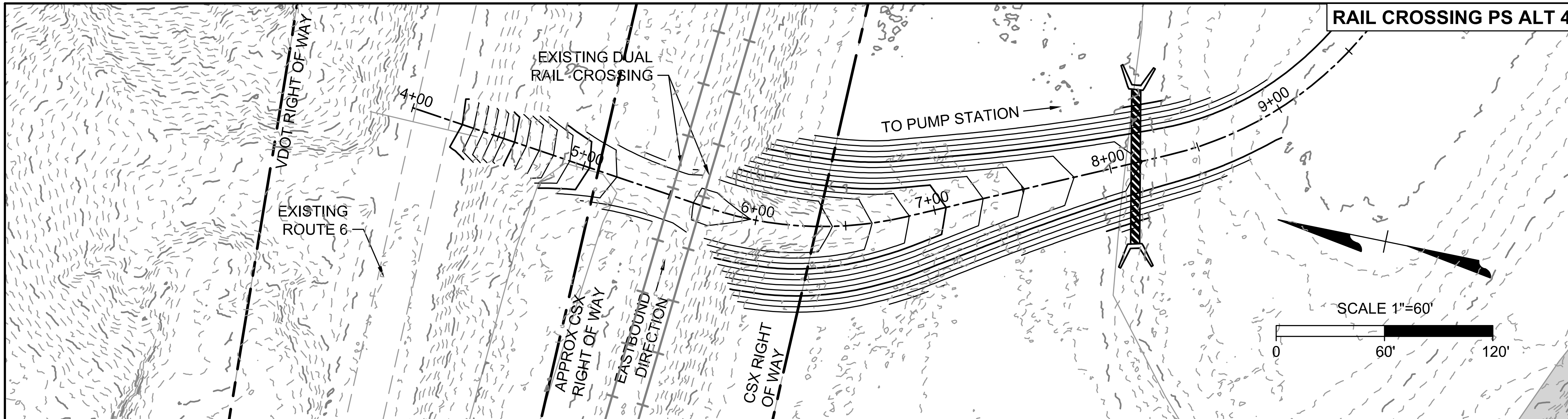
FLUVANNA COUNTY, VIRGINIA

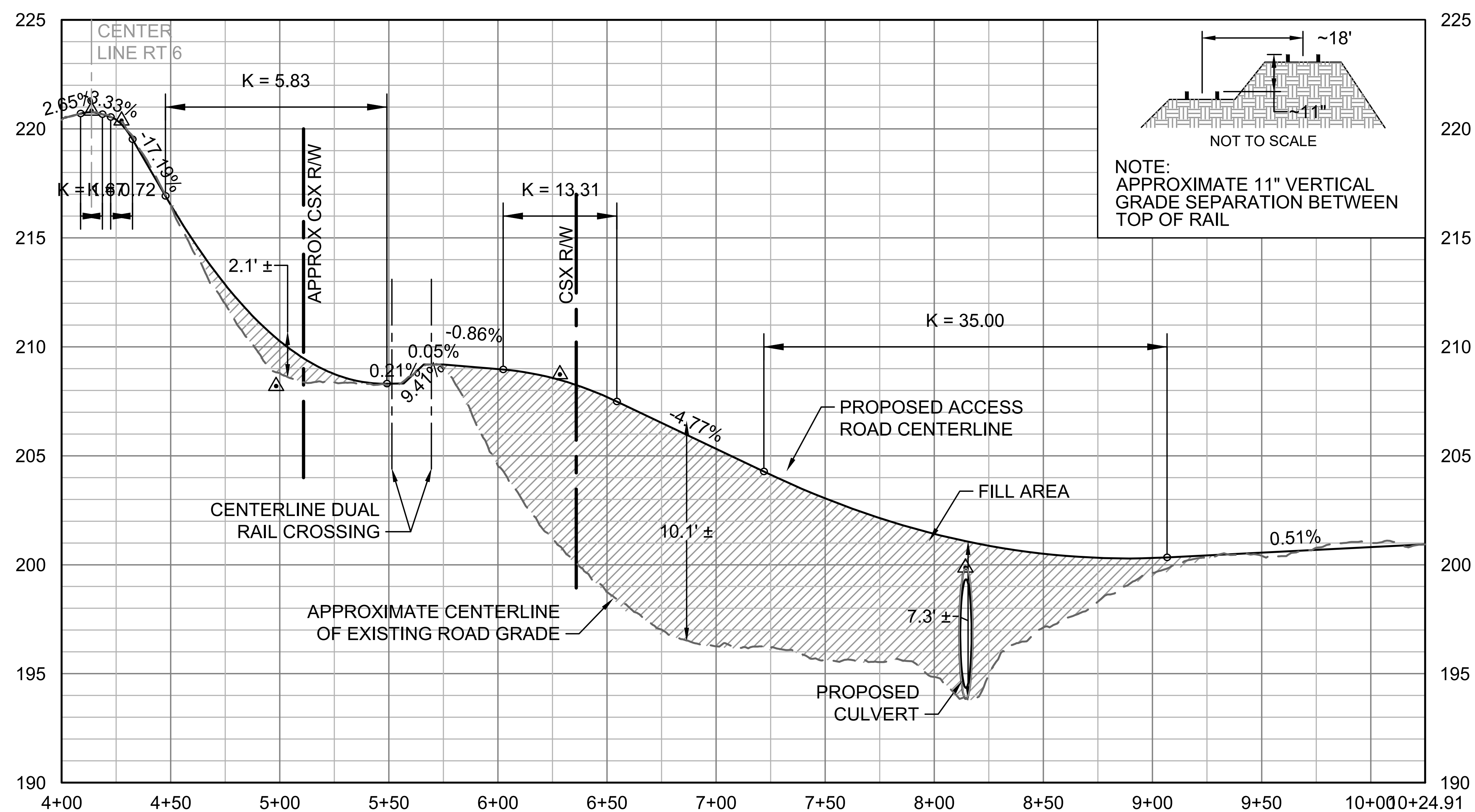
ALTERNATIVE 2 PROPOSED ACCESS ROAD PROFILE

JOB NO. 34967

SHEET NO. ----

RAIL CROSSING PS ALT 4





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JAMES RIVER WATER AUTHORITY

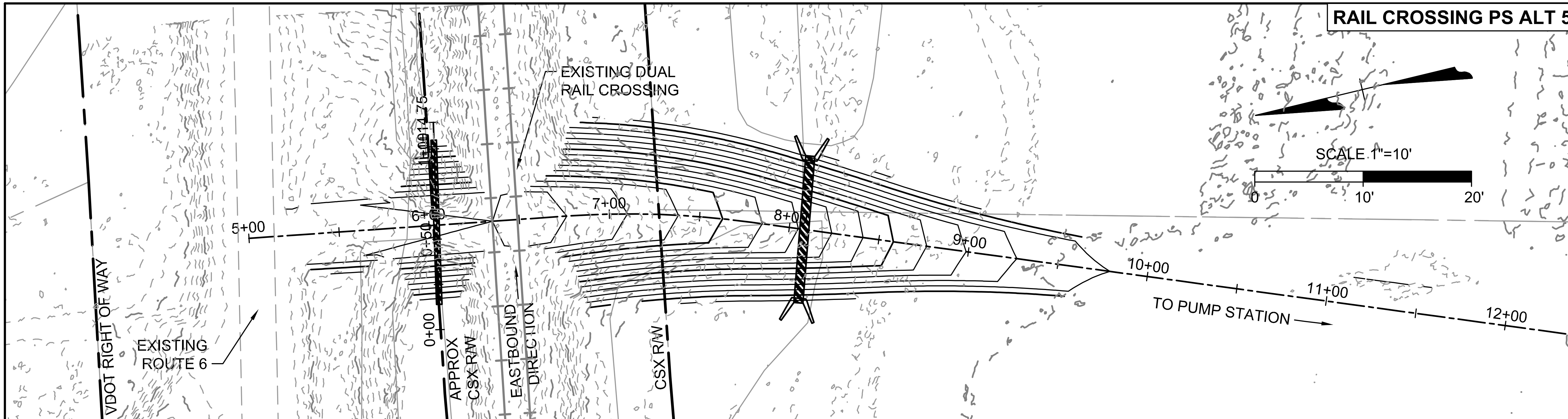
FLUVANNA COUNTY, VIRGINIA

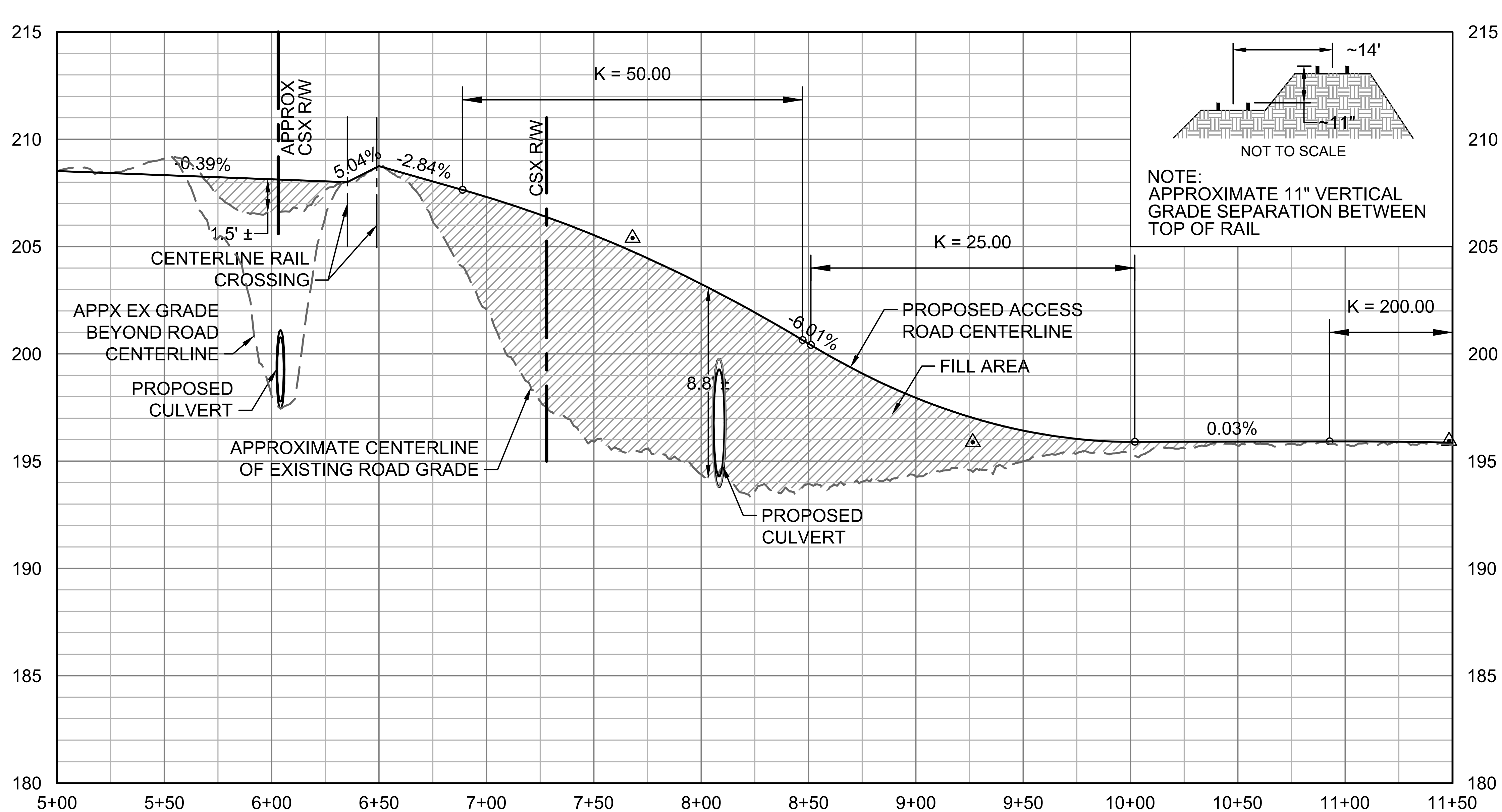
ALTERNATIVE 4 PROPOSED ACCESS ROAD PROFILE

JOB NO. 34967

SHEET NO. ----

RAIL CROSSING PS ALT 5





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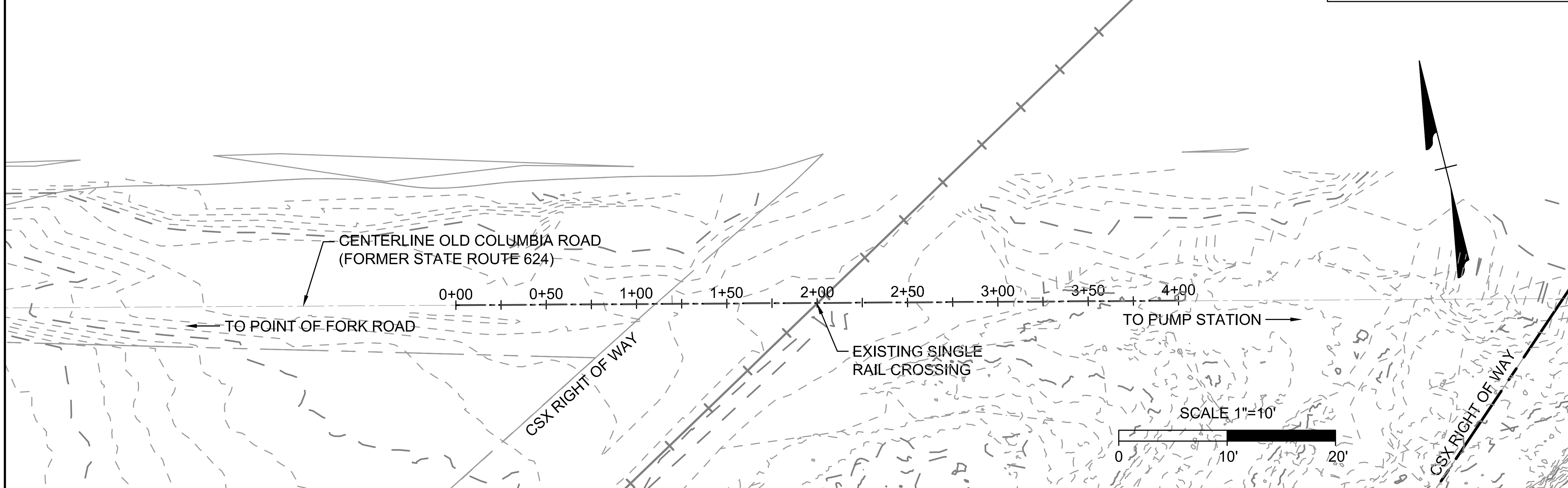
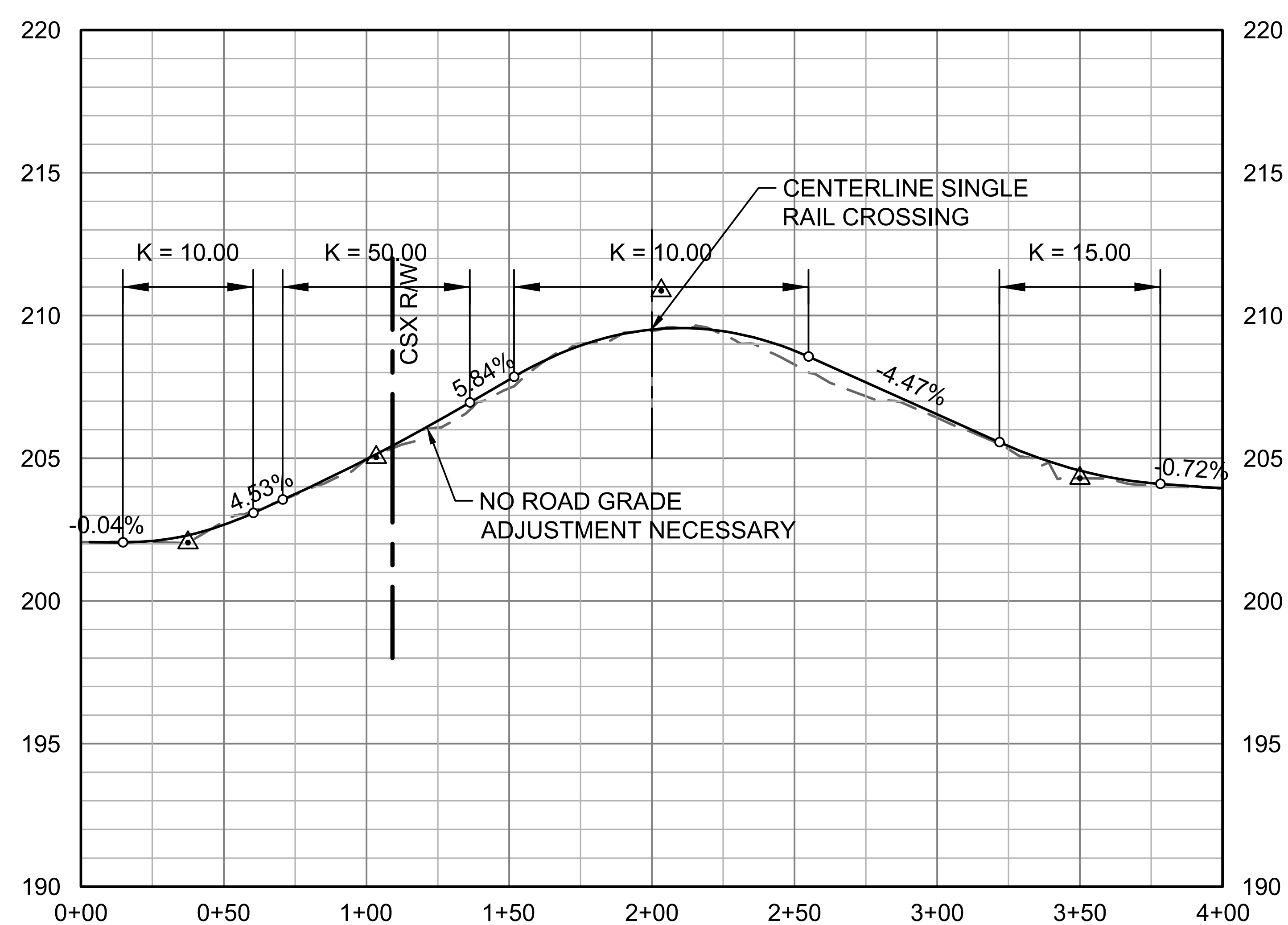
JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
ALTERNATIVE 5 PROPOSED ACCESS ROAD PROFILE

JOB NO. 34967
SHEET NO. ----

RAIL CROSSING PS ALT 6





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JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA
ALTERNATIVE 6 PROPOSED ACCESS ROAD PROFILE

JOB NO. 34967
SHEET NO. ----

APPENDIX H-6

SELECTED VIRGINIA ADMINISTRATIVE CODE

APPENDIX H-6-1

VIRGINIA ADMINISTRATIVE CODE TITLE 12. HEALTH AGENCY 5. DEPARTMENT OF HEALTH CHAPTER 590. WATERWORKS REGULATIONS 12VAC5-590-200 PROCUREMENT OF OBTAINING A CONSTRUCTION PERMIT

Virginia Administrative Code
Title 12. Health
Agency 5. Department of Health
Chapter 590. Waterworks Regulations

12VAC5-590-200. Procedure for Obtaining a Construction Permit.

Construction permits are issued by the Commissioner, but all requests for a construction permit are directed initially to the Field Office. The procedure for obtaining the permit includes the following steps: (i) the submission of an application, (ii) a preliminary engineering conference, (iii) the submission of an engineer's report (optional at the discretion of the Field Director), and (iv) the submission of plans, specifications, design criteria and other data in the number requested by the Division.

A. An application for a permit shall be submitted by the owner or authorized agent requesting permission to establish, construct, expand, modify, and/or operate a waterworks or water supply. The application shall clearly indicate whether the affected water supply is a community, nontransient noncommunity, or noncommunity waterworks.

B. A preliminary conference with the Division's appropriate District Engineer will be held. The applicant's engineer shall be prepared to set forth the water supply problems and the proposed solution in such a manner as to support his conclusions and recommendations.

C. The engineer's report and preliminary plans for waterworks shall present the following information where applicable:

1. General information - The report shall include:

    a. A description of any existing waterworks and sewerage facilities.

    b. Identification of the municipality or area served.

    c. The name and mailing address of the owner.

2. Extent of waterworks system - The report shall include:

    a. A description of the nature and extent of the area to be served.

    b. Provisions for extending the waterworks system to include additional areas.

    c. An appraisal of the future requirements for service, including existing and potential industrial, commercial, institutional and other water supply needs.

3. Alternate plans - Where two or more solutions exist for providing public water supply facilities, each of which is feasible and practicable, the report shall discuss the alternate plans and give reasons for selecting the one recommended, including financial considerations.

4. Soil, groundwater conditions, and foundation problems - The report shall include:

a. A description of the character of the soil through which water mains are to be laid.

b. A description of foundation conditions prevailing at sites of proposed structures.

c. A description of the approximate elevation of ground water in relation to subsurface structures.

5. Water consumption - The report shall include:

a. A description of the population trends as indicated by available records, and the estimated population which will be served by the proposed water supply system or expanded system.

b. Present and estimated future water consumption values used as the basis of design.

c. Present and estimated future yield of the sources of supply.

6. Fire flow requirements - if fire flows are to be provided, the quantity of fire flow which will be made available by the proposed or enlarged system shall be given.

7. Sewerage system available - Describe the existing system and sewage treatment works, with special reference to its relationship to the existing or proposed waterworks which may affect the operation of the water supply system, or which may affect the quality of the water supply.

8. Source of water supply - Describe the proposed source or sources of water supply to be developed and the reasons for their selection by supplying the following data:

a. Surface water sources

(1) Hydrological data, stream flow, and weather records;

(2) Safe yield, including all factors that may affect it;

(3) Maximum flood flow, together with approval for safety features of spillway and dam from appropriate reviewing authority;

(4) Summarized quality of raw water with special references to fluctuation in quality, changing meteorological conditions, sources of contamination, measures to protect the watershed, etc.

b. Groundwater sources

(1) Sites considered,

(2) Advantages of site selected,

(3) Elevation with respect to surroundings and 100-year flood,

(4) Probable character of geological formations through which source is to be developed,

(5) Unusual geological conditions affecting site,

(6) Summary of source exploration, test well depth and method of construction, placement of liners or screens; pumping test, hours, capacity; water level and specified yield, water quality,

(7) Possible sources of contamination.

9. Proposed treatment processes - Summarize and establish the adequacy of proposed processes for the treatment of the specified water under consideration (pilot studies may be required).

10. Waste disposal - Discuss the various wastes from the water treatment plant, their volume, proposed treatment and points for discharge.

11. Automatic equipment - Provide supporting data justifying automatic equipment, including servicing.

12. Project sites - The report shall include:

a. A discussion on various sites considered and advantages of the recommended one,

b. A description of the proximity of residences, industries, and other establishments,

c. The location of potential sources of pollution that may influence the quality of the supply or interfere with the effective operation of the waterworks system, such as sewage absorption systems, septic tanks, privies, cesspools, sink holes, sanitary landfills, petroleum storage tanks, etc.

13. Financing - The report shall state:

a. The estimated cost of integral parts of the system,

b. The detailed estimated annual cost of operation,

c. The proposed method of financing, both capital charges and operating expenses.

14. Future extensions - Summarize planning for future needs and service.

D. Plans for waterworks improvements shall provide the following:

1. A general layout which includes:

a. Suitable title, to include name of waterworks,

b. Name of owner of waterworks,

c. Area or institution to be served,

d. Scale, in feet,

e. North Point,

f. Datum used,

g. Boundaries of the municipality or area to be served,

h. Date, address, and name of designing engineer,

i. Imprint of professional engineer's seal (see 12VAC5-590-220),

j. Legible prints suitable for microfilming, with size not to exceed 30 inches by 42 inches,

k. Location and size of existing water mains,

l. Location and nature of existing waterworks structures and appurtenances affecting the proposed improvements noted on one sheet.

2. Detailed plans which include where applicable:

a. Stream crossings, providing profiles with elevations of the stream bed and the normal and extreme high and low water levels,

b. Profiles having a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch, with both scales clearly indicated,

c. Location and size of the property to be used for the groundwater development with respect to known references such as street intersections or section lines,

d. Topography and arrangement of present or planned wells or structures, with contour intervals not greater than two feet,

e. Elevation of highest known flood level, floor of structure, upper terminal of protective casing, and outside surrounding grade, using United States Coast and Geodetic Survey, United States Geological Survey, or equivalent elevations where applicable as reference,

f. Schematic drawing of well construction, showing diameter and depth of drillholes, casing and liner diameters and depths, grouting depths, elevations and designation of geological formation, water levels, and other details to describe the proposed well completely,

g. Location of all sources of pollution within 250 feet (or further, depending upon aquifer type and recharge area) of drilled wells, 100 feet of treated water storage facilities, five miles upstream from surface water intakes, and the entire drainage area of springs;

h. Size, length, identity and location or sewers, drains, water mains, and plant structures,

i. Schematic flow diagrams and hydraulic profiles showing the flow through various plant units,

j. Piping in sufficient detail to show flow through plant, including waste lines,

k. Location of all chemical feeding equipment and points of chemical application,

l. All appurtenances, specific structures, equipment, water treatment plant waste disposal units and point of discharge having any relationship to the plans for water mains and/or waterworks structures,

m. Location of sanitary or other facilities such as lavatories, showers, toilets, and lockers,

n. Location, dimensions and elevations of all proposed plant facilities,

o. Adequate description of all features not otherwise covered by the specifications.

E. Complete, detailed, technical specifications shall be supplied for the proposed project which include where applicable:

1. A program for keeping existing waterworks facilities in operation during construction of additional facilities so as to minimize interruption of service,

2. Laboratory facilities and equipment, as well as sampling taps and their locations,

3. Number and design of treatment process components,

4. Materials or proprietary equipment for sanitary or other facilities including any necessary backflow or backsiphonage protection,

5. Workmanship,

6. Other equipment.

F. A summary of complete design criteria shall be submitted for the proposed project, containing but not limited to the following where applicable:

1. Yield of source of supply,

2. Reservoir surface area,

3. Area of watershed,

4. Estimated water consumption,

5. Number of proposed services,

6. Fire-fighting requirements,

7. Basin capacities,

8. Retention times,

9. Unit loadings,

10. Filter area and proposed filtration rate,

11. Backwash rate,

12. Feeder capacities and ranges.

Statutory Authority

§§ 32.1-12 and 32.1-170 of the Code of Virginia.

Historical Notes

Derived from VR355-18-003.15 § 1.21, eff. August 1, 1991; amended, Virginia Register Volume 9, Issue 17, eff. June 23, 1993.

APPENDIX H-6-2

VIRGINIA ADMINISTRATIVE CODE TITLE 9. AGENCY 25. STATE WATER CONTROL BOARD. CHAPTER 260. WATER QUALITY STANDARDS PART IX. RIVER BASIN SECTION TABLES 9VAC25-260-360. SECTION NUMBER AND DESCRIPTIVE COLUMNS

Virginia Administrative Code
Title 9. Environment
Agency 25. State Water Control Board
Chapter 260. Water Quality Standards

Part IX. River Basin Section Tables

9VAC25-260-360. Section Number and Description Columns.

A. Basin descriptions. The tables that follow divide the state's surface waters into 10 river basins, some with subbasins: Potomac River Basin (Potomac and Shenandoah Subbasins), James River Basin (Appomattox River Subbasin), Rappahannock River Basin, Roanoke River Basin, Yadkin River Basin, Chowan and Dismal Swamp Basin (Chowan and Albemarle Sound Subbasins), Tennessee and Big Sandy Basins (Big Sandy, Clinch and Holston Subbasins), Chesapeake Bay, Atlantic Ocean and Small Coastal Basin, York River Basin and New River Basin. (See Figure 2.)

Figure 2.

Each basin is further divided into sections. Each section is assigned a class, represented by Roman Numerals I through VII, based on its geographic location or, in the case of trout waters, on its use. Descriptions of these classes are found in 9VAC25-260-50.

B. Potomac water supplies (raw water intakes). The Leesburg and County of Fairfax intakes in the Potomac are in Maryland waters and the board cannot adopt the public water supply criteria in 9VAC25-260-140 B to apply at the raw water intake points. However, applications to discharge into, or otherwise alter the physical, chemical, or biological properties of Virginia waters within an area five miles upstream of the intake will be reviewed on a case-by-case basis to ensure that they will protect the water supply. Basin sections where this would be applicable are shown with an asterisk (*) in the basin and section description columns.

Statutory Authority

§ 62.1-44.15 of the Code of Virginia; 33 USC § 1251 et seq. of the federal Clean Water Act; 40 CFR Part 131.

Historical Notes

Derived from VR680-21-08.1, eff. May 20, 1992; amended, Virginia Register Volume 14, Issue 4, eff. December 10, 1997; Volume 26, Issue 12, eff. February 1, 2010.

APPENDIX H-7
GEOTECHNICAL REPORTS

APPENDIX H-7-1
BREMO BRIDGE GEOTECHNICAL REPORT

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.			15	0015-014-V11, PE102, B605	8(56)

Boring No. 3
Station 108+79.0
Offset 2.7 Rt

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP. Columns: DESCRIPTION | STRATUM ELEV. | SAMPLE ELEV. | SAMPLE NO. | SPT HAMMER BLOWS

Description	Stratum Elev.	Sample Elev.	RQD	Rec.
ALLUVIUM brown medium sand	66.41			
FILL on N casing	66.11			
slate and quartzite boulder riprap in brown medium sand				
casing seated - on NQ Core Barrel		62.75		
BEDROCK	62.23			
.46m slate boulders & river cobbles 2.47m gray fine grained quartzite - 99% recovery RQD 98		59.70	98	99%
gray fine grained quartzite		56.96	100	101%

Boring No. 4
Station 108+83.0
Offset 3.0 Lt

Description	Stratum Elev.	Sample Elev.	Sample No.	SPT Hammer Blows
ALLUVIUM brown medium sand	65.98			
FILL	65.68			
slate and quartzite boulder riprap in brown medium sand				
slate fragments in brown medium sand		64.67 / 64.21	1	10 14 16
auger refusal - on NW34 core barrel		63.21		
gray fine grained quartzite boulder		62.25		97%
BEDROCK	61.04			
0.45 slate boulders, river cobbles & quartzite boulder 0.82 gray fine grained quartzite - (100% recovery "RQD" 44)		60.22	44	100%

Bottom of footing Pier 1

Boring No. 4A
Station 108+84.0
Offset CL

Description	Stratum Elev.	Sample Elev.	RQD	Recovery
FILL on N casing	65.83			
slate and quartzite boulder riprap in brown medium sand				
casing seated - on NQ core barrel		61.50		
BEDROCK	61.14			
0.18 quartzite boulder 1.25 gray fine grained quartzite - (100% recovery RQD 95)		59.19	95	100%

Bottom of footing Pier 1

Boring No. 5 (River Sounding)
Station 109+29.6
Offset 2.1 Rt

Description	Stratum Elev.
BEDROCK quartzite	60.53

Bottom of footing Pier 2

Boring No. 6 (River Sounding)
Station 109+30.0
Offset CL

Description	Stratum Elev.
BEDROCK quartzite	60.31

Elevation scale: 72, 70, 68, 66, 64, 62, 60, 58, 56

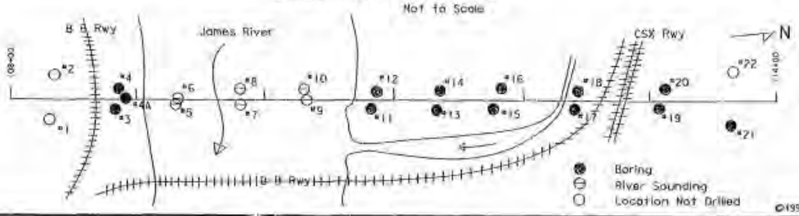
SUBSURFACE INFORMATION
Scale: 1 : 50

SUBSURFACE INFORMATION

This subsurface information shown on the boring logs in these plans was obtained with reasonable care and recorded in good faith solely for use by the Department in establishing design controls for the project. The Department has no reason to suspect that such information is not reasonably accurate as an approximate indication of the subsurface conditions at the sites where the borings were taken. The Department does not in any way warrant or guarantee that such data can be projected as indicative of conditions beyond the limits of the borings shown and any such projections by bidders are purely interpretive and altogether speculative. Further, the Department does not in any way guarantee, either expressly or by implication, the sufficiency of the information for bid purposes.

The boring logs are made available to bidders in order that they may have access to subsurface data identical to that which is possessed by the Department, and are not intended as a substitute for personal investigation, interpretation and judgment by the bidders.

BORING LAYOUT SKETCH
Not to Scale



EQUIPMENT - Hollow Stem Augers

VDOT METRIC

97-53-12
Route 15 over James River and CSX and Buckingham Branch Railways

No.	Description	Date
	Revisions	

COMMONWEALTH OF VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

0015-014-V11, 101, B605
BUCKINGHAM & FLUVANNA COUNTIES
ENGINEERING GEOLOGY

Logged: KJJ / Drawn: GLW / Checked: GLW	Date	Plan No.	Sheet No.
	MAR. 1998	267-61	56 of 59

20 20 20

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.			15	0015-014-V11, PE102, B605	B571

Boring No. 7 (River Sounding)

Station 109+79.4
Offset 1.3 Rt

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP

DESCRIPTION	STRATUM ELEV.	SAMPLE ELEV.	SAMPLE NO.	SPT HAMMER BLOWS
BEDROCK quartzite	60.88			

Bottom of footing Pier 3

Boring No. 8 (River Sounding)

Station 109+78.7
Offset 3.5 Lt

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP

DESCRIPTION	STRATUM ELEV.	SAMPLE ELEV.	SAMPLE NO.	SPT HAMMER BLOWS
BEDROCK quartzite	60.15			

Boring No. 9 (River Sounding)

Station 110+29.1
Offset CL

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP

DESCRIPTION	STRATUM ELEV.	SAMPLE ELEV.	SAMPLE NO.	SPT HAMMER BLOWS
BEDROCK quartzite & slate	60.26			

Bottom of footing Pier 4

Boring No. 10 (River Sounding)

Station 110+28.1
Offset 2.9 Lt

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP

DESCRIPTION	STRATUM ELEV.	SAMPLE ELEV.	SAMPLE NO.	SPT HAMMER BLOWS
BEDROCK quartzite & slate	61.04			

Boring No. 11

Station 110+78.7
Offset 2.6 Rt

STANDARD PENETRATION TEST: SPOON 51 mm O.D., 63.5 kg HAMMER, 0.76 m DROP

DESCRIPTION	STRATUM ELEV.	SAMPLE ELEV.	SAMPLE NO.	SPT HAMMER BLOWS
ALLUVIUM brown silty sand	64.36			
brown silty sand		62.93 – 62.47	1	2 1 2
groundwater measuremnt - caved in	62.16			
	61.86			
coarse sand, gravel & cobble		61.40 – 60.95	2	7 8 11
COBBLES & BOULDERS	60.64	60.47		
BEDROCK auger refusal - on AW34 core barrel	60.46			
clay seam	59.36			
	59.30			
1-31 quartzite interbedded with slate near vertical fractures		58.95	26	96%

RQD Recovery

Bottom of footing Pier 5

Elevation scale: 72, 70, 68, 66, 64, 62, 60, 58, 56

SUBSURFACE INFORMATION

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SUBSURFACE INFORMATION

Scale: 1 : 50

EQUIPMENT - Hollow Stem Augers

VDOT METRIC

97-53-12
Route 15 over the James River and CSX and Buckingham Branch Railways
2

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

0015-014-V11, 101, B605
BUCKINGHAM & FLUVANNA COUNTIES
ENGINEERING GEOLOGY

No.	Description	Date		Date	Plan No.	Sheet No.
	Revisions		Drilled: KJJ Drawn: DLW Checked: DLW	MAR. 1998	267-61	57 of 59

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20 20 20

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
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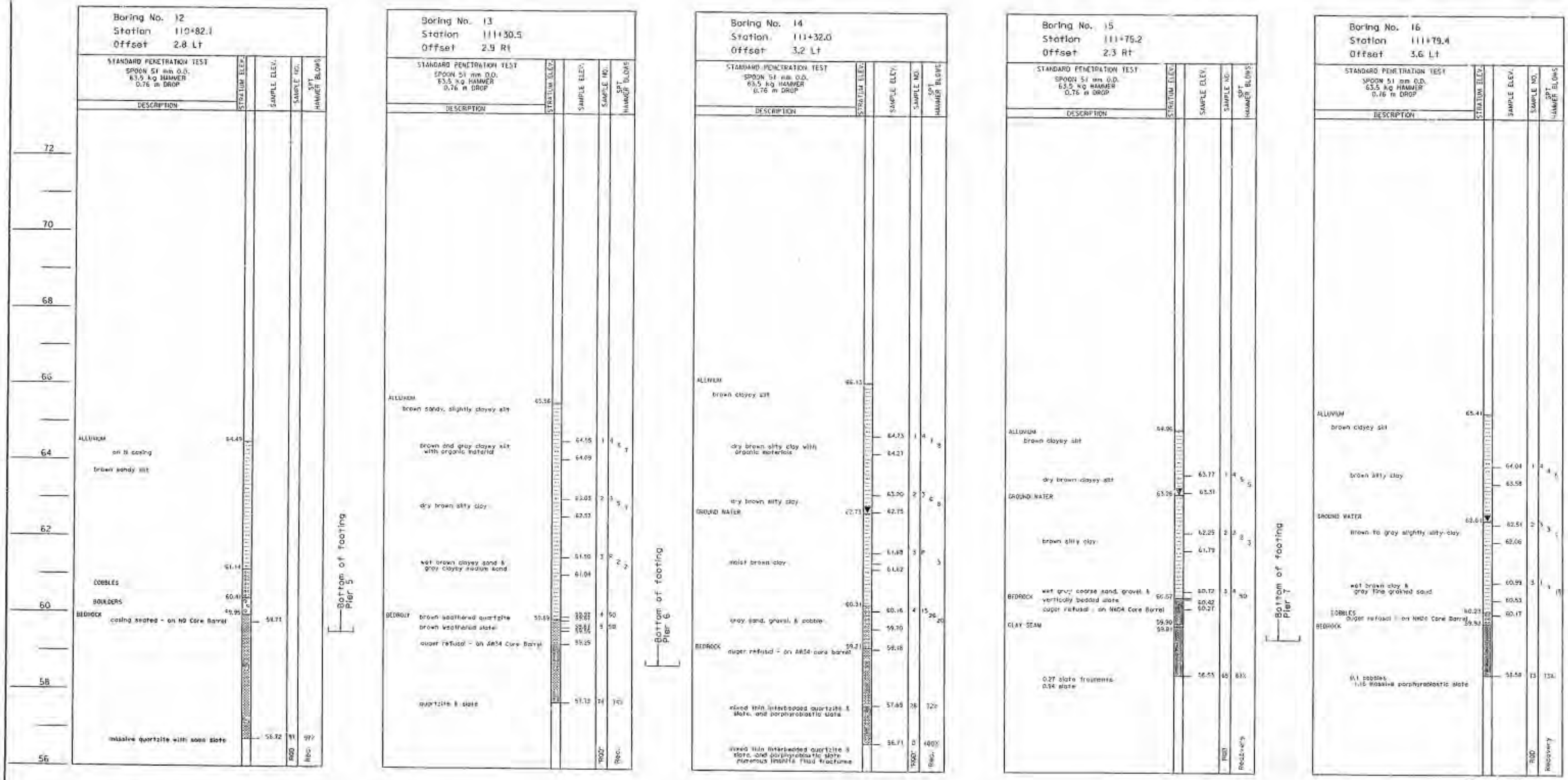

SUBSURFACE INVESTIGATION
Scale: 1 : 50

SUBSURFACE INFORMATION

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97-53-12
Route 15 over the James River and
CSX and Bukingham Branch Railways
3

