RIVANNA WATER & SEWER AUTHORITY

695 Moores Creek Lane
Charlottesville, VA 22902

Technical Memorandum

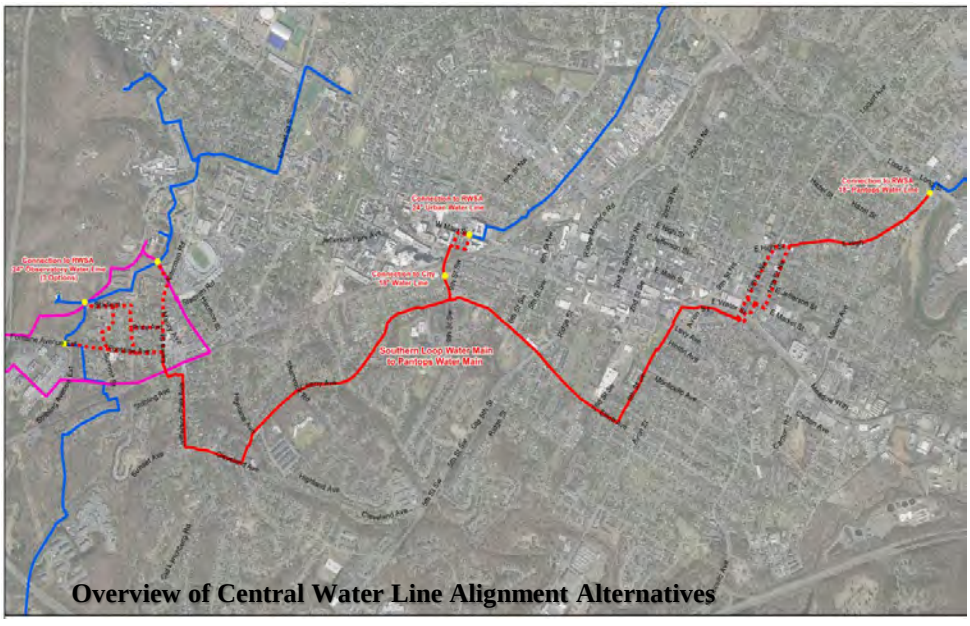
Work Authorization No. 4

Central Water Line Routing Study

Baker Project No. 182779

Railroad Crossing at JPA & Lewis Street

11th Street & Jefferson Street



Overview of Central Water Line Alignment Alternatives

December 14, 2021

Final VERSION

Prepared by:

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We Make a Difference

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1. INTRODUCTION

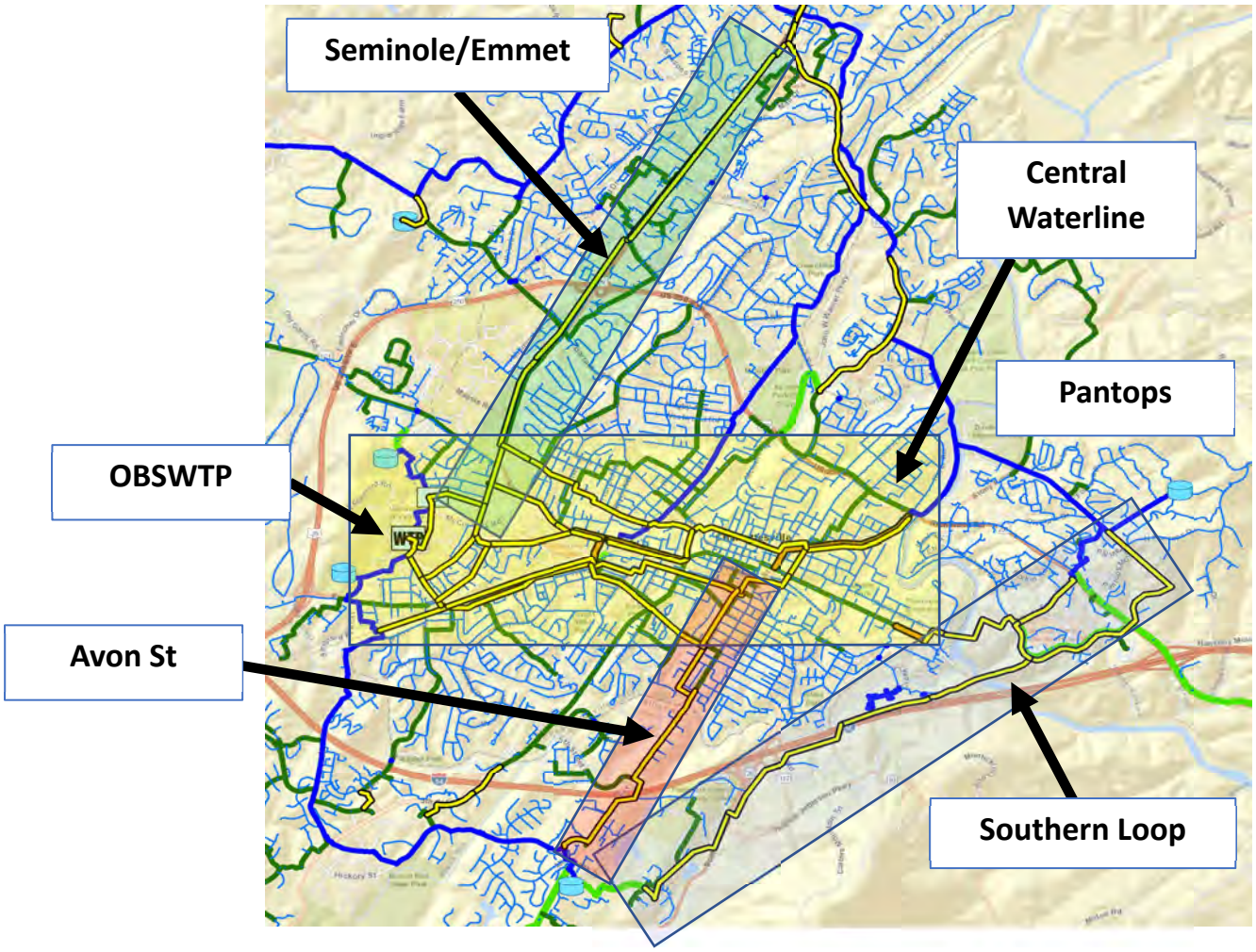
1.1. Purpose

The Rivanna Water and Sewer Authority (RWSA) has retained Michael Baker International (Baker) to evaluate transmission main alignment alternatives for the Central Water Line project (previously referred to as the Avon to Pantops Water Line project). The goal of this evaluation is to identify routing options for the Central Water Line transmission main, which will improve the hydraulic connectivity of the Urban Area Drinking Water System, for the benefit of both the City of Charlottesville (City) and Albemarle County (County). Specifically, the Central Water Line will improve the connection between the Observatory Water Treatment Plant (OBSWTP) and the RWSA water transmission mains in the center and east part of the City of Charlottesville, and thereby improve the hydraulic connection between the Avon Tank and the Pantops Tank in Albemarle County. This memorandum summarizes the evaluation criteria, route alternatives evaluated, and the costs for each of these alternatives.

