APPENDIX B – Previous Studies (key sections)

1. **Zion Crossroads Guidebook by TJPDC (pages 1, 4, 7,16, 17, 18)**
2. **PER for James River Water System – Timmons 2009 (Section 3 – pages 1-11, Section 4 (pages related to Pleasant Grove site R-5), Section 5 (pages 1-4), Section 7 (pages 1-4)**
3. **Zion Crossroads Area Master Plan, 2004 by Dewberry – Louisa County**

Zion Crossroads Guidebook

Fluvanna County, Virginia
August, 2013

Prepared by the Thomas Jefferson Planning District Commission

Thomas Jefferson
Planning District Commission

> "Zion Crossroads is the gateway to the heart of Fluvanna County, and should be enhanced to provide a scenic, rural welcome to residents and tourists while at the same time it develops as an employment, retail, commercial, and recreation destination for both county residents and travelers en route to other places along Routes 64, 15, and 250."
>
> – Fluvanna Comprehensive Plan 2009

The purpose of the Zion Crossroads Guidebook is to serve as a resource for Fluvanna County citizens, property owners, builders and developers who are involved in planning, designing, and building projects within Zion Crossroads. This area is envisioned as the County's primary regional economic development engine, where regional employment and mixed-use development can occur side by side. This template encourages the efficient use of developable land and provides direction to developers and staff to implement the County's goals in regards to Zion Crossroads.

HOW TO READ THIS PLAN

for Land Developers

Zion Crossroads is brimming with potential for new growth. This template assists developers who are considering projects within Zion Crossroads by communicating Fluvanna County's vision for the area. This establishes expectations before a development review process is initiated, to ensure that any future endeavors are both cost-effective and beneficial to the citizens of Fluvanna County.

for Policy Makers

The Zion Crossroads Guidebook builds upon previous public processes and plans, and it articulates a land use and design vision specific to the Zion Crossroads area. Fluvanna County elected officials and staff may reference this template when deciding upon implementation tools to ensure the health, safety, and welfare of the community.

for Citizens

Successful planning depends upon an active citizenry. By presenting a potential outcome for Zion Crossroads, this template may inspire individual residents of Fluvanna County, and of the Zion Crossroads area in particular, to share their own ideas for their community.

Any new direction for Zion Crossroads must fully take into account what is already there, what infrastructure is available or planned, how the land is being used, and what trends are currently underway.

- An interchange of I-64 creates a vital connection for Zion Crossroads to the national **transportation system**, and US routes 15 and 250 both serve the area as well.
- A total of 155 **housing units** were counted in Fluvanna County's portion of the Zion Crossroads area in the 2010 Census. This was only a marginal increase from the 131 units counted in 2000.
- In 2009, Fluvanna County's portion of Zion Crossroads contained approximately 26,300 sq. ft. of **commercial space** and 485,202 sq. ft. of **industrial space**. This represents an estimated 301 jobs in the area. There was substantial growth of industry between 2002 and 2009.
- Approximately 43% of all land in the Zion Crossroads Community Planning Area is identified as **vacant**, and 7% of the land area is identified as **agricultural only**. An additional 26% of the land area has another existing use but may be suitable for **redevelopment** because the land value of the parcel exceeds the improvement value.
- The 2013 **assessed value** of all land and improvements in the area is $180,994,000. The assessed property values decreased by 15% between 2007 and 2013, although the decline was less extreme than that of the County as a whole.
- The Zion Crossroads area straddles the Fluvanna-Louisa county border. The Louisa side experienced significant commercial and residential growth over the last decade. The area increased from almost no commercial to over a million sq. ft. and almost tripled the number of housing units.
- Most of the land (98%) in the area is **currently zoned** for agricultural use. Based on current residential allowances, a total of 2,977 homes could be built on this land by-right.
- **Public water and sewer capacity** is under consideration for the Fluvanna County portion of Zion Crossroads, and the County is currently weighing options for providing such service to the area.
- The Fluvanna Correctional Center for Women is a significant use within the Community Planning Area. The center has an average daily population of 1,200.

Zion Crossroads Urban Development Area

This Guidebook pertains to the Zion Crossroads Urban Development Area, as designated in the 2009 Fluvanna County Comprehensive Plan.

An Urban Development Area (UDA) is defined by the Code of Virginia as an area that is appropriate for higher-density development due to its proximity to transportation facilities, the availability of a public or community water and sewer system, or a developed area wherein redevelopment and infill are feasible. By allowing more intense development in UDAs, Fluvanna County can provide public services more efficiently and preserve its rural and agricultural landscape by reducing development pressures on these areas. UDAs also include design features tailored to compact, mixed-use areas, known broadly as Traditional Neighborhood Development.

Zion Crossroads is currently designated as the County's only UDA. This area is intended to absorb most of the County's growth over the next ten to twenty years, as intended in the state code. The Zion Crossroads UDA was selected because its proximity to Interstate 64 and Routes 15 and 250, and to Louisa's most intensive growth area.

Zion Crossroads Community Planning Area

The Community Planning Areas (CPA) are defined in the Fluvanna County Comprehensive Plan as areas designated to receive higher densities of residential and commercial growth. The plan sets the goal of dispersing 70% of all new development to the five CPAs of the County. Although the function of CPAs is similar to that of UDAs, they are intended to contain less density and public services.

Zion Crossroads is Fluvanna County's largest CPA, and the County places a special emphasis on commercial and industrial growth in this area.

Zion Crossroads Urban Development Area (UDA)

T4: MIXED USE VILLAGE

The *Zion Crossroads Mixed Use Villages* are vibrant places to live and work within the Zion Crossroads Urban Development Area, as designated by the Comprehensive Plan. The intensity of commercial and cultural activity is less than that of the Town Center, but the neighborhood remains closely tied to the center:

1. A variety of housing types integrated with each other, including multifamily structures, townhomes, duplexes, and single-family homes.
2. Spacious and well-designed public spaces for recreation, aesthetic appeal, and stormwater management.
3. Smaller scale commercial and industrial uses near major roadway corridors, connected to but somewhat removed from residential areas.
4. Complete streets throughout, including sidewalks, landscaping, narrower vehicle lanes, and on-street parking.
5. Residential gross densities of between 8 and 12 dwelling units per acre (as pictured).
6. Neighborhood-serving retail and restaurants within closer proximity to residential areas.

Market Street Condos
Reston, VA

Reston-Condos.com

New Town
Williamsburg, VA

Williamsburg Real Estate

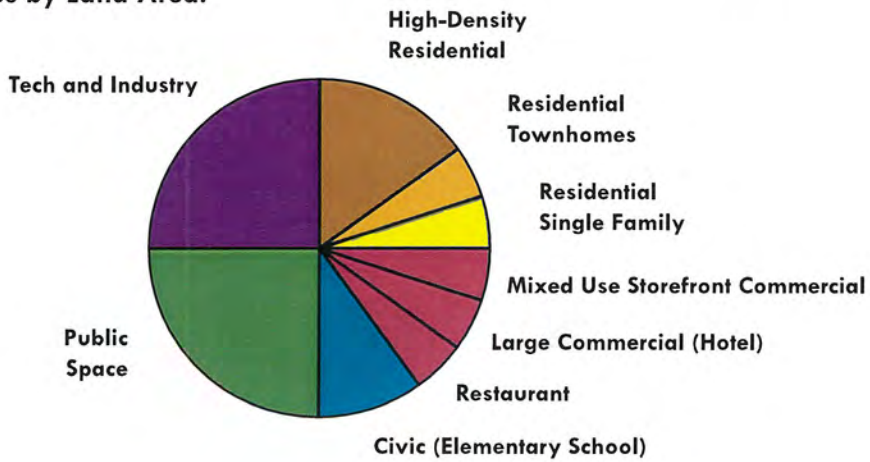
Mix of Uses

Civic (School)

Commercial/mixed use structures are concentrated along the main streets with easy pedestrian access. Retail, restaurants and other uses needing exposure occupy ground floors, while offices and residences are above. General civic uses are appropriate for these locations as well.

The uses and activities featured in the Zion Crossroads Mixed Use Village both support and benefit from the higher intensities activity that occurs in the Town Center. As the title makes clear, there is an integration of various uses, but this must be careful planned and tailored to the appropriate transportation infrastructure. With correct proportions, the area can provide a very high quality of life for those who prefer a walkable and green neighborhood, while still supporting the economic engine of the Zion Crossroads area.

Uses by Land Area:

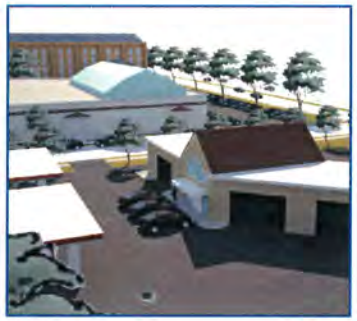


Public Space

The primary public spaces in the Mixed Use Village are parks that serve the local residents and other uses such as schools. Public spaces are especially important for higher-density residential residents, who do not otherwise have private lawns.

Parks could provide such amenities as playgrounds, picnic shelters, dog park fencing, benches, and playing fields. Parks should be connected with a pathway system. Generally, unprogrammed and informal open space is also discouraged in these areas.

Technology/ Light Industry



Technology and light industry buildings may be located in the Mixed Use Village in areas that are removed, to some degree, from residential streets.

The uses and forms of technology and light industry are much the same as described for the Town Center.

High-Density Residential

High-density apartments (rented) or condominiums (owner-occupied) should directly front streets with minimal setbacks. In this illustration, the multifamily buildings are arranged around a common greenspace encircled by a narrow one-way street.

All parking for multifamily residential buildings should be provided behind the building with a few on-street spaces available for guests.

Medium Density Residential

Medium-density residential areas take the form of the traditional neighborhood commonly built throughout the United States prior to World War II.

Streets are tree-lined with sidewalks. Single-family detached dwellings are integrated with townhomes and duplexes. There are a variety of home styles, with front porches as a dominant feature and front-loaded garages discouraged. Lot sizes are relatively narrow and rectilinear, with private backyard space for each unit. An appropriate density is between 8 and 12 dwelling units per gross acre. Homes are setback a small distance from the streets. Streets are narrow and formed generally into a grid.

Mixed-Use Commercial

Commercial and mixed use uses may take a similar form to those in the Town Center, although the merchandise should ideally cater to more local clientele in the surrounding area. This includes cafes, small grocers, florists, and retail offer convenience goods. Office space or residences are appropriate for above floors.

These uses should be located on the periphery of residential areas so customers from outside the neighborhood need not travel on residential streets. More intense uses may be appropriate near the gateway from an arterial into the neighborhood.

All parking should be provided behind the building with a few on-street spaces available for guests.

Section 3
Future Customers and Service Areas

Background and Project History

In 1996, Timmons Group produced a report for Fluvanna and Louisa Counties titled, Water Resources Study for the Zion Crossroads Area. This report estimated the average daily water demand for build-out for the Zion Crossroads area of Fluvanna and Louisa Counties at 2.1 MGD at year 2040. To this demand for typical residential, commercial, and industrial growth was added a 50% reserve capacity for one or two large industrial customers to arrive at an average daily demand of 3.2 MGD. A peaking factor of 1.8 was applied to obtain an estimated peak day demand of 5.8 MGD. The study area of the 1996 report consisted of 5,240 acres. The typical average daily demand per acre (2.1 MGD ÷ 5,240 acres) calculated to 401 gallons per day per acre.

In 1998, Timmons Group produced a report for Fluvanna County titled, Water and Wastewater Preliminary Engineering Report and Facilities Master Plan for Fluvanna County. This report examined county-wide growth and water demands. An average population growth rate of 3.4% was projected for the study period of 1998 – 2025 resulting in a 2025 population projection of 44,400. The report calculated a ratio of residential use acreage to commercial use acreage of 20:1. Industrial Use property was estimated based on proximity to the Zion Crossroads interchange or then existing patterns of industrial growth. 2025 water demand was projected as follows.