VDOT METRIC

No.	Description	Date
	Revisions	

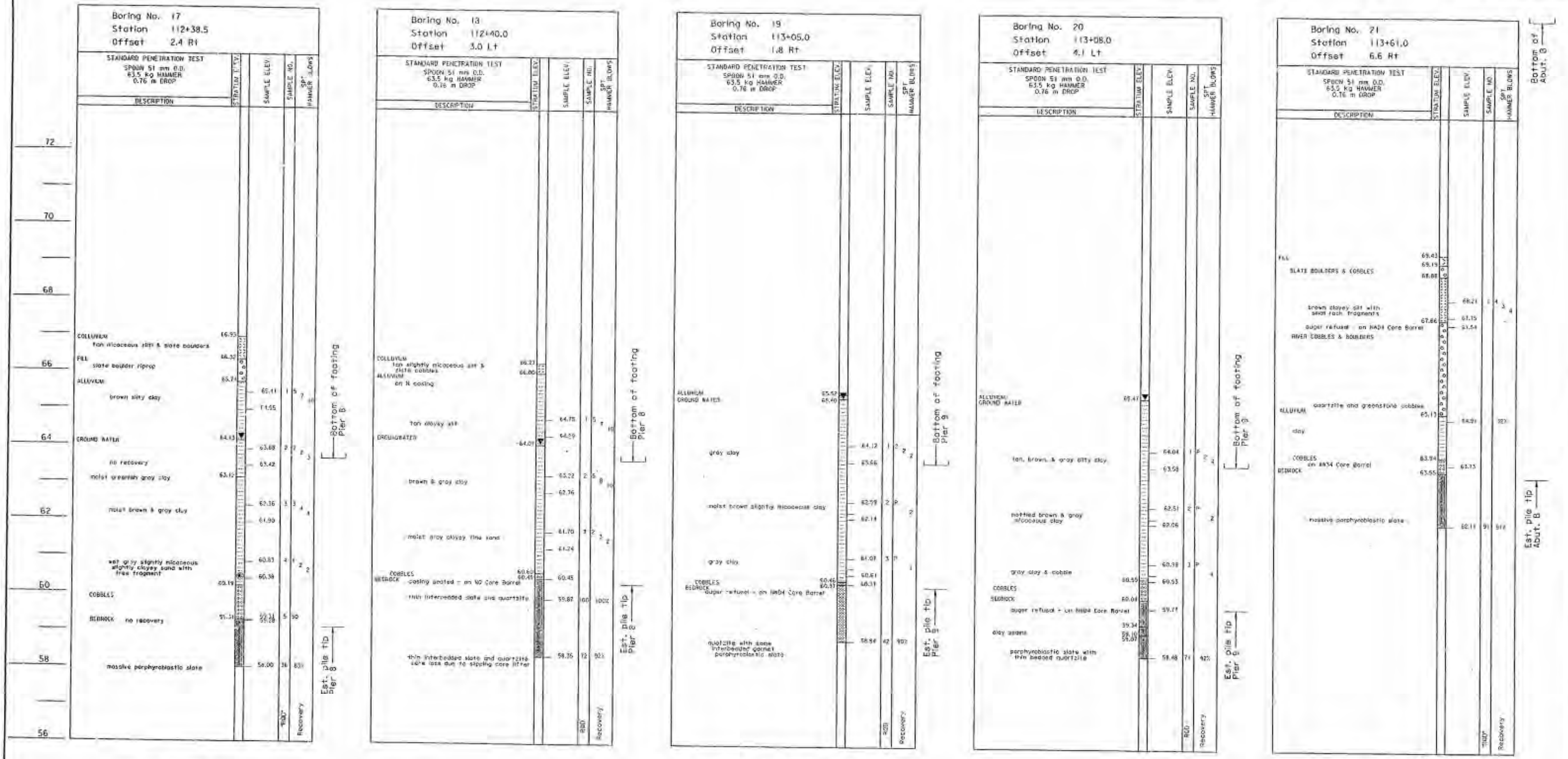
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

MATERIALS DIVISION

0015-014-V11, 101, B605
BUCKINGHAM & FLUVANNA COUNTIES
ENGINEERING GEOLOGY

Drilled: KJJ / Drawn: DLH / Checked: DLH	Date	Plan No.	Sheet No.
	MAR. 1998	267-61	58 of 59

FHWA REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.
3	VA.			15	0015-014-V11, PE102, B605	8(59)



SUBSURFACE INVESTIGATION
Scale: 1 : 50

SUBSURFACE INFORMATION

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97-53-12
Route 15 over the James River and CSX and Buckingham Railways

VDOT METRIC

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

0015-014-V11, 101, B605
BUCKINGHAM & FLUVANNA COUNTIES
ENGINEERING GEOLOGY

No.	Description	Date		Date	Plan No.	Sheet No.
Revisions			Drilled: KJJ / Drawn: DLW / Checked: DLB	MAR. 1998	267-61	59 of 59

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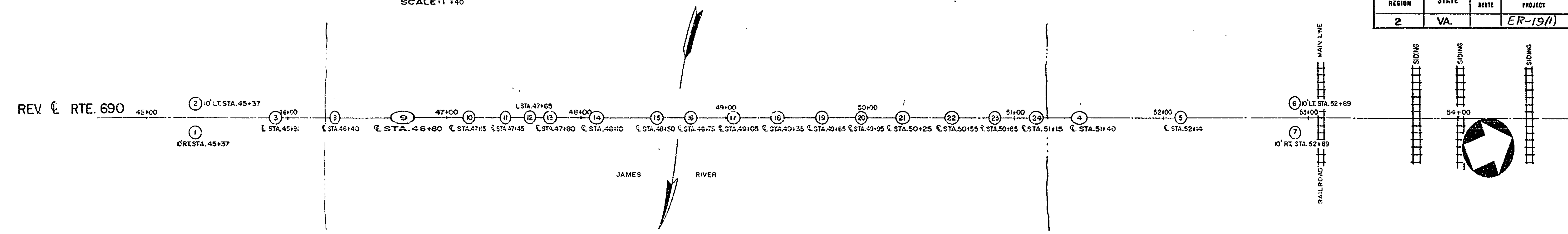
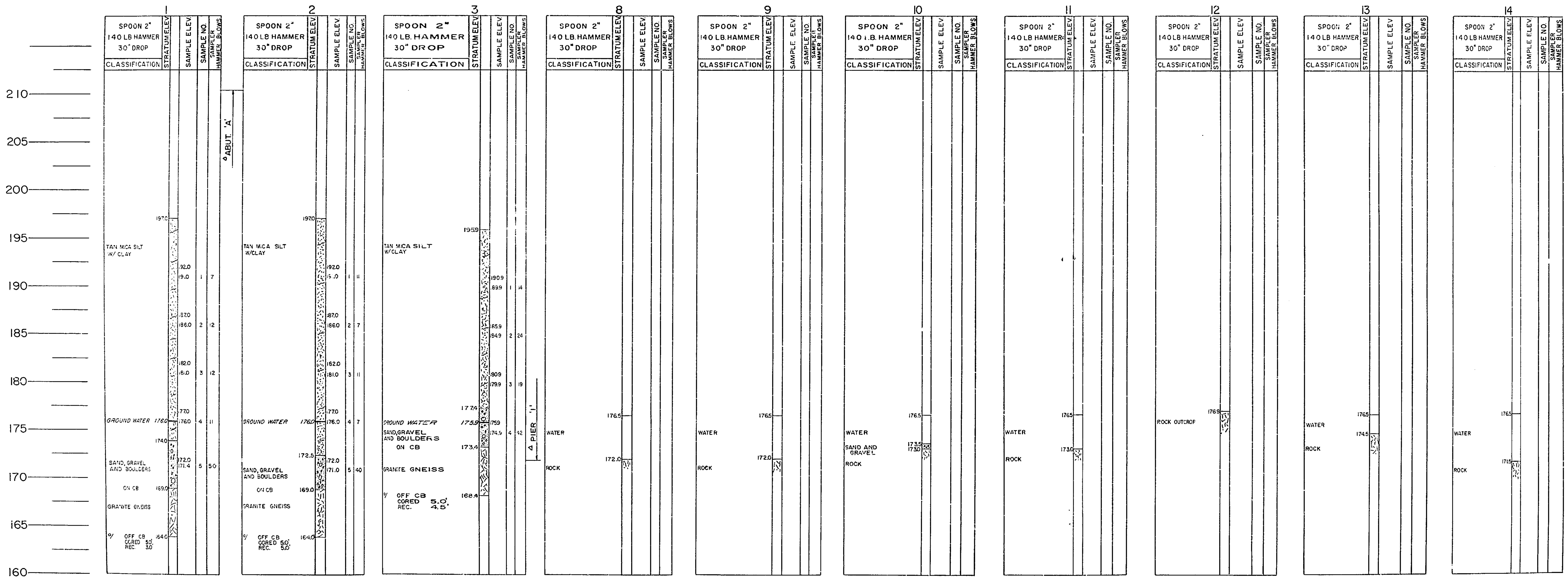
APPENDIX H-7-2
COLUMBIA BRIDGE GEOTECHNICAL REPORT

PUB. RD. REGION	STATE	FEDERAL AID ROUTE	FEDERAL AID PROJECT	STATE ROUTE	STATE PROJECT	SHEET NO.	TOTAL SHEETS
2	VA.		ER-19(1)	690	0690-032-119, B608		

PLAN
SCALE: 1"=40'





^ DENOTES BOTTOM OF FOOTING.

GEOLOGIC SECTION
SCALE: 1"=5'

NOTE:
THE LOGS SHOWN ON THIS PLAN WERE TAKEN FROM FIELD NOTES THEY REPRESENT THE BEST INFORMATION AVAILABLE TO THE VIRGINIA DEPARTMENT OF HIGHWAYS
% ELEVATION AT BOTTOM OF DRILL HOLE
EQUIPMENT - S & H CORE DRILL
CB - CORE BARREL
BORINGS 8 THRU 14 ARE PROBES (3/4")

VIRGINIA DEPARTMENT OF HIGHWAYS
ROUTE NO. 690 STA. 49+15
PROJ. NO. 0690-032-119, B608
ENGINEERING GEOLOGY
MATERIALS DIVISION
RTE. 690 OVER JAMES RIVER
FLUVANNA COUNTY
NOVEMBER 5, 1969

69-57-15
SHEET 1 OF 2

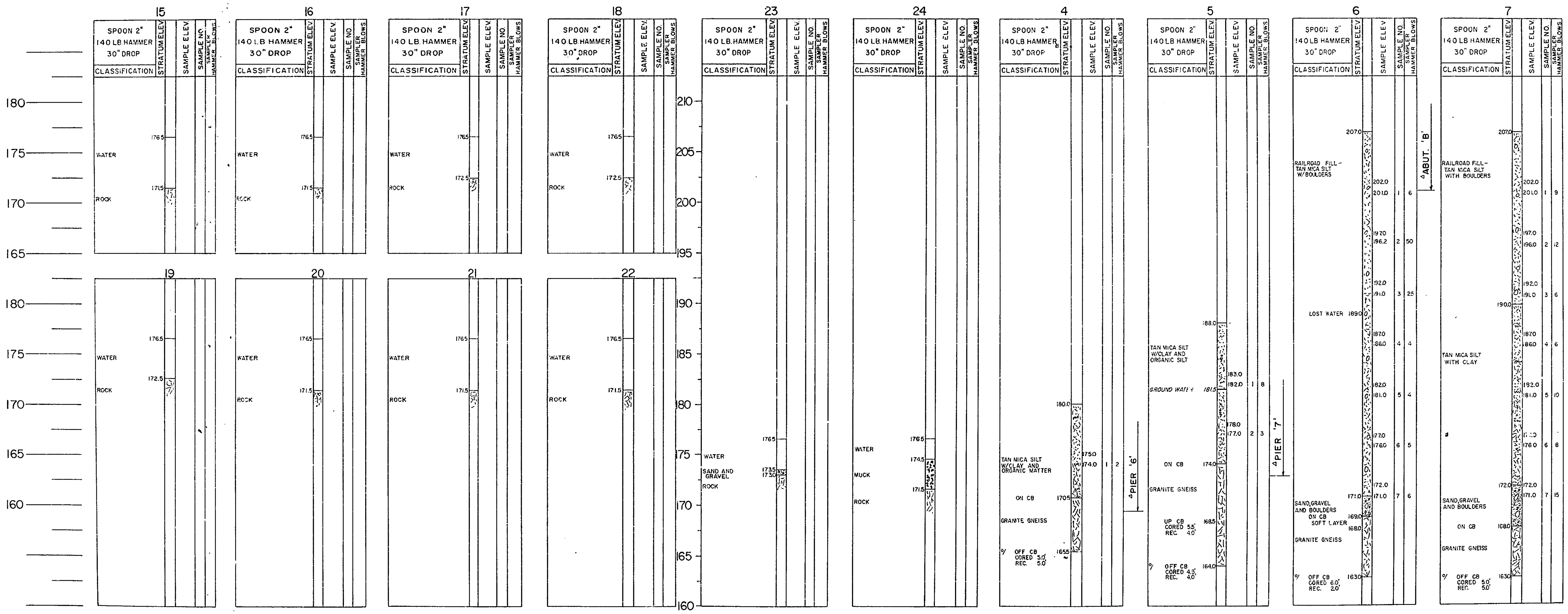
FIELD LOG BY: G.T. GILBERT
Drawn by: R. SARKOZI
Traced by:
Checked by: T.A. HOUSTON

224-22
Sheet 21 of 22

2 2 4 - 2 2 _ 0 2 2 1

PUB. RD. REGION	STATE	FEDERAL AID		STATE		SHEET NO.	TOTAL SHEETS
		ROUTE	PROJECT	ROUTE	PROJECT		
2	VA.		ER-19(1)	690	0690-032-119, B608		

FOR LAYOUT SEE SHEET 1



$^{\Delta}$ DENOTES BOTTOM OF FOOTING.

GEOLOGIC SECTION

SCALE: 1"=5'

NOTE:

THE LOGS SHOWN ON THIS PLAN WERE TAKEN FROM FIELD NOTES THEY REPRESENT THE BEST INFORMATION AVAILABLE TO THE VIRGINIA DEPARTMENT OF HIGHWAYS

% ELEVATION AT BOTTOM OF DRILL HOLE

EQUIPMENT - S & H CORE DRILL

CB - CORE BARREL

BORINGS 15 THRU 24 ARE PROBES ($\frac{3}{4}$")

69-57-15
SHEET 2 OF 2

VIRGINIA DEPARTMENT OF HIGHWAYS
ROUTE NO. 690 STA. 49+15
PROJ. NO. 0690-032-119, B608
ENGINEERING GEOLOGY
MATERIALS DIVISION
RTE. 690 OVER JAMES RIVER
FLUVANNA COUNTY
NOVEMBER 5, 1969

FIELD LOG BY - G.T. GILBERT
Drawn by: R. SARKOZI
Traced by:
Checked by: T.A. HOUSTON

224-22
Sheet 22 of 22
F

APPENDIX H-8

3-PHASE POWER TIE-IN LOCATIONS SUPPORT DOCUMENT

TIMMONS GROUP

Memorandum to File:

Project: JRWA Alternatives Analysis
Date: March 2020
Re: Tie-in Locations for 3-phase Power for proposed Pump Station Locations
By: David Saunders, PE & Joe Hines, PE

Overview:

As part of the Alternatives Analysis for the JRWA, Timmons Group had to assess a reasonable location for to tie-in 3-phase power for each pump station (PS) alternative. As such, Timmons Group engaged William Jennings, PE Electrical Engineer (contact information below) to help evaluate and confirm potential tie-in locations that would be closest to each PS site.

Timmons Group forwarded pictures of the closest power poles that were in place along existing roads. After consultation with Jennings, it was concluded that the locations shown on the attached exhibit were logical and reasonable tie-in points for the 3-phase power for each of the PS alternatives.

Basic requirements for tie-in locations included Jennings confirming these locations, based upon the pictures provided, has 3-phase power available on the power poles and based upon his experience, thought that Dominion could provide "power drops" to allow the JRWA to tie-in the pump stations to the Dominion system.

William R Jennings, Jr.
Consulting Engineering, PC
316 Brook Park Place
Suite A3
Forest, VA 24551
Phone: (434) 525-7099
Cell: (434) 941-4923
Email: bjennings@jenningspe.com
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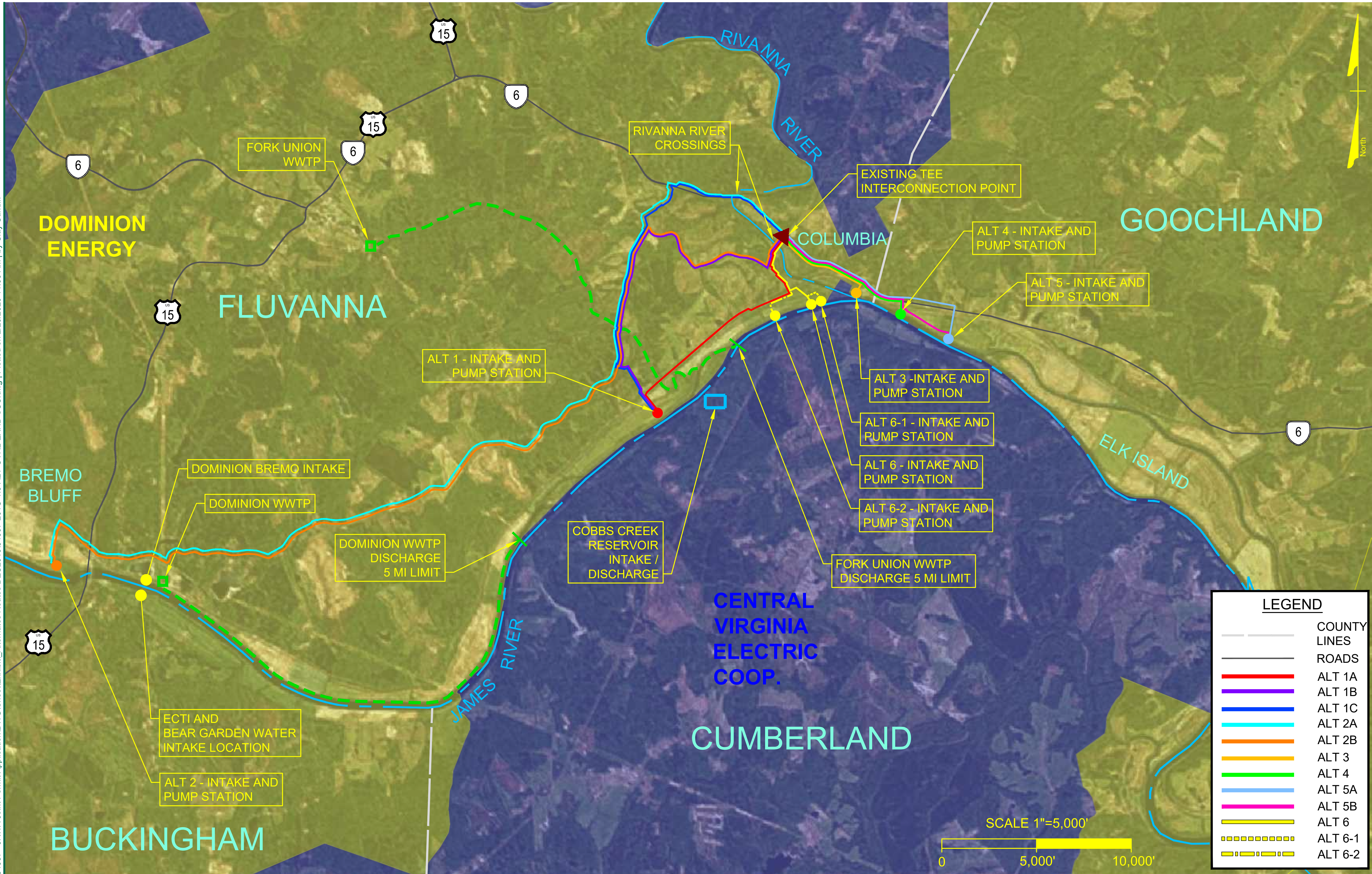

JRWA ALTERNATIVE INTAKE, PUMP STATION AND PIPELINE LOCATIONS

Electric Service Territory Map: Dominion is yellow and CVEC is blue

\\timmons.com\gfs\200\201\34967 - JRWA Joint Permit Application\DWG\Sheet\Exhibit_Alternates Routes DEC2019\34967-201C-1.0-ALT-OVRL-EXHB-SCC.dwg | Plotted on 2/20/2020 11:00 AM | by Clay Cundiff

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REVISION DESCRIPTION

DATE

DATE
DRAWN BY
DESIGNED BY
CHECKED BY
SCALE 1"= 5,000'

JAMES RIVER WATER AUTHORITY PROJECT
FORK UNION DISTRICT, FLUVANNA COUNTY, VIRGINIA
ALTERNATIVE INTAKE, PUMP STATION AND PIPELINE LOCATION

JOB NO. 34967
SHEET NO. --

APPENDIX H-9

COST CONSIDERATION SUPPORT DOCUMENTS

APPENDIX H-9-1
CONSTRUCTION COST CONSIDERATIONS

JRWA Construction Cost Estimate Line Item Summary

The Build Alternative Cost Estimate Analysis construction cost estimates are based on a common set of cost line items that are listed below. Each of these line items represent the total cost to construct each item and include all Labor, Materials and Equipment (LME) associated with the item. These cost estimates were developed working with our contracting partners, Faulconer Construction and MEB, to reflect a contractor's proposed Schedule of Values, which is intended to be as accurate and as complete as possible given the level of information available at the time the estimates were developed. It's important to note these estimates do not include a "contingency" fee as is normal in engineer's estimates as these numbers are based upon what our team believes are bid level unit prices.

The line items in these estimates are further described below:

Item 100 - Intake Structure and Gravity Pipe to Wetwell
Includes all LME including but not limited to coffer dam in river, dewatering, soil and rock excavation, bedding, backfill, concrete structure, intake screens, manifold piping, deflector rails, riverbank stabilization and gravity pipe to pump station wetwell.

Item 101 – Pump Station (everything in the building envelope)
Includes all LME including but not limited to dewatering, reinforced concrete wetwell structure, structural framing and piers, building enclosure, generator alcove, stairs, landings, pumps, piping, electrical equipment and lighting, generator, heat, ventilation, air handling, intake screen air-burst system, pump controls, backfill of soil, and all incidental items to construct a complete working pump station.

Item 102 – Pump Station Site Work
Includes all LME including but not limited, site grading and clearing, erosion and sediment control, graveled pavement surfaces, temporary and permanent site stabilization and fencing.

Item 103 – Pump Station; Excavation & Rock Removal
Includes all LME including but not limited to excavation of soil and rock necessary to construct pump station with a layback excavation, temporary stockpile of excavated soils, haul and disposal of excess excavated soils and rock.

Item 104 – New Access Road on Ag. Field
Includes all LME including but not limited to subgrade preparation and 12 inches minimum depth gravel road surface to permit a safe and sustainable access for construction equipment and long-term use and operation of the pump station facilities.

Item 105 – Upgrade Existing Gravel Access Road
Includes all LME including but not limited to installation of 4 to 12 inches of gravel road surface to permit a safe and sustainable access for construction equipment and long-term use and operation of the pump station facilities.

Item 106 – Rail Crossing Improvements; per track
Includes all LME including but not limited to construction of rail crossing guard ties, driving surface and approach aprons to permit a safe and sustainable access for construction

equipment, and long-term use and operation of the pump station facilities. In addition this number is intended to include a reasonable budget for the CSX Force Account, which allows CSX to have personnel on site during the construction activities for these improvements.

Item 107 – Rail Crossing Approach Fill
Includes all LME including but not limited to import, placement and compaction of soil materials to construct an approach and exit ramp at rail crossings to permit a safe and sustainable access for construction equipment and long-term use and operation of the pump station facilities.

Item 108 – Culvert/Stream Crossing Approach Fill
Includes all LME including but not limited to import, placement and compaction of soil materials to construct a fill section for road crossings to permit a safe and sustainable access for construction equipment, and long-term use and operation of the pump station facilities.

Item 109 – 60" RCP Culvert
Includes all LME including but not limited to excavation, bedding, backfill, and reinforced concrete pipe installation.

Item 110 – 36" RCP Culvert
Includes all LME including but not limited to excavation, bedding, backfill and, reinforced concrete pipe installation.

Item 111 – Concrete Headwall with Riprap
Includes all LME including but not limited to excavation, backfill, and reinforced concrete headwall construction, with riprap apron.

Item 112 – Guardrail
Includes all LME to install a Virginia Department of Transportation (VDOT) standard guardrail to prevent provide safe access at sloped fill embankments.

Item 200 – 24" Class 350 Ductile Iron Pipe
Includes all LME including but not limited to excavation, bedding, backfill, and ductile iron pipe installation. This line item also includes all pipe fittings, valves, air release valves, hydrants, tracer tapes, testing, and restoration.

Item 201 – 30" Class 350 Ductile Iron Pipe
Includes all LME including but not limited to excavation, bedding, backfill, and ductile iron pipe installation. This line item also includes all pipe fittings, valves, air release valves, hydrants, tracer tapes, testing, and restoration.

Item 202 – Clearing
Includes all LME including but not limited to clearing and chipping of trees and tree limbs within the construction corridor.

Item 203 – Rock Excavation
Includes all LME including excavation and disposal of rock to permit the installation of pipeline and appurtenances to the proposed horizontal and vertical alignment.

Item 204 – Pipeline Production Adjustment Along VDOT R/W
Includes all LME for the additional cost of construction in a VDOT R/W to include but not limited to additional cost of staging materials, reduced production due to limited staging areas, and equipment access. A Maintenance of Traffic (MOT) plan would be developed in conjunction with VDOT for these improvements.

Item 205 – Pipeline Adjustment for Construction in Travel Lane
Includes all LME to construct a pipeline in a travel lane to include but not limited to pavement removal and replacement, full depth trench backfilled with stone, restoration of pavement markings, plated excavation closures during off work hours, traffic barricades, and reduce production. A Maintenance of Traffic (MOT) plan would be developed in conjunction with VDOT for these improvements.

Item 206 – Maintenance of Traffic Route 6
Includes all LME to provide flagging, signage, and or temporary signals. A Maintenance of Traffic (MOT) plan would be developed in conjunction with VDOT for these improvements.

Item 207 – Maintenance of Traffic Secondary Roads
Includes all LME to provide flagging, signage, and or temporary signals. A Maintenance of Traffic (MOT) plan would be developed in conjunction with VDOT for these improvements.

Item 208 – Stream Crossing (Temporary)
Includes all LME to construct a stream crossing and provide restoration of the crossing to preconstruction conditions.

Item 209 – Colonial Gas Pipeline Crossing (Open Field)
Includes all LME to construct a crossing of the gas pipeline including hand excavation in proximity of the gas pipeline, additional depth of installation, additional testing of backfill, increased safety oversight, and restoration.

Item 210 – Colonial Gas Pipeline Crossing (Adjacent to Rte. 6)
Includes all LME to construct a crossing of the gas pipeline including hand excavation in proximity of the gas pipeline, increased safety oversight, and restoration, and additional cost to coordinate additional utilities in proximity of the gas pipeline.

Item 211 – 42” Jack & Bore Rail Crossing for 24” Pipe
Includes all LME to install a jacked and bored crossing to include but not limited to excavation, dewatering, backfill and restoration of bore and receiving pits, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 212 – 48” Jack & Bore Rail Crossing for 30” Pipe
Includes all LME to install a jacked and bored crossing to include but not limited to excavation, dewatering, backfill and restoration of bore and receiving pits, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 213 – 42” Jack & Bore Road Crossing for 24” Pipe

Includes all LME to install a jacked and bored crossing to include but not limited to excavation, dewatering, backfill and restoration of bore and receiving pits, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 214 – 48” Jack & Bore Road Crossing for 30” Pipe
Includes all LME to install a jacked and bored crossing to include but not limited to excavation, dewatering, backfill and restoration of bore and receiving pits, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 215 – Rivanna River Crossing for 24” Pipe
Includes all LME to install the river crossing but not limited to excavation of approach ramps, provision of coffer dam, dewatering, rock excavation, installation and testing of ductile iron pipe and fittings, concrete pipe encasement, riverbank stabilization, pipe bedding, backfill, and restoration of site.

Item 216 – Rivanna River Crossing for 30” Pipe
Includes all LME to install the river crossing but not limited to excavation of approach ramps, provision of coffer dam, dewatering, rock excavation, installation and testing of ductile iron pipe and fittings, concrete pipe encasement, riverbank stabilization, pipe bedding, backfill, and restoration of site.

Item 300 – Add Pre-Settling Basin and Clarifiers at Treatment Plant
Includes all LME to construct a 5 million gallon open-top prestressed concrete pre-settling basin with inlet and outlet piping, valves, access ladders, solids removal sump and disposal facilities. Construction of dual sludge blanket clarifiers (each rated at 2 MGD) with inlet and outlet piping, valve, platforms, compressor, and sludge piping. Includes recirculation pumps for clarifier startup, chemical feed systems, and controls in a building enclosure.

Item 301 – Sheeted Excavation to Bedrock
Includes all LME to install a sheeting for maintaining a safe excavation during construction. Includes cost of installing and removal of steel sheeting.

Item 302 – Horizontal Sheet Braces at 8’ O.C. and Whalers
Includes all LME to install horizontal bracing to support steel sheeted excavation. Cost is based on welded and/or bolted steel “I” beam cross members. Bracing will be installed as the excavation descends and will be removed as the wetwell structure and other structural components are installed, and structures are backfilled.

Item 303 – Excavate Soil Through Horizontal Sheet Bracing
Includes all LME for the additional cost of construction through the braced excavation. This process will be exceeding slow due to limited use of mechanized equipment as compared to an excavation that is laidback thus providing ample room for use of dozers and long reach excavation arms.

Item 304 – Excavate Rock Through Horizontal Sheet Bracing

Includes all LME for the additional cost of construction through the braced excavation. This process will be exceeding slow due to limited use of mechanized equipment as compared to an excavation that is laidback thus providing ample room for use of dozers and long reach excavation arms.

Item 305 – Additional Crane for Pump Station Construction
Includes all LME to provide a construction crane for additional project duration due to site constraints.

Item 306 – Mobilization of Boring Equipment Through Horizontal Sheet Bracing
Includes all LME to setup and remove horizontal jack and bore equipment though a braced excavation.

Item 307 – Jack & Bore Gravity Inlet Pipe Through Rock
Includes all LME to install a jacked and bored excavation with casing to include but not limited to excavation of receiving pit, dewatering, backfill and restoration of receiving pit, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 308 – Jack & Bore Air Bursting Piping
Includes all LME to install a jacked and bored excavation with casing to include but not limited to excavation of receiving pit, dewatering, backfill and restoration of receiving pit, boring and jacking of steel casing, casing pipe, welding, pipe spacers in casing end closures, and inspections.

Item 309 – Increase Gravity Inlet Pipe
Includes all LME for installation of additional gravity pipe inside casing, due to lengthened distance between intake and pump station.

Item 310 – Increase Air Burst Pipe
Includes all LME for installation of additional air burst inside casing, due to lengthened distance between intake and pump station.

Item 311 – Pump Station Productivity Losses (5 FTE @ $80k/yr)
Accounts for increased labor required due to site constraints.

Item 312 – Crane for Intake Construction
Includes all LME to provide a construction crane for project duration of intake construction due to site constraints
.
Item 313 – MOT; Close Lane at Columbia Bridge
Includes all LME to provide additional maintenance of traffic during work hours. Includes flagging, signage and barricades.

Item 314 – Temporary Traffic Signal at Bridge
Includes all LME to provide temporary traffic signals at bridge to control traffic around construction equipment and barricades during non-working hours.

Item 315 – Intake Productivity Losses (3 FTE @ $80k/yr)
Accounts for increased labor required due to site constraints.

APPENDIX H-9-2
OPINION OF PROBABLE COST

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Summary

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Project Comparison
Date: March 2020
Re: Opinion of Probable Cost

Project Comparison; To Least Cost Sub-Alternative

Build Sub-Alternative	Total Project Cost	Comparison to Least Cost Sub-Alternative	
		$ Increase	% Increase
ALT 1A	$ 33,854,000	$ 9,757,000	40%
ALT 1B	$ 41,659,000	$ 17,562,000	73%
ALT 1C	$ 43,896,000	$ 19,799,000	82%
ALT 2A	$ 93,569,000	$ 69,472,000	288%
ALT 2B	$ 91,565,000	$ 67,468,000	280%
ALT 3	$ 50,759,000	$ 26,662,000	111%
ALT 4	$ 43,690,000	$ 19,593,000	81%
ALT 5A	$ 49,425,000	$ 25,328,000	105%
ALT 5B	$ 46,532,000	$ 22,435,000	93%
ALT 6	$ 24,097,000	$ -	0%
ALT 6-1	$ 24,489,000	$ 392,000	2%
ALT 6-2	$ 24,779,000	$ 682,000	3%

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ALT 1A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000	$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000	$4,445,000
102	Pump Station Site Work	1	EA	$110,000	$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000	$630,000
104	New Access Road on Ag field	650	LF	$150	$97,500
105	Upgrade Existing Gravel Access Road	2,170	LF	$50	$108,500
106	Rail Crossing Improvements; per track	1	EA	$150,000	$150,000
107	Rail Crossing Approach Fill	1,470	CY	$15	$22,050
108	Culvert/Stream Crossing Approach Fill	1,995	CY	$15	$29,925
109	60" RCP Culvert	0	LF	$500	$0
110	36" RCP Culvert	330	LF	$350	$115,500
111	Concrete Headwall with Riprap	6	EA	$5,000	$30,000
112	Guardrail	160	LF	$35	$5,600
				Sub-Total	$7,239,000
Raw Water Pipeline Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
200	24" Class 350 Ductile Iron Pipe	14,500	LF	$375	$5,437,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425	$0
202	Clearing	2,200	LF	$25	$55,000
203	Rock Excavation	0	LF	$200	$0
204	Pipeline Production Adjustment Along VDOT R/W	100	LF	$48	$4,800
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200	$0
206	Maintenance of Traffic Route 6	100	LF	$50	$5,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35	$0
208	Stream Crossing (Temporary)	930	LF	$500	$465,000
209	Colonial Gas Pipeline Crossing (Open Field)	2	EA	$150,000	$300,000
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000	$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	100	LF	$1,300	$130,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500	$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200	$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300	$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500	$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000	$0
				Sub-Total	$7,129,000
Additional Construction Costs					
Item	Description	Quantity	Units	Unit $	Total Cost
300					$0
				Sub-Total	$0
				Sub-Total	**$14,368,000**
			Contractor General Conditions	4.0%	$574,720
			Construction Quality Control	1.0%	$143,680
			Support Services; Administrative and Professional	20.0%	$2,873,600
				Total Construction and Support Services	**$17,960,000**

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ALT 1A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	21.75	Ac	$25,051	$544,859
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	11	EA	$23,372	$257,092
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$857,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	3	Estimated Mile of WOUS Perimeter	$3,000	$9,870
501	WOUS Delineation; Field Time & Mapping	12	Day	$1,500	$18,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	3	Each VMRC Impact	$12,000	$36,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	3	Crossing	$12,000	$36,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	2	Crossing	$8,000	$16,000
507	Stream Mitigation Credits	223	Credit	$400	$89,200
508	Wetland Mitigation Credit	0.14	Credit	$55,000	$7,700
				Sub-Total	**$343,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Phase I Cultural Resource Survey	1	LS	$381,000	$381,000
				Sub-Total	**$381,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$17,960,000
				Property Acquisition Cost	$857,000
				Environmental Cost	$343,000
				Cultural Impacts Cost	$381,000
Project Financing					
			Total Project Costs Prior to Financing		$19,541,000
			Loan Origination Fee	3.00%	$586,200
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$13,727,000
				Total Probable Project Cost - ALT 1A	**$33,854,000**

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ALT 1B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	650	LF	$150		$97,500
105	Upgrade Existing Gravel Access Road	2,170	LF	$50		$108,500
106	Rail Crossing Improvements; per track	1	EA	$150,000		$150,000
107	Rail Crossing Approach Fill	1,470	CY	$15		$22,050
108	Culvert/Stream Crossing Approach Fill	1,995	CY	$15		$29,925
109	60" RCP Culvert	0	LF	$500		$0
110	36" RCP Culvert	330	LF	$350		$115,500
111	Concrete Headwall with Riprap	6	EA	$5,000		$30,000
112	Guardrail	160	LF	$35		$5,600
					Sub-Total	$7,239,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	20,900	LF	$375		$7,837,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	9,300	LF	$25		$232,500
203	Rock Excavation	0	LF	$200		$0
204	Pipeline Production Adjustment Along VDOT R/W	13,100	LF	$48		$628,800
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200		$0
206	Maintenance of Traffic Route 6	100	LF	$50		$5,000
207	Maintenance of Traffic Secondary Roads	13,000	LF	$35		$455,000
208	Stream Crossing (Temporary)	910	LF	$500		$455,000
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	200	LF	$1,300		$260,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200		$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500		$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$10,606,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$17,845,000**
				Contractor General Conditions	4.0%	$713,800
				Construction Quality Control	1.0%	$178,450
				Support Services; Administrative and Professional	20.0%	$3,569,000
					Total Construction and Support Services	**$22,306,000**

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ALT 1B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
400	Easement Purchase Cost	25.4	Ac	$25,051		$635,293
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	18	EA	$23,372		$420,696
402	Intake and Pump Station Parcel	1	EA	$55,000		$55,000
					Sub-Total	**$1,111,000**
Environmental Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
500	WOUS Delineation; Travel and supplies	1	Estimated Mile of WOUS Perimeter	$3,000		$2,460
501	WOUS Delineation; Field Time & Mapping	6	Day	$1,500		$9,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000		$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000		$120,000
504	Permitting Cost; VMRC	3	Each VMRC Impact	$12,000		$36,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	3	Crossing	$12,000		$36,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	1	Crossing	$8,000		$8,000
507	Stream Mitigation Credits	223	Credit	$400		$89,200
508	Wetland Mitigation Credit	0.34	Credit	$55,000		$18,700
					Sub-Total	**$329,000**
Cultural Impacts Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
600	Cultural Resources Ph I Costs	1	LS	$300,000		$300,000
					Sub-Total	**$300,000**
Project Sub-Totals						
					Total Construction and Support Services Cost	$22,306,000
					Property Acquisition Cost	$1,111,000
					Environmental Cost	$329,000
					Cultural Impacts Cost	$300,000
Project Financing						
				Total Project Costs Prior to Financing		$24,046,000
				Loan Origination Fee	3.00%	$721,400
				Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$16,891,000
					Total Probable Project Cost - ALT 1B	**$41,659,000**

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ALT 1C

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1C Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000	$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000	$4,445,000
102	Pump Station Site Work	1	EA	$110,000	$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000	$630,000
104	New Access Road on Ag field	650	LF	$150	$97,500
105	Upgrade Existing Gravel Access Road	2,170	LF	$50	$108,500
106	Rail Crossing Improvements; per track	1	EA	$150,000	$150,000
107	Rail Crossing Approach Fill	1,470	CY	$15	$22,050
108	Culvert/Stream Crossing Approach Fill	1,995	CY	$15	$29,925
109	60" RCP Culvert	0	LF	$500	$0
110	36" RCP Culvert	330	LF	$350	$115,500
111	Concrete Headwall with Riprap	6	EA	$5,000	$30,000
112	Guardrail	160	LF	$35	$5,600
				Sub-Total	$7,239,000
Raw Water Pipeline Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
200	24" Class 350 Ductile Iron Pipe	21,300	LF	$375	$7,987,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425	$0
202	Clearing	9,900	LF	$25	$247,500
203	Rock Excavation	4,500	LF	$200	$900,000
204	Pipeline Production Adjustment Along VDOT R/W	11,000	LF	$48	$528,000
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200	$0
206	Maintenance of Traffic Route 6	9,000	LF	$50	$450,000
207	Maintenance of Traffic Secondary Roads	2,000	LF	$35	$70,000
208	Stream Crossing (Temporary)	845	LF	$500	$422,500
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000	$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000	$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	200	LF	$1,300	$260,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500	$0
213	42" Jack & Bore Road Crossing for 24" Pipe	50	LF	$1,200	$60,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300	$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500	$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000	$0
				Sub-Total	$11,586,000
Additional Construction Costs					
Item	Description	Quantity	Units	Unit $	Total Cost
300					$0
				Sub-Total	$0
				Sub-Total	**$18,825,000**
			Contractor General Conditions	4.0%	$753,000
			Construction Quality Control	1.0%	$188,250
			Support Services; Administrative and Professional	20.0%	$3,765,000
				Total Construction and Support Services	**$23,531,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 1C