1.2. Background

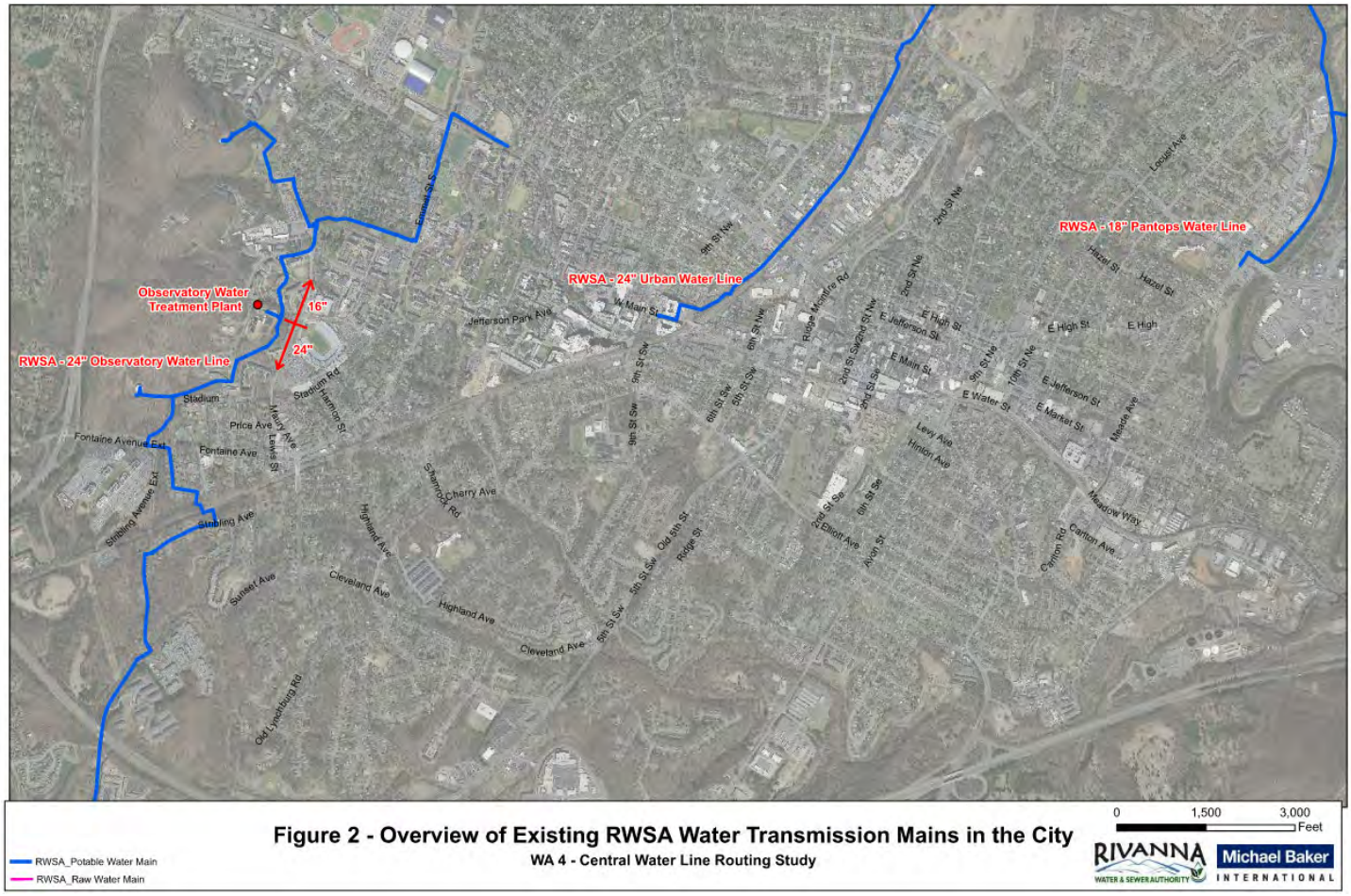
Michael Baker was previously contracted by RWSA under the Urban Finished Water System Master Plan project to perform hydraulic model analysis and evaluation for various projects utilizing the urban water system hydraulic model. The urban system includes the City of Charlottesville, the University of Virginia (UVA), and portions of the Albemarle County Service Authority (ACSA) service area excluding Crozet and Scottsville. Recognizing the challenges in moving water between the southwestern part of the urban water system, which is hydraulically well-connected to the OBSWTP, and the rest of the system, which is hydraulically well-connected to the SRWTP, RWSA evaluated several potential corridors for improving conveyance via new water transmission main(s), as shown in Figure 1. Of the initial water transmission main corridors evaluated through hydraulic model analysis, the Southern Loop corridor had minimal impact on improving system hydraulics while also resulting in water age issues; and the Avon Street and Seminole/Emmet corridors both improved system performance in other areas but did not provide a primary solution to the challenge of conveying water efficiently from OBSWTP to Pantops. An east-west corridor for a new transmission main, referred to as the Central Water Line, was confirmed as the most hydraulically beneficial to the City and County for future system operations.

Figure 1 – Potential Corridors for Improving Conveyance from the OBSWTP to Pantops



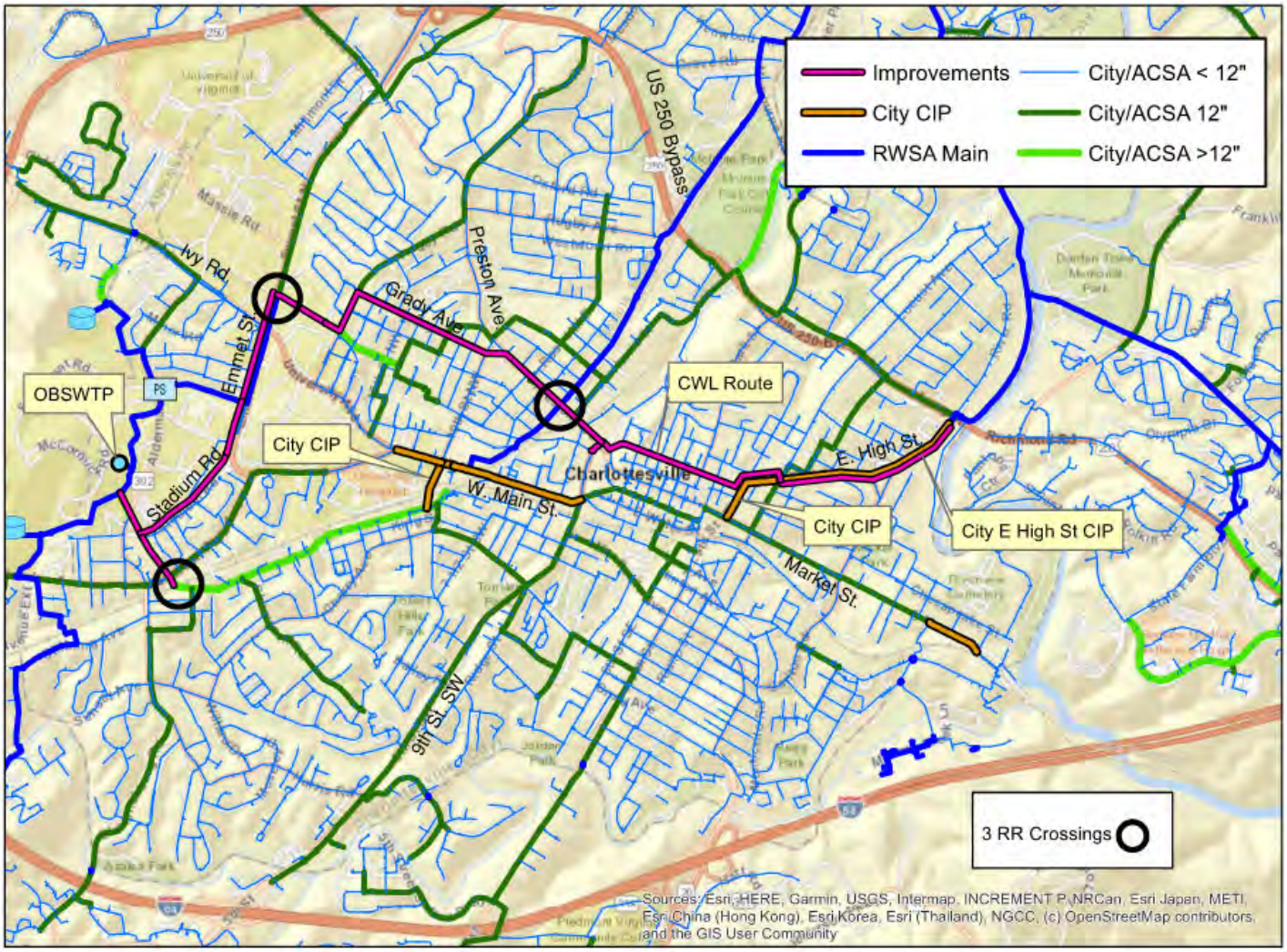
The Urban Finished Water Master Plan next evaluated several "parallel" alternative routes for the Central Water Line corridor to confirm hydraulic requirements could be met. Regardless of route, a key feature of any Central Water Line alignment is to connect the 24-inch RWSA Observatory Water Line (on the west side of the City) with RWSA's 24-inch Urban Water Line terminating in West Main Street (in the center of the City) and RWSA's 18-inch Pantops Water Line at East High Street/Long Street (in the east side of the City). See Figure 2 for location of the existing RWSA transmission mains.