Residential	3.08 MGD
Commercial	1.41
Industrial	0.97
Total Fluvanna County	5.46 MGD

In 2002, the Fluvanna County Board of Supervisors created a water supply work group to "provide a more reliable water supply source for the Fork Union Sanitary District and other County needs". The work group returned that same year a report titled, Report of Recommended Water Supply Alternative. The report recommended the James River as the best source of water for the County. In the work group's study, the 1998 Timmons Group demand projections were rejected as being "too high". The report developed the table of projected demand provided below.

Area	2005	2010	2015	2025
Fork Union	200,000	250,000	275,000	300,000
Palmyra	50,000	250,000	500,000	1,000,000
Columbia	50,000	100,000	200,000	300,000
Women's Prison	150,000	150,000	150,000	150,000
Louisa County	50,000	250,000	750,000	1,200,000
Total	**500,000**	**1,000,000**	**1,875,000**	**2,950,000**

In 2003, Anderson and Associates, Inc. produced a report for Fluvanna County titled, Water Study, Fluvanna County, Virginia. Anderson and Associates utilized Year 2000 Census data to determine Fluvanna County population densities and projections. The County's Comprehensive Plan was utilized to determine the area to be served. A chart was produced that provided 2025 and ultimate water demands for Fluvanna County of 3.77 MGD and 6.44 MGD, respectively. Of these amounts, the County would supply 1.57 MGD in 2025 and ultimately 2.92 MGD. To these were added demands of 0.15 MGD for the Women's Correctional Center and 1.50 MGD for Louisa County for totals of 5.42 MGD at 2025 and 4.57 MGD at ultimate.

Population Growth Methodology

The 2000 Census was used as the starting point for Fluvanna County population projections. Numerous population and population density maps are available online from the U.S. Census Bureau. The geographic areas did not exactly match the "planning areas" as delineated in the County's existing comprehensive plan. The population areas were therefore interpolated to arrive at estimates for the County's growth areas.

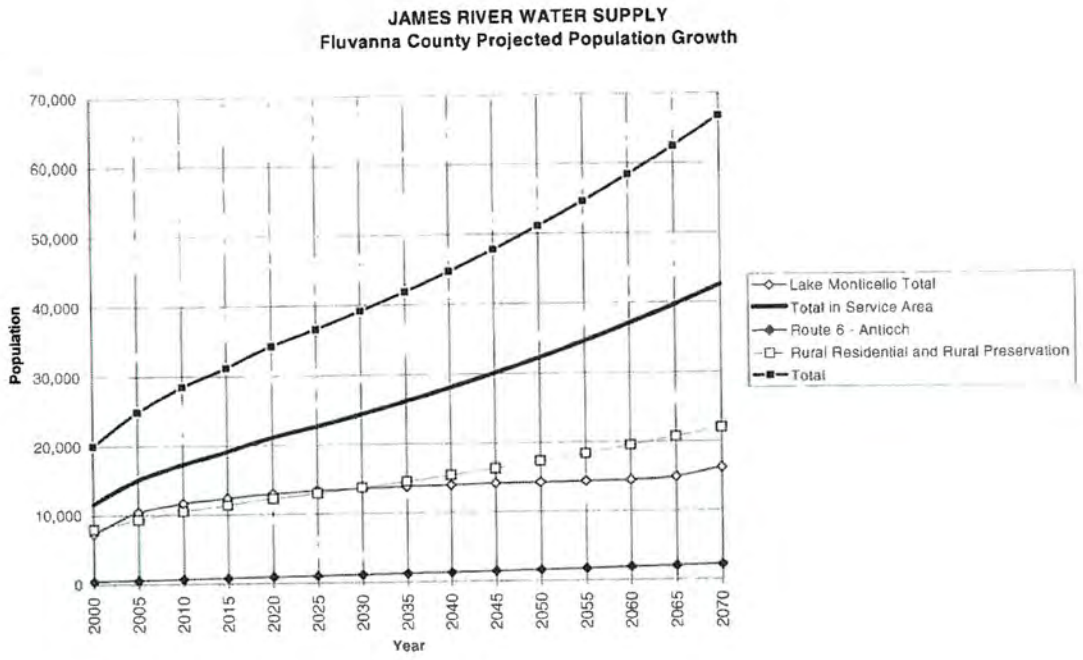
Since 2001, Fluvanna County has tracked building permits, land re-zonings, and site plans to chart the growth in the various planning areas and rural areas. The existing County Comprehensive Plan established a goal of directing 70% of growth to the planning areas and 30% of growth to rural areas. From 2001 to 2006 an annual report was prepared by the Planning Department to state the past year's growth and grade the effectiveness of the plan in directing growth in the desired percentages. Therefore, from 2000 to 2006, County growth trended generally with the plan. Further, the number of building permits was multiplied by 2.7 persons per residence to obtain an annual projection of population growth in each planning area.

The U.S. Census Bureau has since developed population projections from 2006 to 2030. These projections were then used as benchmarks for projecting Fluvanna County's growth to 2030. The growth rates between the five and ten year intervals used by the agencies were then interpolated to produce annual estimates. Growth rates after 2030 were estimated in generally decreasing rates. If the period of growth from 1970 to 2000 were included within the historic population figures from 2000 to 2006 and the projections from 2007 to beyond 2030, a classic "S" curve is produced. Of course, the farther into the future that a projection is made, the greater the chance for error.

The projected countywide populations were then divided among the planning and rural areas based on the rates described above. The area of greatest historic growth, the Lake Monticello Community, is much farther along in approaching build-out than other areas of the County. This area was "capped" at approximately 11,000 people. The rate of growth was slowed in this area and the population distributed to other areas to maintain a total accounting for the overall population growth. Last, the Route 6 / Antioch area was included in the development area populations, but is not considered in the service area of this project. Therefore, 4% of county-wide population growth is applied to the Route 6 / Antioch planning area.

Projected Fluvanna County Population (TJPDC Projections)

Year	North-South 250	Zion Crossroads	Palmyra	Fork Union	Columbia	Lake Monticello Community	Lake Monticello Primary Residential	Total in Service Area	Route 6 - Antioch	Rural Residential and Rural Preservation	Total	Annual Growth Rate
2000	1,173	712	329	2,000	96	7,022	305	11,637	435	7,975	20,047	
2005	1,357	835	378	2,031	102	9,812	586	15,101	524	9,291	24,916	2.590%
2010	1,646	1,140	585	2,065	131	10,433	1,214	17,293	665	10,513	28,471	2.788%
2015	1,940	1,506	897	2,093	159	10,727	1,654	19,127	776	11,346	31,250	1.880%
2020	2,302	2,010	1,299	2,133	179	10,928	2,057	21,140	898	12,261	34,300	1.880%
2025	2,646	2,510	1,487	2,180	210	11,006	2,370	22,703	992	12,972	36,667	1.344%
2030	3,080	3,345	1,503	2,213	244	11,023	2,603	24,374	1,094	13,731	39,198	1.344%
2035	3,597	4,235	1,521	2,302	279	11,041	2,746	26,154	1,202	14,540	41,896	1.340%
2040	4,168	5,187	1,540	2,360	317	11,060	2,917	28,057	1,317	15,405	44,779	1.340%
2045	4,778	6,224	1,561	2,400	358	11,080	3,100	30,091	1,440	16,330	47,861	1.340%
2050	5,495	7,441	1,582	2,444	358	11,102	3,165	32,265	1,572	17,318	51,155	1.340%
2055	6,262	8,743	1,606	2,490	358	11,125	3,235	34,588	1,713	18,374	54,675	1.340%
2060	6,808	10,282	1,655	2,614	358	11,150	3,334	37,072	1,863	19,503	58,438	1.340%
2065	7,021	11,769	1,682	3,012	358	11,203	3,706	39,726	2,024	20,709	62,460	1.340%
2070	7,248	12,903	1,682	3,041	358	11,543	4,699	42,563	2,196	21,999	66,758	1.340%



TIMMONS GROUP

Ultimate Water Demand

The ultimate water demands as determined by Anderson and Associates, Inc. were used for Zion Crossroads, North / South 250, Palmyra, Fork Union, and Columbia planning areas. The Lake Monticello Community was estimated to have a build-out population of approximately 11,500. An ultimate demand of 1,200,000 GPD was assumed. An ultimate demand of 500,000 GPD was assumed for Lake Monticello Primary Residential. Then the ultimate demands for each planning area were divided by the acreage to arrive at a per acre demand as shown in the following table:

Fluvanna County Build-out Demands

Planning Area		Acreage	Residential Acreage	Development Factor
Planning Area	Ultimate Demand (GPD)	Area (Acres)	Usable Area (Acres)	Demand/Acre
North-South 250	900,000	6,200	3720	242
Zion Crossroads	1,410,000	4,800	2880	490
Palmyra	235,000	4,700	2820	83
Fork Union	330,000	3,000	1800	183
Columbia	45,000	1,600	960	47
Lake Monticello Community	1,200,000	5,100	3060	392
Lake Monticello Primary Res.	500,000	5,300	3180	157
Total	4,620,000	30,700	18,420	251

Net usable land area was estimated to be 65% of gross land area. Commercial / industrial land use was estimated at 10% of the total area in the Zion Crossroads and North / South 250 planning areas. Commercial / industrial land use was estimated at 5% of the total area in all other planning areas. Commercial / industrial average daily demands per acre were then assumed for each planning area, each relative to the proposed ultimate demands and nature of existing and proposed development.

Ultimate Residential Demand								
Planning Area	Ultimate Demand (GPD)	Usable Area (acres)	Commercial /Industrial Area (acres)	Commercial Demand (GPD)	Average Commercial /Industrial Demand /acre	Residential Area (acres)	Residential Demand (GPD)	Average Residential Demand /acre
North-South 250	900,000	3,720	372	186,000	500	3,348	714,000	213
Zion Crossroads	1,410,000	2,880	288	144,000	500	2,592	1,266,000	488
Palmyra	235,000	2,820	141	70,500	500	2,679	164,500	61
Fork Union	330,000	1,800	90	27,000	300	1,710	303,000	177
Columbia	45,000	960	48	9,600	200	912	35,400	39
Lake Monticello Community	1,200,000	3,060	153	45,900	300	2,907	1,154,100	397
Lake Monticello Primary Res.	500,000	3,180	159	47,700	300	3,021	452,300	150
Total	4,620,000	18,420	1,251	530,700		17,169	4,089,300	238

Deducting the commercial / industrial demands for each planning area resulted in a remainder representing residential development demand. The ultimate residential demand was then divided by 100 GPD per capita to determine an ultimate population for each planning area.

Ultimate Population			
Planning Area	Residential Demand (GPD)	Per Capita Demand (GPD)	Ultimate Population
North-South 250	714,000	100	7,140
Zion Crossroads	1,266,000	100	12,660
Palmyra	164,500	100	1,645
Fork Union	303,000	100	3,030
Columbia	35,400	100	354
Lake Monticello Community	1,154,100	100	11,541
Lake Monticello Primary Res.	452,300	100	4,523
Total	4,089,300		40,893

The combined residential / commercial / industrial demand per capita was then determined in the following table:

Combined Per Capita Demand			
Planning Area	Ultimate Demand (GPD)	Ultimate Population	Combined per Capita Demand
North-South 250	900,000	7,140	126
Zion Crossroads	1,410,000	12,660	111
Palmyra	235,000	1,645	143
Fork Union	330,000	3,030	109
Columbia	45,000	354	127
Lake Monticello Community	1,200,000	11,541	104
Lake Monticello Primary Res.	500,000	4,523	111
Total	4,620,000	40,893	113

Determination of Annual Demand Growth

It is anticipated that as the system builds out that a greater percentage of the population is served by public water. This is reflected as a percentage of population served that increases through the planning period.