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 1C Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Item	Description	Quantity	Units	Unit $		Total Cost
Property Acquisition Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
400	Easement Purchase Cost	21.9	Ac	$25,051		$547,865
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	26	EA	$23,372		$607,672
402	Intake and Pump Station Parcel	1	EA	$55,000		$55,000
					Sub-Total	**$1,211,000**
Environmental Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
500	WOUS Delineation; Travel and supplies	1.2	Estimated Mile of WOUS Perimeter	$3,000		$3,600
501	WOUS Delineation; Field Time & Mapping	7.0	Day	$1,500		$10,500
502	WOUS Delineation; Prep, Reporting, & Confirmation	1.0	EA	$10,000		$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1.0	Each	$120,000		$120,000
504	Permitting Cost; VMRC	3.0	Each VMRC Impact	$12,000		$36,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	3	Crossing	$12,000		$36,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	2	Crossing	$8,000		$16,000
507	Stream Mitigation Credits	223	Credit	$400		$89,200
508	Wetland Mitigation Credit	0.35	Credit	$55,000		$19,250
					Sub-Total	**$341,000**
Cultural Impacts Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
600	Cultural Resources Ph I Costs	1	LS	$255,000		$255,000
					Sub-Total	**$255,000**
Project Sub-Totals						
					Total Construction and Support Services Cost	$23,531,000
					Property Acquisition Cost	$1,211,000
					Environmental Cost	$341,000
					Cultural Impacts Cost	$255,000
Project Financing						
				Total Project Costs Prior to Financing		$25,338,000
				Loan Origination Fee	3.00%	$760,100
				Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$17,799,000
					Total Probable Project Cost - ALT 1C	**$43,896,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 2A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 2A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	2,310	LF	$150		$346,500
105	Upgrade Existing Gravel Access Road	170	LF	$50		$8,500
106	Rail Crossing Improvements; per track	1	EA	$150,000		$150,000
107	Rail Crossing Approach Fill	2,795	CY	$15		$41,925
108	Culvert/Stream Crossing Approach Fill	2,280	CY	$15		$34,200
109	60" RCP Culvert	100	LF	$500		$50,000
110	36" RCP Culvert	500	LF	$350		$175,000
111	Concrete Headwall with Riprap	10	EA	$5,000		$50,000
112	Guardrail	400	LF	$35		$14,000
					Sub-Total	$7,550,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	0	LF	$375		$0
201	30" Class 350 Ductile Iron Pipe	55,500	LF	$425		$23,587,500
202	Clearing	20,100	LF	$25		$502,500
203	Rock Excavation	9,200	LF	$200		$1,840,000
204	Pipeline Production Adjustment Along VDOT R/W	46,100	LF	$48		$2,212,800
205	Pipeline Adjustment for Construction in Travel Lane	6,400	LF	$200		$1,280,000
206	Maintenance of Traffic Route 6	2,100	LF	$50		$105,000
207	Maintenance of Traffic Secondary Roads	44,000	LF	$35		$1,540,000
208	Stream Crossing (Temporary)	895	LF	$500		$447,500
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	0	LF	$1,300		$0
212	48" Jack & Bore Rail Crossing for 30" Pipe	195	LF	$1,500		$292,500
213	42" Jack & Bore Road Crossing for 24" Pipe	0	LF	$1,200		$0
214	48" Jack & Bore Road Crossing for 30" Pipe	50	LF	$1,300		$65,000
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500		$0
216	Rivanna Crossing for 30" Pipe	120	LF	$6,000		$720,000
					Sub-Total	$32,593,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$40,143,000**
				Contractor General Conditions	4.0%	$1,605,720
				Construction Quality Control	1.0%	$401,430
				Support Services; Administrative and Professional	20.0%	$8,028,600
					Total Construction and Support Services	**$50,179,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 2A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 2A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	45.0	Ac	$25,051	$1,127,546
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	81	EA	$23,372	$1,893,132
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$3,076,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	3	Estimated Mile of WOUS Perimeter	$3,000	$8,100
501	WOUS Delineation; Field Time & Mapping	15	Day	$1,500	$22,500
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	3	Each VMRC Impact	$12,000	$36,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	3	Crossing	$12,000	$36,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	6	Crossing	$8,000	$48,000
507	Stream Mitigation Credits	277	Credit	$400	$110,800
508	Wetland Mitigation Credit	0.63	Credit	$55,000	$34,650
				Sub-Total	**$426,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$329,000	$329,000
				Sub-Total	**$329,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$50,179,000
				Property Acquisition Cost	$3,076,000
				Environmental Cost	$426,000
				Cultural Impacts Cost	$329,000
Project Financing					
			Total Project Costs Prior to Financing		$54,010,000
			Loan Origination Fee	3.00%	$1,620,300
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$37,940,000
				Total Probable Project Cost - ALT 2A	**$93,569,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 2B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 2B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	2,310	LF	$150		$346,500
105	Upgrade Existing Gravel Access Road	170	LF	$50		$8,500
106	Rail Crossing Improvements; per track	1	EA	$150,000		$150,000
107	Rail Crossing Approach Fill	2,795	CY	$15		$41,925
108	Culvert/Stream Crossing Approach Fill	2,280	CY	$15		$34,200
109	60" RCP Culvert	100	LF	$500		$50,000
110	36" RCP Culvert	500	LF	$350		$175,000
111	Concrete Headwall with Riprap	10	EA	$5,000		$50,000
112	Guardrail	400	LF	$35		$14,000
					Sub-Total	$7,550,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	0	LF	$375		$0
201	30" Class 350 Ductile Iron Pipe	55,200	LF	$425		$23,460,000
202	Clearing	19,400	LF	$25		$485,000
203	Rock Excavation	4,700	LF	$200		$940,000
204	Pipeline Production Adjustment Along VDOT R/W	48,000	LF	$48		$2,304,000
205	Pipeline Adjustment for Construction in Travel Lane	6,400	LF	$200		$1,280,000
206	Maintenance of Traffic Route 6	100	LF	$50		$5,000
207	Maintenance of Traffic Secondary Roads	47,900	LF	$35		$1,676,500
208	Stream Crossing (Temporary)	960	LF	$500		$480,000
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	0	LF	$1,300		$0
212	48" Jack & Bore Rail Crossing for 30" Pipe	195	LF	$1,500		$292,500
213	42" Jack & Bore Road Crossing for 24" Pipe	0	LF	$1,200		$0
214	48" Jack & Bore Road Crossing for 30" Pipe	60	LF	$1,300		$78,000
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500		$0
216	Rivanna Crossing for 30" Pipe	120	LF	$6,000		$720,000
					Sub-Total	$31,721,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$39,271,000**
				Contractor General Conditions	4.0%	$1,570,840
				Construction Quality Control	1.0%	$392,710
				Support Services; Administrative and Professional	20.0%	$7,854,200
					Total Construction and Support Services	**$49,089,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 2B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 2B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	48.6	Ac	$25,051	$1,218,230
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	73	EA	$23,372	$1,706,156
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$2,979,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	2.3	Estimated Mile of WOUS Perimeter	$3,000	$6,960
501	WOUS Delineation; Field Time & Mapping	15	Day	$1,500	$22,500
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	3	Each VMRC Impact	$12,000	$36,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	3	Crossing	$12,000	$36,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	5	Crossing	$8,000	$40,000
507	Stream Mitigation Credits	277	Credit	$400	$110,800
508	Wetland Mitigation Credit	0.62	Credit	$55,000	$34,100
				Sub-Total	**$416,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$368,000	$368,000
				Sub-Total	**$368,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$49,089,000
				Property Acquisition Cost	$2,979,000
				Environmental Cost	$416,000
				Cultural Impacts Cost	$368,000
Project Financing					
			Total Project Costs Prior to Financing		$52,852,000
			Loan Origination Fee	3.00%	$1,585,600
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$37,126,000
				Total Probable Project Cost - ALT 2B	**$91,565,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 3

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 3 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000	$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000	$4,445,000
102	Pump Station Site Work	1	EA	$110,000	$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000	$630,000
104	New Access Road on Ag field	160	LF	$150	$24,000
105	Upgrade Existing Gravel Access Road	0	LF	$50	$0
106	Rail Crossing Improvements; per track	2	EA	$150,000	$300,000
107	Rail Crossing Approach Fill	0	CY	$15	$0
108	Culvert/Stream Crossing Approach Fill	0	CY	$15	$0
109	60" RCP Culvert	0	LF	$500	$0
110	36" RCP Culvert	0	LF	$350	$0
111	Concrete Headwall with Riprap	0	EA	$5,000	$0
112	Guardrail	0	LF	$35	$0
				Sub-Total	$7,004,000
Raw Water Pipeline Construction Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
200	24" Class 350 Ductile Iron Pipe	5,300	LF	$375	$1,987,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425	$0
202	Clearing	1,000	LF	$25	$25,000
203	Rock Excavation	1,300	LF	$200	$260,000
204	Pipeline Production Adjustment Along VDOT R/W	4,000	LF	$48	$192,000
205	Pipeline Adjustment for Construction in Travel Lane	2,200	LF	$200	$440,000
206	Maintenance of Traffic Route 6	4,000	LF	$50	$200,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35	$0
208	Stream Crossing (Temporary)	380	LF	$500	$190,000
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000	$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	1	EA	$300,000	$300,000
211	42" Jack & Bore Rail Crossing for 24" Pipe	0	LF	$1,300	$0
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500	$0
213	42" Jack & Bore Road Crossing for 24" Pipe	40	LF	$1,200	$48,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300	$0
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500	$0
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000	$0
				Sub-Total	$3,643,000
Additional Construction Costs					
Item	Description	Quantity	Units	Unit $	Total Cost
300	Adds for Site Constraints				
	Pump Station Adds				
	Sheeted Excavation to Bedrock	10,080	SF	$35	$352,800
	Horizontal Sheet Braces at 8' O.C. and Whalers	8,640	LF	$150	$1,296,000
	Excavate Soil Through Horizontal Sheet Bracing	8,400	CY	$50	$420,000
	Excavate Rock Through Horizontal Sheet Bracing	4,800	CY	$100	$480,000
	Additional Crane for Pump Station Construction	2	Month	$20,000	$40,000
	Mob. of Boring Equip. Through Horiz. Sheet Bracing	1	LS	$50,000	$50,000
	Jack & Bore Gravity Inlet Pipe through Rock	500	LF	$3,000	$1,500,000
	Jack & Bore Air Burst Piping	500	LF	$1,500	$750,000
	Increase Gravity Inlet Pipe	275	LF	$250	$68,750
	Increase Air Burst Pipe	275	LF	$250	$68,750
	Productivity Losses (5 FTE @ $80k/yr)	6	Month	$33,333	$200,000
	Intake Adds				
	Crane for Intake Construction	5	Month	$20,000	$100,000

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ALT 3

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 3 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

	MOT; Close lane at Columbia Bridge	5	Month	$15,000		$75,000
	Temporary Traffic Signal at Bridge	5	Month	$15,000		$75,000
	Productivity Losses (3 FTE @ $80k/yr)	5	Month	$20,000		$100,000
301	Add Pre Settling Basin and Clarifiers at Treatment Plant	1	EA	$6,100,000		$6,100,000
					Sub-Total	$11,676,000
					Sub-Total	**$22,323,000**
				Contractor General Conditions	4.0%	$892,920
				Construction Quality Control	1.0%	$223,230
				Support Services; Administrative and Professional	20.0%	$4,464,600
					Total Construction and Support Services	**$27,903,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 3

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 3 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
400	Easement Purchase Cost	4.96	Ac	$25,051		$124,253
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	16	EA	$23,372		$373,952
402	Intake and Pump Station Parcel	1	EA	$473,000		$473,000
					Sub-Total	**$971,000**
Environmental Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
500	WOUS Delineation; Travel and supplies	0.11	Estimated Mile of WOUS Perimeter	$3,000		$330
501	WOUS Delineation; Field Time & Mapping	3	Day	$1,500		$4,500
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000		$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000		$120,000
504	Permitting Cost; VMRC	1	Each VMRC Impact	$12,000		$12,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	1	Crossing	$12,000		$12,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	1	Crossing	$8,000		$8,000
507	Stream Mitigation Credits	0	Credit	$400		$0
508	Wetland Mitigation Credit	0	Credit	$55,000		$0
					Sub-Total	**$167,000**
Cultural Impacts Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
600	Cultural Resources Ph I Costs	1	LS	$258,000		$258,000
					Sub-Total	**$258,000**
Project Sub-Totals						
					Total Construction and Support Services Cost	$27,903,000
					Property Acquisition Cost	$971,000
					Environmental Cost	$167,000
					Cultural Impacts Cost	$258,000
Project Financing						
				Total Project Costs Prior to Financing		$29,299,000
				Loan Origination Fee	3.00%	$879,000
				Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$20,581,000
					Total Probable Project Cost - ALT 3	**$50,759,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 4

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 4 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Item	Description	Quantity	Units	Unit $		Total Cost
Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	310	LF	$150		$46,500
105	Upgrade Existing Gravel Access Road	215	LF	$50		$10,750
106	Rail Crossing Improvements; per track	2	EA	$150,000		$300,000
107	Rail Crossing Approach Fill	1,760	CY	$15		$26,400
108	Culvert/Stream Crossing Approach Fill	0	CY	$15		$0
109	60" RCP Culvert	130	LF	$500		$65,000
110	36" RCP Culvert	0	LF	$350		$0
111	Concrete Headwall with Riprap	2	EA	$5,000		$10,000
112	Guardrail	400	LF	$35		$14,000
					Sub-Total	$7,153,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	8,500	LF	$375		$3,187,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	2,900	LF	$25		$72,500
203	Rock Excavation	3,800	LF	$200		$760,000
204	Pipeline Production Adjustment Along VDOT R/W	6,600	LF	$48		$316,800
205	Pipeline Adjustment for Construction in Travel Lane	2,500	LF	$200		$500,000
206	Maintenance of Traffic Route 6	6,600	LF	$50		$330,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	510	LF	$500		$255,000
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	1	EA	$300,000		$300,000
211	42" Jack & Bore Rail Crossing for 24" Pipe	155	LF	$1,300		$201,500
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	55	LF	$1,200		$66,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500		$0
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$5,989,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
301	Add Pre Settling Basin and Clarifiers at Treatment Plant	1	EA	$6,100,000		$6,100,000
					Sub-Total	$6,100,000
					Sub-Total	**$19,242,000**
				Contractor General Conditions	4.0%	$769,680
				Construction Quality Control	1.0%	$192,420
				Support Services; Administrative and Professional	20.0%	$3,848,400
					Total Construction and Support Services	**$24,052,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 4

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 4 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	8.39	Ac	$25,051	$210,178
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	18	EA	$23,372	$420,696
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$686,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.23	Estimated Mile of WOUS Perimeter	$3,000	$690
501	WOUS Delineation; Field Time & Mapping	3	Day	$1,500	$4,500
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	1	Each VMRC Impact	$12,000	$12,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	1	Crossing	$12,000	$12,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	1	Crossing	$8,000	$8,000
507	Stream Mitigation Credits	99	Credit	$400	$39,600
508	Wetland Mitigation Credit	0.05	Credit	$55,000	$2,750
				Sub-Total	**$210,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$270,000	$270,000
				Sub-Total	**$270,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$24,052,000
				Property Acquisition Cost	$686,000
				Environmental Cost	$210,000
				Cultural Impacts Cost	$270,000
Project Financing					
			Total Project Costs Prior to Financing		$25,218,000
			Loan Origination Fee	3.00%	$756,500
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$17,715,000
				Total Probable Project Cost - ALT 4	**$43,690,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 5A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 5A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	1,030	LF	$150		$154,500
105	Upgrade Existing Gravel Access Road	365	LF	$50		$18,250
106	Rail Crossing Improvements; per track	2	EA	$150,000		$300,000
107	Rail Crossing Approach Fill	3,905	CY	$15		$58,575
108	Culvert/Stream Crossing Approach Fill	0	CY	$15		$0
109	60" RCP Culvert	140	LF	$500		$70,000
110	36" RCP Culvert	150	LF	$350		$52,500
111	Concrete Headwall with Riprap	4	EA	$5,000		$20,000
112	Guardrail	400	LF	$35		$14,000
					Sub-Total	$7,368,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	12,200	LF	$375		$4,575,000
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	5,900	LF	$25		$147,500
203	Rock Excavation	6,700	LF	$200		$1,340,000
204	Pipeline Production Adjustment Along VDOT R/W	9,500	LF	$48		$456,000
205	Pipeline Adjustment for Construction in Travel Lane	2,500	LF	$200		$500,000
206	Maintenance of Traffic Route 6	9,500	LF	$50		$475,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	495	LF	$500		$247,500
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	1	EA	$300,000		$300,000
211	42" Jack & Bore Rail Crossing for 24" Pipe	150	LF	$1,300		$195,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200		$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500		$0
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$8,308,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300	Add Pre Settling Basin and Clarifiers at Treatment Plant	1	EA	$6,100,000		$6,100,000
					Sub-Total	$6,100,000
					Sub-Total	**$21,776,000**
				Contractor General Conditions	4.0%	$871,040
				Construction Quality Control	1.0%	$217,760
				Support Services; Administrative and Professional	20.0%	$4,355,200
					Total Construction and Support Services	**$27,220,000**

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ALT 5A

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 5A Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	12.1	Ac	$25,051	$302,616
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	19	EA	$23,372	$444,068
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$802,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.45	Estimated Mile of WOUS Perimeter	$3,000	$1,350
501	WOUS Delineation; Field Time & Mapping	4	Day	$1,500	$6,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	1	Each VMRC Impact	$12,000	$12,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	1	Crossing	$12,000	$12,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	1	Crossing	$8,000	$8,000
507	Stream Mitigation Credits	85	Credit	$400	$34,000
508	Wetland Mitigation Credit	0.39	Credit	$55,000	$21,450
				Sub-Total	**$225,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$282,000	$282,000
				Sub-Total	**$282,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$27,220,000
				Property Acquisition Cost	$802,000
				Environmental Cost	$225,000
				Cultural Impacts Cost	$282,000
Project Financing					
			Total Project Costs Prior to Financing		$28,529,000
			Loan Origination Fee	3.00%	$855,900
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$20,041,000
				Total Probable Project Cost - ALT 5A	**$49,425,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 5B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 5B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Item	Description	Quantity	Units	Unit $		Total Cost
Raw Water Intake and Pump Station Construction Cost						
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	1,030	LF	$150		$154,500
105	Upgrade Existing Gravel Access Road	365	LF	$50		$18,250
106	Rail Crossing Improvements; per track	2	EA	$150,000		$300,000
107	Rail Crossing Approach Fill	3,905	CY	$15		$58,575
108	Culvert/Stream Crossing Approach Fill	0	CY	$15		$0
109	60" RCP Culvert	130	LF	$500		$65,000
110	36" RCP Culvert	0	LF	$350		$0
111	Concrete Headwall with Riprap	2	EA	$5,000		$10,000
112	Guardrail	400	LF	$35		$14,000
					Sub-Total	$7,300,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	11,200	LF	$375		$4,200,000
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	4,100	LF	$25		$102,500
203	Rock Excavation	3,800	LF	$200		$760,000
204	Pipeline Production Adjustment Along VDOT R/W	6,600	LF	$48		$316,800
205	Pipeline Adjustment for Construction in Travel Lane	2,500	LF	$200		$500,000
206	Maintenance of Traffic Route 6	6,600	LF	$50		$330,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	490	LF	$500		$245,000
209	Colonial Gas Pipeline Crossing (Open Field)	0	EA	$150,000		$0
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	1	EA	$300,000		$300,000
211	42" Jack & Bore Rail Crossing for 24" Pipe	155	LF	$1,300		$201,500
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	55	LF	$1,200		$66,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	0	LF	$5,500		$0
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$7,022,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
301	Add Pre Settling Basin and Clarifiers at Treatment Plant	1	EA	$6,100,000		$6,100,000
					Sub-Total	$6,100,000
					Sub-Total	**$20,422,000**
				Contractor General Conditions	4.0%	$816,880
				Construction Quality Control	1.0%	$204,220
				Support Services; Administrative and Professional	20%	$4,084,400
					Total Construction and Support Services	**$25,528,000**

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ALT 5B

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 5B Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	8.4	Ac	$25,051	$209,978
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	23	EA	$23,372	$537,556
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$803,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.24	Estimated Mile of WOUS Perimeter	$3,000	$720
501	WOUS Delineation; Field Time & Mapping	4	Day	$1,500	$6,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	1	Each VMRC Impact	$12,000	$12,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	1	Crossing	$12,000	$12,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	1	Crossing	$8,000	$8,000
507	Stream Mitigation Credits	85	Credit	$400	$34,000
508	Wetland Mitigation Credit	0.29	Credit	$55,000	$15,950
				Sub-Total	**$219,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$309,000	$309,000
				Sub-Total	**$309,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$25,528,000
				Property Acquisition Cost	$803,000
				Environmental Cost	$219,000
				Cultural Impacts Cost	$309,000
Project Financing					
			Total Project Costs Prior to Financing		$26,859,000
			Loan Origination Fee	3.00%	$805,800
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$18,867,000
				Total Probable Project Cost - ALT 5B	**$46,532,000**

TIMMONS GROUP
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ALT 6

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	0	LF	$150		$0
105	Upgrade Existing Gravel Access Road	4,535	LF	$50		$226,750
106	Rail Crossing Improvements; per track	0	EA	$150,000		$0
107	Rail Crossing Approach Fill	0	CY	$15		$0
108	Culvert/Stream Crossing Approach Fill	650	CY	$15		$9,750
109	60" RCP Culvert	0	LF	$500		$0
110	36" RCP Culvert	0	LF	$350		$0
111	Concrete Headwall with Riprap	0	EA	$5,000		$0
112	Guardrail	0	LF	$35		$0
					Sub-Total	$6,917,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	5,100	LF	$375		$1,912,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	1,800	LF	$25		$45,000
203	Rock Excavation	0	LF	$200		$0
204	Pipeline Production Adjustment Along VDOT R/W	100	LF	$48		$4,800
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200		$0
206	Maintenance of Traffic Route 6	100	LF	$50		$5,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	800	LF	$500		$400,000
209	Colonial Gas Pipeline Crossing (Open Field)	1	EA	$150,000		$150,000
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	100	LF	$1,300		$130,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200		$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500		$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$3,379,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$10,296,000**
				Contractor General Conditions	4.0%	$411,840
				Construction Quality Control	1.0%	$102,960
				Support Services; Administrative and Professional	20.0%	$2,059,200
					Total Construction and Support Services	**$12,870,000**

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ALT 6

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	14.3	Ac	$25,051	$357,300
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	5	EA	$23,372	$116,858
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$529,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.65	Estimated Mile of WOUS Perimeter	$3,000	$1,950
501	WOUS Delineation; Field Time & Mapping	4	Day	$1,500	$6,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	2	Each VMRC Impact	$12,000	$24,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	2	Crossing	$12,000	$24,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	0	Crossing	$8,000	$0
507	Stream Mitigation Credits	76	Credit	$400	$30,400
508	Wetland Mitigation Credit	0.05	Credit	$55,000	$2,750
				Sub-Total	**$219,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$291,000	$291,000
				Sub-Total	**$291,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$12,870,000
				Property Acquisition Cost	$529,000
				Environmental Cost	$219,000
				Cultural Impacts Cost	$291,000
Project Financing					
			Total Project Costs Prior to Financing		$13,909,000
			Loan Origination Fee	3.00%	$417,300
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$9,771,000
				Total Probable Project Cost - ALT 6	**$24,097,000**

TIMMONS GROUP
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ALT 6-1

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6-1 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Item	Description	Quantity	Units	Unit $		Total Cost
Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	275	LF	$150		$41,250
105	Upgrade Existing Gravel Access Road	4,545	LF	$50		$227,250
106	Rail Crossing Improvements; per track	0	EA	$150,000		$0
107	Rail Crossing Approach Fill	0	CY	$15		$0
108	Culvert/Stream Crossing Approach Fill	650	CY	$15		$9,750
109	60" RCP Culvert	0	LF	$500		$0
110	36" RCP Culvert	0	LF	$350		$0
111	Concrete Headwall with Riprap	0	EA	$5,000		$0
112	Guardrail	0	LF	$35		$0
					Sub-Total	$6,958,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	5,400	LF	$375		$2,025,000
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	2,100	LF	$25		$52,500
203	Rock Excavation	0	LF	$200		$0
204	Pipeline Production Adjustment Along VDOT R/W	100	LF	$48		$4,800
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200		$0
206	Maintenance of Traffic Route 6	100	LF	$50		$5,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	800	LF	$500		$400,000
209	Colonial Gas Pipeline Crossing (Open Field)	1	EA	$150,000		$150,000
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	100	LF	$1,300		$130,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200		$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500		$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$3,499,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$10,457,000**
				Contractor General Conditions	4.0%	$418,280
				Construction Quality Control	1.0%	$104,570
				Support Services; Administrative and Professional	20%	$2,091,400
					Total Construction and Support Services	**$13,072,000**

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

ALT 6-1

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6-1 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	14.3	Ac	$25,051	$357,227
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	6	EA	$23,372	$140,232
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$552,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.65	Estimated Mile of WOUS Perimeter	$3,000	$1,950
501	WOUS Delineation; Field Time & Mapping	4	Day	$1,500	$6,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	2	Each VMRC Impact	$12,000	$24,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	2	Crossing	$12,000	$24,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	0	Crossing	$8,000	$0
507	Stream Mitigation Credits	76	Credit	$400	$30,400
508	Wetland Mitigation Credit	0.05	Credit	$55,000	$2,750
				Sub-Total	**$219,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$292,000	$292,000
				Sub-Total	**$292,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$13,072,000
				Property Acquisition Cost	$552,000
				Environmental Cost	$219,000
				Cultural Impacts Cost	$292,000
Project Financing					
			Total Project Costs Prior to Financing		$14,135,000
			Loan Origination Fee	3.00%	$424,100
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$9,929,000
				Total Probable Project Cost - ALT 6-1	**$24,489,000**

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ALT 6-2

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6-2 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Item	Description	Quantity	Units	Unit $		Total Cost
Raw Water Intake and Pump Station Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
100	Intake Structure and Gravity Pipe to Wetwell	1	EA	$1,495,000		$1,495,000
101	Pump Station (everything in the building envelope)	1	EA	$4,445,000		$4,445,000
102	Pump Station Site Work	1	EA	$110,000		$110,000
103	Pump Station: Excavation & Rock Removal	1	LS	$630,000		$630,000
104	New Access Road on Ag field	1,725	LF	$150		$258,750
105	Upgrade Existing Gravel Access Road	4,545	LF	$50		$227,250
106	Rail Crossing Improvements; per track	0	EA	$150,000		$0
107	Rail Crossing Approach Fill	0	CY	$15		$0
108	Culvert/Stream Crossing Approach Fill	650	CY	$15		$9,750
109	60" RCP Culvert	0	LF	$500		$0
110	36" RCP Culvert	0	LF	$350		$0
111	Concrete Headwall with Riprap	0	EA	$5,000		$0
112	Guardrail	0	LF	$35		$0
					Sub-Total	$7,176,000
Raw Water Pipeline Construction Cost						
Item	Description	Quantity	Units	Unit $		Total Cost
200	24" Class 350 Ductile Iron Pipe	5,100	LF	$375		$1,912,500
201	30" Class 350 Ductile Iron Pipe	0	LF	$425		$0
202	Clearing	1,900	LF	$25		$47,500
203	Rock Excavation	0	LF	$200		$0
204	Pipeline Production Adjustment Along VDOT R/W	100	LF	$48		$4,800
205	Pipeline Adjustment for Construction in Travel Lane	0	LF	$200		$0
206	Maintenance of Traffic Route 6	100	LF	$50		$5,000
207	Maintenance of Traffic Secondary Roads	0	LF	$35		$0
208	Stream Crossing (Temporary)	800	LF	$500		$400,000
209	Colonial Gas Pipeline Crossing (Open Field)	1	EA	$150,000		$150,000
210	Colonial Gas Pipeline Crossing (Adjacent to Rte 6)	0	EA	$300,000		$0
211	42" Jack & Bore Rail Crossing for 24" Pipe	100	LF	$1,300		$130,000
212	48" Jack & Bore Rail Crossing for 30" Pipe	0	LF	$1,500		$0
213	42" Jack & Bore Road Crossing for 24" Pipe	60	LF	$1,200		$72,000
214	48" Jack & Bore Road Crossing for 30" Pipe	0	LF	$1,300		$0
215	Rivanna Crossing for 24" Pipe	120	LF	$5,500		$660,000
216	Rivanna Crossing for 30" Pipe	0	LF	$6,000		$0
					Sub-Total	$3,382,000
Additional Construction Costs						
Item	Description	Quantity	Units	Unit $		Total Cost
300						
					Sub-Total	$0
					Sub-Total	**$10,558,000**
				Contractor General Conditions	4.0%	$422,320
				Construction Quality Control	1.0%	$105,580
				Support Services; Administrative and Professional	20.0%	$2,111,600
					Total Construction and Support Services	**$13,197,000**

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ALT 6-2

Project: James River Water Authority - Raw Water Supply Facilities
Subject: Alternative 6-2 Intake, Pump Station, and Pipeline Route Alternative Analysis
Date: March 2020
Re: Opinion of Probable Cost

Property Acquisition Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
400	Easement Purchase Cost	15.2	Ac	$25,051	$381,527
401	Easement Acquisition Services (Survey, Title work, Plats & Acquisition)	6	EA	$23,372	$140,232
402	Intake and Pump Station Parcel	1	EA	$55,000	$55,000
				Sub-Total	**$577,000**
Environmental Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
500	WOUS Delineation; Travel and supplies	0.48	Estimated Mile of WOUS Perimeter	$3,000	$1,440
501	WOUS Delineation; Field Time & Mapping	4	Day	$1,500	$6,000
502	WOUS Delineation; Prep, Reporting, & Confirmation	1	EA	$10,000	$10,000
503	Permitting Cost; 404 and 401 (All assumed to be 401 IPs)	1	Each	$120,000	$120,000
504	Permitting Cost; VMRC	2	Each VMRC Impact	$12,000	$24,000
505	Freshwater Mussels Species Surveys; Mainstem James and Rivanna & Streams with Drainage Area > 5 sq mi	2	Crossing	$12,000	$24,000
506	Freshwater Mussels Species Surveys; All other Perennial Streams	0	Crossing	$8,000	$0
507	Stream Mitigation Credits	76	Credit	$400	$30,400
508	Wetland Mitigation Credit	0.05	Credit	$55,000	$2,750
				Sub-Total	**$219,000**
Cultural Impacts Cost					
Item	Description	Quantity	Units	Unit $	Total Cost
600	Cultural Resources Ph I Costs	1	LS	$310,000	$310,000
				Sub-Total	**$310,000**
Project Sub-Totals					
				Total Construction and Support Services Cost	$13,197,000
				Property Acquisition Cost	$577,000
				Environmental Cost	$219,000
				Cultural Impacts Cost	$310,000
Project Financing					
			Total Project Costs Prior to Financing		$14,303,000
			Loan Origination Fee	3.00%	$429,100
			Interest on Loan, 3.75% over 30 yr., $682K/$1M	3.75%	$10,047,000
				Total Probable Project Cost - ALT 6-2	**$24,779,000**

APPENDIX H-9-3

2015 MEMO VS. 2020 ALTERNATIVES COST COMPARISON

TIMMONS GROUP

Memorandum

To: **James River Water Authority**
From: **Joseph C. Hines, PE and David Saunders, PE**
Date: **March 2020**
Re: **2015 Memo vs. 2020 Alternatives Analysis and Potential Increase in Construction Costs**

In December of 2015, Timmons Group was asked to prepare a preliminary evaluation for potentially moving the pump station from the proposed Point of Fork Farm, LP location to property owned by Forsyth approximately 2 miles upstream from the proposed alternative. As such, Timmons Group prepared a limited review of the routing alternatives and potential impacts to the pump station construction. This December 2015 Memorandum (2015 Memo) was entitled "ALTERNATE INTAKE AND PUMP STATION SITE - PRELIMINARY Evaluation of the Potential Cost and Schedule Implications" (attached to this memo for reference). The opening paragraph of the 2015 Memo states:

> *"Below is a PRELIMINARY evaluation of the potential cost and schedule implications to relocating the JRWA intake further upstream as proposed by Fluvanna County. Please note this is limited review based upon a limited timeline."*

It is important to note that this evaluation was based upon a high-level overview of potential routing alternatives. This evaluation did not include an in-depth review and evaluation of the environmental impacts and routing alternative alignments as presented in this current analysis. The James River Water Authority requested that Timmons prepare a comparative analysis of the two evaluations (2015 Memo vs. 2020 Analysis) to address any potential questions or concerns that might arise during the review of this analysis regarding the difference in costs.

For the 2020 Alternatives Analysis prepared for submission to the U.S. Army Corps of Engineers in March 2020, the Forsyth property is considered Alternative 1, which includes routing alternatives 1A, 1B, and 1C. Below is a comparison of the route alternatives for the 2015 Memo vs. the 2020 Analysis.

2015 Memo Route	2020 Alternative Analysis Route	Route Description
1	1A	Along CSX R/W to Dominion Easement to Dominion / Colonial Gas Easement and then Rivanna Crossing to Tie-in
2	1B	Along Bremo Road to Point of Fork Road to Dominion / Colonial Gas Easement and then Rivanna Crossing to Tie-in
3	1C	Along Bremo Road to Rte 6 and then Rivanna Crossing to Tie-in

The 2015 Memo only accounted for additional construction costs, but not professional and support services (due diligence, survey, design, permitting, etc.) that are included in the 2020 estimates. In order to make an "apples to apples" comparison between the 2015 and 2020 estimates, we need to add these professional and support services costs to the 2015 estimate and apply a reasonable Construction Cost Index escalation to adjust the 2016 construction prices to 2021 construction prices. When we factor in those two adjustments, it becomes evident that the 2015 and 2020 estimates are very comparable—and certainly within the expected margin of error given that the 2015 estimate was only a rough order of magnitude estimate.

The most recent Turner Construction Cost Index was used to calculate the construction cost escalation from 2016 to 2021 dollars. Based on that index, the average annual CCI from 2014 to 2019 is 5.1% (see below).

Quarter	Index	△%
4th Quarter 2019	**1177**	**1.29**
3rd Quarter 2019	1162	1.13
2nd Quarter 2019	1149	1.23
1st Quarter 2019	1135	1.34

Year	Average Index	△%
2019	1156	5.5
2018	1096	5.6
2017	1038	5.0
2016	989	4.8
2015	943	4.5
2014	902	4.4
2013	864	4.1
2012	830	2.1
2011	812	1.6
2010	799	-4.0
2009	832	-8.4
2008	908	6.3
2007	854	7.7

The Turner Building Cost Index is determined by the following factors considered on a nationwide basis: labor rates and productivity, material prices and the competitive condition of the marketplace.

Turner

Memorandum
March 2020
Re: 2015 Memo vs. 2020 Alternatives Analysis

For the purposes of this analysis, we will utilize 5% average annual CCI for the costs adjustment. As such, this adjustment multiplier equates to 1.05 @ 6 years (1.05^6) or 1.34.

2015 Memo Alternative	Order of Magnitude Probable Add'l Costs for Pipeline	Support Services* (20%) not included in 2015 Memo	2015 Total Construction & Support Costs Increase	Adjustment Multiplier for CCI 2015 to 2021 Costs	2015 Memo Equivalent 2021 Total Project Costs Increase
1	$3,500,000	$700,000	$4,200,000	1.34	$5,628,000
2	$5,400,000	$1,080,000	$6,480,000	1.34	$8,683,200
3	$6,300,000	$1,260,000	$7,560,000	1.34	$10,130,400

We have taken the adjusted 2015 estimates and compared them to the estimates developed this year. For consistency with the 2015 memo, the chart below compares the additional construction costs that would be incurred to construct Build Alternatives 1A, 1B, and 1C compared to the construction cost of what was the proposed action at the time (Build Alternative 6-1). Note that these are construction and support services costs only; they do not include other costs (e.g., project finance costs) that were not factored in to the 2015 estimates.

2020 Alternative	2020 Alt Analysis (2021 Prices) Add'l Costs	2015 Memo Equivalent 2021 Total Project Costs Increase	Delta (2015 Memo vs. 2020 Alt Analysis)	% Delta (2015 Memo vs. 2020 Alt Analysis)
1A	$5,090,000	$5,628,000	($538,000)	-10%
1B	$9,436,000	$8,683,200	$752,800	9%
1C	$10,661,000	$10,130,400	$530,600	5%

For the additional pipeline costs, given the PRELIMINARY nature of the evaluation in 2015 vs. the detailed analysis for the 2020 Alternatives Analysis, the “apples to apples” comparison appears to be reasonably equivalent in terms of cost.

In terms of the pump station improvements, the 2020 Alternatives Analysis indicated that an increase in pump size was not necessary and therefore there would be difference in the pump station costs of construction. In the 2015 Memo this was noted pump station costs could increase $1 to $1.5 million should a larger HP motor be required. However, bear in mind that although the 2020 estimates remain rough order of magnitude estimates, they are based on a more detailed analysis of costs and are informed by additional information developed since December 2015. For example, we now know that the easement acquisition and project management cost estimates from the 2015 analysis were understated. At bottom, this exercise shows that that the 2015 estimates were reasonably comparable to the updated 2020 estimates.

ALTERNATE INTAKE AND PUMP STATION SITE

PRELIMINARY Evaluation of the Potential Cost and Schedule Implications

Prepared by Timmons Group - Dec 16, 2015

Below is a PRELIMINARY evaluation of the potential cost and schedule implications to relocating the JRWA intake further upstream as proposed by Fluvanna County. Please note this is a limited review based upon a limited timeline.

Specific Due Diligence to evaluate the Fluvanna proposed intake:

Below is an approximate schedule to perform the additional due diligence to evaluate the feasibility of the proposed Fluvanna site:

1. Bathymetric & Topographic Survey: 4-6 weeks from Notice to Proceed (NTP). We need to establish survey control on the river bank in order to perform the bathymetric survey and river conditions need to be optimal to complete the work.

2. Geotechnical Investigation: 4-6 weeks from NTP

3. Wetlands Delineation & COE Confirmation: 2-3 months (dependent upon COE schedule to confirm wetlands)

4. Preliminary Engineering & Construction Cost Pricing: 4-6 weeks following receipt of bathymetric survey, wetlands & geotechnical information

5. *Total timeline for evaluation of the site:* *3-4 months from NTP.* Assuming NTP early Jan, then this would be completed in Mar/Apr 2016.

6. *Recommended budget:* *$100,000 to $120,000 based upon previous work.*

COE Permit Risks

Currently the proposed pump station and intake have less than 0.1 acres of PERMANENT wetland impacts (0.09 acres permanent impacts as proposed). This is critical because it allows the COE to utilize a Nationwide Permit, which would be an administrative permit and require *little or no public involvement other than public notifications*. If we were to impact any additional wetlands with the new PS site, or have to increase the impacts in the river due to the underwater topography (i.e., push the intake further out into the river), it could force the permanent impacts to exceed 0.1 acres. *This would most likely put this into an "individual permit" category which would require extensive public involvement such as public hearings.*

Additional Pipeline Costs:

We evaluated 3 potential pipeline routes (graphic will be forthcoming). Following are the order of magnitude additional costs just for the pipeline:

Alternate	Length of Add'l Pipeline	Order of Magnitude Probable Add'l Costs	Add'l Property Owners to Cross	Comments*
1	10,000	$3.5 million	3	Along CSX ROW on adjacent properties to Colonial Gas
2	16,300	$5.4 million	12	Along Bremo / Point of Fork Road to Colonial Gas
3	15,900	$6.3 million	14	Along Bremo / Rte 6 to Colonial Gas

* Please note - construction cost along an existing road is further increased due to traffic maintenance and safety issues.

Pump Station Impacts:

Based upon a preliminary review of the pipeline routes, it appears that the pumps will need to be increased from 350 HP to 400 HP due to extra length of pipeline. This will increase electrical equipment and generator costs, etc. *Order of magnitude increase could range from $1 to $1.5 million to include redesign and additional construction costs* (we would need to study further to determine exact numbers).

DEQ Permitting Implications – Major Modification to the Permit:

- Based upon initial conversations with DEQ, moving the intake to this location (approximately 2.2 miles upstream) would represent change in hydrologic characteristics for the intake location.
- As such, this will require another Major Modification for the permit (what JRWA just went through to relocate the recently issued permit).
- Moving the intake upstream about 250' to the Hammond Property would be considered a Minor Modification, which would be administrative in nature and require no additional public involvement, just a simple issuance of a letter by DEQ noting the change.
- Scott Kudlas (who signed the permit) noted that moving it to the adjacent property approximately 250' upstream was "a slam dunk" for DEQ to approve with little or no issue.
- However, moving it a significant distance upstream (such that it changes the hydologic characteristics of the intake location) would give DEQ some heartburn because both DEQ and JRWA would essentially be starting from square one again.
- Furthermore, this opens the permit back up to public comment / scrutiny once again and would the City of Richmond and Henrico another opportunity to scrutinize the permit.
- *A Major Modification would require the JRWA to submit another $25,000 fee to DEQ for review of the application.*

- *A Minor Modification would require the JRWA to submit a $5,000 fee to DEQ for review of the application.*

Schedule & Costs Implications for relocating the intake:

- Given this will require a Major Modification to the DEQ permit, it means that we will start the permitting process all over again.
- It took approximately 20 months to acquire the most recently issued permit and we would anticipate a similar timeline.
- *We would recommend the JRWA budget approximately 18-24 months to complete this task*.
- To date, Timmons Group costs have far exceeded $100,000 to assist JRWA with acquiring the current permit.
- *We would recommend the JRWA budget $125,000 for costs to relocate the permit IN ADDITION to the other costs (bathymetric survey, preliminary engineering, geotech, environmental, etc.) associated with relocating the pump station and intake, which are approximately $120,000*.
- *We would recommend a total $250,000 budget.*

Additional Easement Acquisition Costs:

- Depending upon the route chosen by Fluvanna / JRWA, we would need to acquire anywhere from 3 to 14 additional easements.
- *At approximately $5,000 per easement, this would equate to $15,000 to $70,000 in additional costs, not to mention the associated timeline for acquisition.*

Long-term Operations Costs:

Given the anticipated increase in motor HP, this will in turn require a higher electrical costs for pumping the water to Ferncliff. It is difficult to calculate the total increase on an annual basis without further evaluation, but based upon an initial review of the base rates, *the pumping costs could increase anywhere from 20-30% on an annual basis.*

Construction at the Rte 6 bridge:

It has been noted that there currently is construction going on at the Rte 6 bridge near Columbia. Going this route will still require an independent easement and extensive coordination with VDOT regarding construction.

Interest Rate Increase:

- I attended the VRA Board meeting on December 8, 2015 in Richmond. The VRA's financial advisor put up a graphic showing how the bond issuance rates were starting to trend upwards towards the end of 2015.