Figure 2 – Overview of Existing RWSA Water Transmission Mains in the City



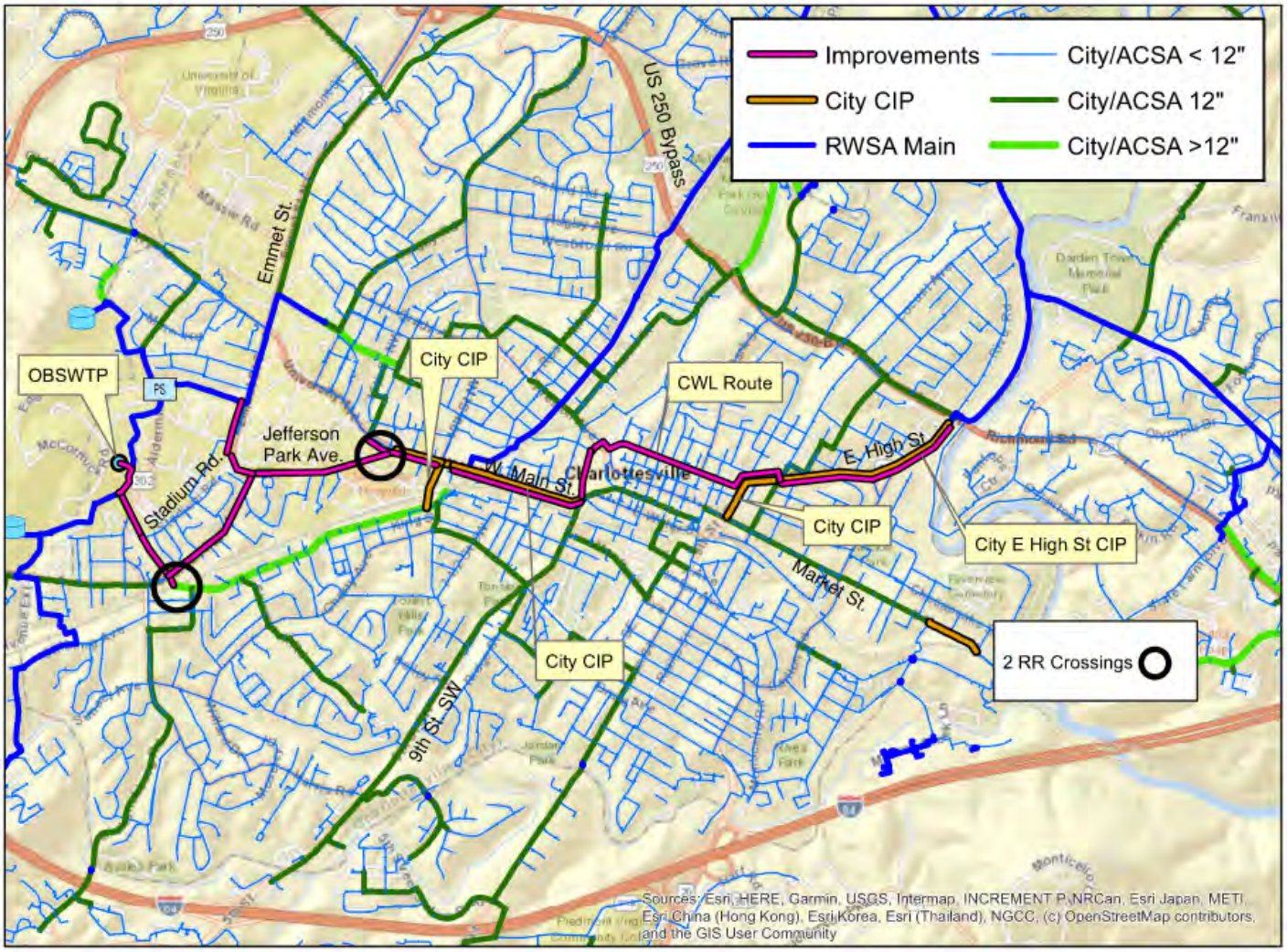
The Urban Finished Water Master Plan identified four primary corridors as hydraulically viable. The evaluation considered the possibility of overlap with some of the City's planned capital improvement projects (CIPs) – utility installations as well as streetscape/roadway projects such as West Main Street, Belmont Bridge, and E. High Street/Locust Avenue/9th Street – for potential conflict as well as for opportunity to co-locate utilities and combine construction efforts. Following is a summary of each corridor and its key features.