Population Served – Multiplication Factors

Year	North-South 250	Zion Crossroads	Palmyra	Fork Union	Columbia	Lake Monticello Community	Lake Monticello Primary Residential
2009	0.1	0.1	0.1	0.6	0.1	0.7	0.1
2010	0.12	0.12	0.12	0.616	0.12	0.705	0.12
2011	0.14	0.14	0.14	0.632	0.14	0.71	0.14
2012	0.16	0.16	0.16	0.648	0.16	0.715	0.16
2013	0.18	0.18	0.18	0.664	0.18	0.72	0.18
2014	0.2	0.2	0.2	0.68	0.2	0.725	0.2
2015	0.22	0.22	0.22	0.696	0.22	0.73	0.22
2016	0.24	0.24	0.24	0.712	0.24	0.74	0.24
2017	0.26	0.26	0.26	0.728	0.26	0.75	0.26
2018	0.28	0.28	0.28	0.744	0.28	0.76	0.28
2019	0.3	0.3	0.3	0.76	0.3	0.77	0.3
2020	0.32	0.32	0.32	0.776	0.32	0.78	0.32
2021	0.34	0.34	0.34	0.792	0.34	0.79	0.34
2022	0.36	0.36	0.36	0.808	0.36	0.8	0.36
2023	0.38	0.38	0.38	0.824	0.38	0.81	0.38
2024	0.4	0.4	0.4	0.84	0.4	0.82	0.4

2025	0.42	0.42	0.42	0.856	0.42	0.83	0.42
2026	0.44	0.44	0.44	0.872	0.44	0.85	0.44
2027	0.46	0.46	0.46	0.888	0.46	0.87	0.46
2028	0.48	0.48	0.48	0.904	0.48	0.89	0.48
2029	0.5	0.5	0.5	0.92	0.5	1	0.5
2030	0.52	0.52	0.52	0.928	0.52	1	0.52
2031	0.55	0.55	0.55	0.936	0.54	1	0.55
2032	0.58	0.58	0.58	0.944	0.56	1	0.58
2033	0.61	0.61	0.61	0.952	0.58	1	0.61
2034	0.64	0.64	0.64	0.96	0.6	1	0.64
2035	0.67	0.67	0.67	0.964	0.62	1	0.67
2036	0.7	0.7	0.7	0.968	0.64	1	0.7
2037	0.73	0.73	0.73	0.972	0.66	1	0.73
2038	0.76	0.76	0.76	0.976	0.68	1	0.76
2039	0.79	0.79	0.79	0.98	0.7	1	0.79
2040	0.82	0.82	0.82	0.984	0.72	1	0.82
2041	0.87	0.87	0.87	0.988	0.74	1	0.87
2042	0.92	0.92	0.92	0.992	0.76	1	0.92
2043	0.97	0.97	0.97	0.996	0.78	1	0.97
2044	1	1	1	1	0.8	1	1
2045	1	1	1	1	0.83	1	1
2046	1	1	1	1	0.86	1	1
2047	1	1	1	1	0.89	1	1
2048	1	1	1	1	0.92	1	1
2049	1	1	1	1	0.95	1	1
2050	1	1	1	1	0.98	1	1
2051	1	1	1	1	1	1	1

Annual water demands were then determined from the assignment of population to planning areas and the factor for population served. Aqua Virginia was allocated 1.0 MGD of demand in the Lake Monticello planning areas. The remainder of demands in those areas is to be provided by the authority either by sales to Aqua Virginia or direct sales to the customers. The Lake Monticello areas were included in Anderson and Associates "ultimate" demands but were not included in incremental demands. It was assumed that Aqua would serve all growth in those areas through 2010. Therefore, an increase in overall demands is presented here due to the "capping" of Aqua water production.

Louisa County demands were determined based on straight line growth from 200,000 GPD in 2009 to 1,500,000 GPD in 2040, with 2025 assumed to be the year of "ultimate" demand. An additional 100,000 GPD was then added to be reached by 2040. This additional growth was considered to serve the Ferncliff area or other areas of Louisa County. Service to the Ferncliff area of Fluvanna County is considered included in overall demand projections, it being assumed that the overall total will be the same as

calculated, with only the distribution of demands modified. Even though the Ferncliff demands are not called out in the spreadsheets, waterline sizing should consider an additional 250,000 GPD demand in the Ferncliff area.

Building Permits

From 2000 to 2007, Fluvanna County has averaged 323 building permits issued per year. The County had a high of 453 homes permitted during 2001 and a low of 177 homes permitted in 2007. Given the investment in a water system, it is reasonable to assume that anywhere from 200 to 300 new homes a year will be constructed in the designated service areas that this system will serve. Below is the table outlining building permits issued from the 2007 Development Activity Report:

Year	Inside Lake Monticello	Outside Lake Monticello	Total
2000	190	158	348
2001	282	171	453
2002	269	162	431
2003	138	221	359
2004	154	182	336
2005	79	184	263
2006	42	176	218
2007	27	150	177
Total	***1181***	***1404***	***2585***
Avg	***148***	***176***	***323***

Existing Households & Businesses

It is anticipated that a number of existing homes and businesses will be desirous to connect to the water system upon installation. In order to account for these existing facilities, we have developed demand / growth projections to mirror what we anticipate will include these facilities coming on line between system completion and the year 2020. It's important to note that water demand projections will be slightly higher than population projections due to existing households and businesses hooking into the system as the Fluvanna "retail" system is extended into the designated growth areas of the County.

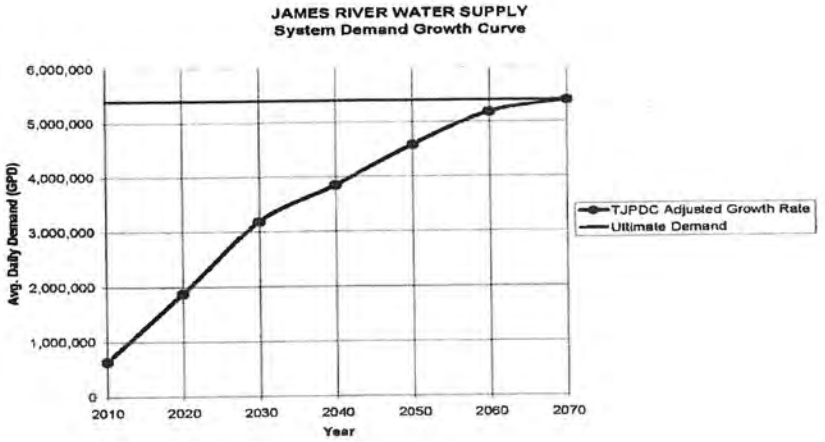
Adjusted Water Demands

Based upon all the factors discussed above, we have developed adjusted water demands that are reflected in the table below:

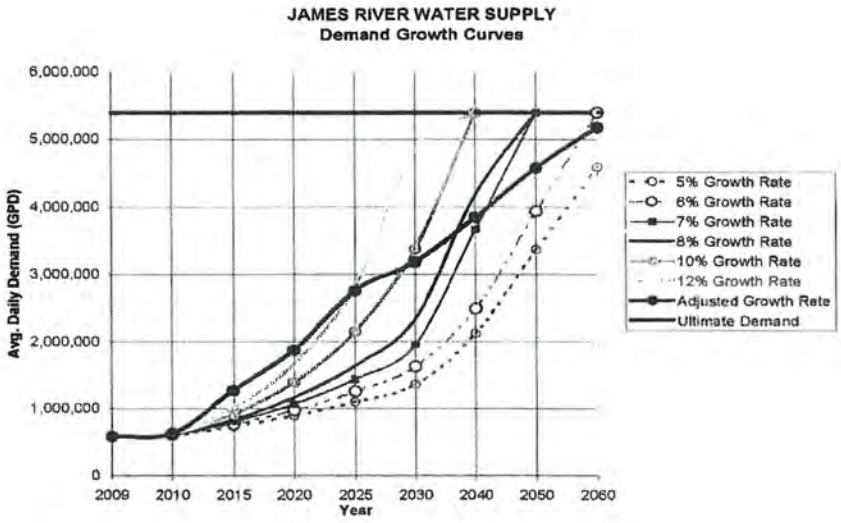
Adjusted Water Demands (GPD)

Planning Area	2009	2010	2015	2020	2025	2030	2040	2050	2060	2070	Ultimate	Ultimate with Aqua
North/South 250	19,919	22,906	56,999	114,644	230,591	371,369	604,921	900,000	900,000	900,000	900,000	900,000
Zion Crossroads	11,841	13,617	33,884	68,152	137,079	220,786	359,605	585,759	1,191,620	1,410,000	1,410,000	1,410,000
Palmyra	7,625	8,769	17,638	35,478	57,135	72,920	118,780	193,480	235,000	235,000	235,000	235,000
Fluvanna Schools	25,000	25,000	30,000	30,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Fork Union	184,000	188,563	208,644	230,281	253,238	273,709	302,867	316,145	330,000	330,000	330,000	330,000
Columbia	0	0	0	0	0	16,107	29,044	44,600	45,000	45,000	45,000	45,000
Lake Monticello Community	0	0	27,000	94,500	162,000	229,500	364,500	400,000	400,000	400,000	400,000	1,200,000
Lake Monticello Primary Residential	0	0	94,500	162,000	229,500	297,000	300,000	300,000	300,000	300,000	300,000	500,000
DOC Womens Correctional Center	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Total Fluvanna Customers	**398,000**	**409,000**	**619,000**	**885,000**	**1,270,000**	**1,681,000**	**2,280,000**	**2,940,000**	**3,364,000**	**3,820,000**	**3,820,000**	**4,820,000**
Louisa County	200,000	240,000	660,000	996,000	1,500,000	1,533,333	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000
Total Demand	**598,000**	**649,000**	**1,279,000**	**1,881,000**	**2,770,000**	**3,214,000**	**3,880,000**	**4,540,000**	**4,964,000**	**5,420,000**	**5,420,000**	**6,420,000**

The demand results produced a system demand growth curve as shown below.



The projected water demands were then compared to various theoretical demand rates to determine the reasonableness of the demand growth results as shown in the following graph.



From the demand projections shown in the above graph, demand nodes were then created along the proposed distribution align to be used in sizing the potable water distribution pipelines. It was also assumed that Aqua Virginia's system would be able to accommodate approximately 1.0 MGD

Therefore, after several discussions with both Fluvanna and Louisa Counties, it was determined to develop the Project in two phases / capacities:

- The initial phase (Phase 1) will have a flow capacity of 3.0 MGD.
- The ultimate phase (Phase 2) should have a flow capacity of 6.0 MGD to accommodate both the Louisa and Fluvanna demands at ultimate build out.

Section 4
Water Treatment Plant and Reservoir Siting Study

Introduction

The 2003 Anderson and Associates Water Study for Fluvanna County recommended the location of a water treatment plant in the vicinity of the State Route 6 and State Route 649 intersection. This would locate the WTP at the receiving connection to the ECTI pipeline. The location of a raw water reservoir was not included in the study, although an 800 acre-foot volume reservoir was included in the costs for Anderson and Associates' Phase 2 improvements.

Since the Anderson and Associates study, discussions with ECTI have developed a plan for a continuous raw water design capacity of 1.5 MGD to 3.0 mgd (Uninterruptable and interruptable) for the proposed water system. Therefore, raw water storage capacity may be warranted in the future after the receiving connection to the ECTI pipeline.

In order to best evaluate the potential water treatment plant sites, we must also consider the proximity and location of potential reservoirs that can be utilized for raw water storage to help optimize the system. It's important to note that dependent upon ultimate operations of the raw water system and the potential costs of a reservoir, it might be in the Counties best interest to consider constructing a second parallel pipeline in lieu of a storage reservoir.