- While there are no guarantees on rates until the bonds are sold, it appears to be common belief that rates are trending upwards and any delay in financing could result in higher rates for both the JRWA and Louisa County.
- *The US Federal Reserve is meeting today to discuss interest rate increases.*

Materials & Labor Costs Increase:

While we enjoyed a somewhat flat construction market during the recession, it appears that construction costs are consistently rising again.
Per the attached Construction Costs Index, construction costs are steadily increasing since 2010, with the last 12-months (Q4 2014 thru Q3 2015) seeing an increase of approximately 4.4% and the last three years of approximately 4% per year.

Other Considerations:

While we have attempted to quantify the mechanics, logistics, schedule and approximate costs for moving the intake structure upstream, we believe Fluvanna and the JRWA also need to take the following items into consideration:

1. Cobbs Creek Intake: The proposed Fluvanna intake location is upstream of the Cobbs Creek reservoir intake. One of the advantages to locating in Columbia was the future ability of JRWA to work with Henrico County to purchase capacity in the reservoir should Louisa or JRWA choose to do so.

2. Dominion WWTP / Coal Ash discharge into the James River: There was significant public concern regarding Dominion's plans to discharge into the James River and a potential "mixing zone" in the James River. This would move the intake 2.2 miles closer to that discharge. Currently the JRWA withdrawal permit issued would have legal precedence over any permit issued by DEQ for the Dominion Coal Ash discharge. Should the JRWA request a Major Modification, then the Dominion discharge permit could have legal precedence (i.e. the relocated JRWA permit would be "in queue" after the Dominion permit, thereby forcing the JRWA to adhere to the Dominion permit, vs. Dominion needing to adhere to the JRWA permit currently issued).

3. DEQ Relationship and Efforts on behalf of JRWA: Given the extensive permitting process the JRWA just went through with DEQ (both time and costs) and the fact that DEQ issued an extensive permit, permit construction limitations, and justification for the withdrawal (a total of 74 pages), it would appear any attempt to move the proposed intake to a location that would change the hydrologic characteristics could make the permit that was just issued invalid. Given the time, effort and involvement by DEQ as well as other agencies, such as engaging the AG's office to defend DEQ's position, DEQ could perceive Fluvanna or the JRWA's desire to move it further upstream as disingenuous and the most recent permit issuance as a "waste of everyone's time".

4. Relationships with other Regulatory Agencies: Impact to relationships with the other review agencies, such as VMRC and COE who have already put significant time and effort into working with our team for the current permit relocation.

5. Ability to construct within Historically Sensitive Areas: While we respect the historical significance and sensitivity of Point of Fork Farm and other properties of historical significance, much like wetlands, there are laws and regulations in place that allow for this type of construction to take place in these areas that help protect and preserve these properties. We can list several examples of past and current projects that have been constructed in areas of historical significance. A very relevant example is a steel recycling plant constructed on the Petersburg National Battlefield in Dinwiddie County.

6. Practical aspect of the above ground impacts: Constructing a 2,400 SF footprint, 35' tall pump station is no different than constructing a similar size 2 story house on a lot on the James River in terms of above ground property impacts.

Summary & Conclusion:

Based upon our PRELIMINARY evaluation of relocating the intake approximately 2.2 miles upstream, following is our summary & conclusion:

1. Increased capital costs for additional pipeline and potential upgrades to the pump station, could range from approximately $5 million upwards to $8 million in 2015 Construction Numbers.

2. JRWA could see an increase in annual pumping costs of 20-30%.

3. A Major Modification to the permit will be required and could take approximately 18-24 months to complete and require a $25,000 DEQ application review fee in addition to approximately $250,000 in costs associated with permit reapplication, due diligence and preliminary design for the new intake.

4. Construction costs are increasing approximately 4% per year based upon most recent 3 years and any delay could see a substantial increase in costs (i.e. 4% of $10 million is $400,000), so delays could see that number increase.

5. There are significant permitting risks associated with DEQ, VMRC and COE, not to mention potential damage to the relationships with regulatory agency staff.

In our professional opinion, we do not believe it is wise or prudent for the JRWA to consider moving the intake to the proposed Fluvanna location. As such, our recommendation would be for the JRWA to move the pump station and intake onto the adjacent Hammond Property and adjust the pipeline routing accordingly.

APPENDIX H-9-4
PROPERTY ACQUISITION COST ANALYSIS

JRWA - Property Acquisition Costs Analysis
By: Timmons Group
March 2020

Notes:

1 - The analysis below is based upon the real costs expended by the JRWA on the acquisition of easements and the pump station parcel associated with the preferred alternative (Alternative 6 - Proposed Action)

2 - For the purpose of the 2020 Alternatives Analysis, Timmons Group utilized the exact numbers below to provide an estimated cost for pump station parcel costs, average easement costs per acre purchase price, and total acquisition services costs per easement.

3 - It's important to note these costs will most likely increase should another Alternative location be chosen.

4 - Easement areas based upon easement plats.

JRWA Easement	Permanent Easement (SF)	Temp Construction Easement (SF)	Access Easement (SF)	Jt Use & Access Easement (SF)	Total Easement Area (SF)	Total Easement Area (Acre)	JRWA Purchase Price	JRWA Cost per Acre
	(a)	(b)	(c)	(d)	(a + b + c + d)			
Hammond (Easement Only)	35,302	85,796	2,103	18,271	141,472	3.25	$25,000	$7,698
Point of Fork Farm, LP	24,995	12,055	52,260	24,103	113,413	2.60	$225,000	$86,419
Bialkowski	29,994	107,453	33,344	24,092	194,883	4.47	$100,000	$22,352
Lyttle	7,206	134,633			141,839	3.26	$5,000	$1,536
CVEC	3,905	25,788			29,693	0.68	$2,300	$3,374
Totals	***101,402***	***365,725***	***87,707***	***66,466***	***621,300***	***14.26***	***$357,300***	***$25,051***

Easement Costs

Total SF	621,300	
Total Acres	14.26	
Total Purchase Price	$357,300	
Average Costs per acre purchase price	***$25,051***	***per acre***

Easement Acquisition Services Costs*

Randolph, Cherry, Boyd & Vaughan	$44,901	Legal Costs paid by JRWA for 5 Easements
Hefty, Wiley & Gore	$6,000	Legal Costs - 4 hrs @ $300/hr per easement
KDR Real Estate Services	$51,507	Paid by JRWA via Faulconer Interim Agreement
Timmons Survey Costs	$11,000	Field work & easement plats
Timmons PM Costs	$3,450	ROW Manager - 6 hrs @ $115 / hr per easement
Total Costs for 5 easements	***$116,858***	
Total Acquisition Services Costs	***$23,372***	***per easement***

* Acquisition Services include Legal, Survey, Real Estate Services, Project Management, etc.

Pump Station Parcel Cost

Hammond Parcel Fee Simple Purchase	***$55,000***	***2.1 acre parcel***

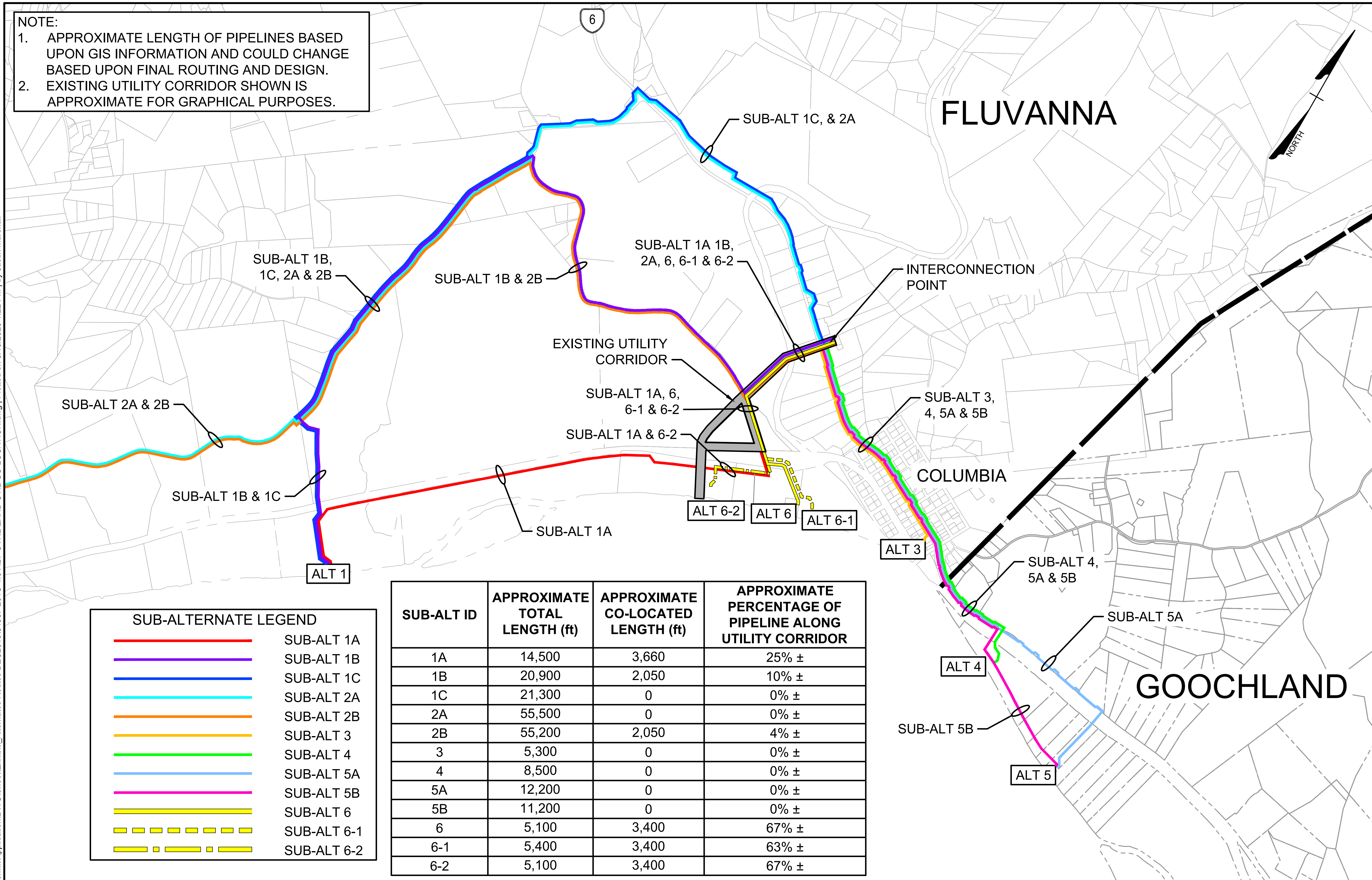
JRWA Property Acquisiton for Columbia Pump Station Site - Estimated Costs of Services & Acquisition

Project Name: JRWA - Columbia Pump Station Parcel Acquisition & Relocation
Project Number: 39677
Client: James River Water Authority
Date of Estimate: February 24, 2020
Prepared By: Joe Sckinto & Joanne Daniel, Right of Way Managers at Timmons Group
Total number of parcels to be acquired for Pump Station Site: 12

Tasks	Right of Way Project Manager	Negotiator / Right of Way Specialist	Offer Packages / ROW Technician	Paralegal / Title Searches / Closings	Clerical / Recordations	Sub-Constractor Appraisal			Direct Labor Expense
Hourly Rate	$ 115.00	$ 100.00	$ 100.00		$ 100.00				
	Estimated Hours								
TASK 1 – RIGHT-OF-WAY ESTIMATE									
Right of Way Estimate									$0
Plan Review Comments	3								$345
Subtotal									**$345**
TASK 2 – PROPERTY OWNER NOTIFICATION									
Names and Addresses of Impacted Property Owners		6							$600
Subtotal									**$600**
TASK 3 – TITLE WORK									
See Direct Cost									
									$0
Subtotal									**$0**
TASK 4 – APPRAISALS									
See Direct Cost									$0
Subtotal									**$0**
TASK 5 – NEGOTIATIONS									
Negotiation Package(s) 12 Parcels		36							$3,600
Property Owner Meetings 5 Landowners Residential		125							$12,500
Property Owner Meetings Relocation 1 Parcel		50							$5,000
Counteroffers, Donations, and Acceptances									$0
Condemnations									$0
Subtotal									**$21,100**
TASK 6 – CLOSING									
Releases from Deeds of Trust, Taxes and Judgments									$0
Check Requests		6							$600
Recordation		36							$3,600
Closings with Landowners		36							$3,600
Subtotal									**$7,800**
TASK 7 – PROGRESS REPORTS AND PROJECT MANAGEMENT									
Progress Reports	20								$2,300
General Project Management	40								$4,600
Subtotal									**$6,900**
TASK 8 - CIM MEETING									
Project Manager									
Subtotal									**$0**
DIRECT COSTS									
Appriasals	12 Appraisals $2,000.00 each								$24,000
Cost to purchase 12 parcels	Note: Total Assessed Value of 12 Parcels on Fluvann GIS is $143,300								$200,000
Relocations	1 Residential Relocation								$200,000
Printing/ Copying/ Binding									$300
Postage/ Courier									$300
Processing Fees for Releases									
Recordation Fees	12 Instruments @ $30.00 each								$360
Title Research	60 Year Title Searches and Report $900.00 per Parcel								$10,800
Subtotal									**$435,760**
Estimated Property Acquisition Costs & Relocation for Columbia Pump Station Site									**$473,000**

APPENDIX H-10
CO-LOCATION OF UTILITIES EXHIBIT

NOTE:
1. APPROXIMATE LENGTH OF PIPELINES BASED UPON GIS INFORMATION AND COULD CHANGE BASED UPON FINAL ROUTING AND DESIGN.
2. EXISTING UTILITY CORRIDOR SHOWN IS APPROXIMATE FOR GRAPHICAL PURPOSES.



SUB-ALTERNATE LEGEND

- SUB-ALT 1A
- SUB-ALT 1B
- SUB-ALT 1C
- SUB-ALT 2A
- SUB-ALT 2B
- SUB-ALT 3
- SUB-ALT 4
- SUB-ALT 5A
- SUB-ALT 5B
- SUB-ALT 6
- SUB-ALT 6-1
- SUB-ALT 6-2

SUB-ALT ID	APPROXIMATE TOTAL LENGTH (ft)	APPROXIMATE CO-LOCATED LENGTH (ft)	APPROXIMATE PERCENTAGE OF PIPELINE ALONG UTILITY CORRIDOR
1A	14,500	3,660	25% ±
1B	20,900	2,050	10% ±
1C	21,300	0	0% ±
2A	55,500	0	0% ±
2B	55,200	2,050	4% ±
3	5,300	0	0% ±
4	8,500	0	0% ±
5A	12,200	0	0% ±
5B	11,200	0	0% ±
6	5,100	3,400	67% ±
6-1	5,400	3,400	63% ±
6-2	5,100	3,400	67% ±

JAMES RIVER WATER AUTHORITY ALTERNATIVE WATER MAIN CO-LOCATION OF UTILITIES

L:\20\134967 - JRWA Joint Permit Application\DWG\Sheet\Exhibit_Alternates Routes DEC2019\34967-201C-1.0-ALT-OVRL-EXHB-UTIL-CO-LOCATION.dwg | Plotted on 3/16/2020 1:22 PM | by Justin Marshall

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TIMMONS GROUP

DATE	REVISION DESCRIPTION

DATE	
DRAWN BY	
DESIGNED BY	
CHECKED BY	
SCALE	1"= 5,000'

JAMES RIVER WATER AUTHORITY PROJECT

FORK UNION DISTRICT, FLUVANNA COUNTY, VIRGINIA

ALTERNATIVE WATER MAIN CO-LOCATION OF UTILITIES

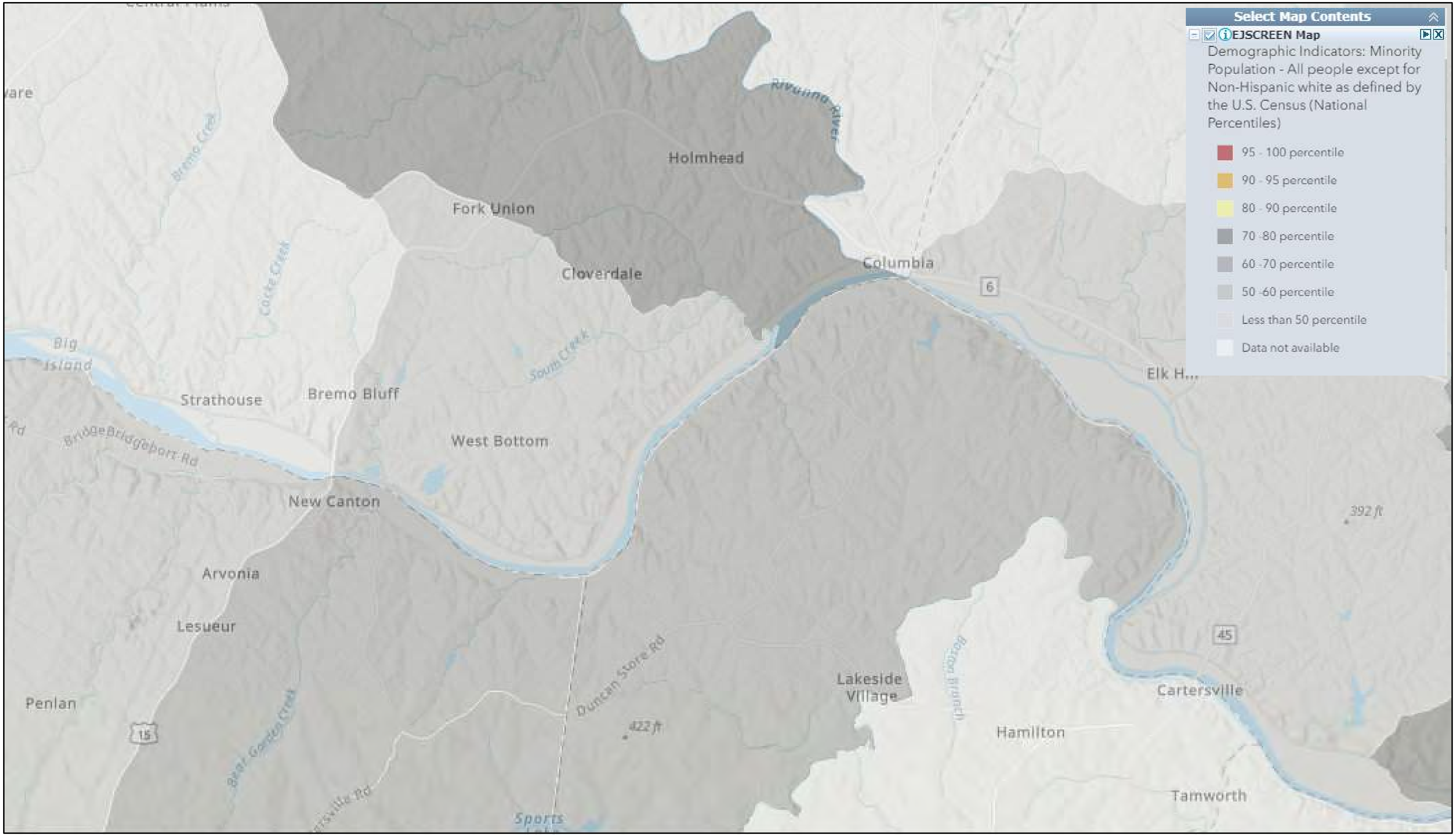
JOB NO. 33927

SHEET NO. EXB-1

APPENDIX H-11
ENVIRONMENTAL JUSTICE DOCUMENTS

APPENDIX H-11-1
EJSCREEN ENVIRONMENTAL JUSTICE MINORITY POPULATIONS

JRWA - Surrounding Minority Populations



November 21, 2019

1:144,448

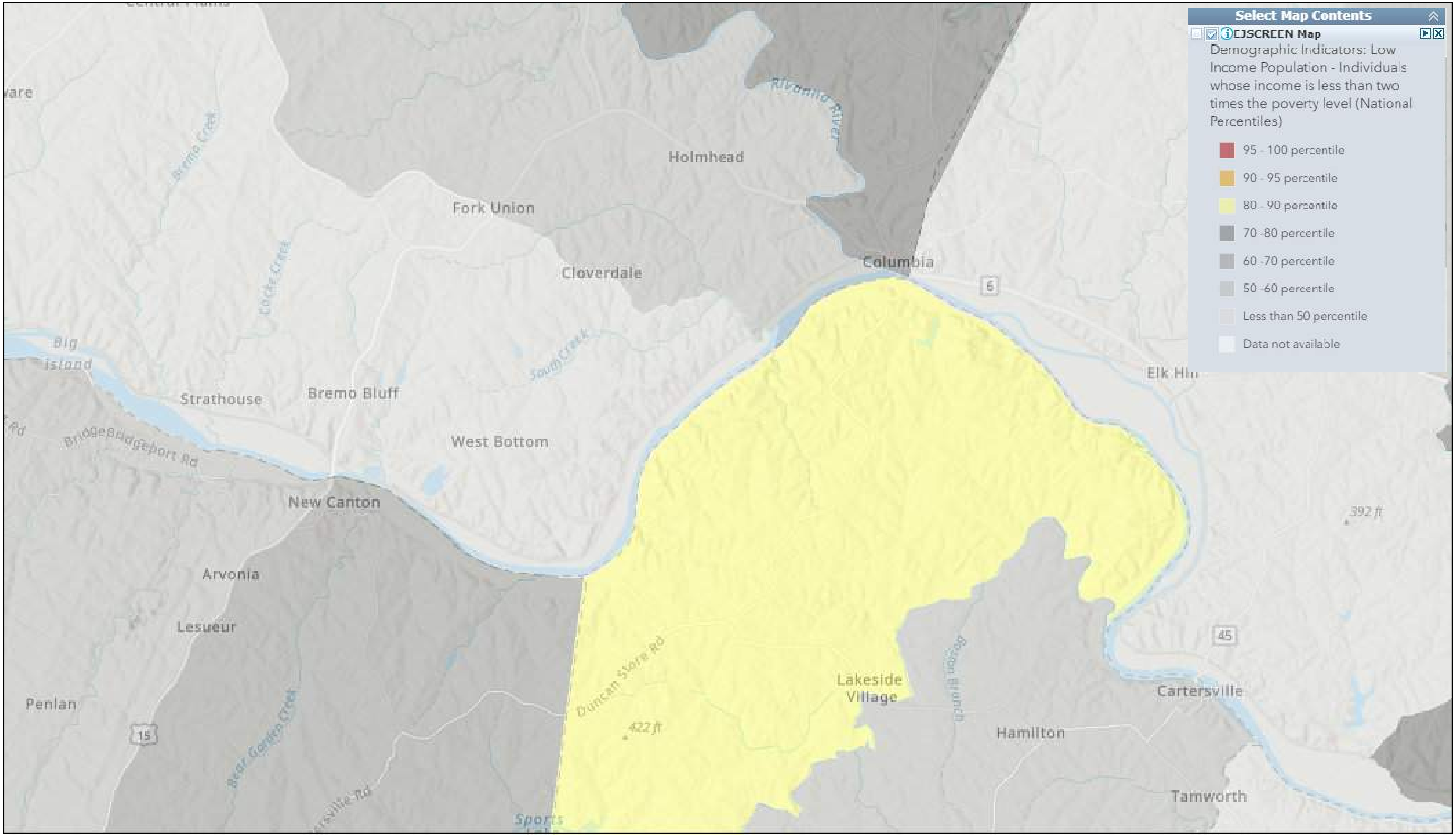
0 1.25 2.5 5 mi

0 2 4 8 km

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

APPENDIX H-11-2
EJSCREEN ENVIRONMENTAL JUSTICE LOW INCOME POPULATION

JRWA - Surrounding Low Income Populations



November 21, 2019

1:144,448

0 1.25 2.5 5 mi

0 2 4 8 km

Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

APPENDIX H-11-3
ENVIRONMENTAL JUSTICE STUDY AREA CENSUS BLOCK RAW DATA

Environmental Justice
Census Block Raw Data

OBJECTID	ID	ACSTOTPOP	ACSIPOVBAS	ACSEDUCBAS	ACSTOTHH	ACSTOTHU
202708	510650203002	1873	1857	1530	856	901
202706	510650202004	695	635	435	247	318
202705	510650202003	2204	2204	1265	680	737
202704	510650202002	837	837	524	345	365
202840	510754005003	1278	1258	830	422	446

Row Labels	Sum of ACSTOTPOP	Sum of MINORPOP	Sum of MINORPCT	Sum of LOWINCOME	Sum of LOWINCPCT
510650202002	837	48	0.05734767	368	0.439665472
510650202003	2204	1360	0.617059891	679	0.308076225
510650202004	695	238	0.342446043	59	0.092913386
510650203002	1873	420	0.224239188	433	0.233171782
510754005003	1278	435	0.340375587	281	0.223370429
Grand Total	**6887**	**2501**	**1.58146838**	**1820**	**1.297197294**

MINORPOP	MINORPCT	LOWINCOM	LOWINCPC	LESSHS	LESSHSPCT	LINGISO	LINGISOPC	UNDER5	UNDER5PC	OVER64	OVER64PC	PRE1960
420	0.224239	433	0.233172	138	0.090196	0	0	14	0.007475	277	0.147891	197
238	0.342446	59	0.092913	57	0.131034	0	0	71	0.102158	58	0.083453	118
1360	0.61706	679	0.308076	73	0.057708	44	0.064706	20	0.009074	329	0.149274	300
48	0.057348	368	0.439665	58	0.110687	0	0	51	0.060932	156	0.18638	74
435	0.340376	281	0.22337	128	0.154217	0	0	106	0.082942	227	0.177621	98

Environmental Justice
Census Block Raw Data

PRE1960PC	VULEOPCT	VULSVI6PC	VULEO	VULSVI6	DISPEO	DISPSVI6	DSLPM	CANCER	RESP	PTRAF	PWDIS	PNPL
0.218646	0.228705	0.117162	428.3654	219.4447	-239.3	-122.376	0.179832	28.54302	0.367839	0	0.000113	0.029932
0.371069	0.21768	0.125334	151.2874	87.10729	-96.4581	-39.7296	0.184321	28.68128	0.377607	0	0.081922	0.029845
0.407056	0.462568	0.200983	1019.5	442.9665	233.8437	40.73843	0.184321	28.68128	0.377607	0	0.000233	0.026198
0.20274	0.248507	0.142502	208	119.2742	-90.364	-33.4776	0.184321	28.68128	0.377607	0.811162	0.000986	0.021644
0.219731	0.281873	0.163088	360.2337	208.4261	-95.3329	-24.8078	0.20424	29.01316	0.384098	0	0.000582	0.023711

PRMP	PTSDF	OZONE	PM25	D_LDPNT_:	LDPNT_D6	LDPNT_B2	LDPNT_B6	LDPNT_P2	LDPNT_P6	D_DSLPM_	DSLPM_D6	DSLPM_B2
0.167431	0.036698	39.34276	7.427364	-52.3219	-26.7571	93.66035	47.98069	0.050006	0.025617	-43.0337	-22.0071	77.03359
0.167266	0.02547	39.34126	7.453508	-35.7926	-14.7424	56.13809	32.32283	0.080774	0.046508	-17.7792	-7.32299	27.8854
0.095279	0.027667	39.34126	7.453508	95.1874	16.58281	414.9932	180.312	0.188291	0.081811	43.10224	7.508935	187.9149
0.066395	0.029083	39.34126	7.453508	-18.3204	-6.78724	42.16986	24.18161	0.050382	0.028891	-16.656	-6.17061	38.3387
0.047451	0.02975	39.21358	7.486049	-20.9476	-5.45104	79.15449	45.79766	0.061936	0.035835	-19.4708	-5.06675	73.57426

DSLPM_B6	DSLPM_P2	DSLPM_P6	D_CANCR_	CANCR_D6	CANCR_B2	CANCR_B6	CANCR_P2	CANCR_P6	D_RESP_2	RESP_D6	RESP_B2	RESP_B6
39.46306	0.041128	0.021069	-6830.34	-3492.99	12226.84	6263.613	6.527945	3.344161	-88.0237	-45.0147	157.5693	80.72022
16.05568	0.040123	0.023102	-2766.54	-1139.5	4339.116	2498.349	6.243333	3.594746	-36.4233	-15.0022	57.12717	32.89232
81.6479	0.085261	0.037045	6706.937	1168.43	29240.57	12704.85	13.26704	5.76445	88.30101	15.38311	384.9703	167.2672
21.9847	0.045805	0.026266	-2591.76	-960.18	5965.706	3420.936	7.127487	4.08714	-34.1221	-12.6414	78.54224	45.03875
42.56902	0.05757	0.033309	-2765.91	-719.753	10451.52	6047.099	8.178026	4.731689	-36.6172	-9.52863	138.3651	80.0561

RESP_P2	RESP_P6	D_PTRAF_2	PTRAF_D6	PTRAF_B2	PTRAF_B6	PTRAF_P2	PTRAF_P6	D_PWDIS_	PWDIS_D6	PWDIS_B2	PWDIS_B6	PWDIS_P2
0.084127	0.043097	0	0	0	0	0	0	-0.02714	-0.01388	0.04858	0.024887	2.59E-05
0.082197	0.047327	0	0	0	0	0	0	-7.90201	-3.25472	12.39372	7.135978	0.017833
0.174669	0.075893	0	0	0	0	0	0	0.054578	0.009508	0.237949	0.103387	0.000108
0.093838	0.05381	-73.2998	-27.1558	168.7217	96.75065	0.201579	0.115592	-0.08907	-0.033	0.20502	0.117566	0.000245
0.108267	0.062642	0	0	0	0	0	0	-0.0555	-0.01444	0.209714	0.121337	0.000164

PWDIS_P6	D_PNPL_2	PNPL_D6	PNPL_B2	PNPL_B6	PNPL_P2	PNPL_P6	D_PRMP_2	PRMP_D6	PRMP_B2	PRMP_B6	PRMP_P2	PRMP_P6
1.33E-05	-7.16272	-3.66296	12.82182	6.568412	0.006846	0.003507	-40.0662	-20.4896	71.72164	36.74184	0.038292	0.019617
0.010268	-2.87884	-1.18575	4.515244	2.599758	0.006497	0.003741	-16.1342	-6.64542	25.30525	14.5701	0.03641	0.020964
4.69E-05	6.126351	1.067285	26.70935	11.60505	0.012119	0.005265	22.28032	3.881504	97.13662	42.20527	0.044073	0.019149
0.00014	-1.95584	-0.72459	4.50196	2.581575	0.005379	0.003084	-5.99974	-2.22275	13.8102	7.919232	0.0165	0.009461
9.49E-05	-2.26041	-0.58821	8.541387	4.941925	0.006683	0.003867	-4.52364	-1.17716	17.09346	9.890031	0.013375	0.007739

D_PTSDF_2	PTSDF_D6	PTSDF_B2	PTSDF_B6	PTSDF_P2	PTSDF_P6	D_OZONE_	OZONE_D6	OZONE_B2	OZONE_B6	OZONE_P2	OZONE_P6	D_PM25_2
-8.78191	-4.49101	15.72031	8.05326	0.008393	0.0043	-9414.72	-4814.62	16853.08	8633.559	8.997906	4.609482	-1777.37
-2.45676	-1.0119	3.853247	2.218598	0.005544	0.003192	-3794.78	-1563.01	5951.837	3426.911	8.563795	4.930807	-718.951
6.469759	1.127111	28.20653	12.25556	0.012798	0.005561	9199.707	1602.701	40108.42	17426.86	18.19801	7.906925	1742.956
-2.62804	-0.97362	6.049233	3.468833	0.007227	0.004144	-3555.03	-1317.05	8182.982	4692.396	9.776562	5.606208	-673.529
-2.83619	-0.73804	10.7171	6.200763	0.008386	0.004852	-3738.34	-972.803	14126.05	8173.134	11.05325	6.395253	-713.667

PM25_D6	PM25_B2	PM25_B6	PM25_P2	PM25_P6	STATE_NAI	ST_ABBRE\	REGION	P_MINORP	P_LWINCP(	P_LESHSPC	P_LNGISPC	P_UNDR5P
-908.933	3181.625	1629.895	1.698679	0.870206	Virginia	VA	3	41.36677	38.99356	48.40046	45.01944	5.475475
-296.125	1127.622	649.2549	1.622478	0.93418	Virginia	VA	3	54.36553	11.87426	62.83186	45.01944	86.59753
303.6442	7598.852	3301.655	3.447755	1.498028	Virginia	VA	3	74.36693	52.29056	32.94946	76.65862	6.079904
-249.526	1550.33	889.011	1.852246	1.06214	Virginia	VA	3	13.54854	71.6647	56.30632	45.01944	53.86622
-185.712	2696.727	1560.288	2.110115	1.220883	Virginia	VA	3	54.17436	37.19932	69.01209	45.01944	74.74888

P_OVR64P(	P_LDPNT	P_VULEOP(	P_VSVI6PC	P_DSLPM	P_CANCR	P_RESP	P_PTRAF	P_PWDIS	P_PNPL	P_PRMP	P_PTSDF	P_OZONE
56.89925	54.39941	36.89975	29.04677	15.68436	36.77281	33.08006	4.268489	55.09588	27.20243	31.62171	4.728524	26.46331
23.55375	68.09824	34.52519	33.5255	16.44788	37.43755	35.54149	4.268489	89.2283	27.12312	31.57307	2.331484	26.45513
57.57516	70.67479	70.35349	65.225	16.44788	37.43755	35.54149	4.268489	58.58119	23.88923	14.72676	2.78471	26.45513
73.3955	52.64476	41.0296	42.4541	16.44788	37.43755	35.54149	6.081758	66.48852	19.4618	8.08665	3.050066	26.45513
70.02262	54.50794	47.09227	51.8144	20.00992	39.03234	37.23517	4.268489	63.47963	21.53442	4.27169	3.19246	25.97025

P_PM25	P_LDPNT_[	P_LDPNT_[	P_LDPNT_E	P_LDPNT_E	P_LDPNT_F	P_LDPNT_F	P_DSLPM_	P_DSLPM_	P_DSLPM_	P_DSLPM_	P_DSLPM_	P_DSLPM_
25.49754	22.5053	18.43579	57.01937	53.26913	52.79566	49.0696	39.90031	36.77275	26.4014	20.7699	22.03199	14.56747
26.10089	28.13404	27.4016	44.39492	42.76256	63.23686	62.84978	50.41813	50.62516	8.182495	5.526043	21.37251	17.22111
26.10089	83.84902	77.65374	87.81927	86.06884	80.24681	76.61136	67.3892	64.65426	49.90682	42.4029	43.64173	33.72583
26.10089	36.30337	36.89142	38.02548	36.32066	52.95053	51.68155	50.95949	51.92425	12.4691	9.249873	24.97533	21.22562
26.91543	34.79769	39.06078	52.69987	51.95152	57.37552	56.64328	49.65902	53.22717	25.31763	22.72643	31.633	29.67944

P_CANCR_	P_CANCR_	P_CANCR_	P_CANCR_	P_CANCR_	P_CANCR_	P_RESP_D2	P_RESP_D6	P_RESP_B2	P_RESP_B6	P_RESP_P2	P_RESP_P6	P_PTRAF_D
29.56458	24.13155	41.32089	37.50734	36.03376	29.90173	30.37819	25.06117	39.69548	35.87988	34.57357	28.64316	59.22874
47.68513	47.42106	12.96131	8.859101	34.35865	33.481	47.6091	47.36764	13.48791	9.589892	33.76713	32.64678	59.22874
72.45215	66.90673	71.32471	66.67944	64.82714	58.50917	71.92514	66.65848	69.25366	64.40363	62.54466	55.8495	59.22874
48.49067	49.54605	20.07497	16.49233	39.43059	40.04969	48.44139	49.46671	20.30345	16.93646	38.45804	38.7184	53.79759
47.68701	52.28103	36.13224	36.07272	44.81593	47.90124	47.54031	52.21557	35.62223	35.56745	43.71991	46.17619	59.22874

P_PTRAF_[	P_PTRAF_E	P_PTRAF_E	P_PTRAF_F	P_PTRAF_F	P_PWDIS_I	P_PWDIS_I	P_PWDIS_I	P_PWDIS_I	P_PWDIS_I	P_PWDIS_I	P_PNPL_D2	P_PNPL_D(
60.35179	4.284179	4.268873	4.284179	4.268873	25.79558	25.65238	55.14177	54.52512	54.63038	54.03749	38.10628	35.73075
60.35179	4.284179	4.268873	4.284179	4.268873	7.434806	7.628094	84.02538	84.27285	87.90039	88.1067	48.75932	49.09584
60.35179	4.284179	4.268873	4.284179	4.268873	82.82474	82.06865	63.19293	61.6072	61.73446	60.12301	68.71987	65.47976
54.93417	6.005224	5.814873	6.510238	6.266613	22.07267	22.87025	62.38762	62.31473	66.23716	66.29676	51.68097	52.72431
60.35179	4.284179	4.268873	4.284179	4.268873	23.61022	25.53243	62.50684	62.48845	64.01442	64.02411	50.71728	53.93078

P_PNPL_B2	P_PNPL_B6	P_PNPL_P2	P_PNPL_P6	P_PRMP_D	P_PRMP_D	P_PRMP_B	P_PRMP_B	P_PRMP_P	P_PRMP_P	P_PTSDF_D	P_PTSDF_D	P_PTSDF_B
30.14097	26.19426	26.92426	22.34594	35.55808	32.69413	32.41637	29.36692	31.13561	27.78666	51.32008	50.62196	9.469192
9.934382	8.113177	25.52438	24.1183	47.54251	48.20677	14.07747	11.63144	30.05199	29.43035	56.28277	56.91378	1.240017
48.16076	41.14353	43.0107	34.26265	65.13425	63.48234	38.47927	32.42621	34.19795	27.21352	61.22739	61.0537	16.53243
9.892502	8.025983	20.71092	18.85236	54.21029	55.12968	6.670026	4.629927	14.21571	11.43007	56.12361	57.0108	2.618592
21.01714	19.48209	26.28818	25.09799	55.25181	57.08039	8.899894	6.691126	10.86758	8.067672	55.95631	57.53652	5.966224

P_PTSDF_E	P_PTSDF_P	P_PTSDF_P	P_OZONE_	P_OZONE_	P_OZONE_	P_OZONE_	P_OZONE_	P_OZONE_	P_PM25_D	P_PM25_D	P_PM25_B	P_PM25_B
6.559024	6.235886	3.265525	32.00729	26.1203	40.61166	35.76334	34.02643	25.11792	31.46772	25.7415	40.28376	35.71362
0.765104	2.927401	1.650693	49.17565	49.07539	9.433248	5.100096	31.75	29.49452	48.88507	48.71616	10.37341	6.135273
10.93256	11.75341	5.641826	73.0946	67.15303	74.157	69.51709	67.39786	61.14159	72.67487	66.98498	72.68123	67.87467
1.741604	4.823279	3.028246	49.84282	50.86574	16.3914	11.85151	38.04201	38.26393	49.59844	50.60403	17.34641	13.08477
4.499929	6.224088	4.280833	49.32941	53.23663	33.89098	33.14432	44.01183	47.32355	48.96514	53.079	34.38715	33.72747

Environmental Justice

Census Block Raw Data

P_PM25_P	P_PM25_P	B_MINORP	B_LWINCP(	B_LESHSPC	B_LNGISPC	B_UNDR5P	B_OVR64P(	B_LDPNT	B_VULEOP(	B_VSVI6PC	B_DSLPM	B_CANCR
34.19741	25.92015	5	4	5	5	1	6	6	4	3	2	4
32.21698	29.99817	6	2	7	5	9	3	7	4	4	2	4
65.82383	59.30232	8	6	4	8	1	6	8	8	7	2	4
37.95629	37.94669	2	8	6	5	6	8	6	5	5	2	4
43.92505	46.76758	6	4	7	5	8	8	6	5	6	3	4

B_RESP	B_PTRAF	B_PWDIS	B_PNPL	B_PRMP	B_PTSDF	B_OZONE	B_PM25	B_LDPNT_[	B_LDPNT_[	B_LDPNT_[	B_LDPNT_[	B_LDPNT_[
4	1	6	3	4	1	3	3	3	2	6	6	6
4	1	9	3	4	1	3	3	3	3	5	5	7
4	1	6	3	2	1	3	3	9	8	9	9	9
4	1	7	2	1	1	3	3	4	4	4	4	6
4	1	7	3	1	1	3	3	4	4	6	6	6

B_LDPNT_I	B_DSLPM_	B_DSLPM_	B_DSLPM_	B_DSLPM_	B_DSLPM_	B_DSLPM_	B_CANCR_	B_CANCR_	B_CANCR_	B_CANCR_	B_CANCR_	B_CANCR_
5	4	4	3	3	3	2	3	3	5	4	4	3
7	6	6	1	1	3	2	5	5	2	1	4	4
8	7	7	5	5	5	4	8	7	8	7	7	6
6	6	6	2	1	3	3	5	5	3	2	4	5
6	5	6	3	3	4	3	5	6	4	4	5	5