Figure 3 – Central Water Line – Northern Corridor



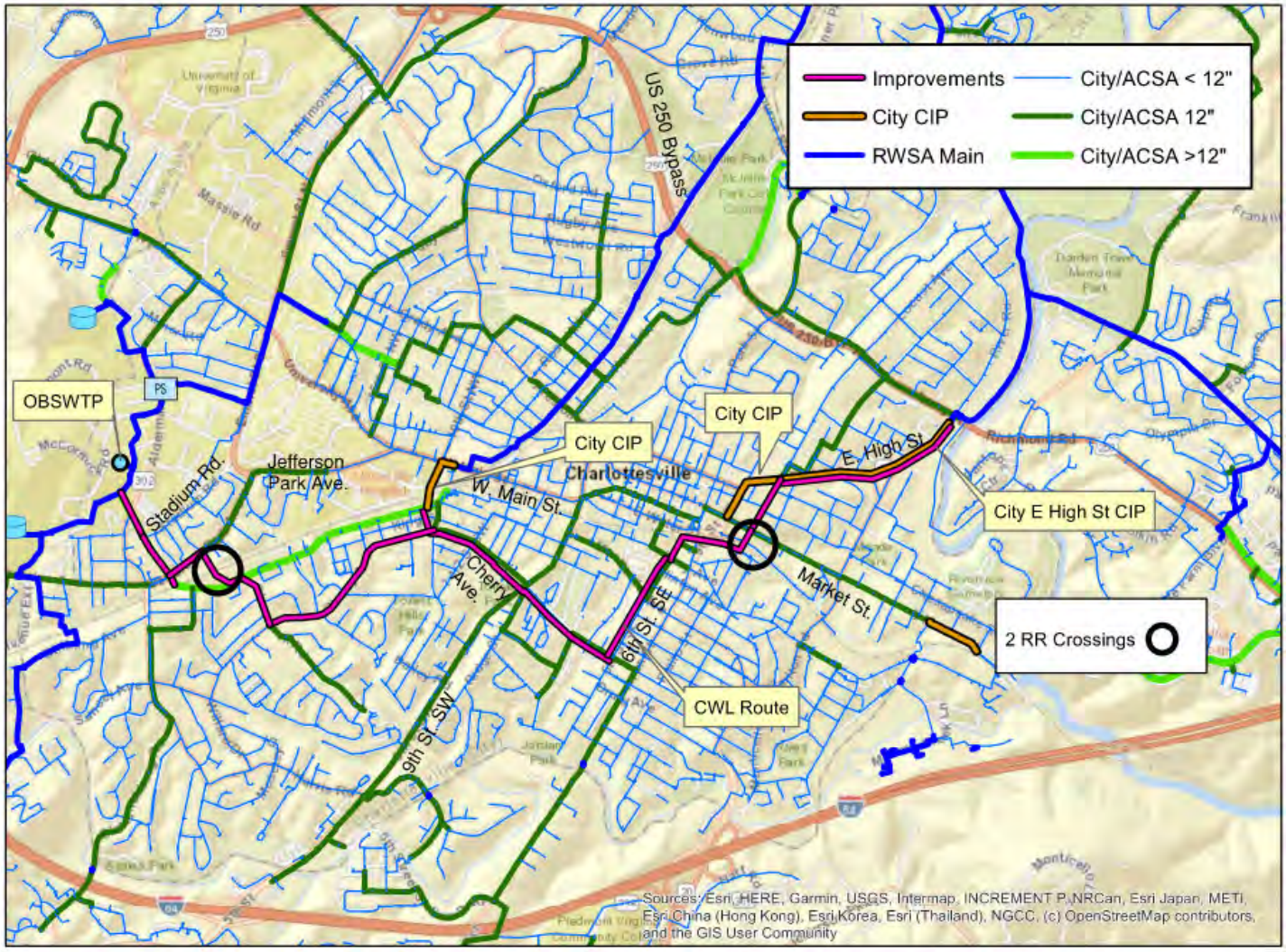
- Generally, follows Emmet Street north, then cuts through neighborhood streets in the northern part of the City and through downtown to E. High Street
- Overlaps with the E. High Street CIP project
- Narrow and congested neighborhood streets in the north, and congested and heavily trafficked downtown streets, present challenges to construction including traffic detours and impacts to parking, sidewalk, and biking lanes
- Downtown City water mains provide decent connectivity already in the center of the City, reducing the overall hydraulic impact of the Central Water Line with this route
- An additional railroad crossing is required for this option versus the other three options
- Length is approximately 23,000 feet

Figure 4 – Central Water Line - Middle Corridor



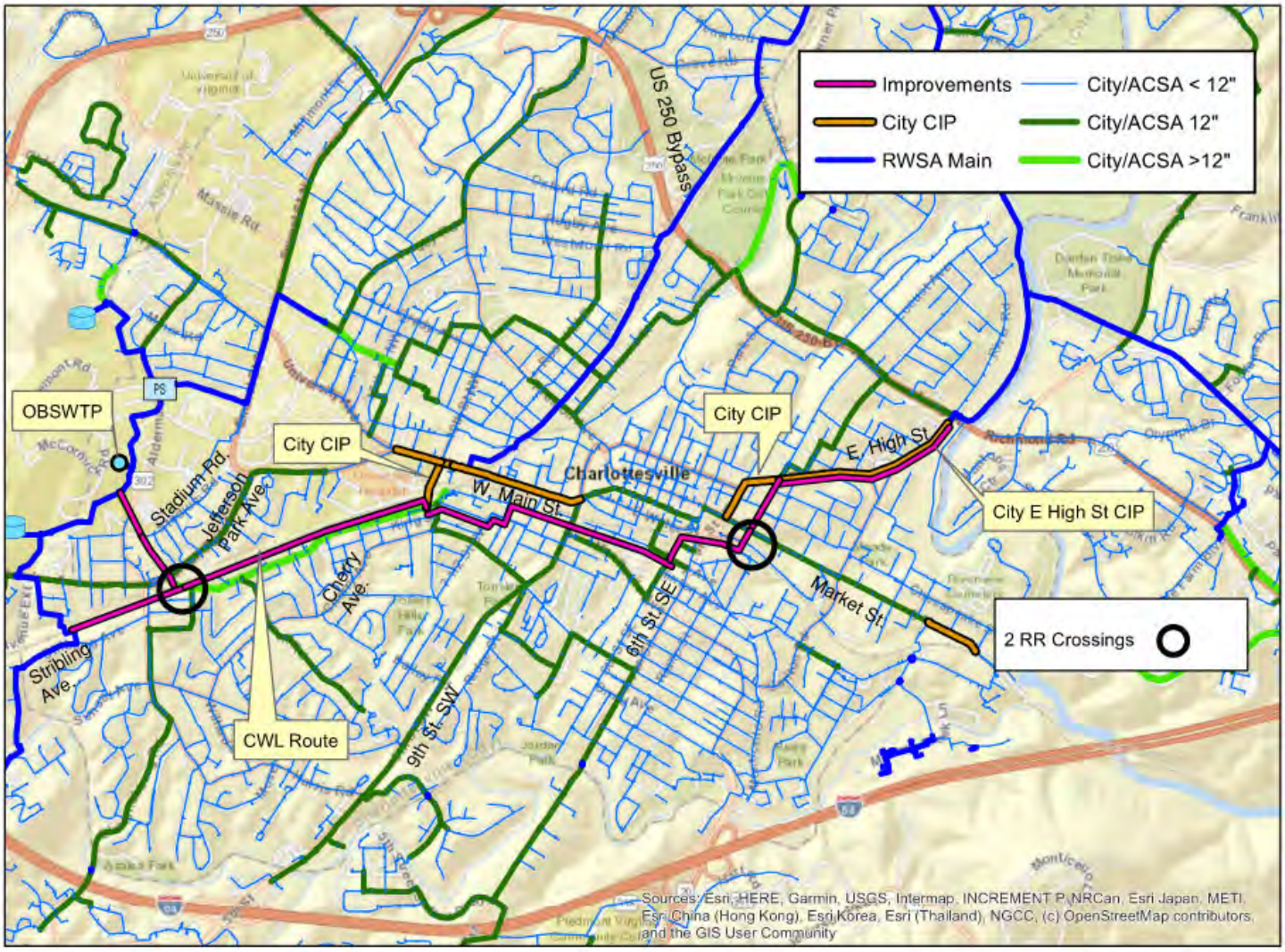
- Generally, traverses through or around University of Virginia (UVA) campus/streets, then east through neighborhood streets in the west side of the City, and through downtown to E. High Street
- Overlaps with City's West Main Street CIP, which has been indefinitely postponed
- Overlaps with E. High Street CIP
- Narrow and congested neighborhood streets in the north, and congested and heavily trafficked downtown streets, present challenges to construction including traffic detours and impacts to parking, sidewalks, and biking lanes
- Downtown City water mains provide decent connectivity already in the center of the City, reducing the overall hydraulic impact of the Central Water Line with this route
- Length is approximately 20,000 feet and is one of the shortest routes