Reservoir Design & Evaluation Considerations

Raw water reservoirs contain three vertical zones. The top one-third of the reservoir depth is considered the usable volume. The middle one-third of the reservoir depth is considered the usable reserve. The bottom one-third is a sedimentation zone and has an unusable volume. Timmons Group recommends that the raw water reservoir contain a usable volume and usable reserve capacity to sustain system demands for up to 60 days. At 6.0 MGD demand this equates to 360 million gallons (1104 acre-feet).

The proposed impoundment will be created with an earthen dam. Material for the dam is considered to be available onsite in the reservoir cost analysis. A piped flow outlet is proposed to allow discharge downstream while the surface elevation is allowed to vary based on demand drawdown. A concrete raw water intake allowing water withdrawal at multiple depths is proposed.

Reservoir Site Alternative Analysis

Thirteen possible reservoir sites were considered throughout the County in areas that would be proximate to the potential raw water line. It's important to note that the sites selected were evaluated based topography and other geographic considerations. The sites were evaluated based on the following criteria.

- Usable volume and usable reserve capacity
- Acreage requirement for impoundment and dam
- Number of private property owners affected for impoundment and dam
- Acreage of private land required for the impoundment and dam
- Access requirements
- Location relative to the ECTI pipeline and service area
- Environmental and Historical/Cultural Impact
- Dam Size

Usable Volume

The total volume of each reservoir site at normal pool elevation is provided in Figure 4-2. Sites R-2, R-3, R-4, R-7, R-10, R-11, and R-13 provide insufficient volume to meet a 60 day demand and are eliminated from further analysis.

Figure 4-2
Reservoir Alternatives Analysis
Total Impoundment Volume

Site	Total Volume (million gallons)
R-1	652
R-2	229
R-3	89
R-4	64
R-5	574
R-6	425
R-7	190
R-8	368
R-9	482
R-10	144

Figure 4-4

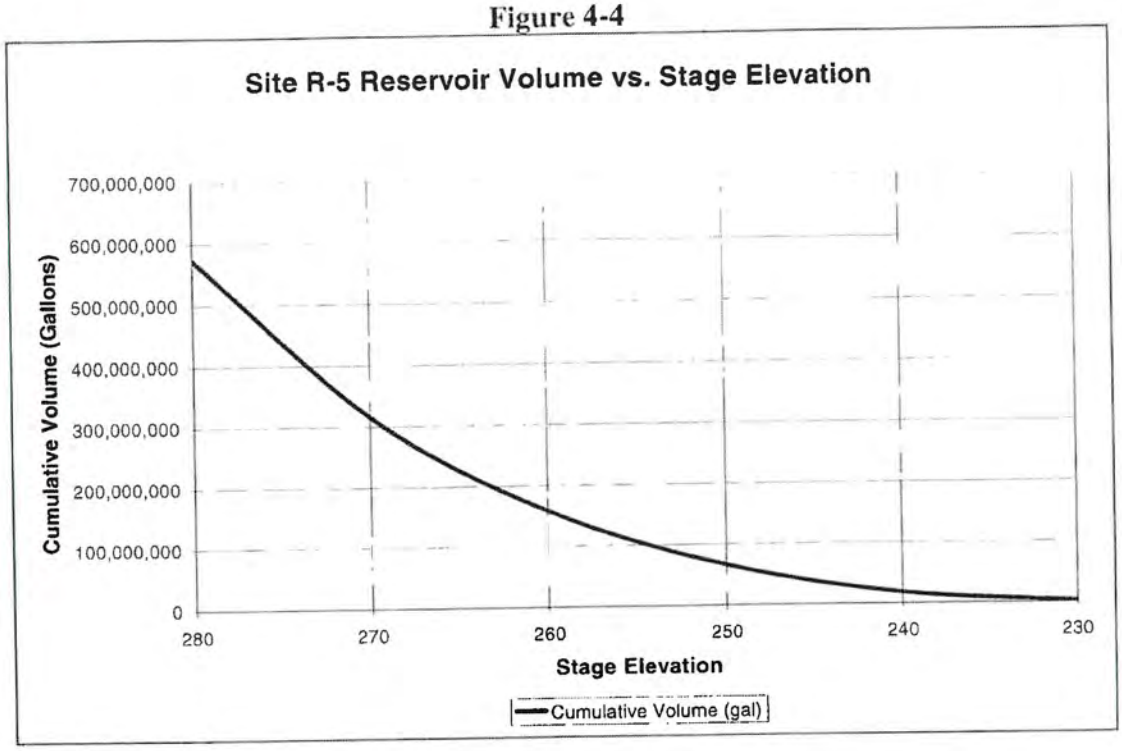


Figure 4-5

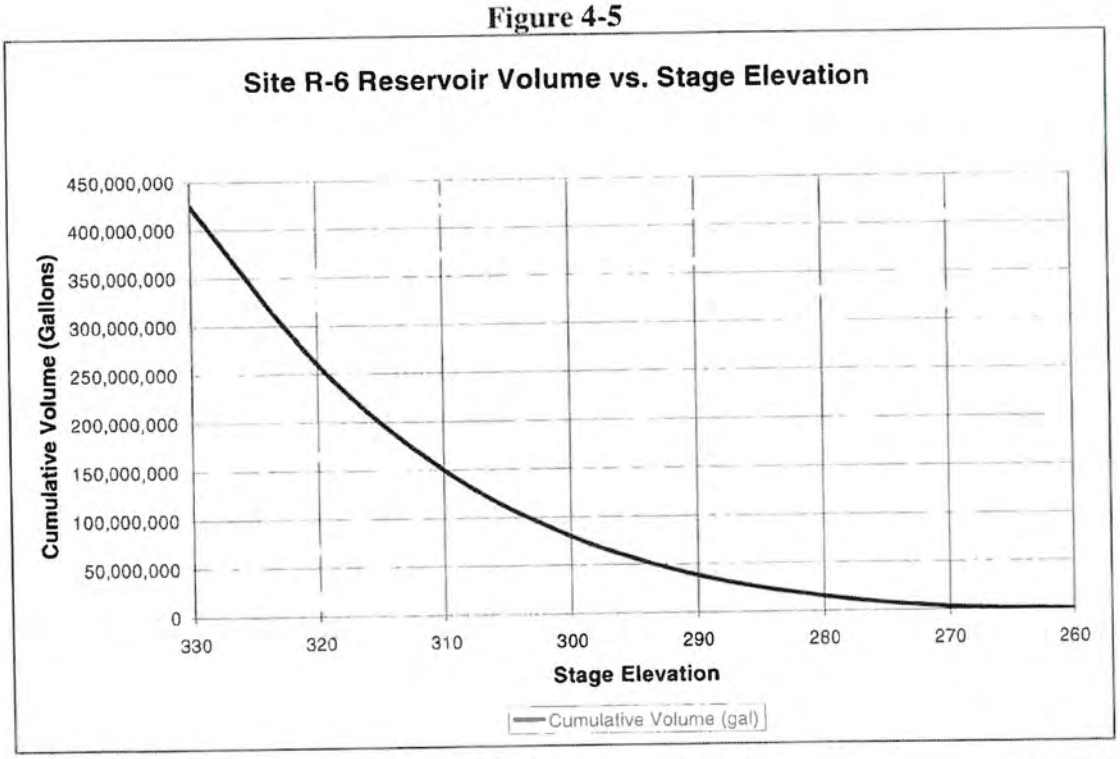
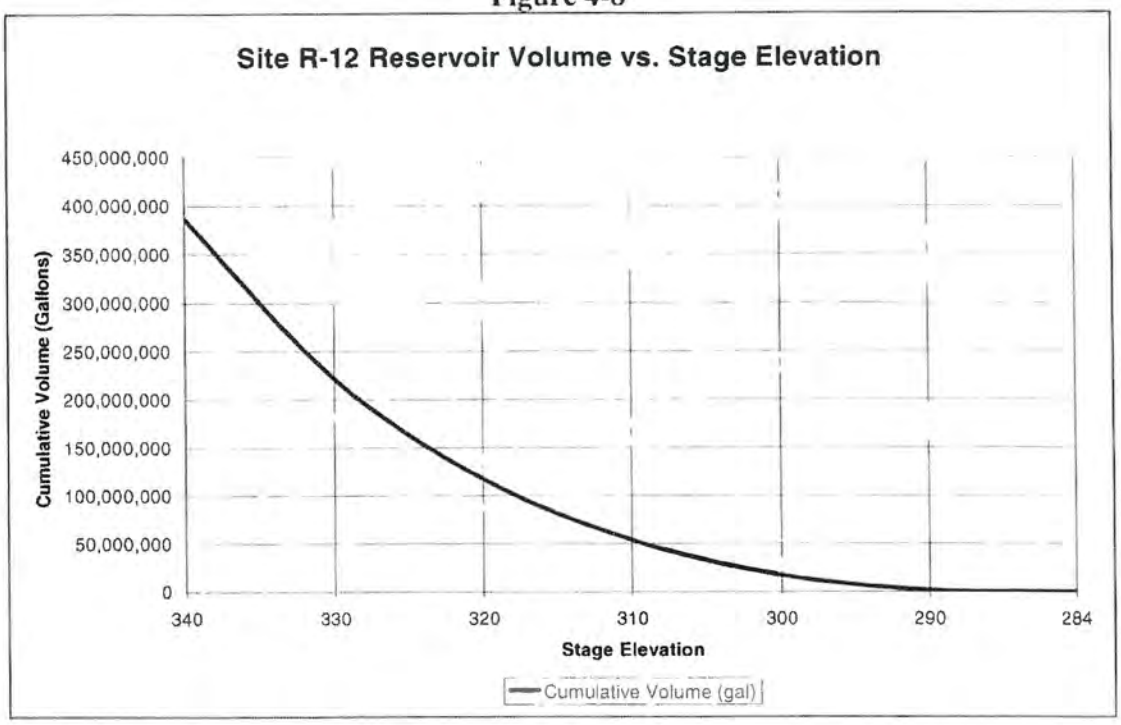


Figure 4-8



From the Stage-Volume curves, the usable volume and usable reserve can be determined for each site. The results are shown below in Figure 4-9.

Figure 4-9
Reservoir Usable Volumes

Site	Usable Volume (million gallons)	Usable Reserve (million gallons)	Total (million gallons)
R-1	417	190	607
R-5	369	160	529
R-6	300	100	400
R-8	243	105	348
R-9	341	120	461
R-12	230	100	330

Sites R-8 and R-12 do not meet the requirement for a usable capacity of 360 million gallons per day, and will not be further considered. Figures 4-10 through 4-13 show the layouts of the remaining four reservoir sites.

Private Property Land Requirements

Land requirements will exceed that of the impoundment and dam. Access, spillways, buffers, pump controls, power line easements, and the general layout of the impoundment require land or easement rights. For the sake of this study, the area of the impoundment and dam are examined. Figure 4-14 compares the land requirements of each site.

Figure 4-14
Private Property Land Requirements

Site	Reservoir and Dam Area (acres)	Area of Private Property Required for Reservoir and Dam (acres)	Number of Private Property Owners Impacted by Area Requirements for Reservoir and Dam	Number of Private Property Owners Impacted including Access and Utility Easements
R-1	124	124	3	5
R-5	99	63	4	4
R-6	62	57	3	3
R-9	102	102	16	16

Access Requirements

Figure 4-15 shows the length of access road from the nearest County or VDOT maintained road required to reach the dam site for each alternative. It is assumed that all waterlines and utilities will follow the access road.

Figure 4-15
Length of Access Road Required

Site	Access Road Requirements (linear feet)
R-1	1100
R-5	2300
R-6	3100
R-9	400

Location Relative to ECTI Pipeline and Service Area

The location of each site is ranked based on distance from the ECTI pipeline and the distance from the service area. Also each is ranked based on the quantity of distribution line and raw water line running parallel to each other, and therefore requiring pumping past the same point twice.