B_RESP_D2	B_RESP_D6	B_RESP_B2	B_RESP_B6	B_RESP_P2	B_RESP_P6	B_PTRAF_[	B_PTRAF_[	B_PTRAF_E	B_PTRAF_E	B_PTRAF_F	B_PTRAF_F	B_PWDIS_I
4	3	4	4	4	3	6	7	1	1	1	1	3
5	5	2	1	4	4	6	7	1	1	1	1	1
8	7	7	7	7	6	6	7	1	1	1	1	9
5	5	3	2	4	4	6	6	1	1	1	1	3
5	6	4	4	5	5	6	7	1	1	1	1	3

B_PWDIS_I	B_PWDIS_I	B_PWDIS_I	B_PWDIS_I	B_PWDIS_I	B_PNPL_D:	B_PNPL_D(	B_PNPL_B:	B_PNPL_B(	B_PNPL_P:	B_PNPL_P(	B_PRMP_D	B_PRMP_D
3	6	6	6	6	4	4	4	3	3	3	4	4
1	9	9	9	9	5	5	1	1	3	3	5	5
9	7	7	7	7	7	7	5	5	5	4	7	7
3	7	7	7	7	6	6	1	1	3	2	6	6
3	7	7	7	7	6	6	3	2	3	3	6	6

B_PRMP_B	B_PRMP_B	B_PRMP_P	B_PRMP_P	B_PTSDF_D	B_PTSDF_D	B_PTSDF_E	B_PTSDF_E	B_PTSDF_F	B_PTSDF_F	B_OZONE_	B_OZONE_	B_OZONE_
4	3	4	3	6	6	1	1	1	1	4	3	5
2	2	4	3	6	6	1	1	1	1	5	5	1
4	4	4	3	7	7	2	2	2	1	8	7	8
1	1	2	2	6	6	1	1	1	1	5	6	2
1	1	2	1	6	6	1	1	1	1	5	6	4

B_OZONE_	B_OZONE_	B_OZONE_	B_PM25_D	B_PM25_D	B_PM25_B	B_PM25_B	B_PM25_P	B_PM25_P	T_MINORP	T_LWINCP(	T_LESHSPC	T_LNGISPC
4	4	3	4	3	5	4	4	3	22% (41%il	23% (38%il	9% (48%ile	0% (45%ile
1	4	3	5	5	2	1	4	3	34% (54%il	9% (11%ile	13% (62%il	0% (45%ile
7	7	7	8	7	8	7	7	6	62% (74%il	31% (52%il	6% (32%ile	6% (76%ile
2	4	4	5	6	2	2	4	4	6% (13%ile	44% (71%il	11% (56%il	0% (45%ile
4	5	5	5	6	4	4	5	5	34% (54%il	22% (37%il	15% (69%il	0% (45%ile

T_UNDR5P	T_OVR64P(	T_VULEOP(	T_VSVI6PC	T_LDPNT	T_LDPNT_[	T_LDPNT_[	T_LDPNT_E	T_LDPNT_E	T_LDPNT_F	T_LDPNT_F	T_DSLPM	T_DSLPM_
1% (5%ile)	15% (56%il	23% (36%il	12% (29%il	0.22 = fract	22%ile	18%ile	57%ile	53%ile	52%ile	49%ile	0.18 ug/m3	39%ile
10% (86%il	8% (23%ile	22% (34%il	13% (33%il	0.37 = fract	28%ile	27%ile	44%ile	42%ile	63%ile	62%ile	0.184 ug/m	50%ile
1% (6%ile)	15% (57%il	46% (70%il	20% (65%il	0.41 = fract	83%ile	77%ile	87%ile	86%ile	80%ile	76%ile	0.184 ug/m	67%ile
6% (53%ile	19% (73%il	25% (41%il	14% (42%il	0.2 = fracti	36%ile	36%ile	38%ile	36%ile	52%ile	51%ile	0.184 ug/m	50%ile
8% (74%ile	18% (70%il	28% (47%il	16% (51%il	0.22 = fract	34%ile	39%ile	52%ile	51%ile	57%ile	56%ile	0.204 ug/m	49%ile

T_DSLPM_I	T_DSLPM_I	T_DSLPM_I	T_DSLPM_I	T_DSLPM_I	T_CANCR	T_CANCR_I	T_CANCR_I	T_CANCR_I	T_CANCR_I	T_CANCR_I	T_CANCR_I	T_RESP
36%ile	26%ile	20%ile	22%ile	14%ile	29 lifetime	29%ile	24%ile	41%ile	37%ile	36%ile	29%ile	0.37 (33%i
50%ile	8%ile	5%ile	21%ile	17%ile	29 lifetime	47%ile	47%ile	12%ile	8%ile	34%ile	33%ile	0.38 (35%i
64%ile	49%ile	42%ile	43%ile	33%ile	29 lifetime	72%ile	66%ile	71%ile	66%ile	64%ile	58%ile	0.38 (35%i
51%ile	12%ile	9%ile	24%ile	21%ile	29 lifetime	48%ile	49%ile	20%ile	16%ile	39%ile	40%ile	0.38 (35%i
53%ile	25%ile	22%ile	31%ile	29%ile	29 lifetime	47%ile	52%ile	36%ile	36%ile	44%ile	47%ile	0.38 (37%i

T_RESP_D2	T_RESP_D6	T_RESP_B2	T_RESP_B6	T_RESP_P2	T_RESP_P6	T_PTRAF	T_PTRAF_D	T_PTRAF_D	T_PTRAF_E	T_PTRAF_E	T_PTRAF_P	T_PTRAF_P
30%ile	25%ile	39%ile	35%ile	34%ile	28%ile	0 daily vehi	59%ile	60%ile	4%ile	4%ile	4%ile	4%ile
47%ile	47%ile	13%ile	9%ile	33%ile	32%ile	0 daily vehi	59%ile	60%ile	4%ile	4%ile	4%ile	4%ile
71%ile	66%ile	69%ile	64%ile	62%ile	55%ile	0 daily vehi	59%ile	60%ile	4%ile	4%ile	4%ile	4%ile
48%ile	49%ile	20%ile	16%ile	38%ile	38%ile	0.81 daily v	53%ile	54%ile	6%ile	5%ile	6%ile	6%ile
47%ile	52%ile	35%ile	35%ile	43%ile	46%ile	0 daily vehi	59%ile	60%ile	4%ile	4%ile	4%ile	4%ile

T_PWDIS	T_PWDIS_[	T_PWDIS_[	T_PWDIS_E	T_PWDIS_E	T_PWDIS_F	T_PWDIS_F	T_PNPL	T_PNPL_D2	T_PNPL_D6	T_PNPL_B2	T_PNPL_B6	T_PNPL_P2
0.00011 to	25%ile	25%ile	55%ile	54%ile	54%ile	54%ile	0.03 sites/k	38%ile	35%ile	30%ile	26%ile	26%ile
0.082 toxic	7%ile	7%ile	84%ile	84%ile	87%ile	88%ile	0.03 sites/k	48%ile	49%ile	9%ile	8%ile	25%ile
0.00023 to	82%ile	82%ile	63%ile	61%ile	61%ile	60%ile	0.026 sites,	68%ile	65%ile	48%ile	41%ile	43%ile
0.00099 to	22%ile	22%ile	62%ile	62%ile	66%ile	66%ile	0.022 sites,	51%ile	52%ile	9%ile	8%ile	20%ile
0.00058 to	23%ile	25%ile	62%ile	62%ile	64%ile	64%ile	0.024 sites,	50%ile	53%ile	21%ile	19%ile	26%ile

T_PNPL_P€	T_PRMP	T_PRMP_D	T_PRMP_D	T_PRMP_B	T_PRMP_B	T_PRMP_P	T_PRMP_P	T_PTSDF	T_PTSDF_D	T_PTSDF_D	T_PTSDF_B	T_PTSDF_B
22%ile	0.17 faciliti	35%ile	32%ile	32%ile	29%ile	31%ile	27%ile	0.037 facili	51%ile	50%ile	9%ile	6%ile
24%ile	0.17 faciliti	47%ile	48%ile	14%ile	11%ile	30%ile	29%ile	0.025 facili	56%ile	56%ile	1%ile	0%ile
34%ile	0.095 facili	65%ile	63%ile	38%ile	32%ile	34%ile	27%ile	0.028 facili	61%ile	61%ile	16%ile	10%ile
18%ile	0.066 facili	54%ile	55%ile	6%ile	4%ile	14%ile	11%ile	0.029 facili	56%ile	57%ile	2%ile	1%ile
25%ile	0.047 facili	55%ile	57%ile	8%ile	6%ile	10%ile	8%ile	0.03 faciliti	55%ile	57%ile	5%ile	4%ile

T_PTSDF_P	T_PTSDF_P	T_OZONE	T_OZONE_	T_OZONE_	T_OZONE_	T_OZONE_	T_OZONE_	T_OZONE_	T_PM25	T_PM25_D	T_PM25_D	T_PM25_B
6%ile	3%ile	39.3 ppb (2	32%ile	26%ile	40%ile	35%ile	34%ile	25%ile	7.43 ug/m3	31%ile	25%ile	40%ile
2%ile	1%ile	39.3 ppb (2	49%ile	49%ile	9%ile	5%ile	31%ile	29%ile	7.45 ug/m3	48%ile	48%ile	10%ile
11%ile	5%ile	39.3 ppb (2	73%ile	67%ile	74%ile	69%ile	67%ile	61%ile	7.45 ug/m3	72%ile	66%ile	72%ile
4%ile	3%ile	39.3 ppb (2	49%ile	50%ile	16%ile	11%ile	38%ile	38%ile	7.45 ug/m3	49%ile	50%ile	17%ile
6%ile	4%ile	39.2 ppb (2	49%ile	53%ile	33%ile	33%ile	44%ile	47%ile	7.49 ug/m3	48%ile	53%ile	34%ile

T_PM25_B	T_PM25_P	T_PM25_P	AREALAND	AREAWATE	NPL_CNT	TSDF_CNT	Shape_Len	Shape_Area
35%ile	34%ile	25%ile	1.16E+08	2217453	0	0	83386.5	1.89E+08
6%ile	32%ile	29%ile	46084157	1567755	0	0	40762.17	76304013
67%ile	65%ile	59%ile	81164080	1023829	0	0	72639.88	1.32E+08
13%ile	37%ile	37%ile	1.14E+08	659311	0	0	84656.14	1.85E+08
33%ile	43%ile	46%ile	88991431	4692467	0	0	72583.56	1.5E+08

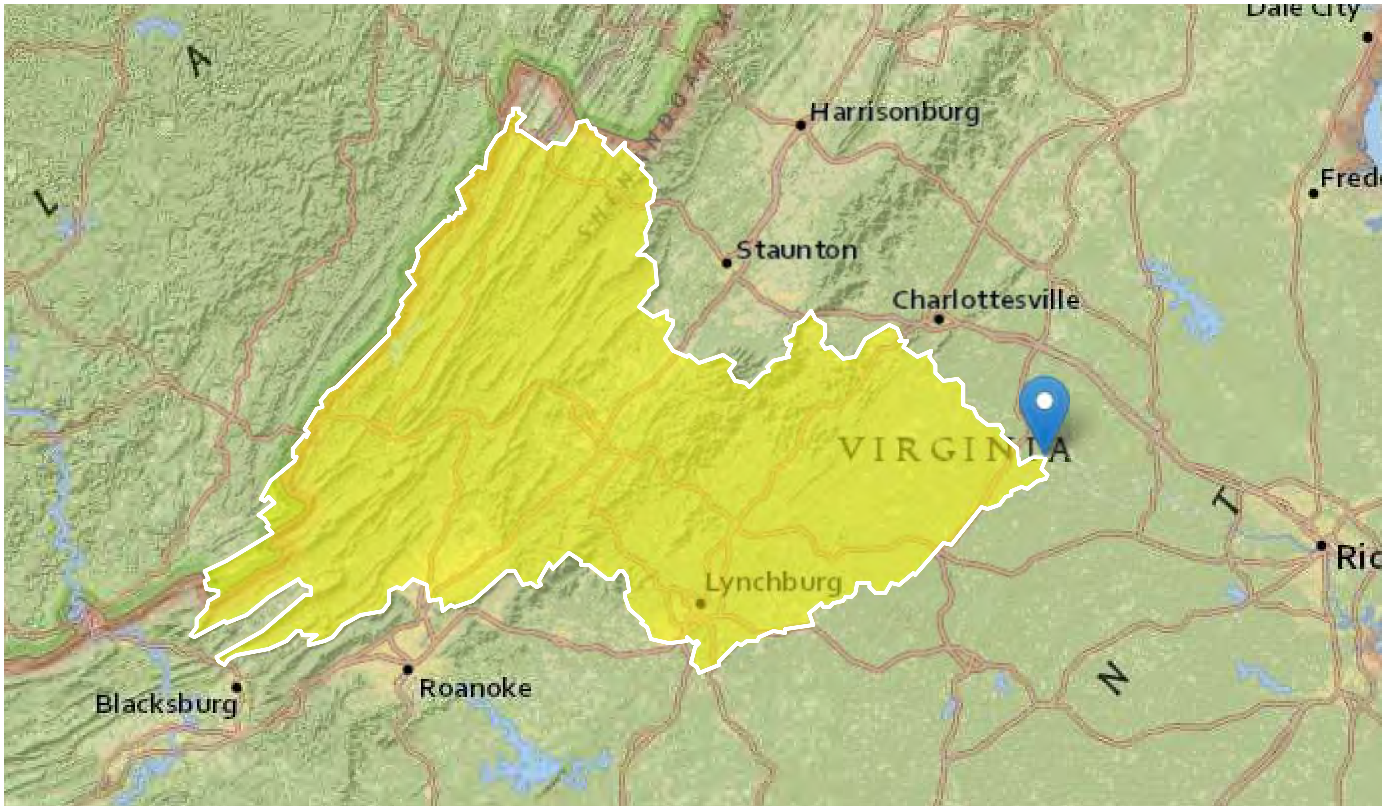
APPENDIX H-12
AQUATIC RESOURCE DOCUMENTATION

APPENDIX H-12-1
STREAMSTATS REPORT

StreamStats Report: PS ALT 1 (Mussel Survey Location 16)

VMRC

Region ID: VA
Workspace ID: VA20200131160519958000
Clicked Point (Latitude, Longitude): 37.73220, -78.19807
Time: 2020-01-31 11:05:42 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5060	square miles

Peak-Flow Statistics Parameters[12 Percent (589 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5060	square miles	0.06	7866

Peak-Flow Statistics Parameters[31 Percent (1540 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5060	square miles	0.06	7866

Peak-Flow Statistics Parameters[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5060	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[12 Percent (589 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[12 Percent (589 square miles) Piedmont nonMesozoic 2011 5144]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	24700	ft^3/s	43
2 33 Year Peak Flood	26300	ft^3/s	42
5 Year Peak Flood	38100	ft^3/s	32
10 Year Peak Flood	49800	ft^3/s	31
25 Year Peak Flood	66100	ft^3/s	32
50 Year Peak Flood	79200	ft^3/s	34
100 Year Peak Flood	93800	ft^3/s	36
200 Year Peak Flood	110000	ft^3/s	38

Peak-Flow Statistics Disclaimers[31 Percent (1540 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[31 Percent (1540 square miles) Blue Ridge 2011 5144]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	56700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	62600	ft^3/s	18
5 Year Peak Flood	92100	ft^3/s	20
10 Year Peak Flood	122000	ft^3/s	24
25 Year Peak Flood	167000	ft^3/s	29
50 Year Peak Flood	205000	ft^3/s	32
100 Year Peak Flood	240000	ft^3/s	30
200 Year Peak Flood	287000	ft^3/s	33

Peak-Flow Statistics Disclaimers[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	58600	ft^3/s	22
2 33 Year Peak Flood	64000	ft^3/s	23
5 Year Peak Flood	85900	ft^3/s	24
10 Year Peak Flood	105000	ft^3/s	27
25 Year Peak Flood	132000	ft^3/s	31
50 Year Peak Flood	152000	ft^3/s	35
100 Year Peak Flood	174000	ft^3/s	39
200 Year Peak Flood	198000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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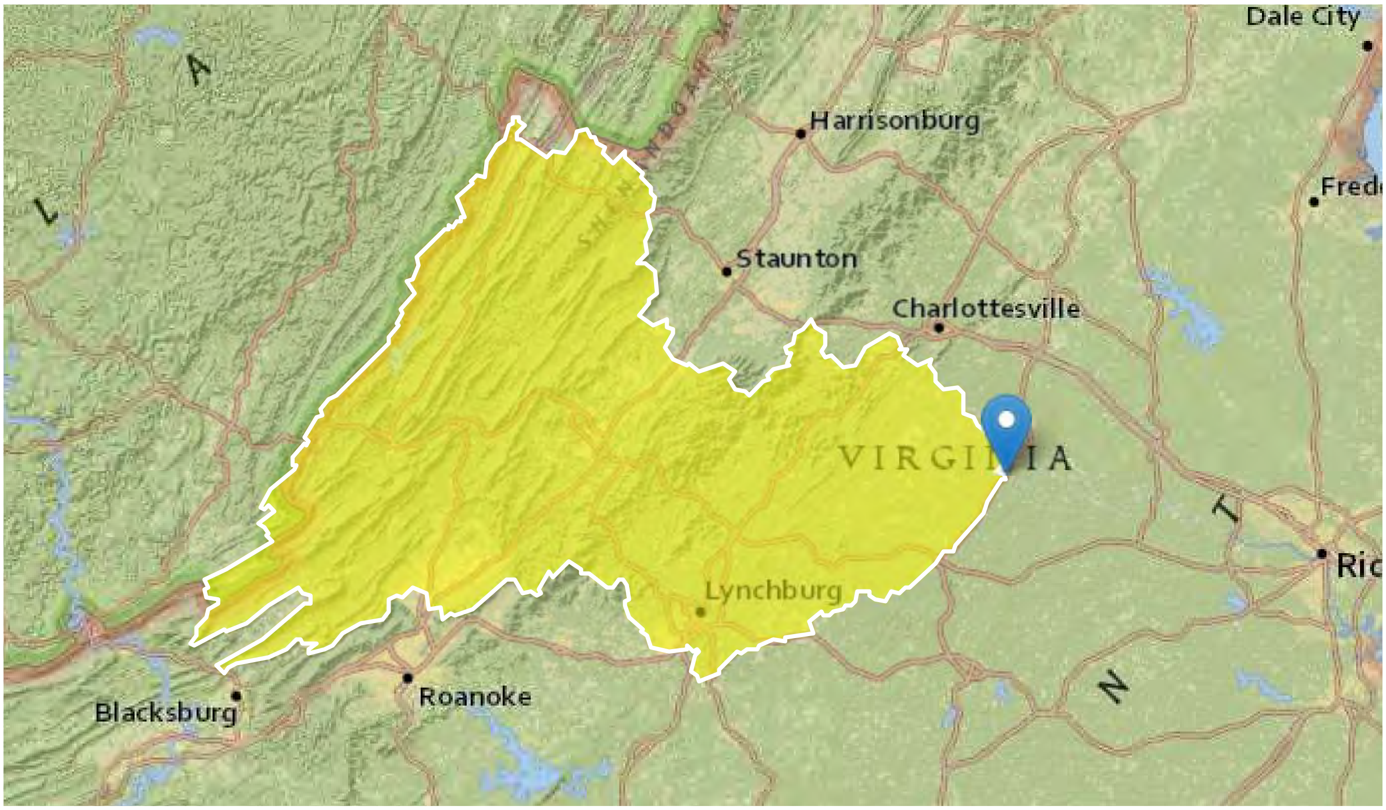
Application Version: 4.3.11

StreamStats Report: PS ALT 2 (Mussel Survey Location 15)

VMRC

Region ID: VA
Workspace ID: VA20200131160111249000
Clicked Point (Latitude, Longitude): 37.71041, -78.30368
Time: 2020-01-31 11:01:34 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5020	square miles

Peak-Flow Statistics Parameters[11 Percent (549 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5020	square miles	0.06	7866

Peak-Flow Statistics Parameters[31 Percent (1540 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5020	square miles	0.06	7866

Peak-Flow Statistics Parameters[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5020	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[11 Percent (549 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[11 Percent (549 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	24600	ft^3/s	43
2 33 Year Peak Flood	26200	ft^3/s	42
5 Year Peak Flood	37900	ft^3/s	32
10 Year Peak Flood	49600	ft^3/s	31
25 Year Peak Flood	65800	ft^3/s	32
50 Year Peak Flood	78900	ft^3/s	34
100 Year Peak Flood	93400	ft^3/s	36
200 Year Peak Flood	109000	ft^3/s	38

Peak-Flow Statistics Disclaimers[31 Percent (1540 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[31 Percent (1540 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	56300	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	62300	ft^3/s	18
5 Year Peak Flood	91600	ft^3/s	20
10 Year Peak Flood	121000	ft^3/s	24
25 Year Peak Flood	166000	ft^3/s	29
50 Year Peak Flood	204000	ft^3/s	32
100 Year Peak Flood	239000	ft^3/s	30
200 Year Peak Flood	286000	ft^3/s	33

Peak-Flow Statistics Disclaimers[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	58300	ft^3/s	22
2 33 Year Peak Flood	63700	ft^3/s	23
5 Year Peak Flood	85500	ft^3/s	24
10 Year Peak Flood	104000	ft^3/s	27
25 Year Peak Flood	131000	ft^3/s	31
50 Year Peak Flood	151000	ft^3/s	35
100 Year Peak Flood	173000	ft^3/s	39
200 Year Peak Flood	197000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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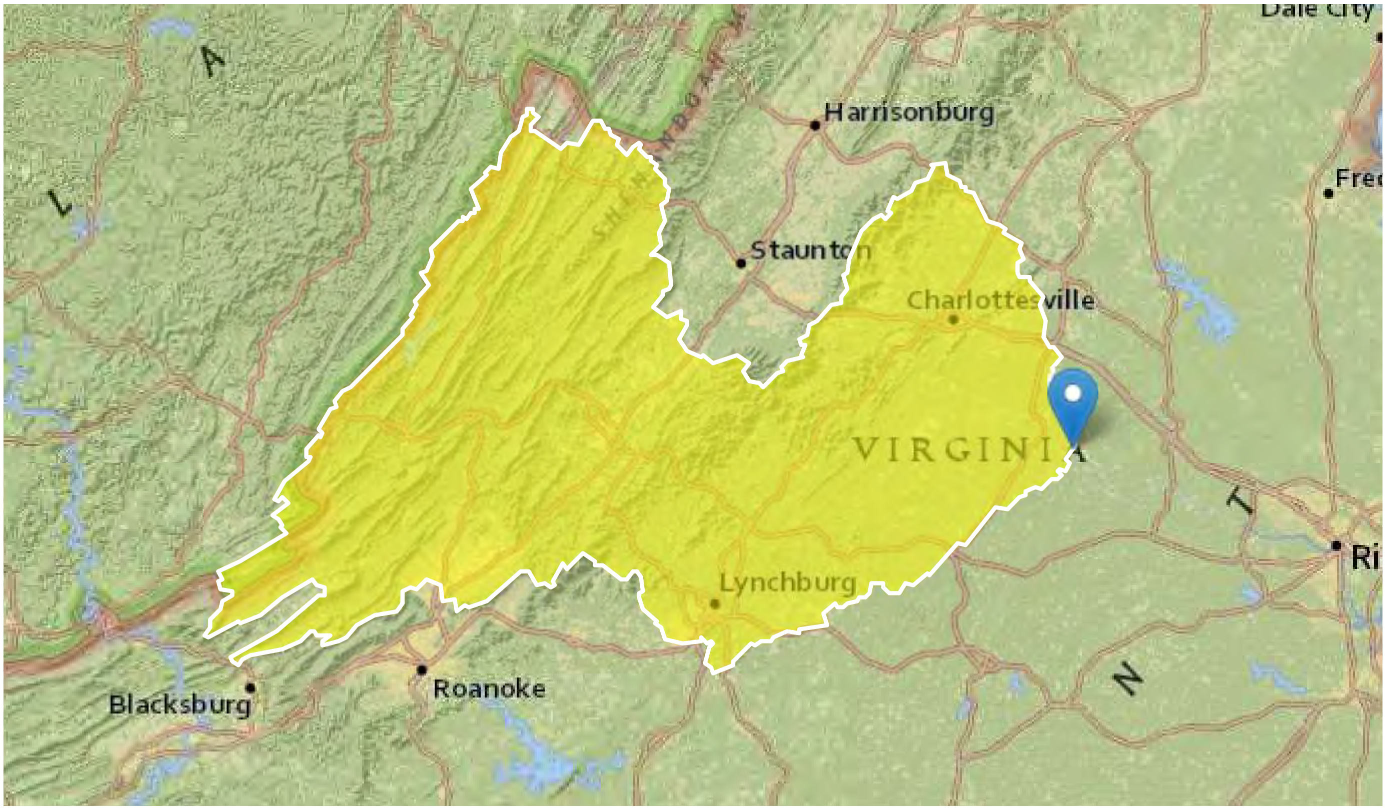
Application Version: 4.3.11

StreamStats Report: PS ALT 3 (Mussel Survey Location19)

VMRC

Region ID: VA
Workspace ID: VA20200131154600358000
Clicked Point (Latitude, Longitude): 37.75012, -78.16176
Time: 2020-01-31 10:46:20 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5840	square miles

Peak-Flow Statistics Parameters[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Parameters[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Parameters[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	26900	ft^3/s	43
2 33 Year Peak Flood	28600	ft^3/s	42
5 Year Peak Flood	41200	ft^3/s	32
10 Year Peak Flood	53700	ft^3/s	31
25 Year Peak Flood	71100	ft^3/s	32
50 Year Peak Flood	85100	ft^3/s	34
100 Year Peak Flood	101000	ft^3/s	36
200 Year Peak Flood	118000	ft^3/s	38

Peak-Flow Statistics Disclaimers[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[36 Percent (2120 square miles) Blue Ridge 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	62700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	69300	ft^3/s	18
5 Year Peak Flood	101000	ft^3/s	20
10 Year Peak Flood	134000	ft^3/s	24
25 Year Peak Flood	183000	ft^3/s	29
50 Year Peak Flood	224000	ft^3/s	32
100 Year Peak Flood	262000	ft^3/s	30
200 Year Peak Flood	313000	ft^3/s	33

Peak-Flow Statistics Disclaimers[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	65100	ft^3/s	22
2 33 Year Peak Flood	71100	ft^3/s	23
5 Year Peak Flood	94900	ft^3/s	24
10 Year Peak Flood	115000	ft^3/s	27
25 Year Peak Flood	144000	ft^3/s	31
50 Year Peak Flood	166000	ft^3/s	35
100 Year Peak Flood	190000	ft^3/s	39
200 Year Peak Flood	216000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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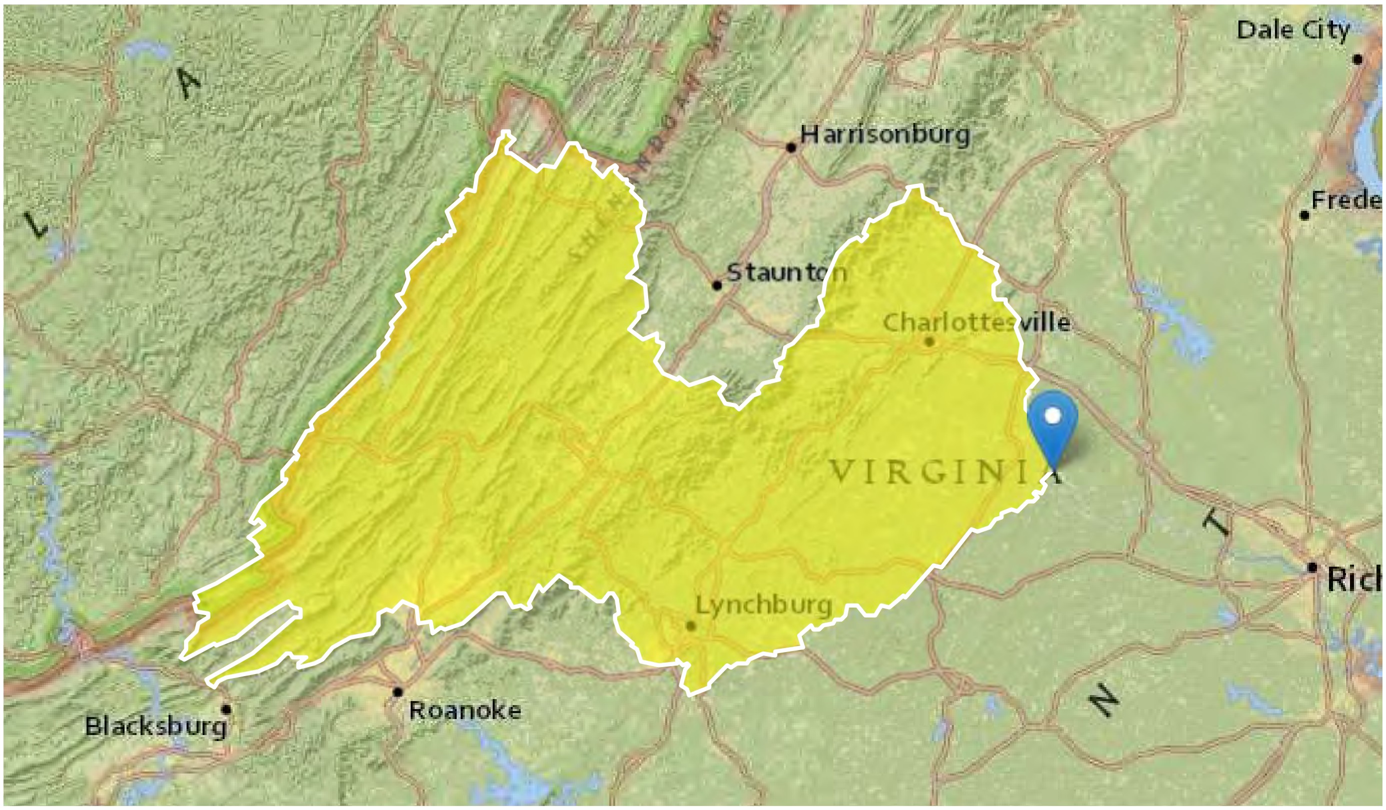
Application Version: 4.3.11

StreamStats Report: PS ALT 4 (Mussel Survey Location 9)

VMRC

Region ID: VA
Workspace ID: VA20200131155518128000
Clicked Point (Latitude, Longitude): 37.74707, -78.15386
Time: 2020-01-31 10:55:38 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5840	square miles

Peak-Flow Statistics Parameters[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Parameters[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Parameters[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5840	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[14 Percent (798 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	26900	ft^3/s	43
2 33 Year Peak Flood	28600	ft^3/s	42
5 Year Peak Flood	41200	ft^3/s	32
10 Year Peak Flood	53700	ft^3/s	31
25 Year Peak Flood	71100	ft^3/s	32
50 Year Peak Flood	85100	ft^3/s	34
100 Year Peak Flood	101000	ft^3/s	36
200 Year Peak Flood	118000	ft^3/s	38

Peak-Flow Statistics Disclaimers[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[36 Percent (2120 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	62700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	69300	ft^3/s	18
5 Year Peak Flood	101000	ft^3/s	20
10 Year Peak Flood	134000	ft^3/s	24
25 Year Peak Flood	183000	ft^3/s	29
50 Year Peak Flood	224000	ft^3/s	32
100 Year Peak Flood	262000	ft^3/s	30
200 Year Peak Flood	313000	ft^3/s	33

Peak-Flow Statistics Disclaimers[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	65100	ft^3/s	22
2 33 Year Peak Flood	71100	ft^3/s	23
5 Year Peak Flood	94900	ft^3/s	24
10 Year Peak Flood	115000	ft^3/s	27
25 Year Peak Flood	144000	ft^3/s	31
50 Year Peak Flood	166000	ft^3/s	35
100 Year Peak Flood	190000	ft^3/s	39
200 Year Peak Flood	216000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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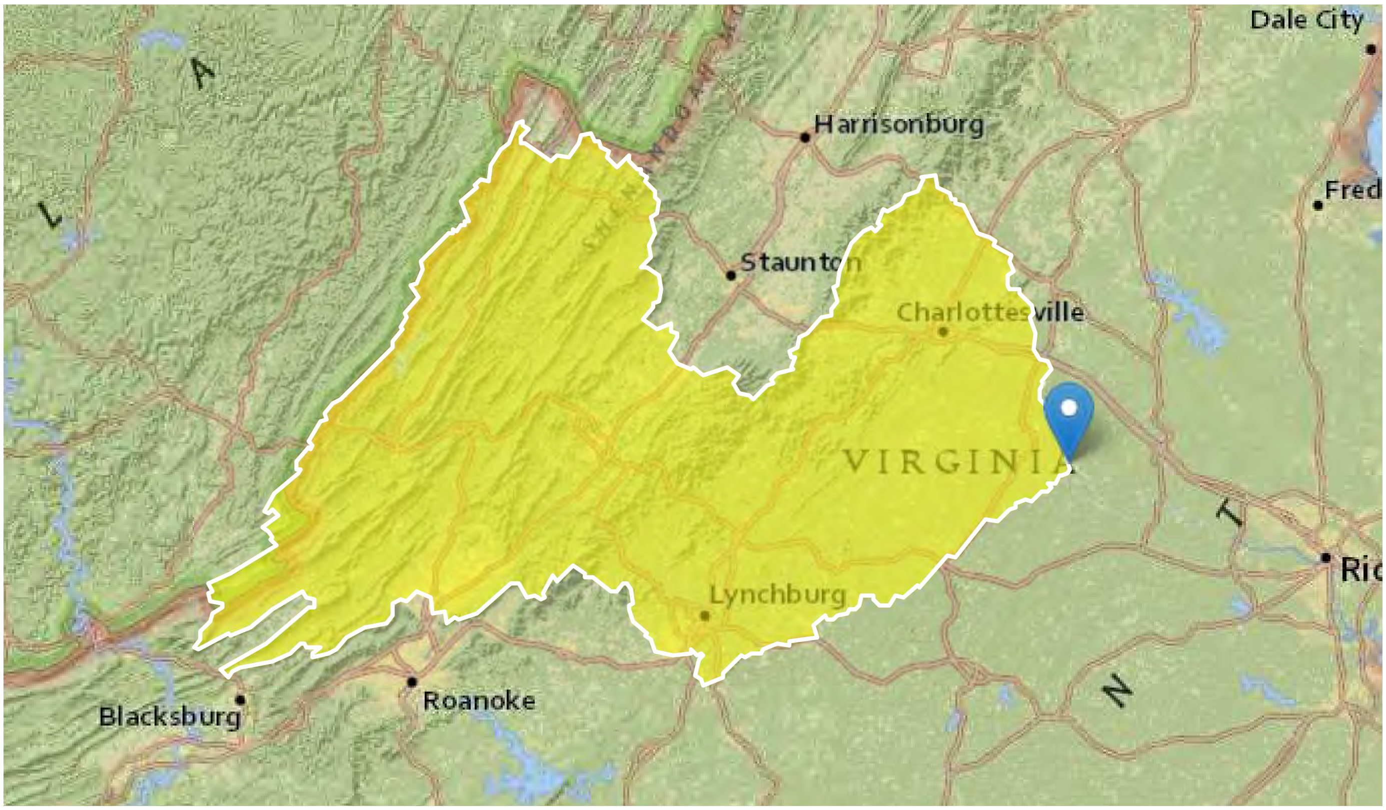
Application Version: 4.3.11

StreamStats Report: PS ALT 5 (Mussel Survey Location 10)

VMRC

Region ID: VA
Workspace ID: VA20200131170004397000
Clicked Point (Latitude, Longitude): 37.74289, -78.14472
Time: 2020-01-31 12:00:24 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5850	square miles

Peak-Flow Statistics Parameters[14 Percent (801 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5850	square miles	0.06	7866

Peak-Flow Statistics Parameters[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5850	square miles	0.06	7866

Peak-Flow Statistics Parameters[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5850	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[14 Percent (801 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[14 Percent (801 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	27000	ft^3/s	43
2 33 Year Peak Flood	28600	ft^3/s	42
5 Year Peak Flood	41300	ft^3/s	32
10 Year Peak Flood	53800	ft^3/s	31
25 Year Peak Flood	71200	ft^3/s	32
50 Year Peak Flood	85200	ft^3/s	34
100 Year Peak Flood	101000	ft^3/s	36
200 Year Peak Flood	118000	ft^3/s	38

Peak-Flow Statistics Disclaimers[36 Percent (2120 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[36 Percent (2120 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	62800	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	69300	ft^3/s	18
5 Year Peak Flood	101000	ft^3/s	20
10 Year Peak Flood	134000	ft^3/s	24
25 Year Peak Flood	183000	ft^3/s	29
50 Year Peak Flood	224000	ft^3/s	32
100 Year Peak Flood	262000	ft^3/s	30
200 Year Peak Flood	313000	ft^3/s	33

Peak-Flow Statistics Disclaimers[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[49 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	65200	ft^3/s	22
2 33 Year Peak Flood	71200	ft^3/s	23
5 Year Peak Flood	95000	ft^3/s	24
10 Year Peak Flood	115000	ft^3/s	27
25 Year Peak Flood	144000	ft^3/s	31
50 Year Peak Flood	166000	ft^3/s	35
100 Year Peak Flood	190000	ft^3/s	39
200 Year Peak Flood	216000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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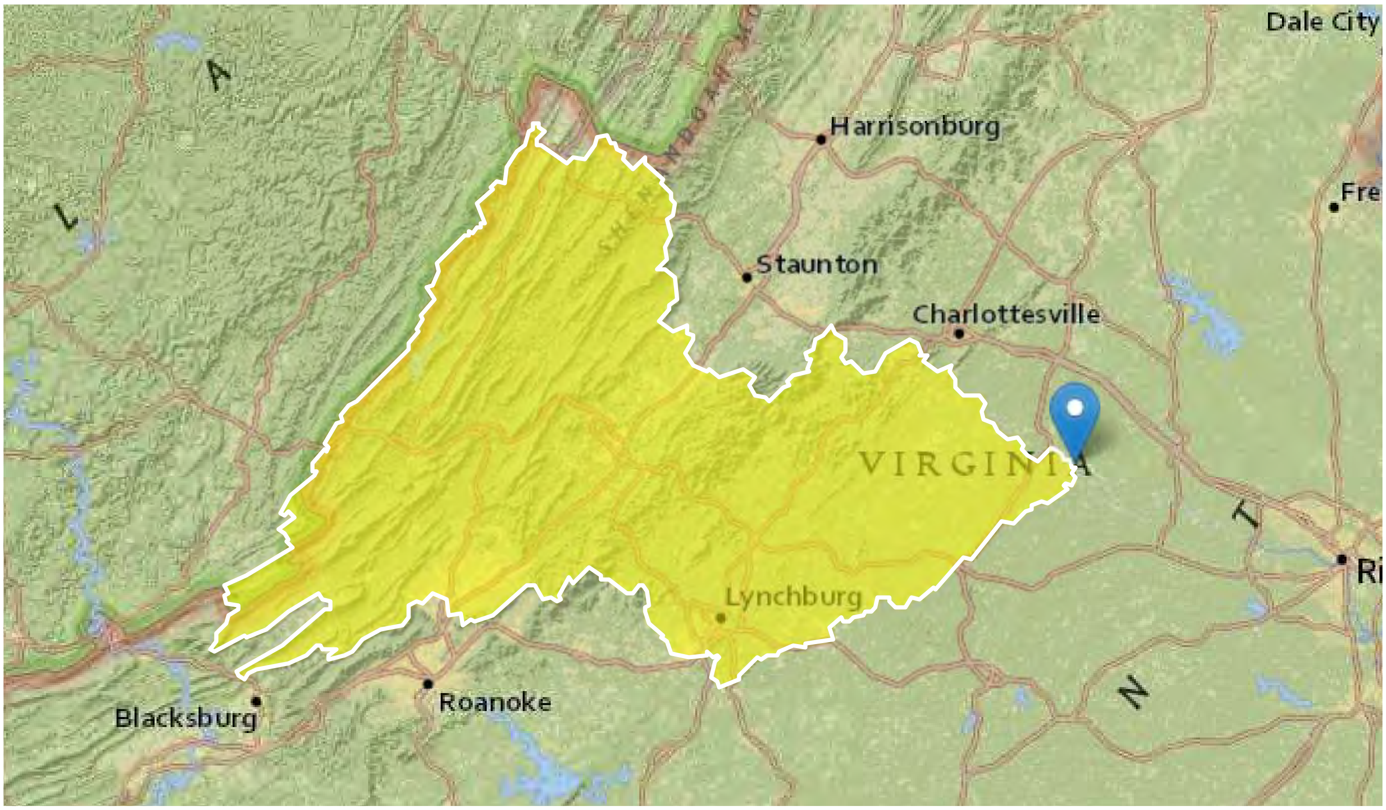
Application Version: 4.3.11

StreamStats Report: PS ALT 6 (Mussel Survey Location 18)

VMRC

Region ID: VA
Workspace ID: VA20200131170340
Clicked Point (Latitude, Longitude): 37.74873, -78.17150
Time: 2020-01-31 12:04:03 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5070	square miles