Figure 5 – Central Water Line – Southern Corridor



- Generally, heads south from OBSWTP through UVA and western City streets, heads across the railroad, and follows Cherry Avenue corridor east to the Avon Street corridor; then follows neighborhood and commercial area streets in the eastern part of the City to E. High Street
- Overlaps with E. High Street CIP project
- Utilizes streets with wider rights-of-way (less congestion, less traffic impact) where possible
- Reduces construction impact on narrow neighborhood streets
- Provides greater hydraulic benefits by allowing for connections across the currently less well-connected southern part of the City system and better connectivity to the Avon Street Tank
- Length is approximately 25,000 feet, making this the longest route

Figure 6 – Central Water Line – Railroad Corridor



- Generally, heads south from OBSWTP through UVA and City streets, then south across the Norfolk-Southern railroad before running east and parallel to the railroad; then through the southern part of downtown to E. High Street
- Overlaps with E. High Street CIP project
- The segment parallel to the railroad likely requires significant impact to residential properties along the southern side of the railroad, due to limited available space amongst challenging existing grades and existing utilities. Extensive private agreements and clearing of the treed buffer between residential homes and the railroad is likely.
- Length is approximately 22,000 feet and is one of the shortest routes

Upon completion of the Urban Finished Water Master Plan hydraulic analysis and planning-level evaluations, RWSA coordinated with the City and ACSA, as stakeholders, to further evaluate the possible routes. The Railroad Corridor was removed from consideration due to the significant constructability challenges and likely residential property impacts compared to other available routes. The Middle Corridor was also removed from detailed consideration; compared to the other available routes, it provided less hydraulic benefit – while also having more constructability challenges through the narrow and heavily trafficked downtown City streets. The indefinite postponement of the City's West Main Street CIP removed a possible ability to coordinate the water line installation with already-planned disturbance in the downtown area.

Focusing on available streets, location of the existing RWSA water transmission mains (as shown in Figure 2) for points of connection, and considering hydraulic benefits, traffic impacts, and overall cost to construct, preliminary discussions between RWSA, the City, and ACSA focused on a North/South Hybrid Corridor and the Southern Corridor, as shown in Figures 7 and 8. The North/South Hybrid Corridor is approximately six miles long – over one mile longer than the approximately five-mile long Southern Corridor - thereby resulting in a much higher cost to construct. The North/South Hybrid Corridor also presents challenges traversing narrow neighborhood streets in the northwestern area of the City, between Emmet Street and downtown.

Figure 7 – Central Water Line – North/South Hybrid Corridor

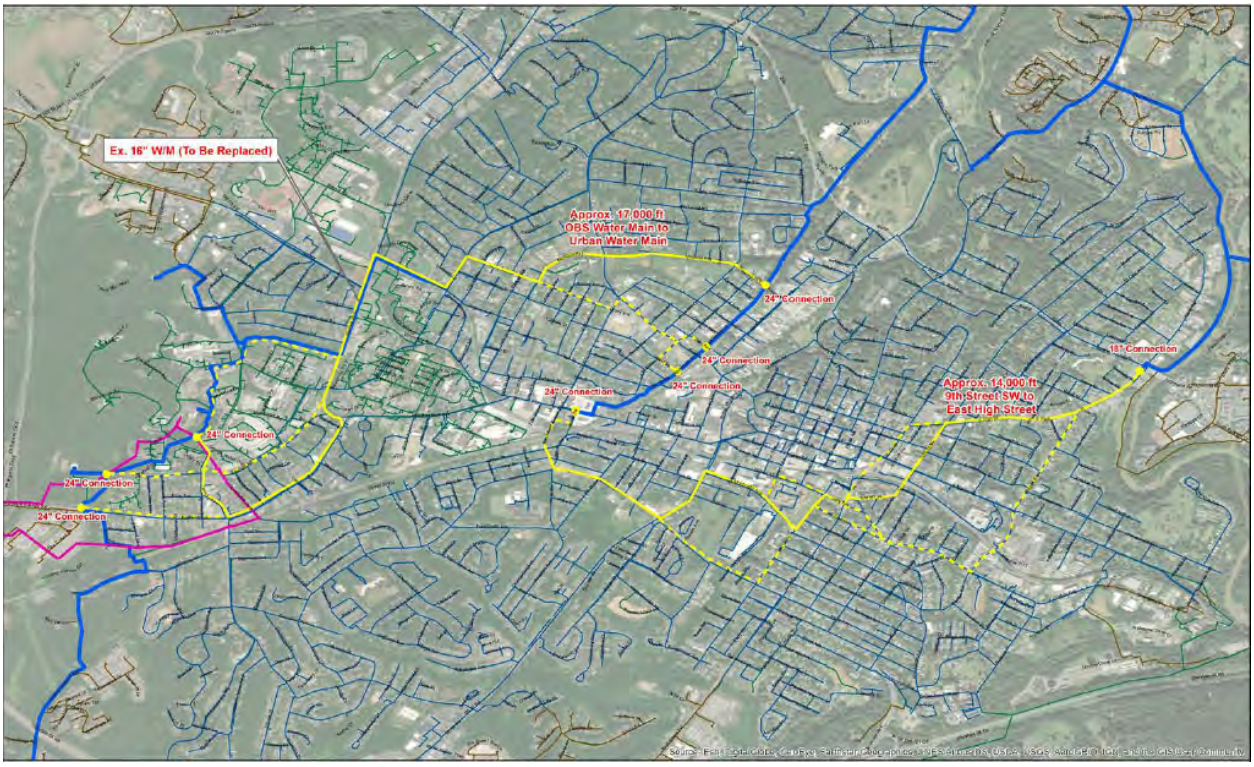
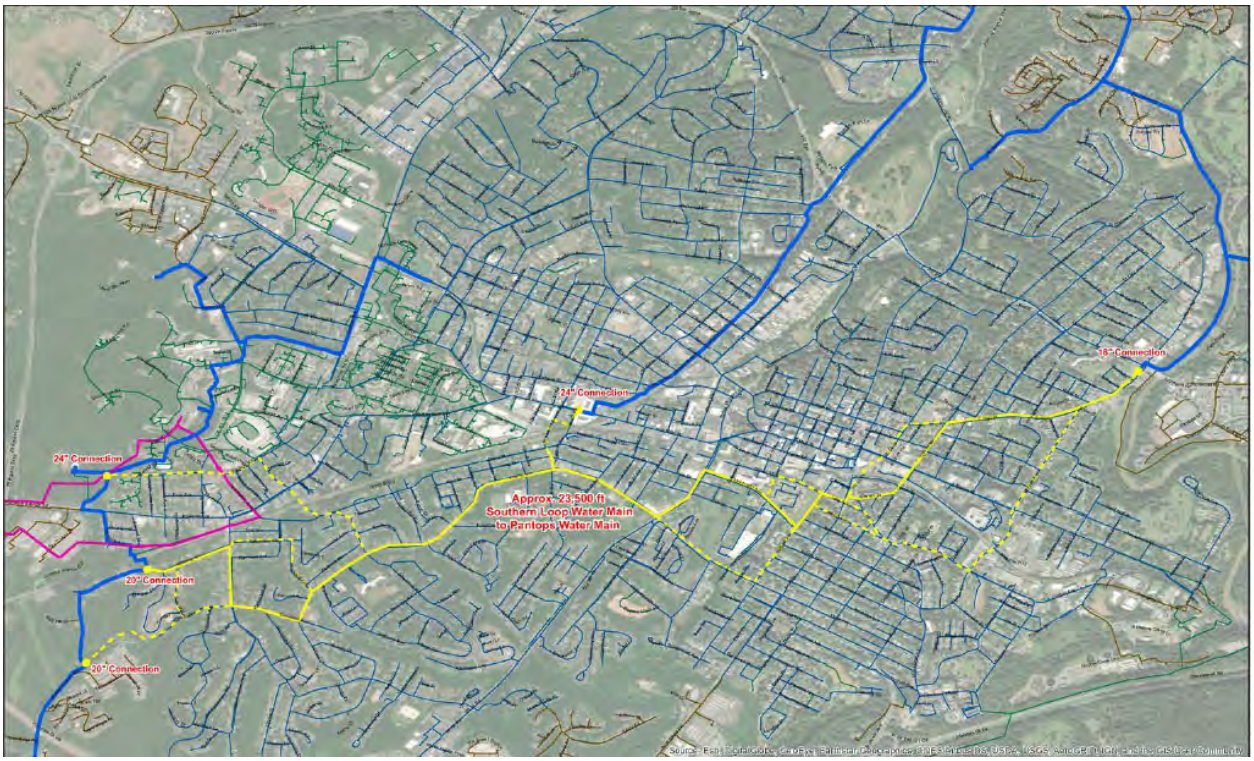