Figure 4-16
Location Relative to ECTI Pipeline and Service Area

Site	Distance from ECTI Pipeline (feet)	Distance from Service Area (feet)	Length of Parallel Raw and Finished Waterlines (feet)	Difficulty of Construction of Lines through Lake Monticello Development
R-1	8400	67600	0	Moderate
R-5	26900	16200	2300	Moderate
R-6	40500	4600	25600	High
R-9	45400	7900	30950	High

Environmental and Historical/Cultural Impacts

This study is not intended to provide detailed analysis of environmental or historical cultural impacts of each reservoir site. The presence of perennial and/or non-perennial streams is anticipated at each site the quantity of each is unknown at this time, as access to sites has not been obtained. The presence of endangered or threatened species specific to each site is also unknown for the same access reason.

The smaller reservoir sites were selected in order to minimize impacts to perennial streams. Those sites were however, insufficient in capacity to meet the needs of the system.

United States Geological Survey (USGS), National Wetland Inventory (NWI), and Federal Emergency Management Agency (FEMA) mapping was utilized to estimate environmental impacts of each site. Figure 4-17 provides the results of the investigation.

Figure 4-17
Estimated Environmental Impacts

Site	Estimated Length of Perennial Streams	Estimated Length of Non-Perennial Streams	**NWI Wetlands (acres)**	FEMA Flood Zone
R-1	7,600	7,600	**4**	0
R-5	10,800	3,600	**5**	4.80
R-6	3,200	2,600	**2**	0
R-9	3,200	7,900	**2**	0

Stream mitigation will be required for all perennial and non-perennial streams impacted. If Fluvanna County performs stream restoration to offset impacted streams, it must restore at a rate of 1.3 to 1. If it seeks mitigation purchase, it must purchase a rate of 1 to 1 for streams impacted.

Wetland mitigation for impacted wetlands must be at a rate of 2 to 1.

Historical/Cultural impacts are anticipated to be minimal. Additional research is required however, to determine all impacts at each site. (See Volume 2 – Preliminary Environmental Evaluation)

Dam Size

The size of the dam is a consideration associated with construction cost. The volume of earth required for dam construction is anticipated to be available on site. The estimated volume of each sites dam is provided in Figure 4-18.

Figure 4-18
Dam Volume

Site	Dam Volume (cubic yards)
R-1	91,000
R-5	125,000
R-6	165,000
R-9	92,000

Figure 4-23 provides a matrix for determining the optimum site for the proposed reservoir.

Figure 4-23
Decision Matrix

Site	Usable Volume and Usable Reserve Capacity	Acreage Requirement for Impoundment and Dam	Area of Private Property Impacted by Impoundment and Dam	Access Length	Number of Private Property Owners Impacted by Access and Utility Easements	Location Relative to ECTI Pipeline and Service Area	Environmental and Historical/Cultural Impact	Dam Volume	**Total Score**
R-1	7	10	10	4	1	17	10	6	**65**
R-5	8	8	5	7	0	17	9	8	**62**
R-6	10	5	5	10	0	28	4	10	**72**
R-9	9	8	8	1	0	31	7	6	**70**

Scale – low number = best score; high number = worst score

Reservoir Siting Recommendation

Timmons Group recommends Site R-5 (Pleasant Grove) as the location of the raw water reservoir. The 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 required is minimized, access distance from the existing park property is minimal, and excavation and hauling quantities of earthen material for the dam is minimized. The alternative requires one pipeline along South Boston Road (State Route 600) through the constricted Lake Monticello area.

Water Treatment Plant Siting

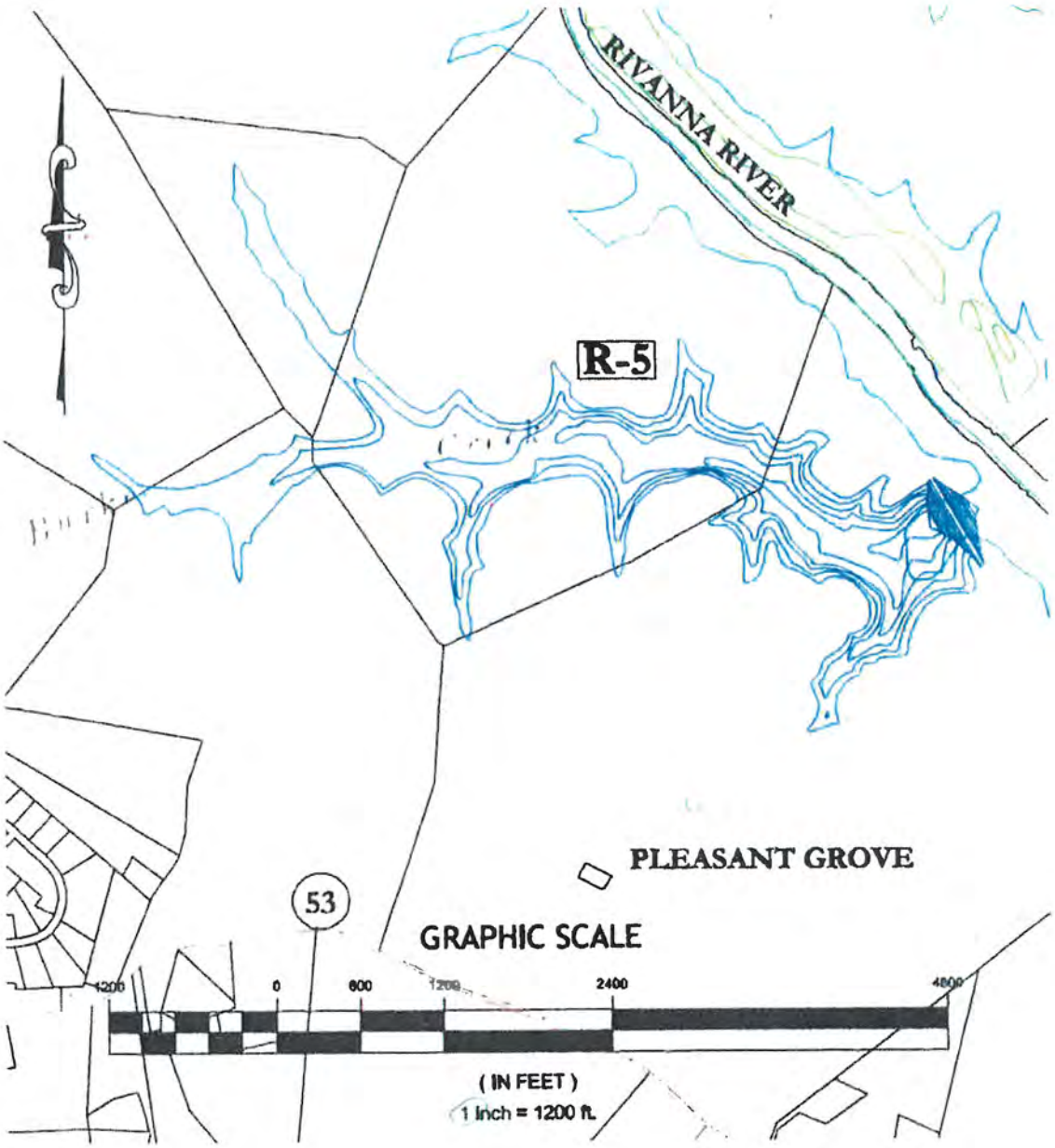
The selection of Site R-5 for the location of the reservoir leads to siting the proposed water treatment plant on the Fluvanna County-owned Pleasant Grove property. The location of the property places the plant roughly midway between the Lake Monticello development and the village of Palmyra. The site is close to both of these areas of the

service area and the paralleling of raw water and finished water lines is minimized along Route 53.

The use of Fluvanna County-owned property eliminates purchase of the site and purchase negotiations with private property owners, thereby minimizing the schedule impact for the project. The selection of the Pleasant Grove site also allows for construction to commence on the water treatment plant while permitting of the reservoir is completed.

The WTP should be located on a relatively flat ground near the lower end off the reservoir. Minimizing distance and elevation gain between the reservoir and WTP will reduce horsepower and/or pipe sizing requirements for the raw water line from the intake structure to the plant. Also the length of power and communication lines will be reduced.

Figure 4-24 provides the proposed location of the water treatment plant on the Pleasant Grove site.



Water Treatment Plant and Reservoir Siting Study
Figure 4-11
Reservoir Site R-5

Section 5
Water System Alternatives Analysis

Water System Alternatives Analysis

For the purpose of this study we considered three separate and distinct alternatives for the evaluation of the system. Following were the objectives for this study / analysis:

1. Evaluate the most feasible and cost effective way to provide water form the James River to supply the Zion Crossroads area
2. Deliver 3 million gallons per day (MGD) for the initial development of the system and up to 6 MGD for the ultimate development of the system
3. Minimize up-front capital costs of the system
4. Respect the current and proposed Comprehensive Plan within Fluvanna County
5. Respect the integrity of the Rte 15 corridor as the "gateway" to Fluvanna County
6. Honor the MOU between Fluvanna and Louisa Counties dated March 2003 for 50/50 split of capital costs.

In order to minimize the up-front capital costs for the project, the Counties have identified key potential project partners that could be utilized for the development of the system. These key potential project partners are listed below:

1. Dominion Virginia Power – utilize the existing intake structure on the James River located at the Bremo Power Facility
2. Tenaska / East Coast Transmission Inc. (ECTI) – Utilize the existing pipeline to serve the Tenaska Plant
3. Aqua Virginia – Potentially use existing system capacity & possible expansion of their water treatment plant
4. Department of Corrections – Need water for system redundancy such that they can replace their existing water system at the Fluvanna Correctional Facility

Alternatives Considered

Following are the three main alternatives that were evaluated for this study. It's important to note that these were the three most logical choices for the system development based upon the previous studies performed and the County's desire to preserve the Rte 15 "gateway" to Palmyra and minimize development pressure along Route 15.

Alternative 1 – Pleasant Grove Site

We considered the Pleasant Grove Alternative for numerous reasons as listed below:

1. Fluvanna County owned property
2. Potential reservoir site
3. Central to Fluvanna County
4. Can easily serve Fluvanna County designated growth areas

The Pleasant Grove Alternative would consist of the following components:

1. Provide raw water to the WTP at Pleasant Grove
2. Construct 3 MGD plant expandable to 6 MGD
3. Construct drinking water pipeline up Rte 53, South & North Boston Road to Zion Crossroad through designated "growth" areas and adjacent to the Lake Monticello water system
4. Counties would own & operate the WTP and distribution system

Initial estimates indicate this alternative will cost approximately $45 million for $15 per gallon of capital costs. In addition, Fluvanna County could extend water to the FUSD with relative ease for a capital cost of approximately $3.8 million.

Alternative 2 – Rte 649/15 WTP Location

This alternative was the original recommended alternative from the Anderson & Associates report in 2003. This system would consist of the following components:

1. Provide raw water to a plant location at Rte 649
2. Counties need to purchase property for the WTP and potential reservoir site
3. Construct a 3 MGD WTP expandable to 6 MGD
4. Construct a pipeline up Rte 15 to Zion Crossroads through the "Rural Preservation" zone
5. Counties would own & operate the WTP and system
6. Need to extend the pipeline to serve Lake Monticello

Initial estimates indicate that this system will cost approximately $50.3 million to install this system for $16.77 per gallon of capital costs. Since the Counties / Authority would need to acquire the property to install the WTP, and this would require the pipeline to be installed along Rte 15 to Zion Crossroads, this is not the recommended long-term alternative.