Peak-Flow Statistics Parameters[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	24800	ft^3/s	43
2 33 Year Peak Flood	26400	ft^3/s	42
5 Year Peak Flood	38100	ft^3/s	32
10 Year Peak Flood	49800	ft^3/s	31
25 Year Peak Flood	66100	ft^3/s	32
50 Year Peak Flood	79300	ft^3/s	34
100 Year Peak Flood	93900	ft^3/s	36
200 Year Peak Flood	110000	ft^3/s	38

Peak-Flow Statistics Disclaimers[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[30 Percent (1540 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	56700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	62700	ft^3/s	18
5 Year Peak Flood	92200	ft^3/s	20
10 Year Peak Flood	122000	ft^3/s	24
25 Year Peak Flood	167000	ft^3/s	29
50 Year Peak Flood	205000	ft^3/s	32
100 Year Peak Flood	240000	ft^3/s	30
200 Year Peak Flood	288000	ft^3/s	33

Peak-Flow Statistics Disclaimers[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	58700	ft^3/s	22
2 33 Year Peak Flood	64100	ft^3/s	23
5 Year Peak Flood	86000	ft^3/s	24
10 Year Peak Flood	105000	ft^3/s	27
25 Year Peak Flood	132000	ft^3/s	31
50 Year Peak Flood	152000	ft^3/s	35
100 Year Peak Flood	174000	ft^3/s	39
200 Year Peak Flood	198000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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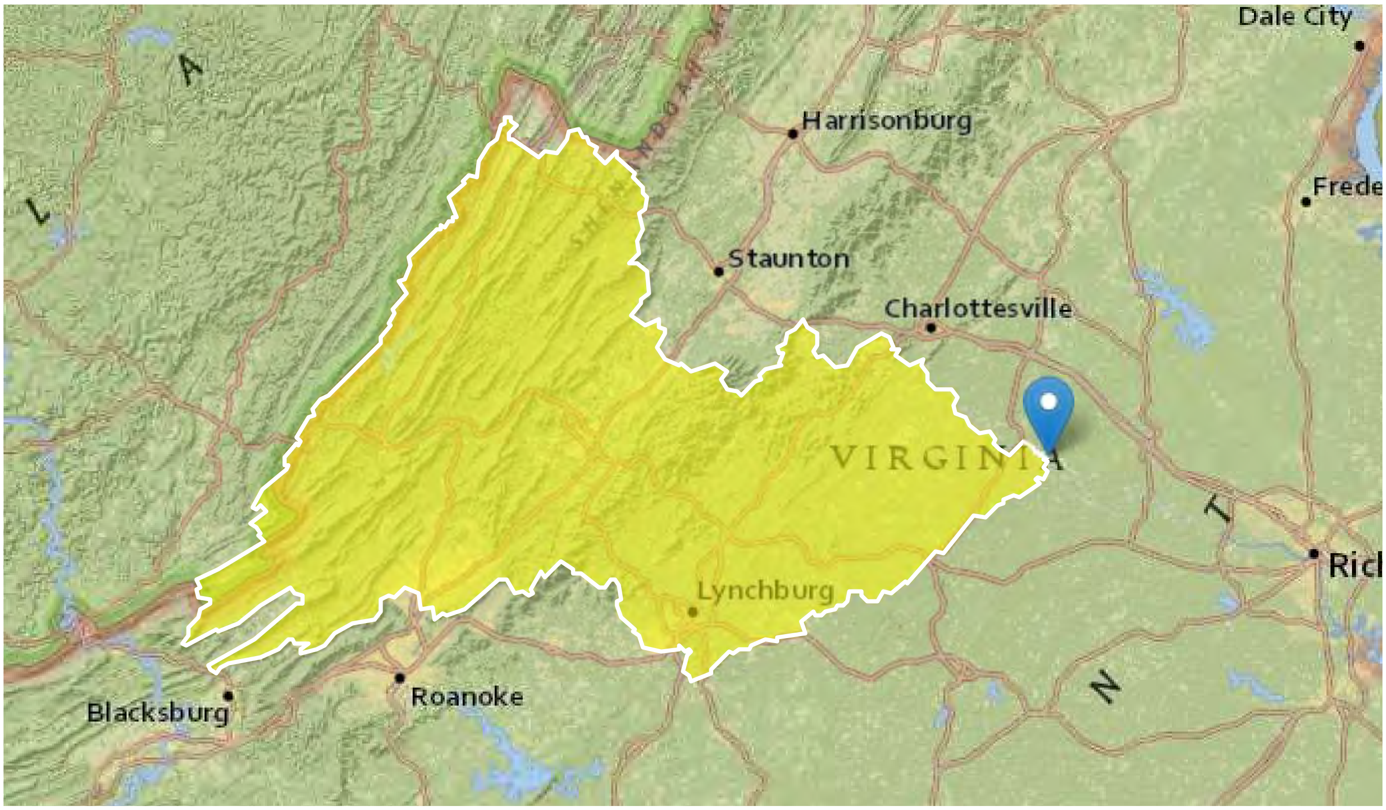
Application Version: 4.3.11

StreamStats Report: PS ALT 6-1 (Mussel Survey Location 18)

VMRC

Region ID: VA
Workspace ID: VA20200131170607036000
Clicked Point (Latitude, Longitude): 37.74910, -78.16940
Time: 2020-01-31 12:06:27 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5070	square miles

Peak-Flow Statistics Parameters[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[12 Percent (608 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	24800	ft^3/s	43
2 33 Year Peak Flood	26400	ft^3/s	42
5 Year Peak Flood	38100	ft^3/s	32
10 Year Peak Flood	49800	ft^3/s	31
25 Year Peak Flood	66100	ft^3/s	32
50 Year Peak Flood	79300	ft^3/s	34
100 Year Peak Flood	93900	ft^3/s	36
200 Year Peak Flood	110000	ft^3/s	38

Peak-Flow Statistics Disclaimers[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[30 Percent (1540 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	56700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	62700	ft^3/s	18
5 Year Peak Flood	92200	ft^3/s	20
10 Year Peak Flood	122000	ft^3/s	24
25 Year Peak Flood	167000	ft^3/s	29
50 Year Peak Flood	205000	ft^3/s	32
100 Year Peak Flood	240000	ft^3/s	30
200 Year Peak Flood	288000	ft^3/s	33

Peak-Flow Statistics Disclaimers[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	58700	ft^3/s	22
2 33 Year Peak Flood	64100	ft^3/s	23
5 Year Peak Flood	86000	ft^3/s	24
10 Year Peak Flood	105000	ft^3/s	27
25 Year Peak Flood	132000	ft^3/s	31
50 Year Peak Flood	152000	ft^3/s	35
100 Year Peak Flood	174000	ft^3/s	39
200 Year Peak Flood	198000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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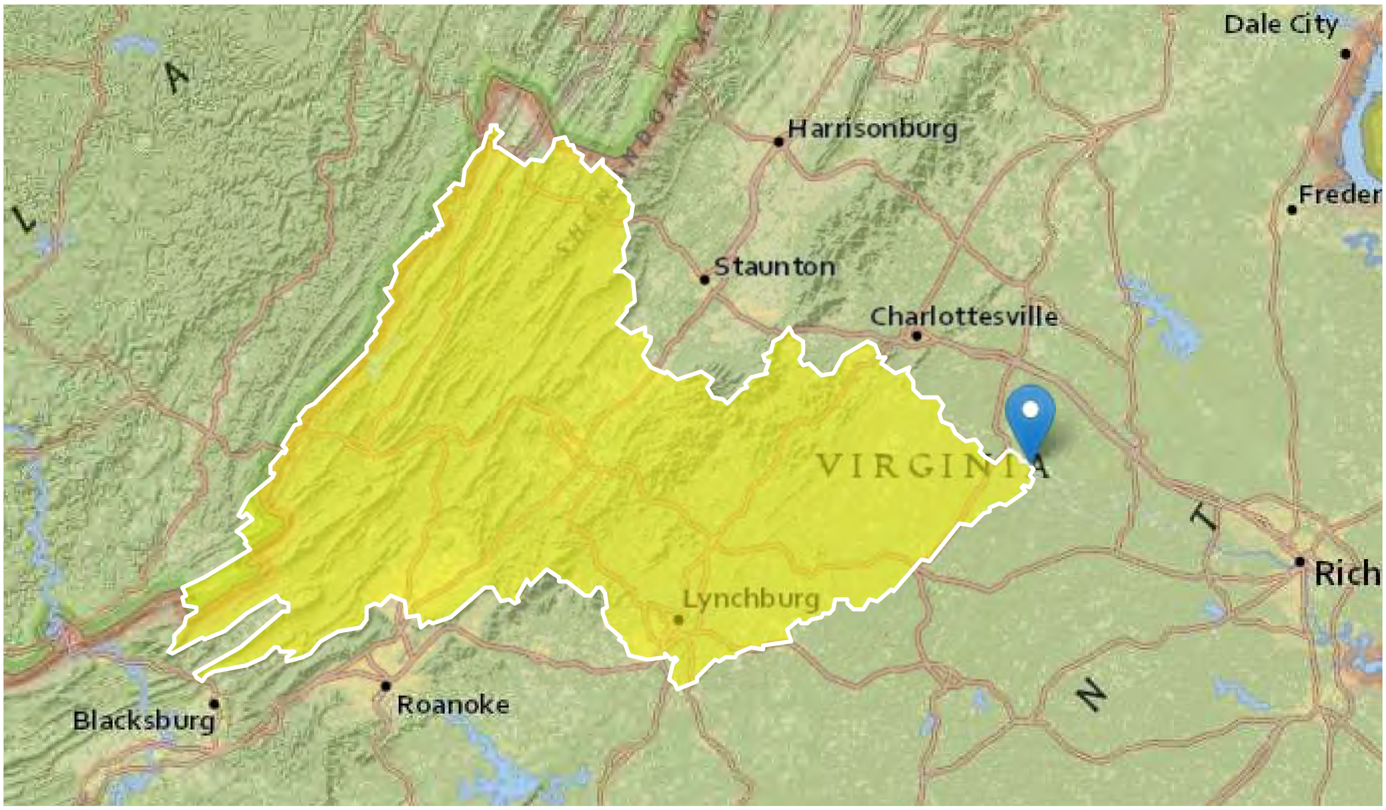
Application Version: 4.3.11

StreamStats Report: PS ALT 6-2 (Mussel Survey Location 17)

VMRC

Region ID: VA
Workspace ID: VA20200131170912651000
Clicked Point (Latitude, Longitude): 37.74710, -78.17712
Time: 2020-01-31 12:09:33 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	5070	square miles

Peak-Flow Statistics Parameters[12 Percent (607 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Parameters[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	5070	square miles	0.06	7866

Peak-Flow Statistics Disclaimers[12 Percent (607 square miles) Piedmont nonMesozoic 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[12 Percent (607 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	24800	ft^3/s	43
2 33 Year Peak Flood	26400	ft^3/s	42
5 Year Peak Flood	38100	ft^3/s	32
10 Year Peak Flood	49800	ft^3/s	31
25 Year Peak Flood	66100	ft^3/s	32
50 Year Peak Flood	79300	ft^3/s	34
100 Year Peak Flood	93900	ft^3/s	36
200 Year Peak Flood	110000	ft^3/s	38

Peak-Flow Statistics Disclaimers[30 Percent (1540 square miles) Blue Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[30 Percent (1540 square miles) Blue Ridge 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	56700	ft^3/s	17

Statistic	Value	Unit	SEp
2 33 Year Peak Flood	62700	ft^3/s	18
5 Year Peak Flood	92200	ft^3/s	20
10 Year Peak Flood	122000	ft^3/s	24
25 Year Peak Flood	167000	ft^3/s	29
50 Year Peak Flood	205000	ft^3/s	32
100 Year Peak Flood	240000	ft^3/s	30
200 Year Peak Flood	288000	ft^3/s	33

Peak-Flow Statistics Disclaimers[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Peak-Flow Statistics Flow Report[57 Percent (2880 square miles) Valley and Ridge 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	58700	ft^3/s	22
2 33 Year Peak Flood	64100	ft^3/s	23
5 Year Peak Flood	86000	ft^3/s	24
10 Year Peak Flood	105000	ft^3/s	27
25 Year Peak Flood	132000	ft^3/s	31
50 Year Peak Flood	152000	ft^3/s	35
100 Year Peak Flood	174000	ft^3/s	39
200 Year Peak Flood	198000	ft^3/s	43

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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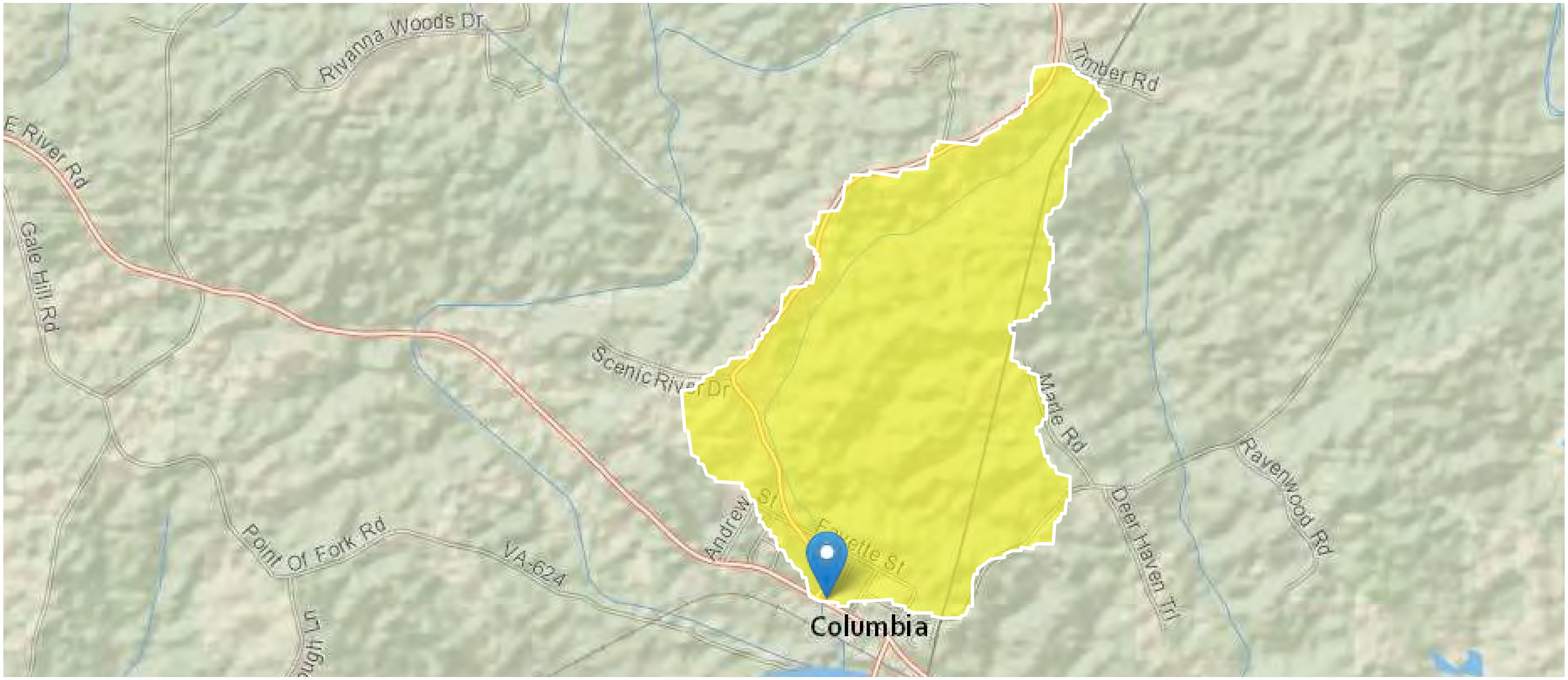
Application Version: 4.3.11

Mussel Survey Location 1 StreamStats Report

Region ID: VA
Workspace ID: VA20200204174216277000
Clicked Point (Latitude, Longitude): 37.75353, -78.16367
Time: 2020-02-04 12:42:32 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.99	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.99	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	156	ft^3/s	43
2 33 Year Peak Flood	193	ft^3/s	42
5 Year Peak Flood	345	ft^3/s	32
10 Year Peak Flood	521	ft^3/s	31
25 Year Peak Flood	820	ft^3/s	32
50 Year Peak Flood	1100	ft^3/s	34
100 Year Peak Flood	1430	ft^3/s	36
200 Year Peak Flood	1820	ft^3/s	38

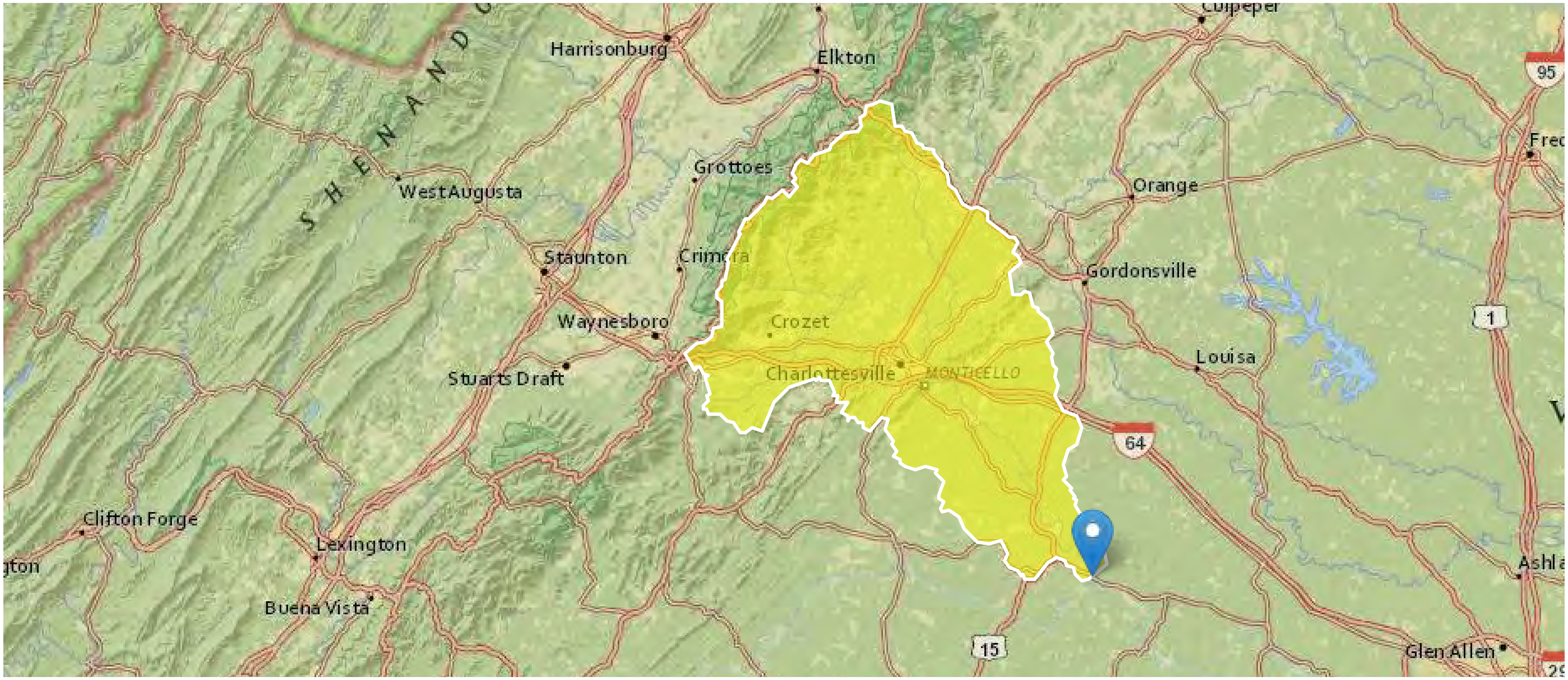
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 2 StreamStats Report VMRC

Region ID: VA
Workspace ID: VA20200305174837621000
Clicked Point (Latitude, Longitude): 37.75733, -78.17652
Time: 2020-03-05 12:48:56 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	768	square miles

Peak-Flow Statistics Parameters[25 Percent (188 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	768	square miles	0.06	7866

Peak-Flow Statistics Parameters[75 Percent (579 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	768	square miles	0.06	7866

Peak-Flow Statistics Flow Report[25 Percent (188 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	8090	ft^3/s	43
2 33 Year Peak Flood	8890	ft^3/s	42
5 Year Peak Flood	13500	ft^3/s	32
10 Year Peak Flood	18200	ft^3/s	31
25 Year Peak Flood	25100	ft^3/s	32
50 Year Peak Flood	30800	ft^3/s	34
100 Year Peak Flood	37200	ft^3/s	36
200 Year Peak Flood	44500	ft^3/s	38

Peak-Flow Statistics Flow Report[75 Percent (579 square miles) Blue Ridge 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	14900	ft^3/s	17
2 33 Year Peak Flood	16700	ft^3/s	18
5 Year Peak Flood	26100	ft^3/s	20
10 Year Peak Flood	36000	ft^3/s	24
25 Year Peak Flood	51000	ft^3/s	29
50 Year Peak Flood	64200	ft^3/s	32
100 Year Peak Flood	78500	ft^3/s	30
200 Year Peak Flood	95200	ft^3/s	33

Peak-Flow Statistics Flow Report[Area-Averaged]

Statistic	Value	Unit
2 Year Peak Flood	13200	ft^3/s
2 33 Year Peak Flood	14800	ft^3/s
5 Year Peak Flood	23000	ft^3/s
10 Year Peak Flood	31600	ft^3/s
25 Year Peak Flood	44600	ft^3/s
50 Year Peak Flood	55900	ft^3/s
100 Year Peak Flood	68300	ft^3/s
200 Year Peak Flood	82700	ft^3/s

Peak-Flow Statistics Citations

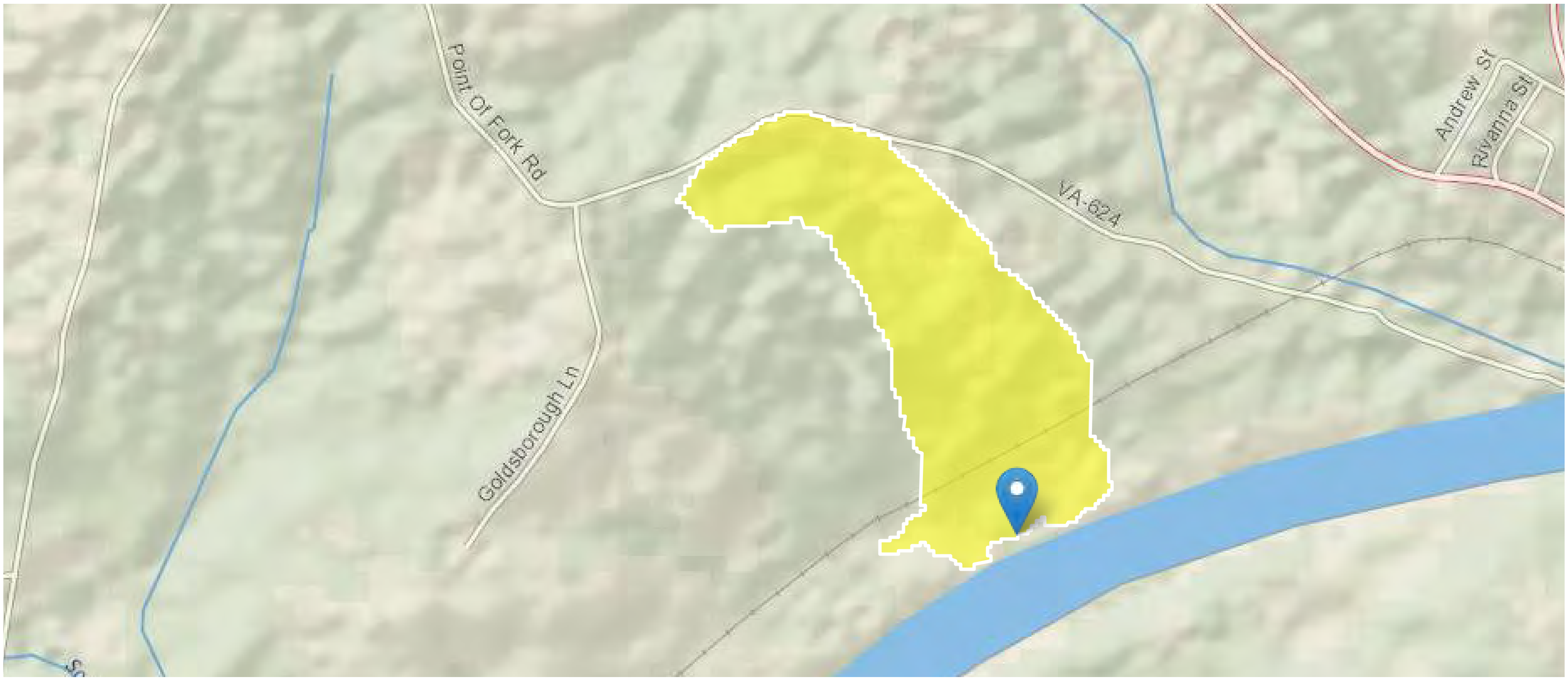
Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD.

(http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 3 StreamStats Report

Region ID: VA
Workspace ID: VA20200204145144343000
Clicked Point (Latitude, Longitude): 37.74780, -78.17976
Time: 2020-02-04 09:52:01 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.16	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.16	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	53.1	ft^3/s	43
2 33 Year Peak Flood	67.4	ft^3/s	42
5 Year Peak Flood	126	ft^3/s	32
10 Year Peak Flood	197	ft^3/s	31
25 Year Peak Flood	321	ft^3/s	32
50 Year Peak Flood	441	ft^3/s	34
100 Year Peak Flood	585	ft^3/s	36
200 Year Peak Flood	760	ft^3/s	38

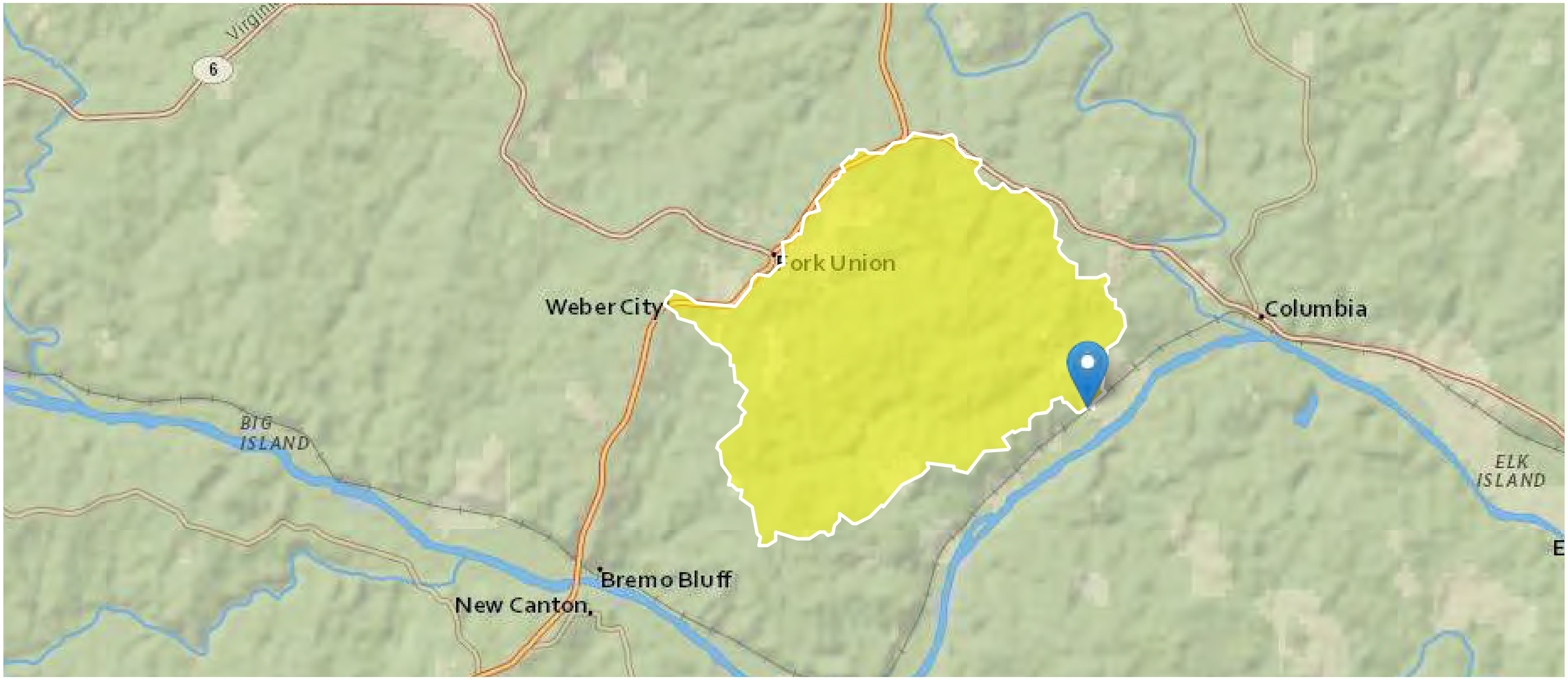
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 4 StreamStats Report VMRC

Region ID: VA
Workspace ID: VA20200204124906507000
Clicked Point (Latitude, Longitude): 37.73819, -78.19824
Time: 2020-02-04 07:49:25 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	13.1	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	13.1	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	724	ft^3/s	43
2 33 Year Peak Flood	852	ft^3/s	42
5 Year Peak Flood	1430	ft^3/s	32
10 Year Peak Flood	2070	ft^3/s	31
25 Year Peak Flood	3090	ft^3/s	32
50 Year Peak Flood	4010	ft^3/s	34
100 Year Peak Flood	5060	ft^3/s	36
200 Year Peak Flood	6300	ft^3/s	38

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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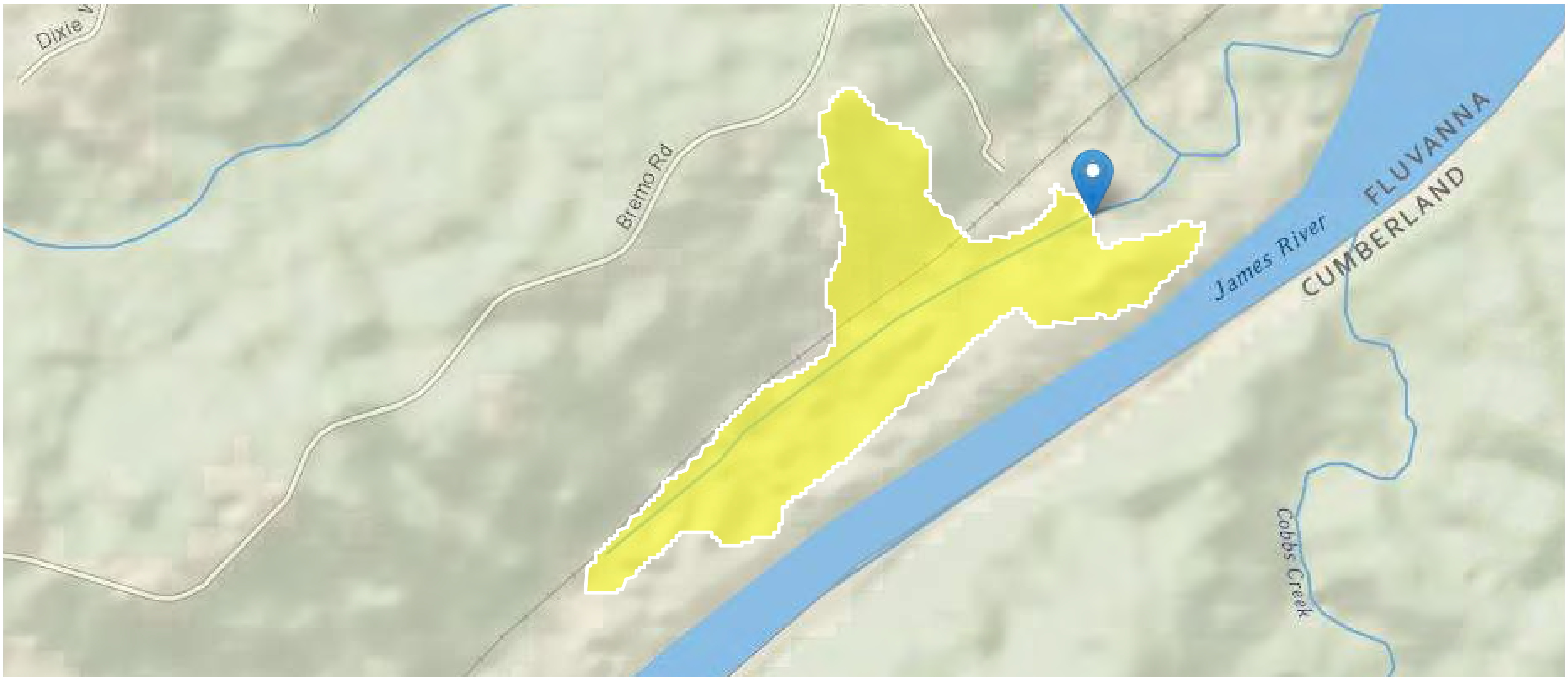
Application Version: 4.3.11

Mussel Survey Location 5 StreamStats Report

Region ID: VA
Workspace ID: VA20200204124641027000
Clicked Point (Latitude, Longitude): 37.73551, -78.19914
Time: 2020-02-04 07:46:57 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.15	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.15	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	51.1	ft^3/s	43
2 33 Year Peak Flood	64.9	ft^3/s	42
5 Year Peak Flood	122	ft^3/s	32
10 Year Peak Flood	190	ft^3/s	31
25 Year Peak Flood	311	ft^3/s	32
50 Year Peak Flood	427	ft^3/s	34
100 Year Peak Flood	567	ft^3/s	36
200 Year Peak Flood	737	ft^3/s	38

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 6 StreamStats Report VMRC

Region ID: VA
Workspace ID: VA20200204125251456000
Clicked Point (Latitude, Longitude): 37.74552, -78.20547
Time: 2020-02-04 07:53:07 -0500

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	12.3	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	12.3	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	697	ft^3/s	43
2 33 Year Peak Flood	822	ft^3/s	42
5 Year Peak Flood	1380	ft^3/s	32
10 Year Peak Flood	2000	ft^3/s	31
25 Year Peak Flood	2990	ft^3/s	32
50 Year Peak Flood	3880	ft^3/s	34
100 Year Peak Flood	4910	ft^3/s	36
200 Year Peak Flood	6110	ft^3/s	38

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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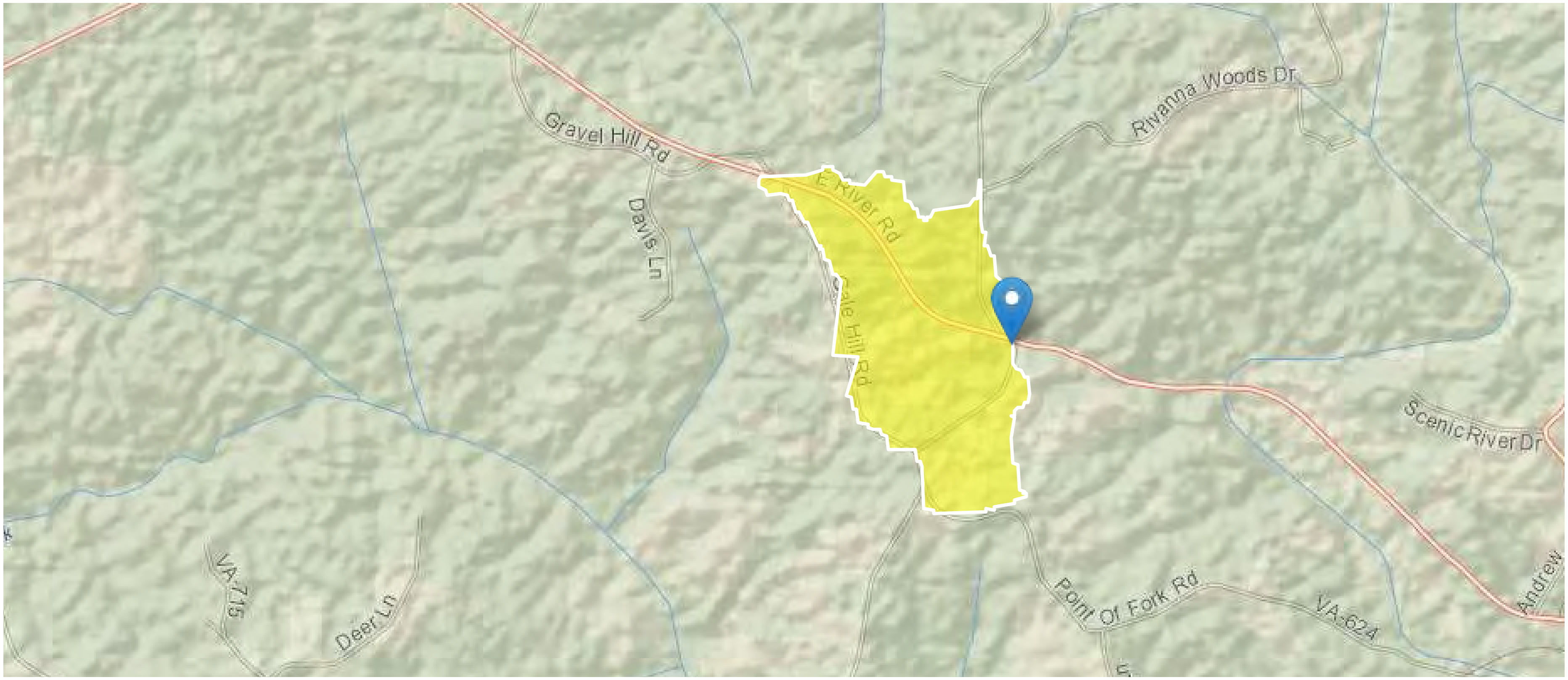
Application Version: 4.3.11

Mussel Survey Location 7 StreamStats Report

Region ID: VA
Workspace ID: VA20200204144150185000
Clicked Point (Latitude, Longitude): 37.76597, -78.19575
Time: 2020-02-04 09:42:06 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.39	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.39	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	90.1	ft^3/s	43
2 33 Year Peak Flood	113	ft^3/s	42
5 Year Peak Flood	206	ft^3/s	32
10 Year Peak Flood	317	ft^3/s	31
25 Year Peak Flood	508	ft^3/s	32
50 Year Peak Flood	689	ft^3/s	34
100 Year Peak Flood	905	ft^3/s	36
200 Year Peak Flood	1170	ft^3/s	38

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

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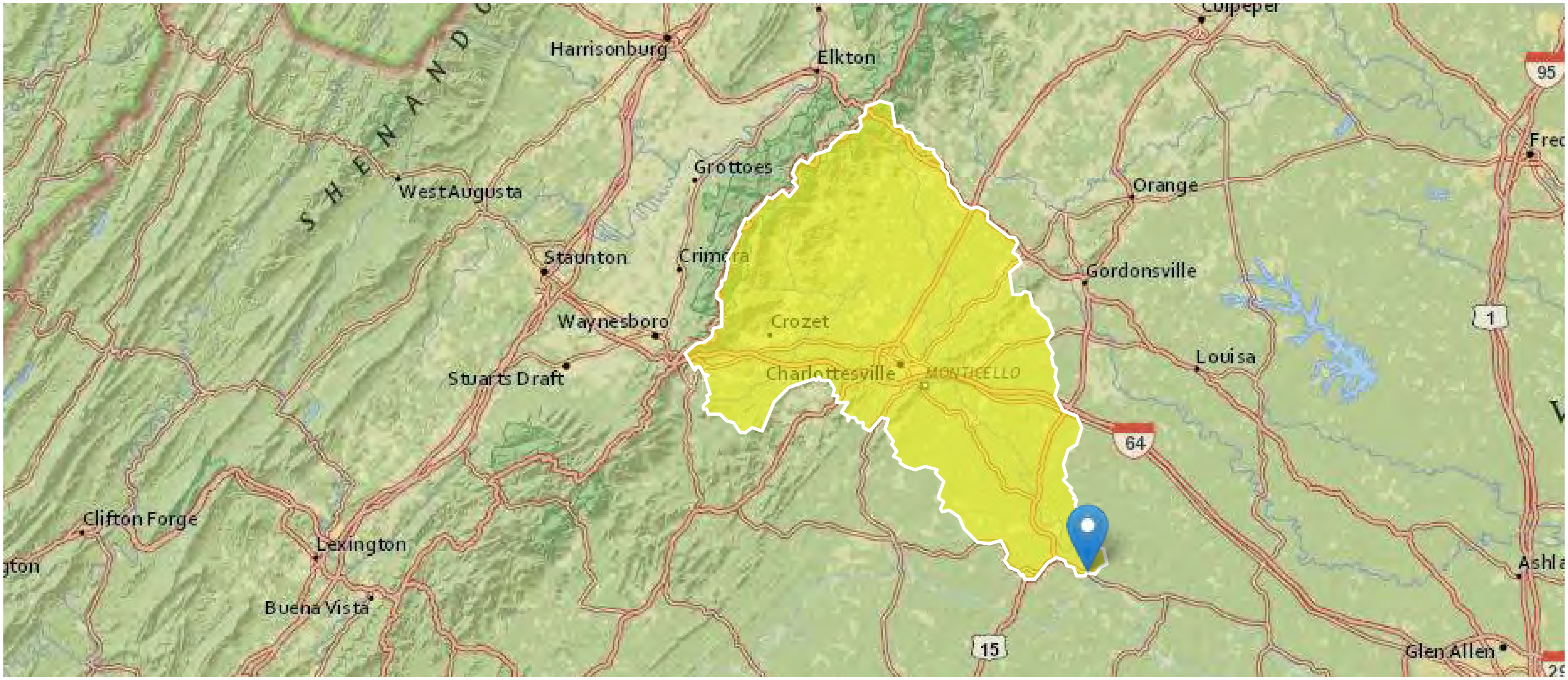
Application Version: 4.3.11