Figure 8 – Central Water Line – Southern Corridor



As the stakeholders reviewed these corridors, a fifth route generally following Emmet Street to Hydraulic Road, and the Route 250 bypass from Hydraulic Road to E. High Street, was also considered, but ultimately eliminated. Due to the narrow Route 250 Bypass corridor and multiple constraining obstructions (retaining walls, bridges, adjacent residential homes, existing utilities, etc.) this route would create significant traffic impacts on the Route 250 Bypass, requiring shutdown of two lanes (in one direction) and/or entrance/exit ramps for extensive periods of time during water main installation. The traffic impacts and necessary detours during construction could also impact emergency services for the Rescue Squad at McIntire Road and the Charlottesville Fire Station along the Route 250 Bypass. The 250 Bypass Route is also longer and more expensive than the other considered routes.

Upon completion of preliminary discussions with the City and ACSA regarding acceptable corridors for the water main route, the consensus amongst all parties was to prioritize investigation of a route traversing the southern portion of the City – generally along Cherry Avenue – in lieu of a route through/near the center of downtown Charlottesville or through the tight neighborhood streets along the north side of the City. This routing study task

evaluates alternative alignments for the installation of approximately 5 miles of 30-inch and 24-inch water main connecting the 24-inch RWSA Observatory Water Line with RWSA's 24-inch Urban Water Line in Roosevelt Brown Boulevard/West Main Street and RWSA's 18-inch Pantops Water Line at East High Street/Long Street, as shown in Figure 8. The City has already commenced design of a new 12-inch City water main to replace an existing 6-inch cast iron water main in East High Street between Long Street and 10th Street NE; the routing study accounts for coordination of the Central Water Line with the City's proposed 12-inch water main.

2. EVALUATION CRITERIA

The proposed transmission main routes were spilt into three primary segments for ease of evaluation:

(1) *West Segment*: 30-inch water main starting with a connection to the 24-inch Observatory Water Line between OBSWTP and Fontaine Avenue, where the line reduces to 20-inch diameter; and heading east to the intersection of Cherry Avenue and Shamrock Road.

(2) *Middle Segment*: 30-inch water main along Cherry Avenue corridor beginning at the intersection of Shamrock Road and Cherry Avenue. The route includes a 24-inch northern spur connecting to the existing 18-inch City water main in Roosevelt Brown Boulevard or the 24-inch RWSA Urban Water Line in West Main Street. The 30-inch water main reduces to 24-inches east of the branch for the northern spur and continues east to the intersection of Cherry Avenue, Ridge Street, and Elliott Avenue.

(3) *East Segment*: 24-inch water main from the intersection of Cherry Avenue, Ridge Street, and Elliot Avenue through the connection to the 18-inch RWSA Pantops Water Line at the intersection of East High Street and Long Street.

The routing study evaluated different alignment alternatives within each of the three segments, evaluating each alternative individually with appropriate scoring methodology. The scoring methodology utilized included well defined, measurable criteria to differentiate and identify the strengths and weaknesses of each alternative; the scoring methodology focused on highlighting differences between alternatives. These criteria are not listed in any particular order of priority but are built on the project's goals and represent the range of challenges that must be addressed in the study area corridor. The eight evaluation criteria for this project are listed and described below.

Public Impact: Alignments that minimize construction impacts to residents and commuters are more desirable than those alignment that could cause road closure, loss of parking/bike lanes. For this study it has been assumed that all construction on the streets will be open cut.

Utility Congestion: The study identified the location and presence of major utilities including water main, sanitary sewer, storm water, gas line and electrical transmission lines. In some locations where clearance is tight, relocation of existing utilities might be needed.

Private Property Impact: The study selected alignment alternatives to minimize passing through residential acreages, commercial development, and other private properties. The study tracked number of properties impacted by each alternative, and therefore number of potential easements required.

Permitting Requirements: The study identified permitting requirements for each alternative including railroad, roadway, and environmental permitting.

Future Maintenance Access: Accessibility to critical locations where significant maintenance of traffic or clearing required is a key factor.

Trenchless Crossings: Crossing a railroad at least twice in the project corridor is inevitable. As such, the routing study identified several potential locations to cross the railroads. Trenchless construction methods will be used for railroad crossings.

Any Miscellaneous Challenges: There are some other miscellaneous challenges including coal cinders in the Water Street area of the East Segment, and potential University of Virginia coordination in the West Segment.

Construction Costs: The study estimated order of magnitude costs for design, permitting, easements, and construction. More direct (shorter) alignments, and those with fewer constructability challenges had lower costs.

A three-tier qualitative rating system was established for each criterion. The ratings are

- 0 = least preferable, great impact
- 1 = medium amount of impact
- 2 = most preferable, least impact

Each of the criteria was rated individually independent of the other criteria. In addition, each individual segment (West, Middle, East) has a different qualitative rating system to account for criteria and conditions specific to that segment. For example, the Private Property Impact in the East Segment will be rated 0 if there are more than 4 parcels impacted; whereas Private Property Impact in the West Segment will be rated 0 if there are more than 5 parcels impacted. The eight evaluation criteria for this project are listed and described below in Table 1. Table 1 below includes detailed descriptions of the eight evaluation criteria and the rating method for each segment.