Alternative 3 – Aqua Virginia Expansion

Aqua Virginia has been identified as a potential project partner since they already own an existing water system in Fluvanna County that serves the Lake Monticello community. Aqua Virginia is an SCC regulated private water company. Based upon the original proposal submitted by Aqua Virginia, this system would consist of the following components:

1. Provide raw water to the existing WTP
2. Expand the existing WTP from 1.38 MGD to 4 MGD
3. Counties to pay $15 million capital costs up-front for the system expansion
4. Counties will have 2.5 MGD capacity
5. Aqua Virginia would own & operate the WTP
6. Counties would pay Aqua a wholesale rate for the water used
7. Counties would not own the WTP
8. Withdrawal permit of 1.095 MGD from the Rivanna River

Initial estimates indicate that to utilize the Aqua Virginia system, the estimated total capital costs investment would be approximately $46 million for $18.40 per gallon (at 2.5 MGD capacity) or $20.44 per gallon (at 2.25 MGD). In addition, Fluvanna County would need to connect the Pleasant Grove / Palmyra / FUSD systems with a water line, the additional capital costs would be approximately $3.8 million.

Recommended Alternative – Pleasant Grove Site

Based upon our analysis of the three alternatives above, we are recommending that the Pleasant Grove Alternative be implemented by the Counties for development of this system. We also recommend that Fluvanna County include a connector to the Fork Union Sanitary District (FUSD) in the initial development of this system. Following are the numerous benefits of this recommended alternative:

1. Property owned by Fluvanna County
2. Central to Fluvanna County
3. Potential reservoir site nearby – recreational and county amenity
4. Serves the designated growth regions designated by the Comprehensive Plans
5. Preserves the "Rural Preservation" areas within the County
6. Maintains integrity of the Rte 15 corridor as "gateway" to Palmyra
7. Counties / Authority owned facilities such that system can be controlled
8. Can easily be expanded to 6.0 MGD or larger with minimal issues
9. Could easily provide finished water or raw water to Aqua Virginia
10. Helps Aqua Virginia reduce long-term dependency on the Rivanna River (current withdrawal permit of 1.095 MGD) as the Lake Monticello service area expands

11. Counties could easily survive another 2002 drought without taxing the Rivanna River
12. Lowest overall capital cost per gallon ($/gal) of the three alternatives
13. FUSD Connector allows for Fluvanna County to pick up substantial user base in Fork Union planning area
14. FUSD Connector removes reliance on the FUSD well system
15. FUSD Connector allows the Fluvanna to connect the existing school system

In addition, the Virginia Department of Health has endorsed this conceptual alternative in a letter dated March 16, 2009 (see attached).

Section 7
Treatment Process Alternatives

Introduction

The new Water Treatment Plant (WTP) will be constructed in two phases: one 3.0 mgd independent plant that will be planned for and expanded to a total of 6.0 mgd in the ultimate phase of the Project.

Consultation with the Virginia Department of Health (VDH) indicated that there appeared to be no issues with water quality and treatability of the James River Water. At this conceptual stage of the Project no water quality or treatability studies are to be made. Therefore, for the purposes of this report Timmons Group visited two existing WTP's that are closest downstream of our intended James River Intake Structure (i.e., VDOC's and Henrico County's water treatment plants). From those site visits general process, water quality, and treatability information was gathered from which the following conceptual WTP design was developed.

Timmons Group's lead design engineer has developed the fundamental design layout patterns, process, and systems utilized for numerous facilities similar to the Henrico WTP. In a follow-up meeting with VDH personnel, the proposed concepts were discussed and they concurred with the approach (see VDH letter dated March 16, 2009).

Conceptual Plant Flow Diagram

The following diagram is the Conceptual Plant Flow Diagram depicting the new WTP.

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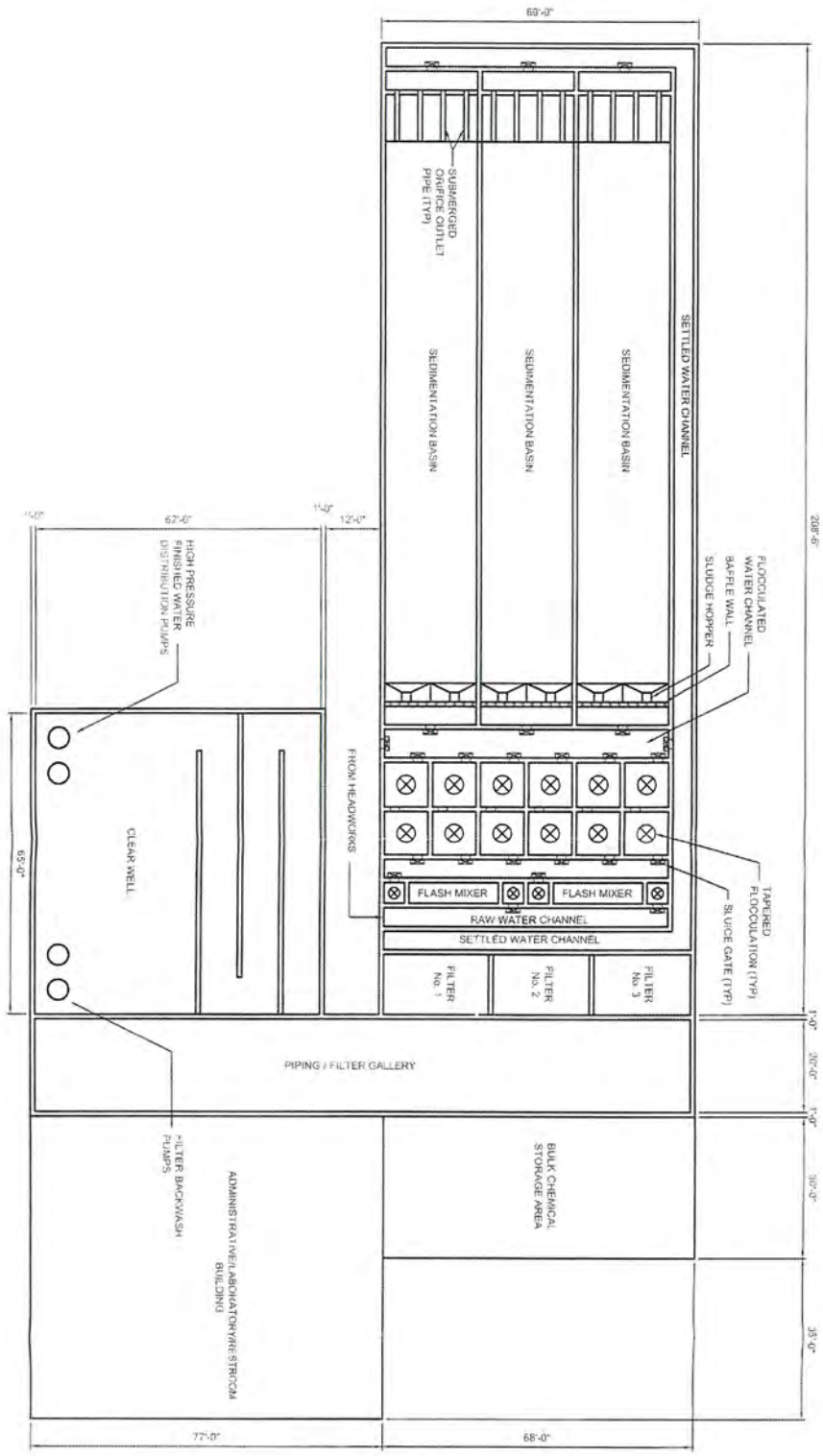

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Site Development | Residential | Infrastructure | Technology

DRAWN BY	DATE	REVISION DESCRIPTION							

DRAWING NO. 24056

JAMES RIVER WATER TREATMENT PLANT

FLUVANNA/LOUSIA COUNTY, VIRGINIA

CONCEPTUAL PLANT LAYOUT

SCALE | DESIGNED BY J. CHRISTIAN | CHECKED BY J. CHRISTIAN | DRAWN BY R. HATTEL | DATE 07/08

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The following is a listing of each process unit with a brief process description (for this conceptual level). Further, pictures of similar facilities have been included to help illustrate our conceptual design intent.

- **General:** In general, several common channels will be utilized throughout the WTP to allow the maximum flexibility in removing any one process unit from service via slide or sluice gate isolation. In addition, should future operating conditions and water quality permit, the facility can be operated in direct filtration mode (i.e., bypassing the Sedimentation Basins).

- **Headworks:** The Headworks will house both an automatically cleaned traveling screen as well as a manually cleaned screen in the event the automatic screen is in need of repair. Slide gates will be utilized to isolate any one of these screens. Depending on the finalized water quality data, the Headworks will be the first point of chemical addition with the following possible chemicals: Potassium Permanganate (for TOC mitigation); Chlorine (for shocking algae blooms periodically only); Chlorine Dioxide (for shocking algae blooms periodically only); Powered Activated Carbon (for taste and odor issues); and Ammonia.

- **Flash Mixers:** The Flash Mixers will be a two staged process to help introduce polymer and / or polymer aid and any other chemicals needed for pretreatment / preconditioning (i.e., pH adjustment). There will be two independent vertical turbine flash mixer trains (two flash mixers per train) isolated by sluice gates to allow any one train to be removed from service should the need arise or low flow dictate.

- **Flocculator Basins:** There will be six independent Flocculator Basin trains isolated with sluice gates to promote the development of larger flocc. Vertical turbine tapered energy flocculation will be used to build the largest flocc in the most efficient way. Therefore, VFD's will be utilized to achieve the varying Flocculator speeds necessary. Chemicals that may be fed at this location include: Polymer; Polymer Aid; and Ammonia.

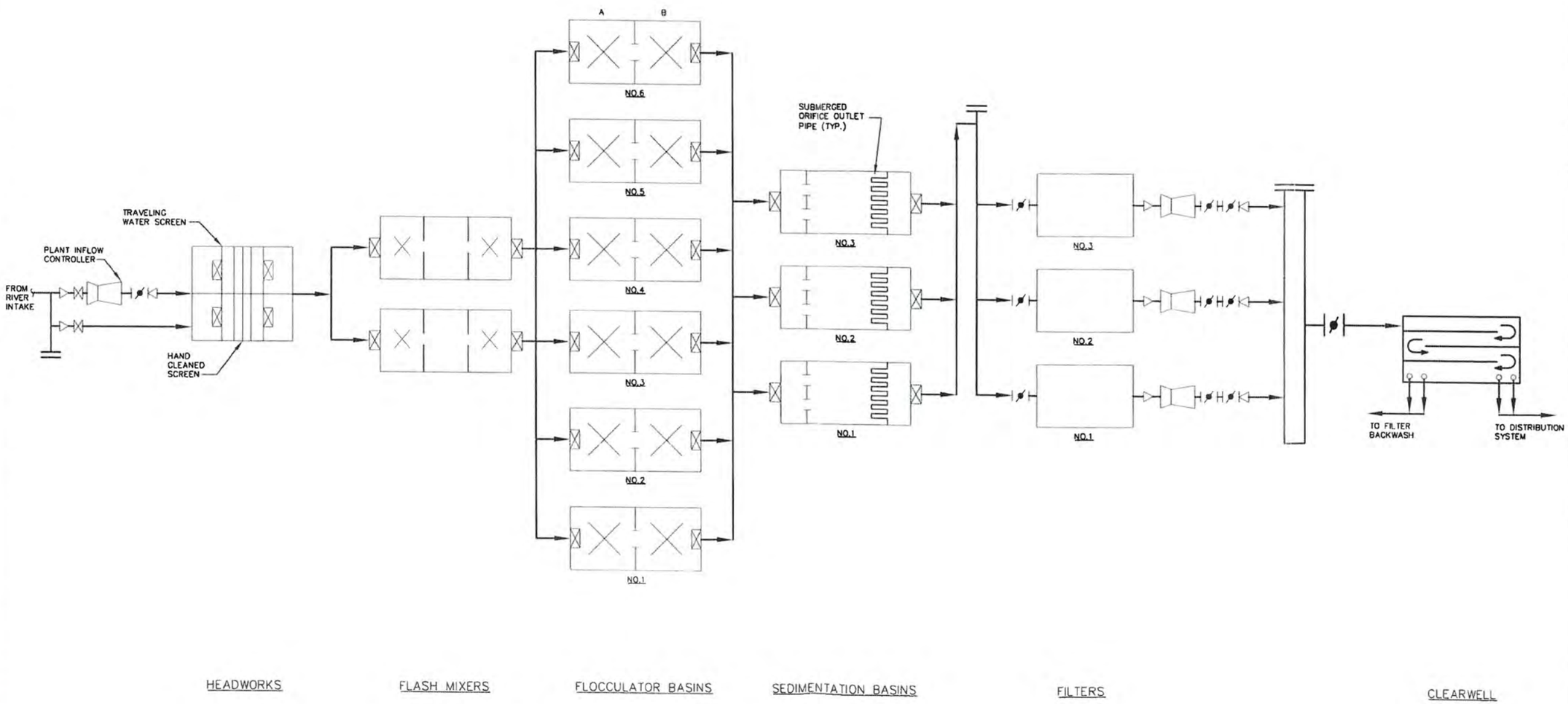
- **Sedimentation Basins:** There will be three independent sedimentation basins isolated with sluice gates to allow any one basin to be taken out of service while the other two (or one) to remain in service. There will be a baffle wall at the inlet for each basin to promote equal flow distribution into the basin. Each basin will have a sloped floor back to the inlet end and a chain and flight sludge collection system with sludge hoppers at the inlet end. The sludge hoppers will remove sludge via telescoping valves to the Sludge Handling Facility. The outlet end of each basin will have submerged orifice outlet pipes. Powered Activated Carbon may be fed in this basin for taste and odor issues.