Mussel Survey Location 8 StreamStats Report VMRC

Region ID: VA
Workspace ID: VA20200305175247881000
Clicked Point (Latitude, Longitude): 37.76413, -78.18496
Time: 2020-03-05 12:53:06 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	767	square miles

Peak-Flow Statistics Parameters[24 Percent (188 square miles) Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	767	square miles	0.06	7866

Peak-Flow Statistics Parameters[75 Percent (579 square miles) Blue Ridge 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	767	square miles	0.06	7866

Peak-Flow Statistics Flow Report[24 Percent (188 square miles) Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	8090	ft^3/s	43
2 33 Year Peak Flood	8880	ft^3/s	42
5 Year Peak Flood	13500	ft^3/s	32
10 Year Peak Flood	18200	ft^3/s	31
25 Year Peak Flood	25000	ft^3/s	32
50 Year Peak Flood	30800	ft^3/s	34
100 Year Peak Flood	37200	ft^3/s	36
200 Year Peak Flood	44400	ft^3/s	38

Peak-Flow Statistics Flow Report[75 Percent (579 square miles) Blue Ridge 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	14900	ft^3/s	17
2 33 Year Peak Flood	16700	ft^3/s	18
5 Year Peak Flood	26100	ft^3/s	20
10 Year Peak Flood	35900	ft^3/s	24
25 Year Peak Flood	51000	ft^3/s	29
50 Year Peak Flood	64100	ft^3/s	32
100 Year Peak Flood	78500	ft^3/s	30
200 Year Peak Flood	95200	ft^3/s	33

Peak-Flow Statistics Flow Report[Area-Averaged]

Statistic	Value	Unit
2 Year Peak Flood	13200	ft^3/s
2 33 Year Peak Flood	14800	ft^3/s
5 Year Peak Flood	23000	ft^3/s
10 Year Peak Flood	31500	ft^3/s
25 Year Peak Flood	44600	ft^3/s
50 Year Peak Flood	55900	ft^3/s
100 Year Peak Flood	68300	ft^3/s
200 Year Peak Flood	82700	ft^3/s

Peak-Flow Statistics Citations

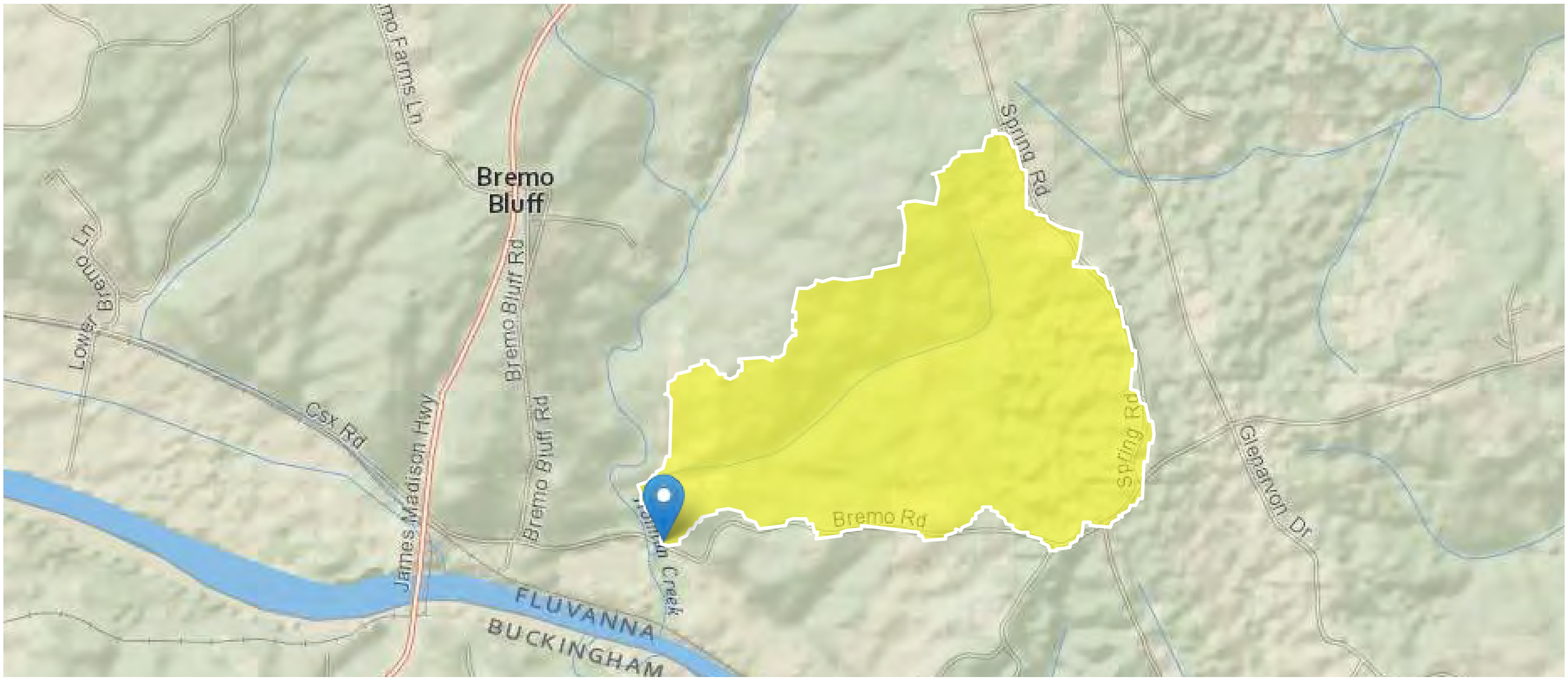
Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD.

(http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 11 StreamStats Report

Region ID: VA
Workspace ID: VA20200204123146020000
Clicked Point (Latitude, Longitude): 37.71248, -78.28988
Time: 2020-02-04 07:32:02 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.97	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.97	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	155	ft^3/s	43
2 33 Year Peak Flood	190	ft^3/s	42
5 Year Peak Flood	341	ft^3/s	32
10 Year Peak Flood	515	ft^3/s	31
25 Year Peak Flood	811	ft^3/s	32
50 Year Peak Flood	1090	ft^3/s	34
100 Year Peak Flood	1410	ft^3/s	36
200 Year Peak Flood	1810	ft^3/s	38

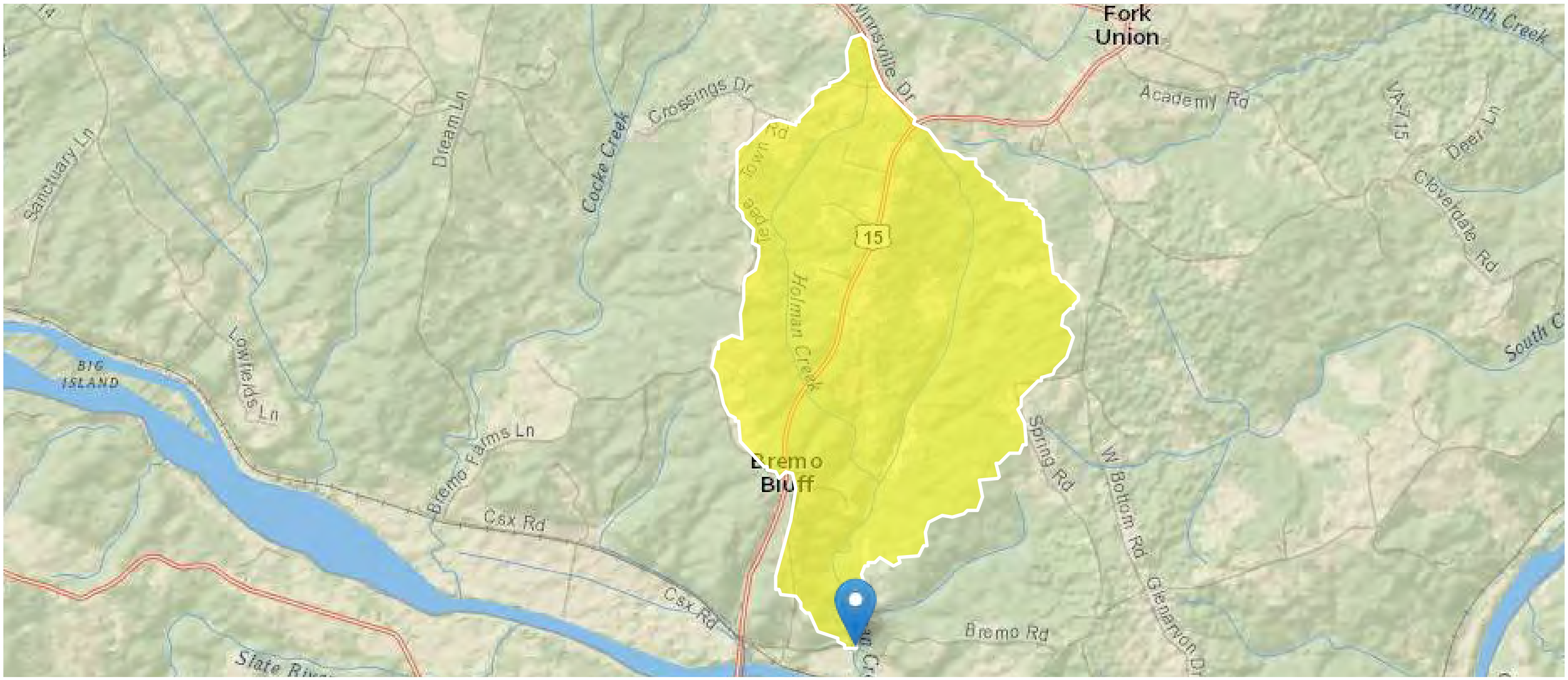
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 12 StreamStats Report

Region ID: VA
Workspace ID: VA20200204123437947000
Clicked Point (Latitude, Longitude): 37.71260, -78.29042
Time: 2020-02-04 07:34:54 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	3.88	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.88	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	352	ft^3/s	43
2 33 Year Peak Flood	423	ft^3/s	42
5 Year Peak Flood	732	ft^3/s	32
10 Year Peak Flood	1080	ft^3/s	31
25 Year Peak Flood	1650	ft^3/s	32
50 Year Peak Flood	2180	ft^3/s	34
100 Year Peak Flood	2790	ft^3/s	36
200 Year Peak Flood	3510	ft^3/s	38

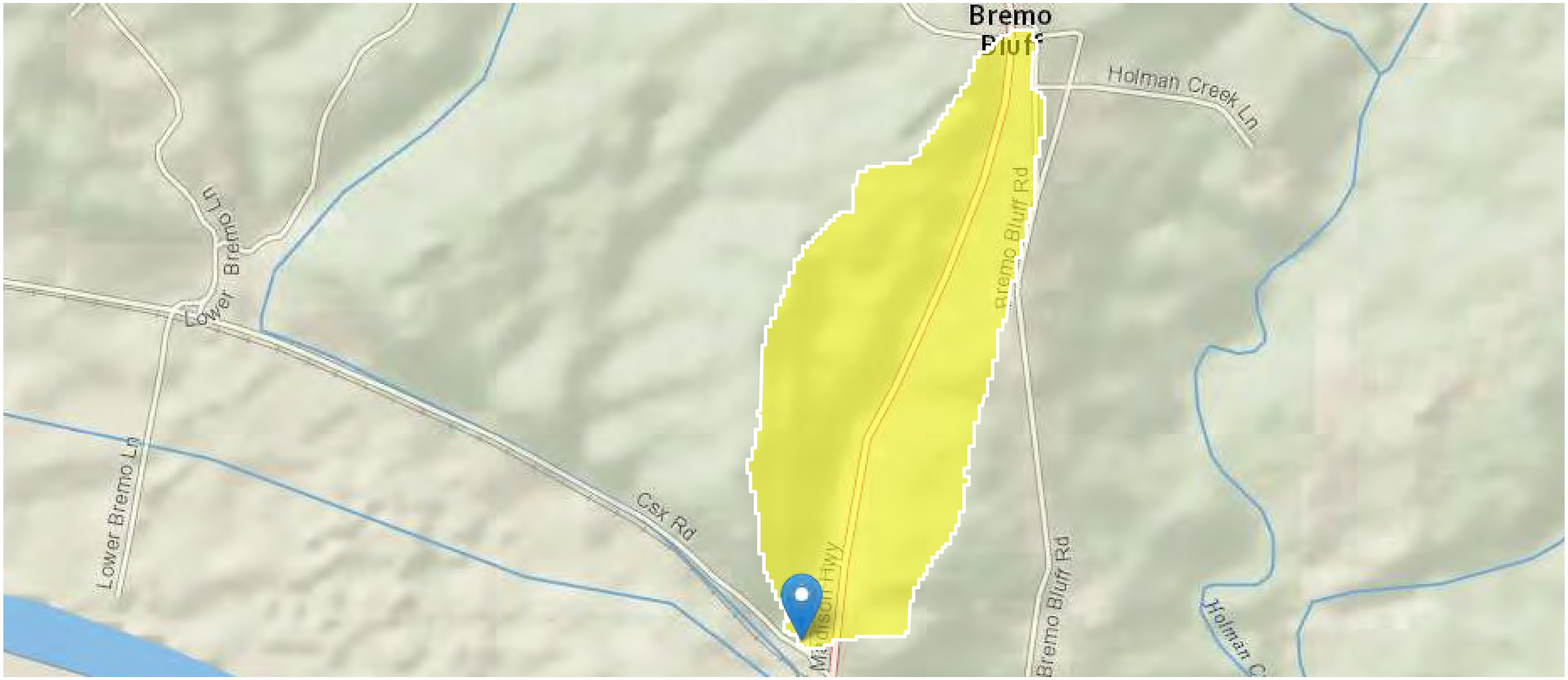
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 13 StreamStats Report

Region ID: VA
Workspace ID: VA20200204120544642000
Clicked Point (Latitude, Longitude): 37.71443, -78.30278
Time: 2020-02-04 07:06:01 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.21	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.21	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	62.4	ft^3/s	43
2 33 Year Peak Flood	78.8	ft^3/s	42
5 Year Peak Flood	147	ft^3/s	32
10 Year Peak Flood	228	ft^3/s	31
25 Year Peak Flood	370	ft^3/s	32
50 Year Peak Flood	505	ft^3/s	34
100 Year Peak Flood	668	ft^3/s	36
200 Year Peak Flood	866	ft^3/s	38

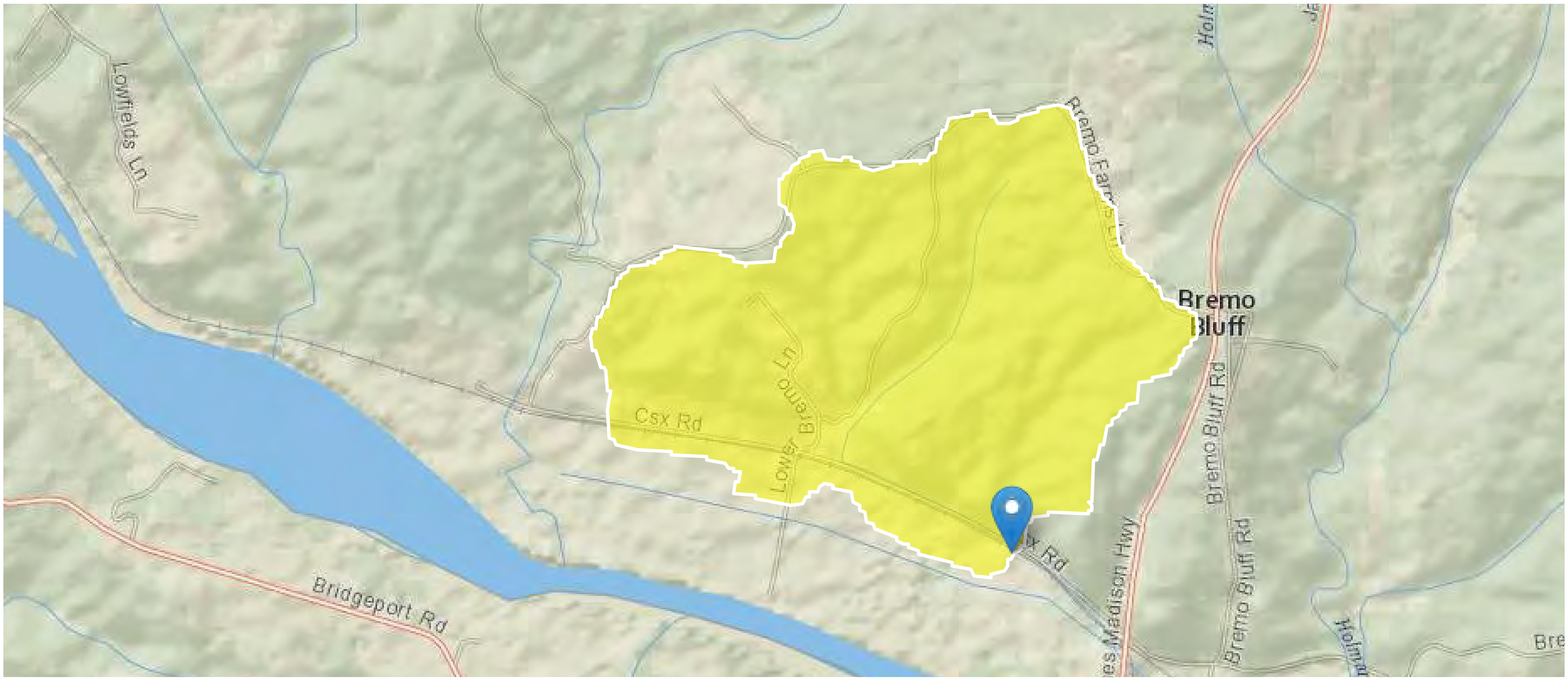
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 14 StreamStats Report

Region ID: VA
Workspace ID: VA20200204165458539000
Clicked Point (Latitude, Longitude): 37.71698, -78.30791
Time: 2020-02-04 11:55:17 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	1.33	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.33	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	186	ft^3/s	43
2 33 Year Peak Flood	228	ft^3/s	42
5 Year Peak Flood	406	ft^3/s	32
10 Year Peak Flood	610	ft^3/s	31
25 Year Peak Flood	954	ft^3/s	32
50 Year Peak Flood	1270	ft^3/s	34
100 Year Peak Flood	1650	ft^3/s	36
200 Year Peak Flood	2100	ft^3/s	38

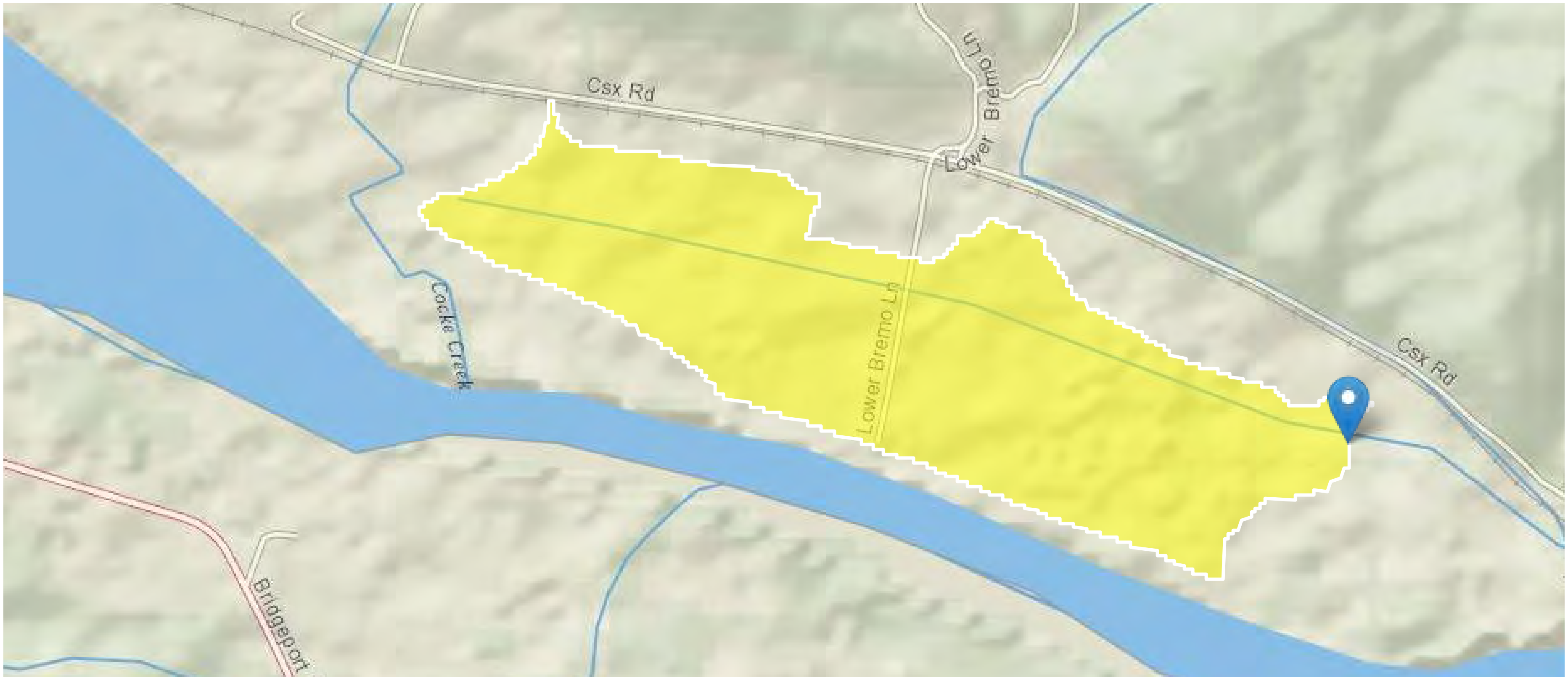
Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

Mussel Survey Location 20 StreamStats Report

Region ID: VA
Workspace ID: VA20200220183415700000
Clicked Point (Latitude, Longitude): 37.71526, -78.30819
Time: 2020-02-20 13:34:33 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	0.33	square miles

Peak-Flow Statistics Parameters[Piedmont nonMesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.33	square miles	0.06	7866

Peak-Flow Statistics Flow Report[Piedmont nonMesozoic 2011 5144]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
2 Year Peak Flood	81.6	ft^3/s	43
2 33 Year Peak Flood	102	ft^3/s	42
5 Year Peak Flood	188	ft^3/s	32
10 Year Peak Flood	290	ft^3/s	31
25 Year Peak Flood	466	ft^3/s	32
50 Year Peak Flood	634	ft^3/s	34
100 Year Peak Flood	834	ft^3/s	36
200 Year Peak Flood	1080	ft^3/s	38

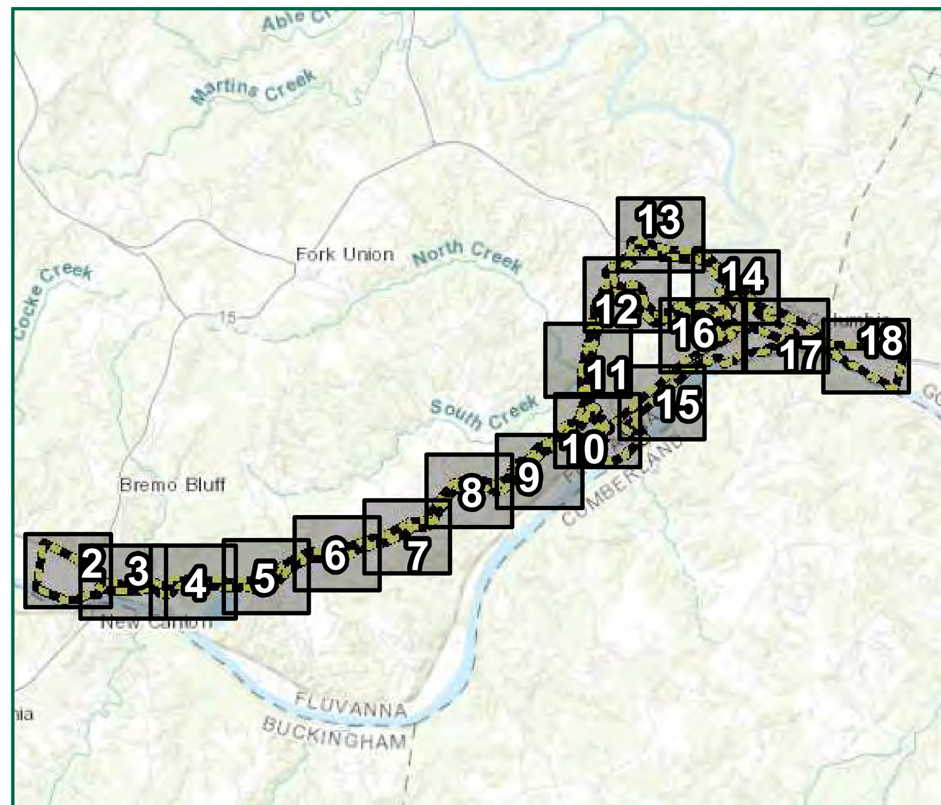
Peak-Flow Statistics Citations

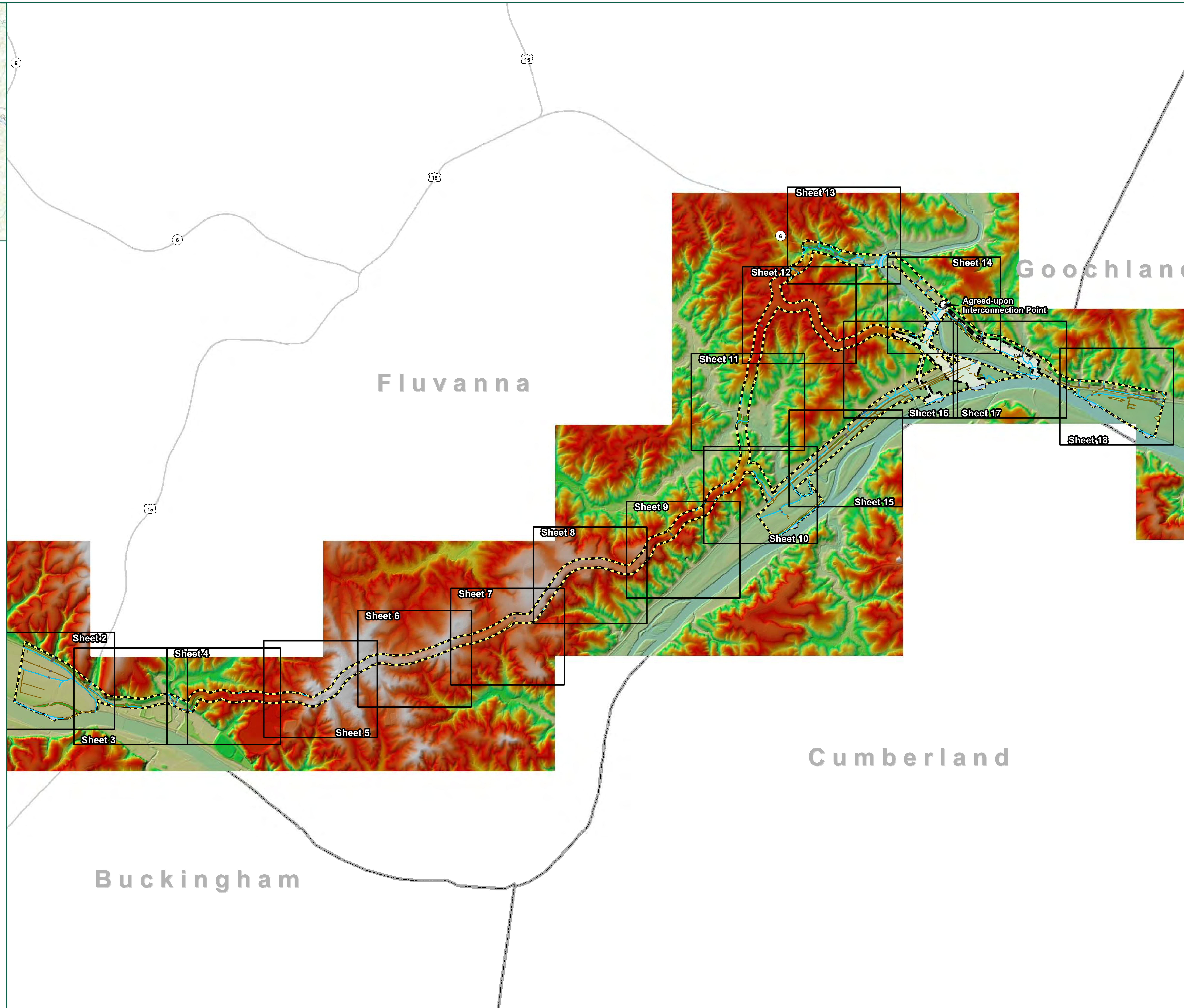
Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Application Version: 4.3.11

APPENDIX H-12-2

ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DELINEATION MAP





Legend

- Project Limits
- Confirmed Delineation Boundary (2014 & 2016)
- National Hydrography Dataset
- National Wetlands Inventory
- Hydric Soils
- Culvert
- Streams
- Palustrine Scrub-Shrub (PSS) Wetland
- Palustrine Emergent (PEM) Wetland
- Palustrine Forested (PFO) Wetland
- Palustrine Open Water (POW) Wetland
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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TEL 804.200.6500
www.timmons.com

PROJECT NAME & LOCATION

JAMES RIVER WATER AUTHORITY
FLUVANNA COUNTY, VIRGINIA

DATE 03/12/2020

PROJECT NUMBER 33927

PROJECT NAME JRWA

DESIGNED BY / DRAWN BY C. CHAPPELL

1. Waters of the U.S. within the confirmed delineation limits have been located using submeter, Bluetooth GPS antennas by Timmons Group.
2. Streams and wetlands outside the confirmed delineation limits have been desktop located using NWI, NHD, USGS lidar, hydric soils, and aerial imagery.
3. Project limits are approximate.
4. Topography based on USGS LiDAR.

REVISIONS

#	MM/DD/YY	DESCRIPTION

DRAWING DESCRIPTION

ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

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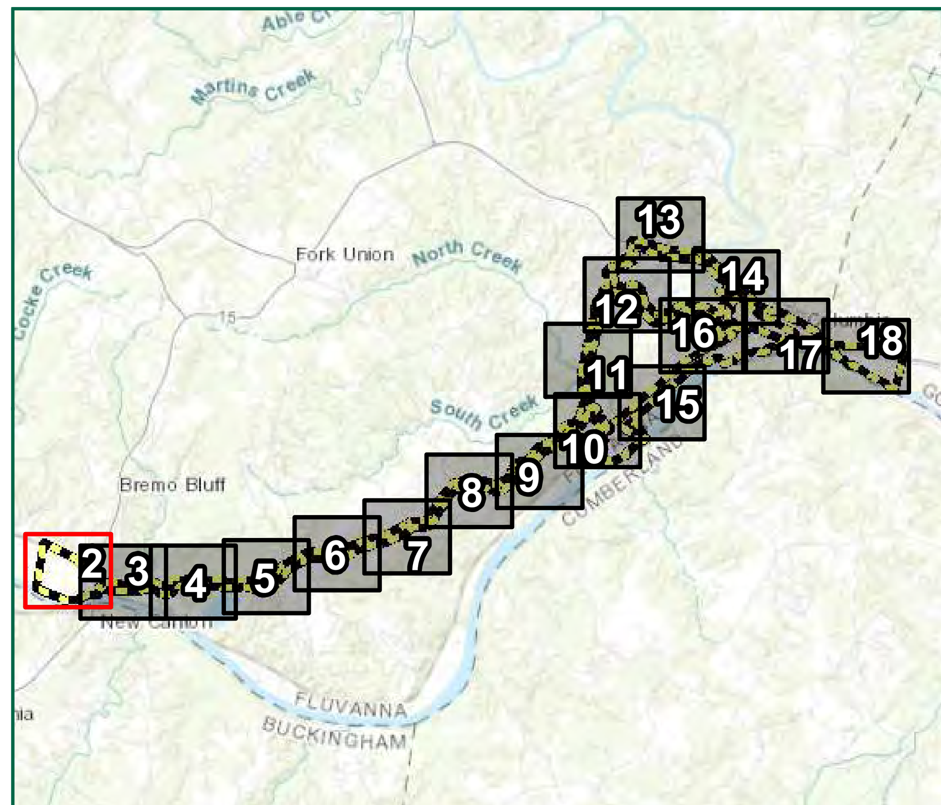
PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE H:1 " = 2,100 '

SHEET NUMBER 1 of 18



Legend

- Project Limits
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- Culvert
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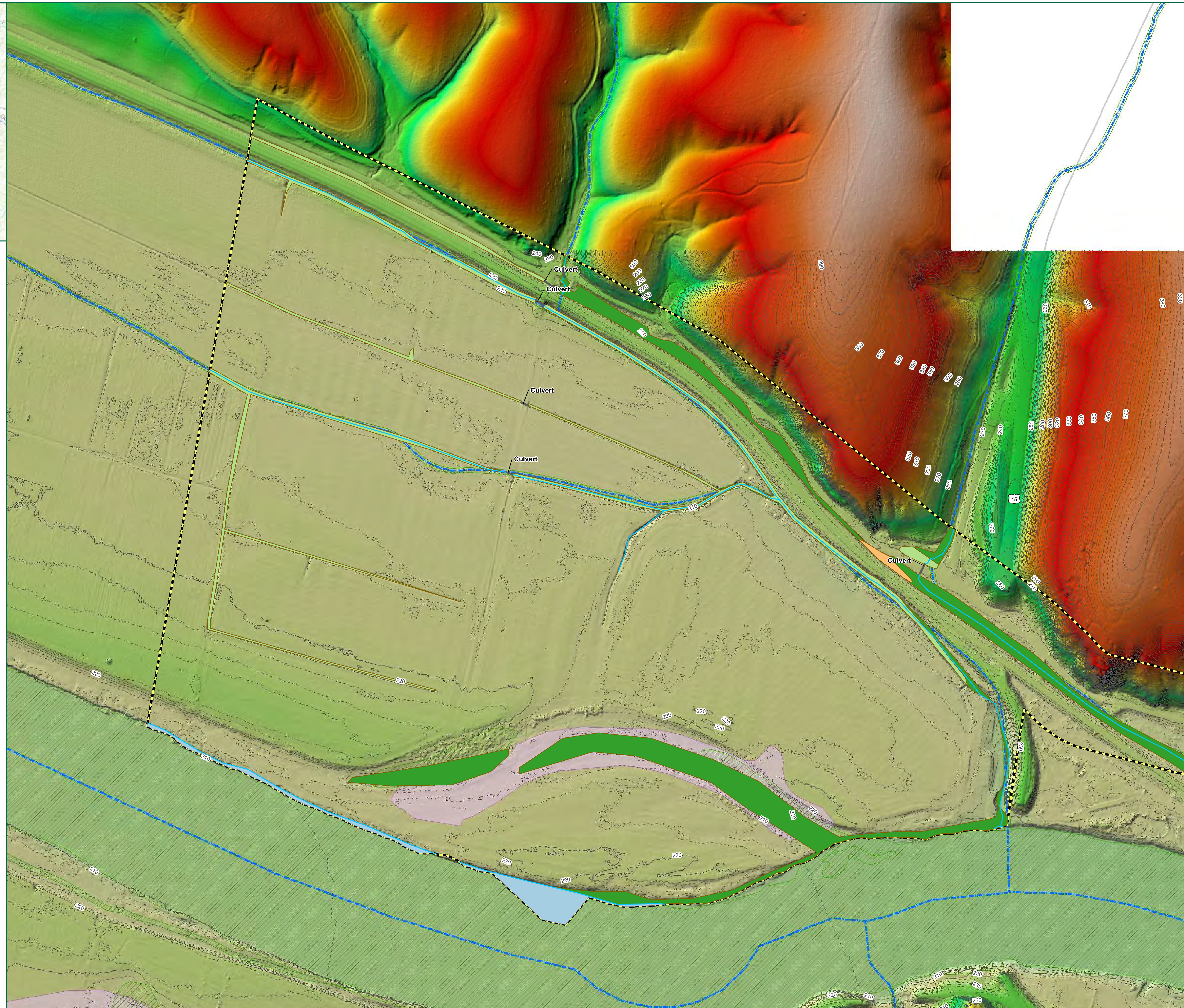
- Palustrine Forested (PFO) Wetland
- Palustrine Open Water (POW) Wetland
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot



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FLUVANNA COUNTY, VIRGINIA

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DESIGNED BY / DRAWN BY	C. CHAPPELL

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DRAWING DESCRIPTION

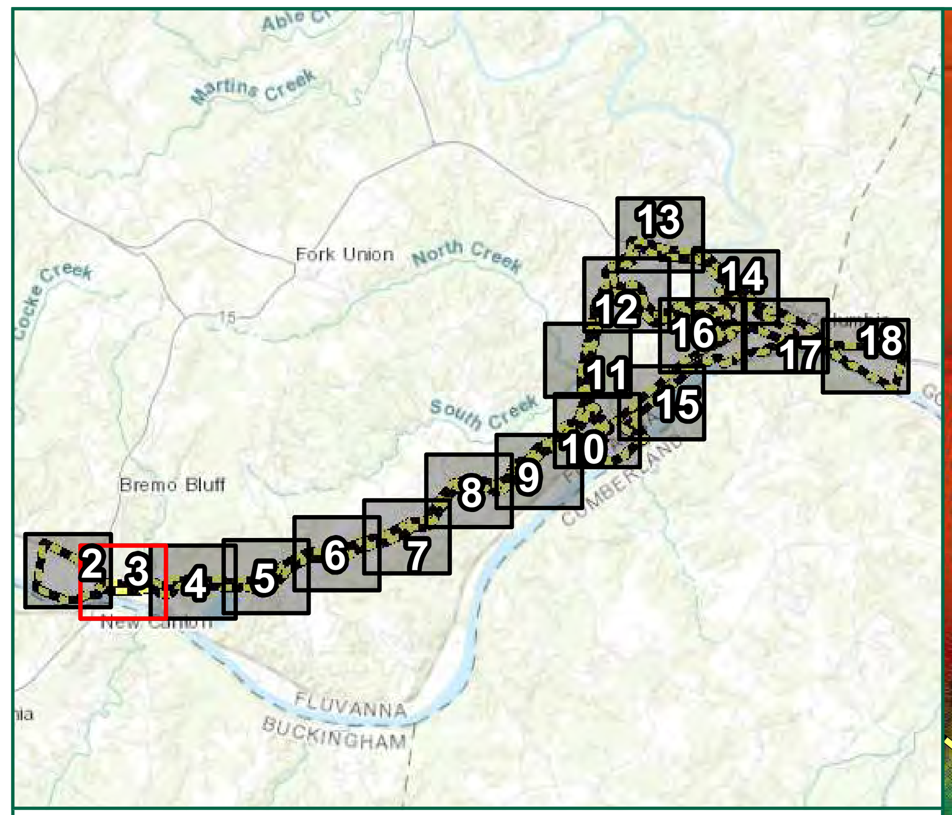
ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