- **Filters:** There will be three dual media, high rate filters. Each filer will have 12 inches of sand under 48 inches of Glandular Activated Carbon (GAC) for Total Organic Carbon (TOC) removal. The final specification of the media and media depths will be fully determined during the final design stage of the Project. The filters will have a filter underdrain system allowing air scour during backwash. A rate of flow controller will also be employed at each filter outlet. The filters will be housed within the main operating building of the WTP (unlike the above basins). Upstream of the filters the following chemicals may be fed: Powered Activated Carbon; Chlorine; Polymer Aid (Filter Aid); and Potassium Permanganate.

- **Clearwell:** There will be one Clearwell with internal concrete baffle walls to promote disinfection contact time. At the end of the baffled Clearwell section will be a larger holding tank housing the Filter Backwash Pumps as well as the High Pressure Finished Water Distribution Pumps (two vertical turbine pumps for each application for a total of four pumps). Chemicals that may be fed include: Chlorine; Chlorine Dioxide; and Zinc Orthophosphate.

- **Future UV Disinfection:** Though not a firm conclusion yet, UV disinfection will be considered to help mitigate THM and HAA formation in the very long potable water lines. As noted in other areas of the PER, in the early years, water age will be an issue leading to the higher potential for higher levels of THM and HAA related issues. Therefore, UV may be considered as a primary disinfectant with chlorine as the secondary disinfectant. However, it is noted that though this approach may be employed, it is recognized that per the existing State regulations, the facility still needs to meet CT via the use of chlorine.

The following are pictures of a similar facility as the one considered above (i.e., the Henrico WTP). The intent of these pictures is to provide a general idea of our future facility.



PLANT FLOW DIAGRAM
SCALE: NTS

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DATE	REVISION DESCRIPTION

DATE 3/08
DRAWN BY S. SCOTT
DESIGNED BY J. CHRISTIAN
CHECKED BY J. CHRISTIAN
SCALE NTS

JAMES RIVER WATER TREATMENT PLANT
FLUVANNA/LOUISA COUNTY, VIRGINIA
CONCEPTUAL PLANT FLOW DIAGRAM

JOB NO 24056
SHEET NO

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ZION CROSSROADS SERVICE AREA
MASTER PLAN

Prepared for:

Louisa County Water Authority
P.O. Box 9
Louisa, Virginia 23093

Project Code: LCWA/ZIONMP

May 2004
Revised: August 2004

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MASTER PLAN
MAY 2004

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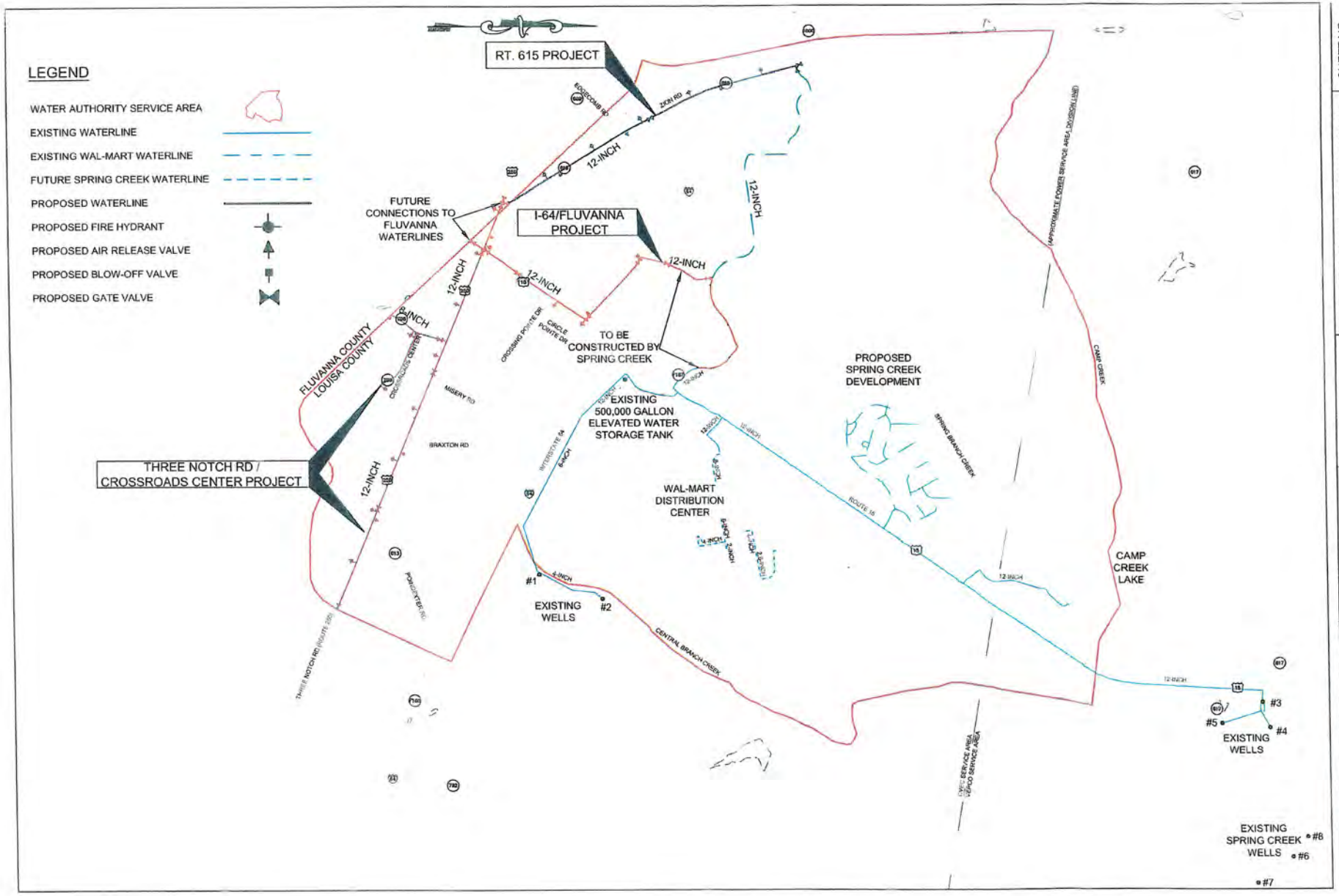
3. Wastewater Treatment Plant: The collection system transports all the sewage to the influent pump station of the 0.10 MGD Wastewater Treatment Plant. The plant has been designed for three (3) specific stages in the development of the Zion Crossroads Service Area (0.10 MGD, 0.70 MGD, 1.5 MGD). The plant consists of an influent pump station, a sequencing batch reactor (SBR), an equalization basin, and ultra-violet (UV) disinfection. Stage two is planned to occur after the proposed Spring Creek Development is 100% complete. The future expansion of the plant will be able to handle 700,000 gallons per day or 0.70 MGD. This will involve changing the SBR to basin digesters, and installing primary clarifiers and an oxidation ditch. The influent pump station and UV disinfection are currently designed to handle 0.7 MGD. The third and final stage will increase plant capacity to 1.5 MGD and is planned to occur once the Zion Crossroads Service Area is completely developed. The influent pump station and UV disinfection will have to be expanded to handle ultimate flows of the Service Area. Construction of additional digesters, clarifiers and another oxidation ditch will also be required.

III. PROPOSED IMPROVEMENTS

Based on the design water and sewer demands of the Service Area, different projects have been identified to support the anticipated growth and build-out of the Service Area.

A. Water System

Based on discussions with LCWA, the existing infrastructure, and anticipated growth of the service area, three (3) water system projects are projected for the planning area. These projects are located northwest, southwest, and southeast of the I-64/Route 15 interchange. The completion of the proposed projects will allow current property owners and future developers access to the public water system. Fire hydrants will be placed approximately every 1,000 linear feet when the waterline runs along roadways. Figure 5 shows the layout of the proposed water projects.



SHEET NO. FIG. 5

TITLE PROPOSED CONDITIONS WATER SYSTEM

SCALE 1" = 1600'

PROJECT ZION CROSSROADS SERVICE AREA MASTER PLAN

DATE MAY 2004

PROJ. NO. LCWA/ZIONMP

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1. Northwest Quadrant: Spring Creek Development plans to construct approximately 8,065 linear feet of 12-inch waterline beginning at the Spring Creek Commercial Entrance and heading west toward Route 615. Approximately 2,907 linear feet of this Spring Creek line will be part of the *I-64/Fluvanna project.* LCWA will construct approximately 5,650 linear feet of 12-inch waterline to connect to the Spring Creek waterline, which will include a directional boring under the existing conservation easement and a horizontal boring under I-64. After passing under I-64, the waterline will travel east along I-64, then south along the western side of S.R. 15 to the intersection with S.R. 250. Once at S.R. 250, the proposed waterline will run south and west within VDOT right-of-way until ending at the Louisa / Fluvanna county line. The proposed waterline will connect to the *Route 615* and the *Three Notch Road/Crossroads Center projects*. It will also provide two stub-outs for possible future connection to Fluvanna waterlines on S.R. 15 and S.R. 250.

   Spring Creek Development will construct all waterlines within the proposed development prior to deeding ownership to LCWA.

2. Northeast Quadrant: No projects are anticipated at this time.

3. Southwest Quadrant: The *Route 615 project* will construct approximately 5,770 linear feet of 12-inch waterline beginning at the intersection of S.R. 250 and Route 615, run along Route 615, under the I-64 overpass, and end at the connection point to the proposed Spring Creek 12-inch waterline.

4. Southeast Quadrant: The *Three Notch Road/Crossroads Center project* will construct approximately 6,300 linear feet of 12-inch waterline along S.R. 250 and approximately 2,090 linear feet of 8-inch waterline along Routes 795 and 796. The 12-inch waterline connects to the *I-64/Fluvanna project* and both 8-inch and 12-inch waterlines run within the VDOT right-of way.