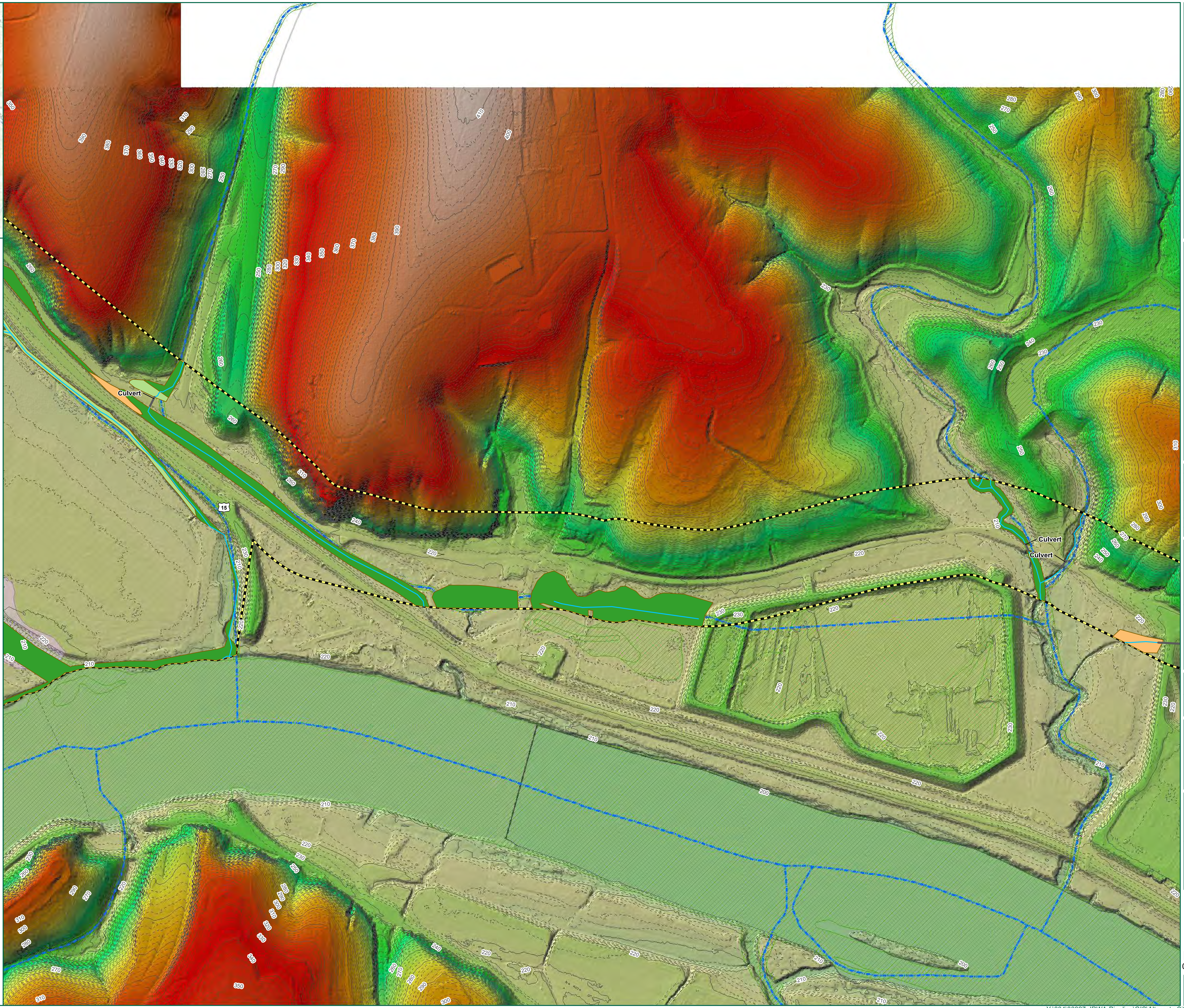
SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
H:1 " = 200 '	2 of 18





Legend

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- Culvert
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- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
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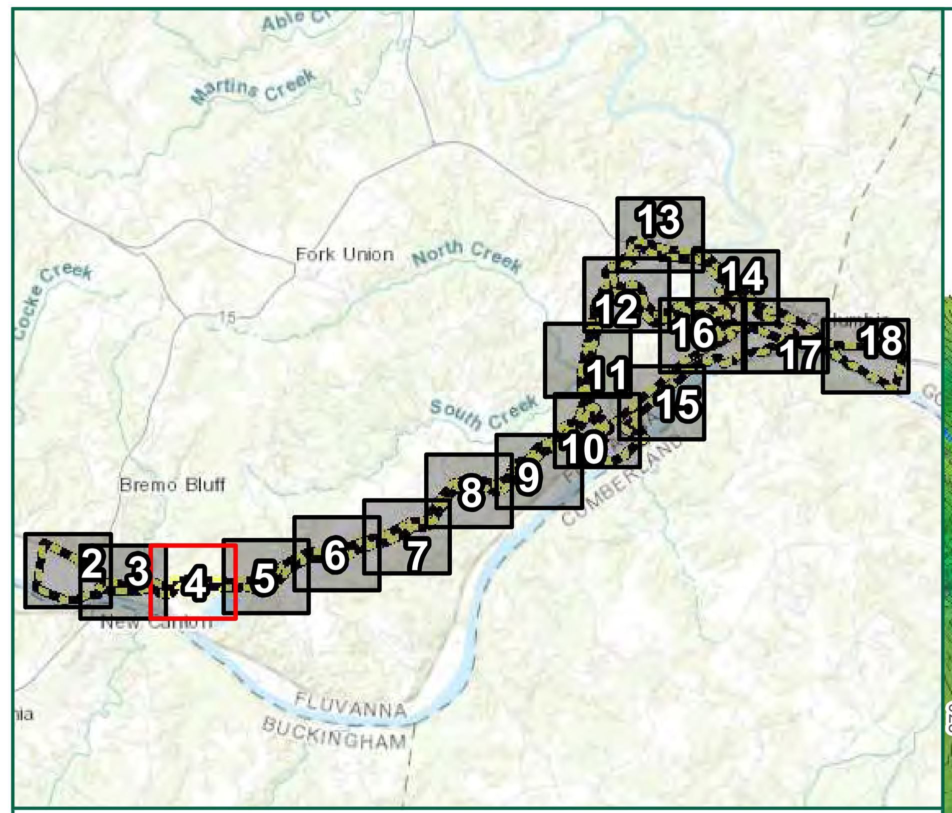

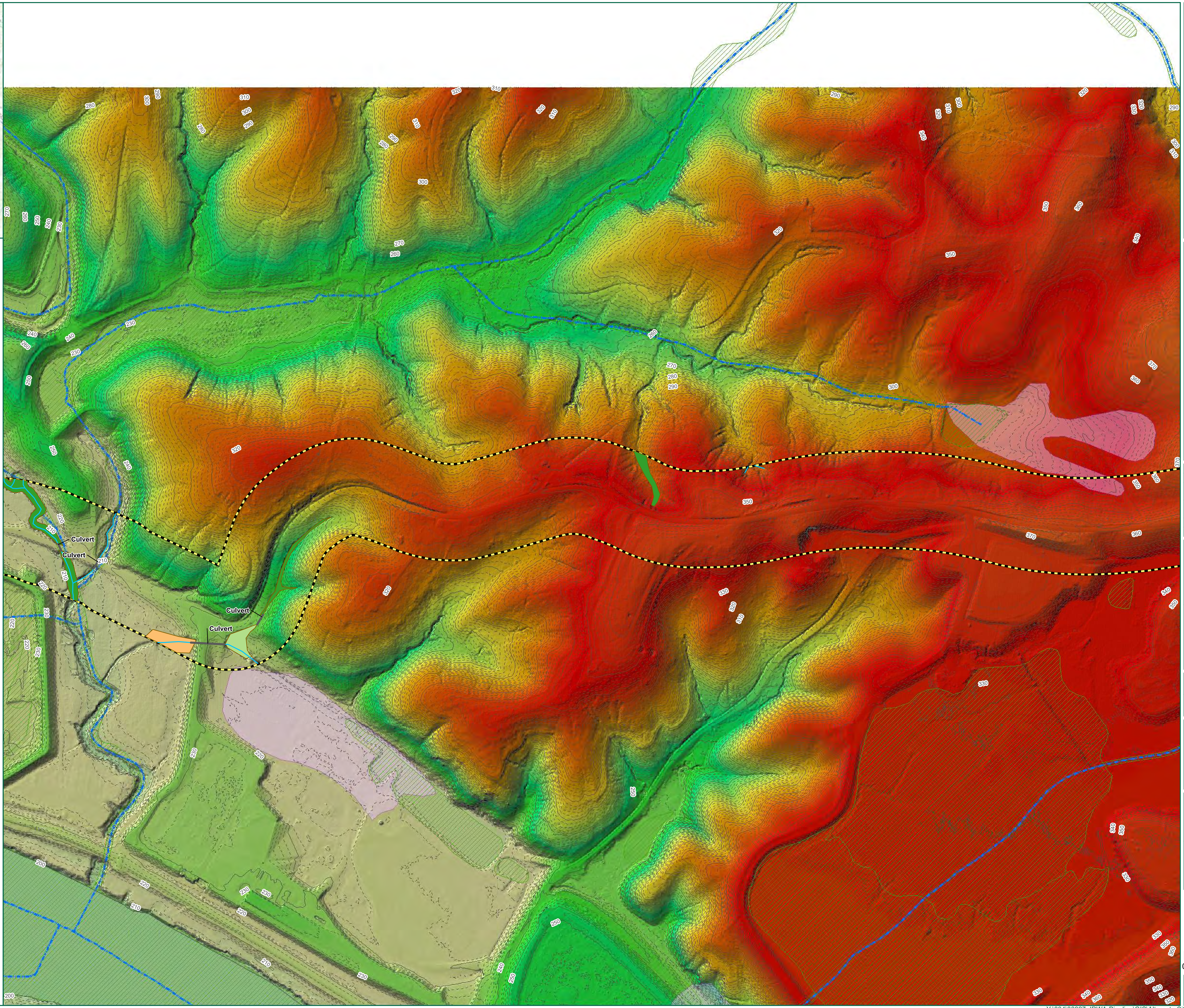

Legend

- Project Limits
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- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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JAMES RIVER WATER AUTHORITY

FLUVANNA COUNTY, VIRGINIA

DATE: 03/12/2020

PROJECT NUMBER: 33927

PROJECT NAME: JRWA

DESIGNED BY / DRAWN BY: C. CHAPPELL

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DRAWING DESCRIPTION

ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
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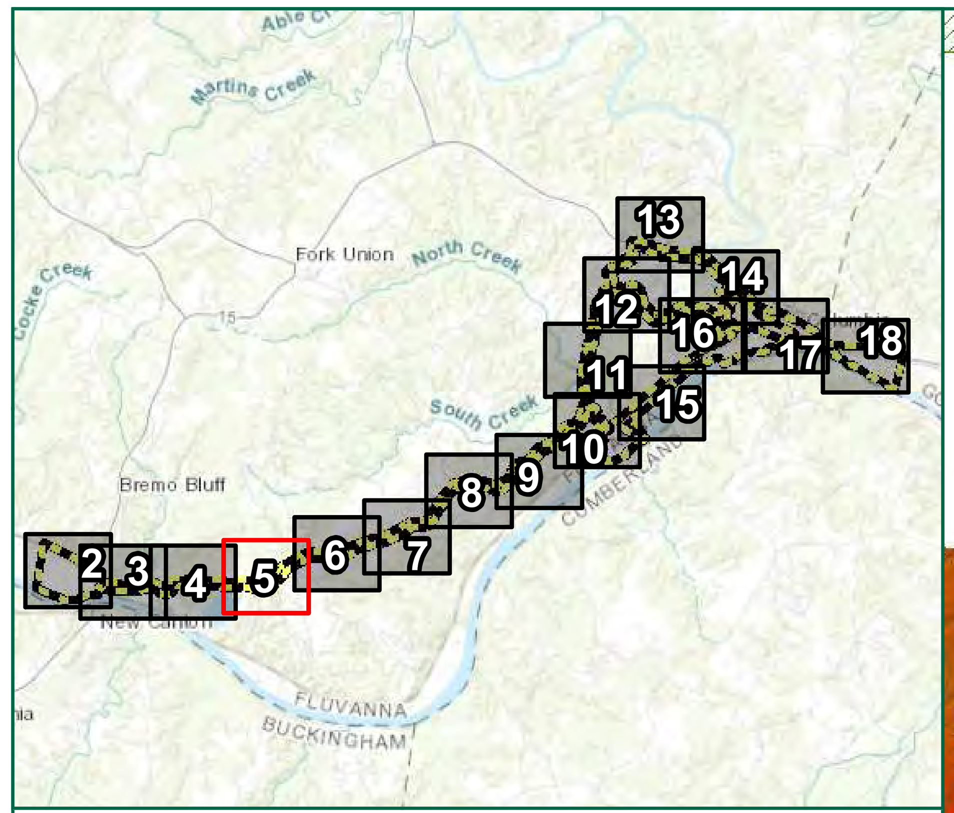

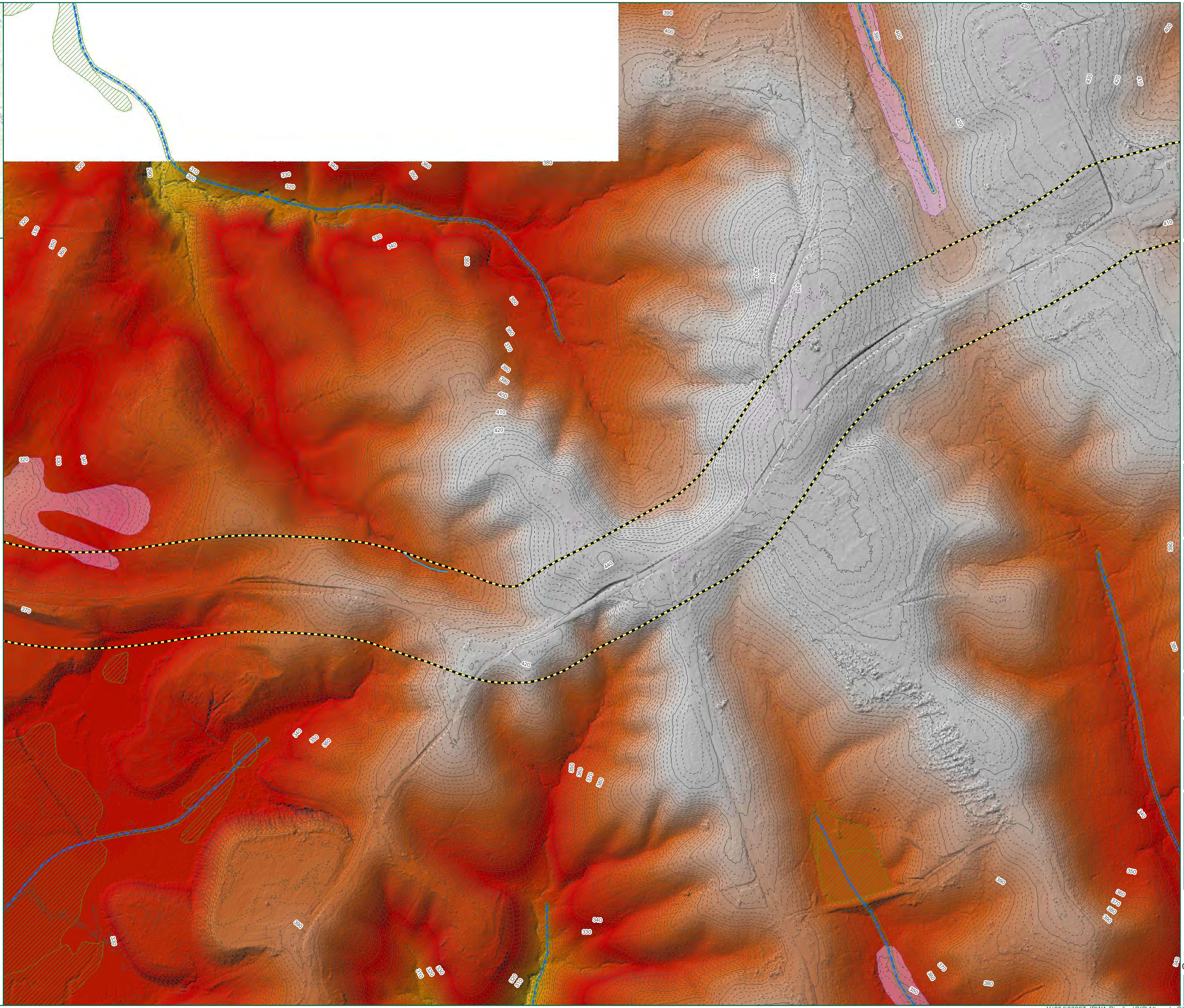

Legend

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- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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DATE	03/12/2020
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ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
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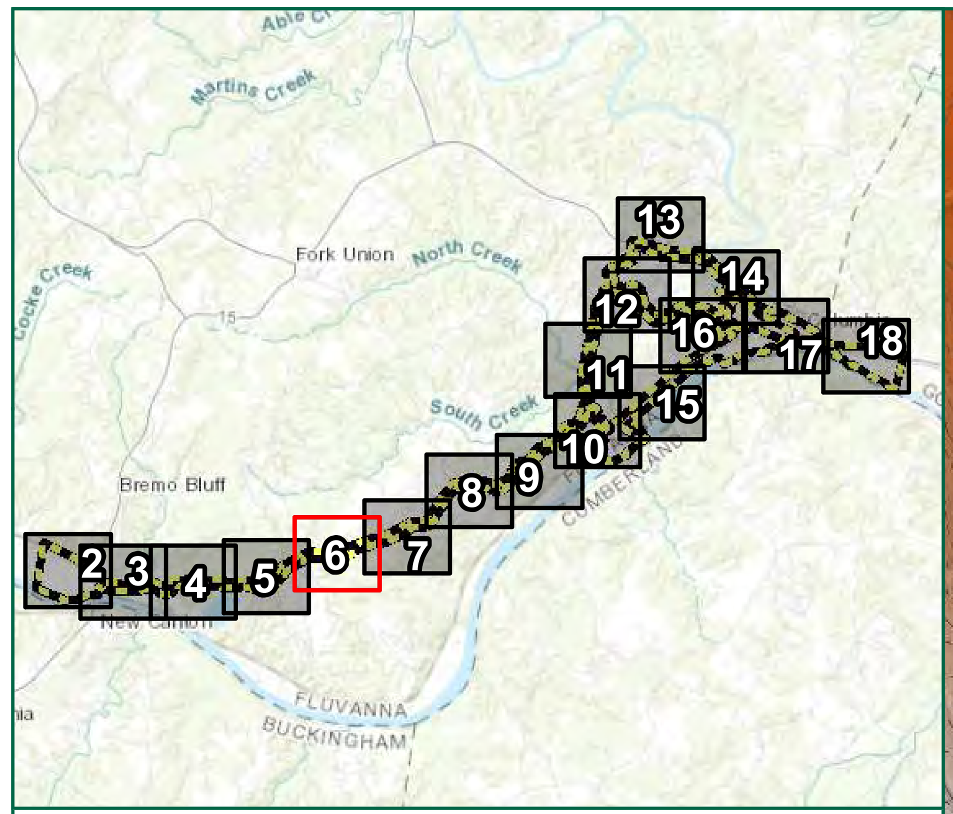

Legend

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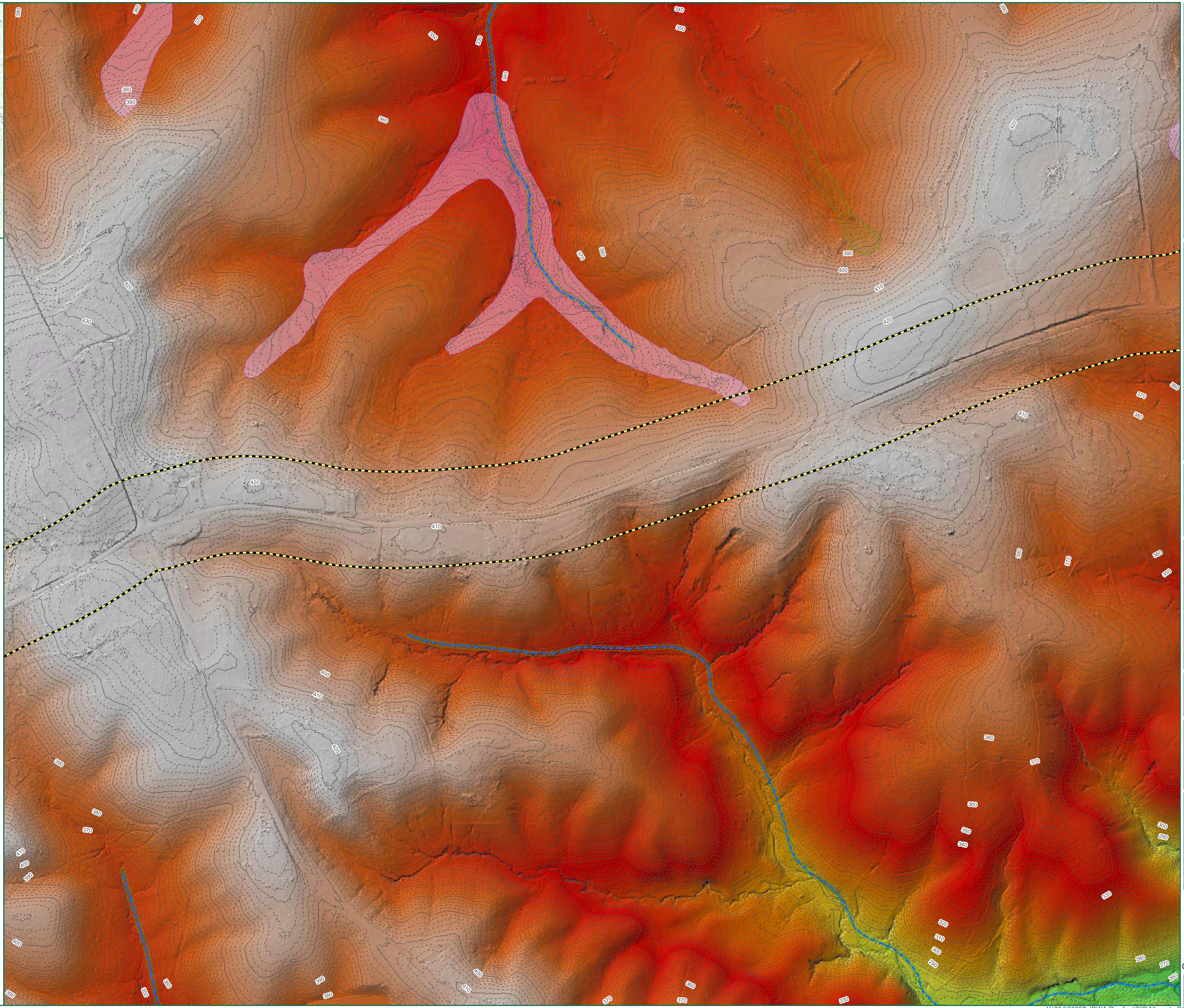
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot



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DRAWING DESCRIPTION

ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
H:1 " = 200 '	6 of 18

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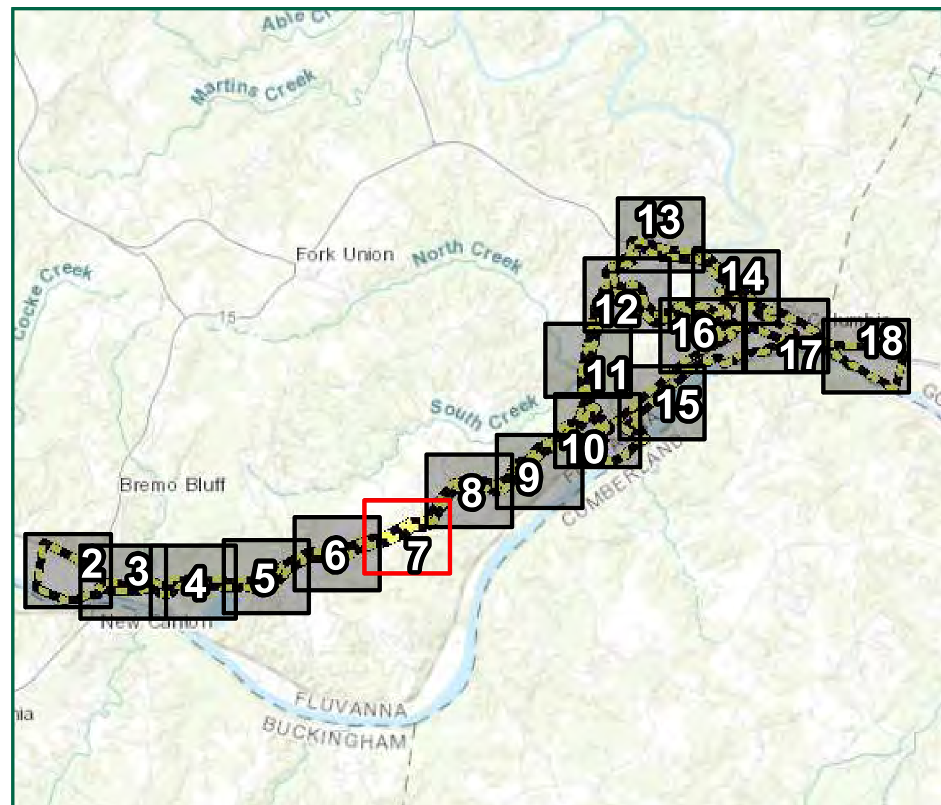

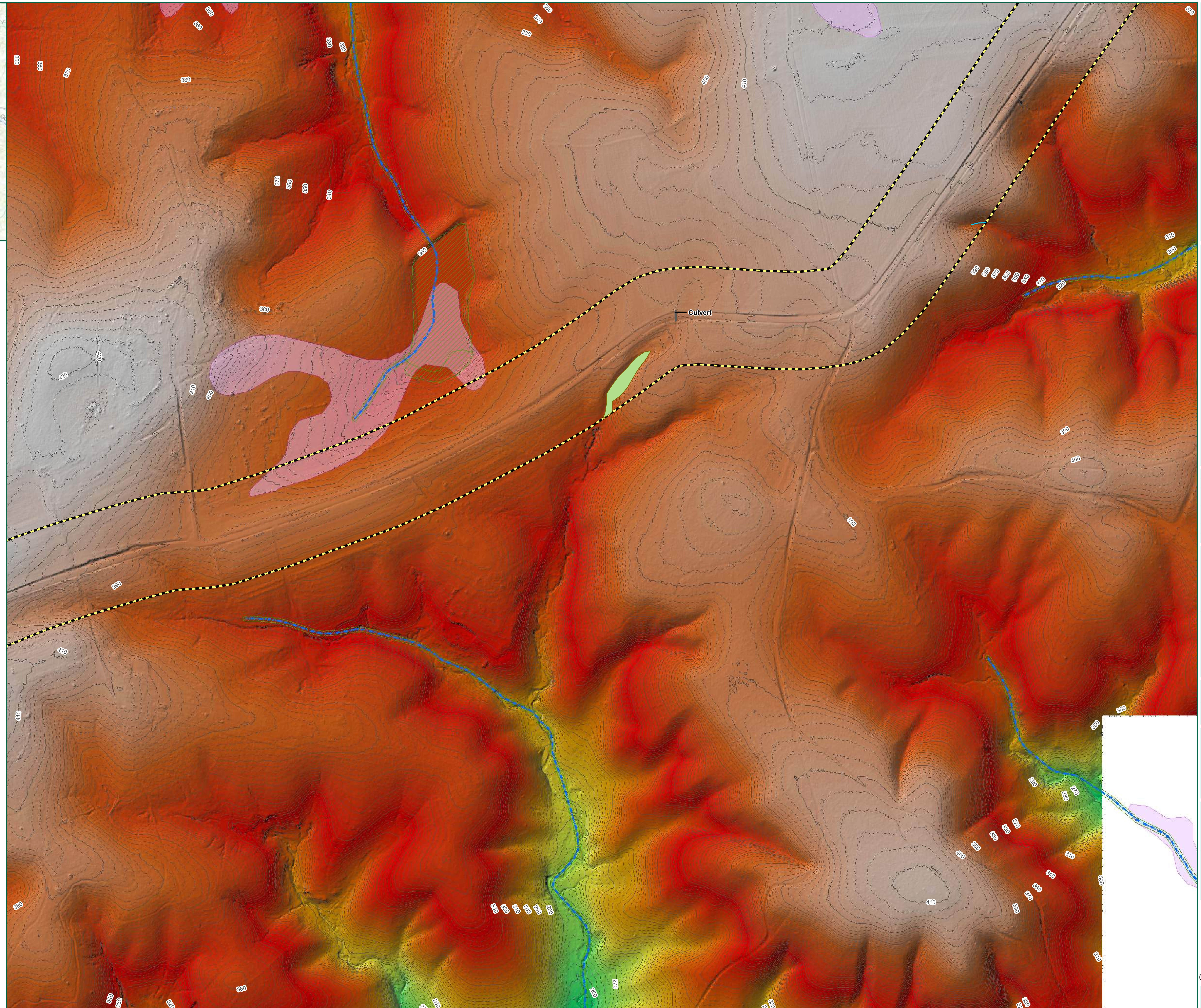

Legend

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- Palustrine Open Water (POW) Wetland
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE H:1 " = 200 '

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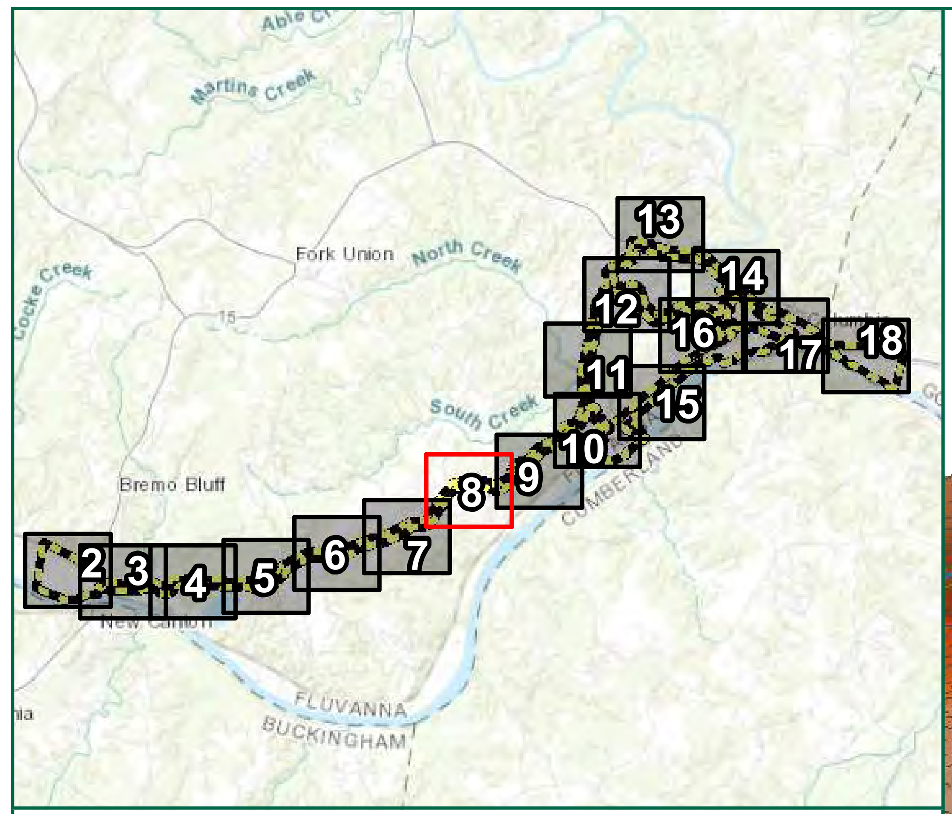

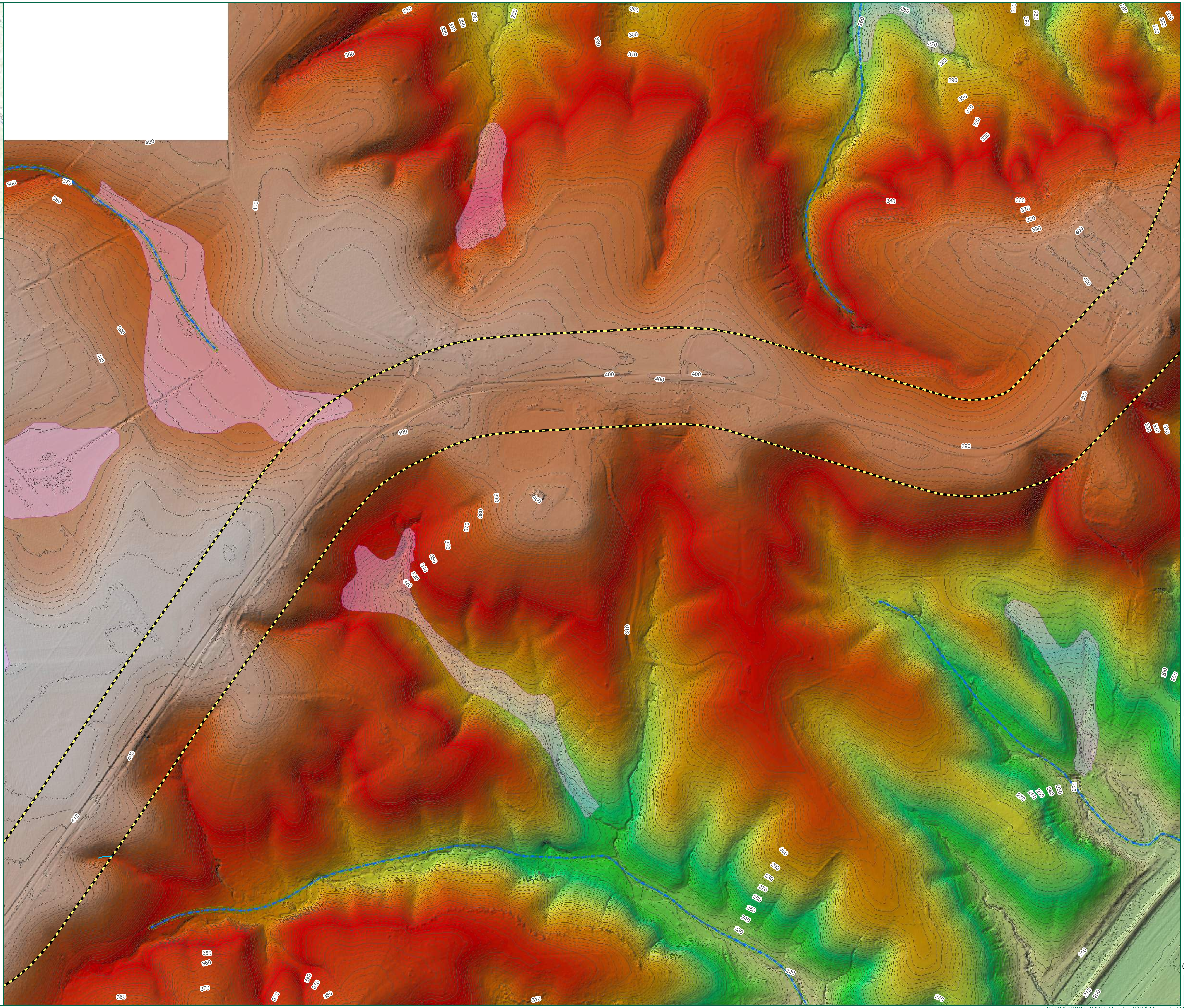

Legend

- Project Limits
- Confirmed Delineation Boundary (2014 & 2016)
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- Hydric Soils
- Culvert
- Streams
- Palustrine Scrub-Shrub (PSS) Wetland
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- Palustrine Open Water (POW) Wetland
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot

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ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)
0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE
H: 1 " = 200 '

SHEET NUMBER

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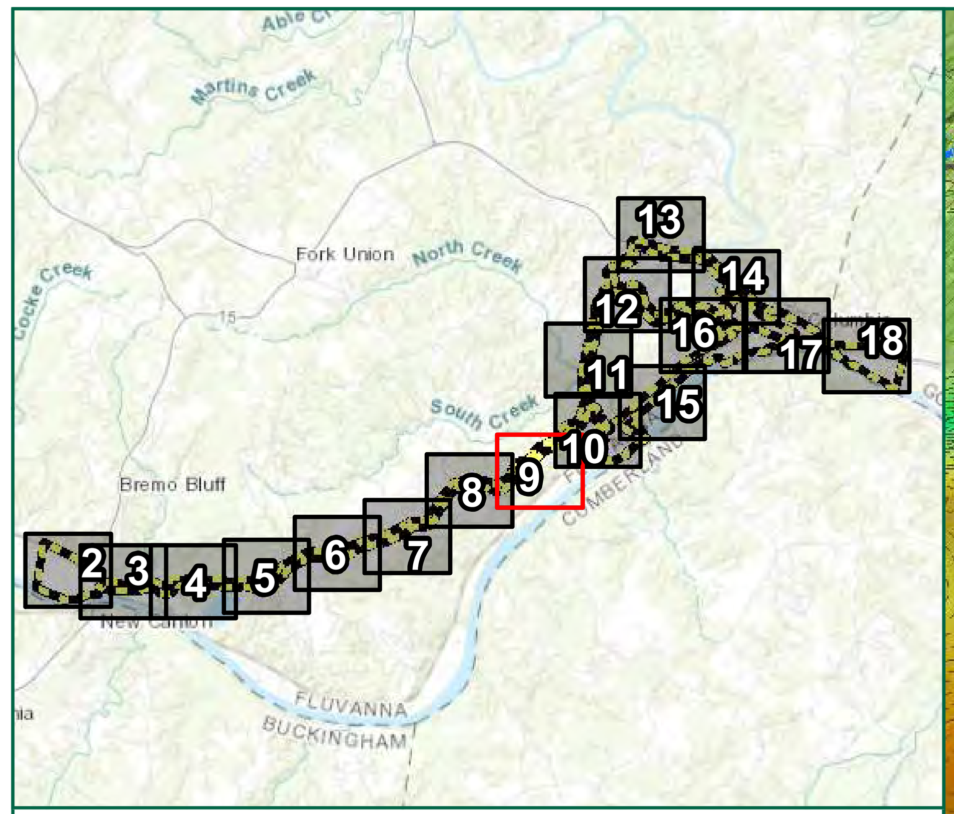

Legend

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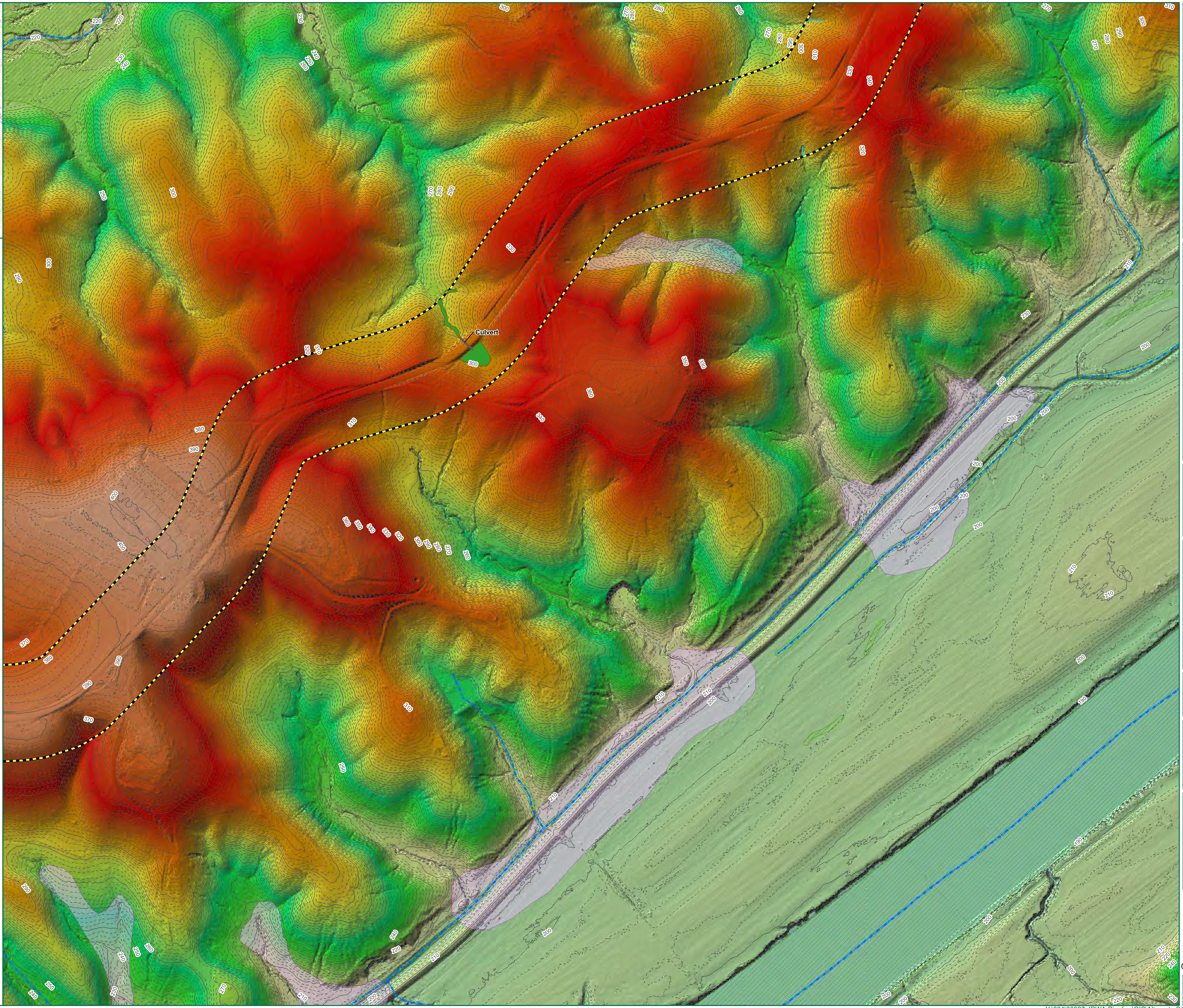
- Palustrine Open Water (POW) Wetland
- Perennial Channel (R3)

Topographic Contours

- 10 Foot
- 2 Foot



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DRAWING DESCRIPTION

ESTIMATED JURISDICTIONAL WATERS OF THE U.S. DESKTOP DELINEATION MAP

SCALE (FEET)

0 200 400

PLANS PRINTED AS 11X17 ARE HALF SCALE

SCALE	SHEET NUMBER
H:1 " = 200 '	9 of 18