5. Cost Estimate: Table 2 shows estimated construction and design costs for each of the proposed water projects. Construction cost includes 20% contingency to address project unknowns that may be identified during design. Design Costs are 10% of total construction cost. Detailed cost estimates can be found in the Appendix.

Table 2

Water Project	Construction Cost	Design Cost	Total Cost
I-64/Fluvanna*	$ 692,424 ($133,494)	$ 69,242 ($13,349)	$ 761,666 ($146,843)
Three Notch Rd / Crossroads Center	$ 397,320	$ 39,732	$ 437,052
Rt. 615	$ 270,540	$ 27,054	$ 297,594

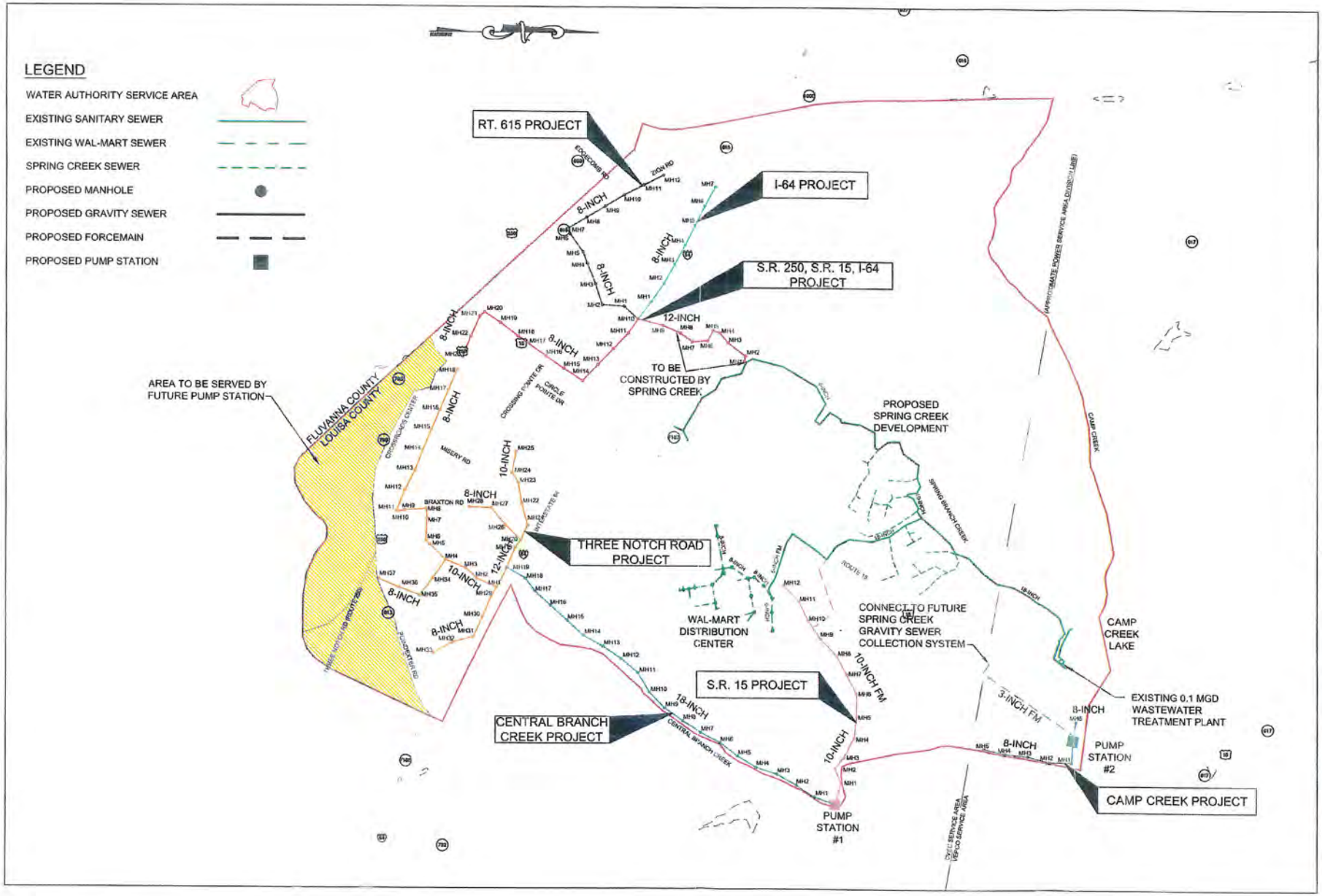
* Cost in ( ) shows portion of total cost to be borne by Spring Creek Development

B. Sanitary Sewer System

The service area has been evaluated by topography and the sanitary sewer lines have been located to service the greatest area by gravity. Seven (7) sewer projects have been identified to support the anticipated growth and build-out of the Service Area. Figure 6 identifies each project. Sections and locations of some or all of the lines can be adjusted based on the actual development of the area. These projects will allow existing property owners to transfer from septic tanks to the public sanitary sewer system. It will also give future developers access to the public sewer system.

The service area has been divided into thirteen (13) drainage areas to determine the flows and sizes for each of the sewer lines in the seven (7) projects. In an attempt to decrease costs associated with construction, maintenance and operation of multiple pump stations, special attention was taken to ensure that the greatest amount of acreage could be serviced by gravity sewer. Based on this delineation and landuse zones, gravity sewer, forcemain, and pump station sizes were determined. Table 3 identifies the flow for each sewer and pipe sizes. Figure 7 shows the drainage areas and landuse zones.

1. Northwest Quadrant: The *S.R. 250, S.R. 15, I-64 project* constructs approximately 2,488 linear feet of 12-inch gravity sewer and 4,472 linear feet of 8-inch gravity sewer. It begins at the existing gravity sewer located in the Spring Creek Development and heads southwest toward I-64. Spring Creek Development will construct approximately 1,734 linear feet of the 12-inch waterline. LCWA will construct the remaining 754 linear feet, which includes a 306 linear foot horizontal boring to preserve the existing conservation easement and a 448 linear foot horizontal boring under I-64. Once on the south side of I-64, LCWA will construct the 8-inch gravity sewer, which follows I-64 east to S.R. 15. The gravity sewer will then extend south on S.R. 15, turning east at S.R. 250 with a horizontal bore under S.R. 15. The proposed sewer will extend approximately 800 linear feet east on S.R. 250.



DATE MAY 2004	SCALE 1" = 1600'	TITLE PROPOSED CONDITIONS SANITARY SEWER SYSTEM		SHEET NO. FIG. 6
PROJ. NO. LCWA/ZIONMP	PROJECT ZION CROSSROADS SERVICE AREA MASTER PLAN			

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TABLE 3

ZION CROSSROADS MASTER PLAN								
LAND USE, WASTEWATER DEMANDS AND PIPE SIZES								
	LOCATION			ULTIMATE BUILDOUT				
LINE	FROM	TO	TYPE OF USE	ACERAGE	DEMAND	AVE. GPD	PEAK GPD	PIPE SIZE
S.R. 250, S.R. 15, I-64 PROJECT LINE 1	MH23	MH20	INDUSTRIAL	0.76	500	380		
			COMMERCIAL	18.27	1000	18,270		
	TOTAL					**18,650**	**140,769**	**8**
	MH20	MH10	MH23 TO MH20	TOTAL MH23 TO MH20		18,650		
			COMMERCIAL	32.96	1000	32,960		
	TOTAL					**51,610**	**320,069**	**8**
	MH10	MH9	MH20 TO MH10	TOTAL MH20 TO MH10		51,610		
			LINE 2	LINE 2 TOTAL		82,058		
			LINE 3	LINE 3 TOTAL		28,718		
	TOTAL					**162,386**	**807,199**	**12**
	MH9	EXMH	MH10 TO MH9	TOTAL MH10 TO MH9		162,386		
			AGRICULTURE	33.92	200	6,784		
			COMMERCIAL	1.76	1000	1,760		
	TOTAL					**170,930**	**841,303**	**12**
RT. 615 PROJECT LINE 2	MH12	MH4	RESIDENTIAL	71.23	200	14,246		
			AGRICULTURE	2.16	200	432		
			COMMERCIAL	11.73	1000	11,730		
	TOTAL					**26,408**	**186,384**	**8**
	MH4	MH10	MH12 TO MH4	TOTAL MH12 TO MH4		26,408		
			RESIDENTIAL	4.5	200	900		
			COMMERCIAL	54.75	1000	54,750		
	TOTAL					**82,058**	**465,333**	**8**
I-64 PROJECT LINE 3	MH7	MH10	RESIDENTIAL	16.26	200	3,252		
			AGRICULTURE	18.73	200	3,746		
			COMMERCIAL	21.72	1000	21,720		
	TOTAL					**28,718**	**199,434**	**8**
THREE NOTCH ROAD PROJECT LINE 4	MH18	MH4	INDUSTRIAL	29.84	500	14,920		
			COMMERCIAL	52	1000	52,000		
	TOTAL					**66,920**	**394,722**	**8**
	MH37	MH4	COMMERCIAL	25	1000	25,000		
	TOTAL					**25,000**	**178,322**	**8**
	MH4	MH1	MH18 TO MH4	TOTAL MH18 TO MH4		66,920		
			MH37 TO MH4	TOTAL MH37 TO MH4		25,000		
			COMMERCIAL	18.8	1000	18,800		
	TOTAL					**110,720**	**592,596**	**10**
	MH33	MH1	COMMERCIAL	38.7	1000	38,700		
	TOTAL					**38,700**	**253,718**	**8**
	MH1	MH19	MH4 TO MH1	TOTAL MH4 TO MH1		110,720		
			MH33 TO MH1	TOTAL MH33 TO MH1		38,700		
			COMMERCIAL	3	1000	3,000		
	TOTAL					**152,420**	**766,978**	**12**
	MH25	MH20	COMMERCIAL	111.07	1000	111,070		
	TOTAL					**111,070**	**594,107**	**10**
	MH28	MH20	COMMERCIAL	30.7	1000	30,700		
	TOTAL					**30,700**	**210,469**	**8**
	MH20	MH19	MH25 TO MH20	TOTAL MH5 TO MH20		111,070		
			MH28 TO MH20	TOTAL MH28 TO MH20		30,700		
			COMMERCIAL	5	1000	5,000		
	TOTAL					**146,770**	**743,951**	**12**
CENTRAL BRANCH CREEK PROJECT LINE 5	MH19	PS#1	LINE 4	LINE 4 TOTAL		299,190		
			INDUSTRIAL	241.85	500	120,925		
	TOTAL					**420,115**	**1,738,306**	**18**
S.R. 15 PROJECT LINE 6	MH12	PS#1	COMMERCIAL	24.93	1000	24,930		
			RESORT	0.12	260	31.2		
			INDUSTRIAL	200.03	500	100,015		
	TOTAL					**124,976**	**653,443**	**10**
			PUMP STATION #1	*TOTAL FLOWS TO PS#1*		***545,091***	***1,362,728***	***10***
CAMP CREEK PROJECT LINE 7	MH5	PS#2	INDUSTRIAL	50.48	500	25,240		
	TOTAL					**25,240**	**179,703**	**8**
	MH6	PS#2	RESORT	4.7	260	1,222.0		
			AGRICULTURE	13.49	200	2,698		
	TOTAL					**3,920**	**39,981**	**8**
			PUMP STATION #2	*TOTAL FLOWS TO PS#2*		***29,160***	***72,900***	***3***

NOTE: A PEAKING FACTOR OF 2.5 IS USED ON PUMP STATION FLOWS TO SIZE FORCEMAINS. ALL OTHER FLOWS ARE PEAKED USING FORM F-2 FROM THE COUNTY OF HENRICO PUBLIC UTILITIES. ALL PIPES ARE SIZED WITH MINIMUM SLOPES PER THE VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY SEWAGE COLLECTION AND TREATMENT REGULATIONS.