Table 1 – Evaluation Criteria and Rating System for Each Segment

Criteria	Description	West Segment	East Segment
Public Impact	Total length of any significant disturbance (road closure, loss of parking/bike lanes)	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Utility Congestion	Total length where clearance is tight and relocation of existing utilities probable	0 – Extensive impact (greater than 1,000 LF) 1 – Medium impact (between 100 LF and 1,000 LF) 2 – Smallest impact (less than 100 LF)	0 – Extensive impact (greater than 1,000 LF) 1 – Medium impact (between 100 LF and 1,000 LF) 2 – Smallest impact (less than 100 LF)
Private Property Impact	Total number of parcels requiring easement	0 – Extensive impact (more than 5 parcels) 1 – Medium impact (1 to 5 parcels) 2 – No impact (0 parcels)	0 – Extensive impact (more than 5 parcels) 1 – Medium impact (1 to 5 parcels) 2 – No impact (0 parcels)
Permitting Requirements	Extent of permitting required (railroad, roadway, environmental)	0 – Extensive impact (More than 2 permits required) 1 – Medium impact (City street and Railroad permits only) 2 – Smallest impact (no permits required)	0 – Extensive impact (More than 2 permits required) 1 – Medium impact (City street and Railroad permits only) 2 – Smallest impact (no permits required)
Future Maintenance Access	Total length where significant MOT or clearing required; access for Miss utility	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Trenchless Crossings	Number required and level of difficulty (depth, access, length)	0 – At least two of: challenging grade; pit depth greater than/equal to 20-feet; utility relocations required 1 – At least two of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required 2 – At most one of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required	0 – At least two of: challenging grade; pit depth greater than/equal to 20-feet; utility relocations required 1 – At least two of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required 2 – At most one of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required
Any Miscellaneous Challenges	E.g. Coal cinders in water street area, UVA impact/coordination	0 – More than two additional route-specific challenges 1 – One or Two additional route-specific challenges 2 – No additional route-specific challenges	0 – More than two additional route-specific challenges 1 – One or Two additional route-specific challenges 2 – No additional route-specific challenges
Construction Costs	Pipe installation and restoration; assumes restrained joints, select backfill, 30% contingency	0 – Cost greater than $10M 1 – Cost between $7.5M and $10M 2 – Cost less than $7.5M	0 – Cost greater than $10M 1 – Cost between $7.5M and $10M 2 – Cost less than $7.5M

3. ALIGNMENT ALTERNATIVES EVALUATION

This section evaluates alternative alignments for the proposed 30-inch and 24-inch transmission main connecting the OBSWTP with the RWSA water transmission mains in the center and east part of the City of Charlottesville. Following initial desktop review and follow-up field investigation, Baker has identified and analyzed each of the alignment alternatives as shown in Figure 9. Proposed transmission main routes have been identified into three segments for alignment evaluation:

(1) West segment: 30-inch water main starting with a connection to the 24-inch Observatory Water Line between OBSWTP and Fontaine Avenue, where the line reduces to 20-inch diameter; and heading east to the intersection of Cherry Avenue and Shamrock Road.

(2) Middle segment: 30-inch water main along Cherry Avenue corridor beginning at the intersection of Shamrock Road and Cherry Avenue. The route includes a 24-inch northern spur connecting to the existing 18-inch City water main in Roosevelt Brown Boulevard or the 24-inch RWSA Urban Water Line in West Main Street. The 30-inch water main reduces to 24-inches east of the branch for the northern spur and continues east to the intersection of Cherry Avenue, Ridge Street, and Elliott Avenue.

(3) East segment: 24-inch water main from the intersection of Cherry Avenue, Ridge Street, and Elliot Avenue through the connection to the 18-inch RWSA Pantops Water Line at the intersection of East High Street and Long Street.

Section 3 includes the evaluation results for each segment.

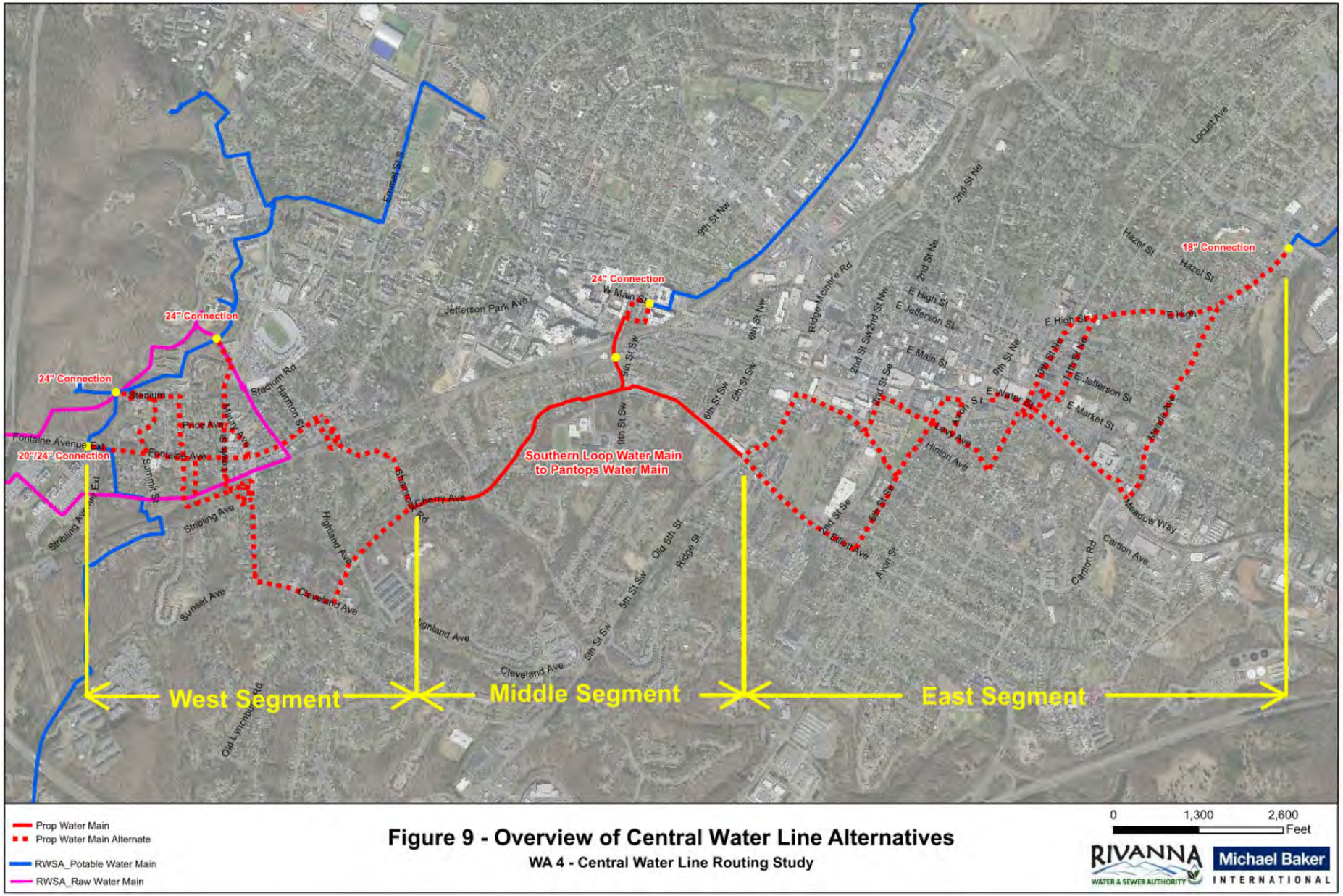


Figure 9 – Overview of Central Water Line Alternatives

3.1. West Segment

Two critical decision points drive selection of the West Segment:

1) Tie-in location along the 24-inch Observatory Water Line
2) Railroad crossing location between Fontaine Avenue/Jefferson Park Avenue and Cherry Avenue

As such, the West Segment routing options have been broken into two sub-segments: North of Fontaine Avenue and South of Fontaine Avenue. The "North of Fontaine Avenue" sub-segment has six alignment alternatives (1-6) evaluated in Section 3.1.1, and the "South of Fontaine Avenue" sub-segment has three alignment alternatives (a-c) evaluated in Section 3.1.2. There are a total of 14 route combinations that the 30-inch pipeline can take for the West Segment portion. An overview of West Segment alternatives is illustrated on Figure 10. All West Segment alternatives connect into the 24-inch Observatory Water Line at the western start, and end at the intersection of Shamrock Road and Cherry Avenue. There are three primary options for the tie-in location to the 24-inch Observatory Water Line: Fontaine Avenue, Stadium Road /Royal Pump Station, and between Alderman Road and OBSWTP. Several alignment alternatives will require easement acquisition on some residential properties and on University of Virginia property. The routing study identified several possible locations to cross the railroad; detailed evaluation of the railroad crossing options is presented in Section 3.1.3.

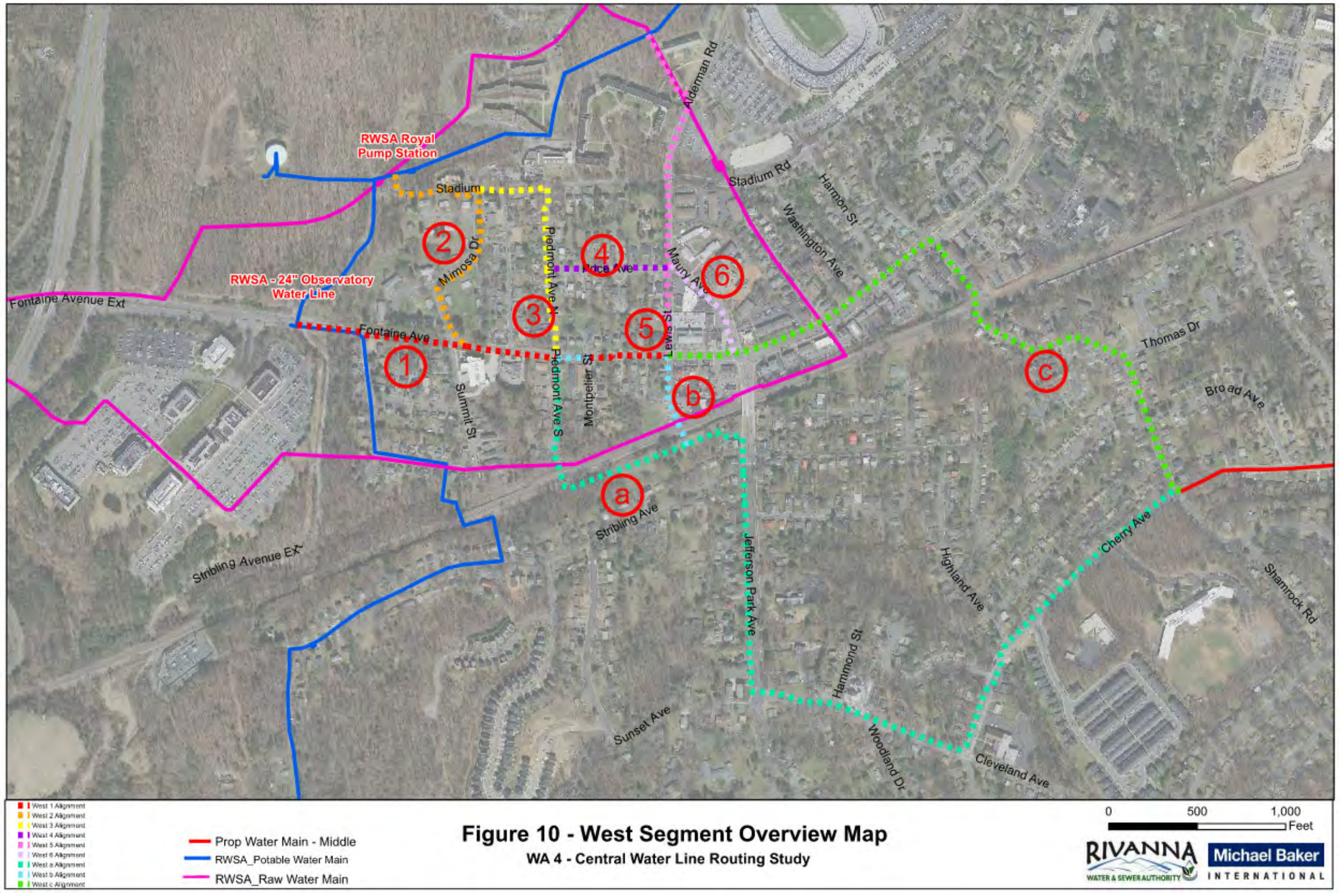


Figure 10 – West Segment Overview Map

3.1.1. North of Fontaine Avenue Sub-Segment (Alignment Alternatives 1-6)

The North of Fontaine Avenue sub-segment has six Alignment Alternatives 1 through 6, all located north of Fontaine Avenue.

- Alignment Alternative 1 consists of 30-inch water main connecting to the 24-inch Observatory Water Line at the intersection of Fontaine Avenue and Stribling Ave. Extended. This option heads east along Fontaine Avenue to Piedmont Avenue, a common terminus with Alignment Alternative 3. Fontaine Avenue is a two-lane local road. There are existing utilities present along Fontaine Avenue, e.g. water main, gas line, sanitary sewer, which may result in tight clearance for the proposed 30-inch water main. Detailed survey and design would determine whether relocation of a portion of the existing gas line or water main is required.

- Alignment Alternatives 2, 3, and 4 begin with a connection to the 24-inch Observatory Water Line near RWSA's Royal Raw Water Pump Station (Royal PS). The connection at Royal PS is on University of Virginia property. Easement acquisition is required for UVA property (Parcel Identifier (P.I.) #1 and #2 in Figure 11). Easement acquisition information for this property is listed on Table 2. The proposed 30-inch water main heads east from the connection point along an existing pedestrian path toward Stadium Road. Alternative 2 turns south to run along Mimosa Drive to Fontaine Avenue, then heads east to Piedmont Avenue. There is sufficient space on Mimosa Drive for the installation of the proposed pipe, but the existing utilities on Fontaine Avenue would cause tight clearance.

- Alignment Alternative 3 heads east into Stadium Road, then turns south along Piedmont Avenue to the intersection with Fontaine Avenue. Existing gas line, water main, storm water and sanitary sewer are present on Piedmont Avenue parallel with proposed water main. The utilities become more congested at the intersection of Piedmont Avenue and Fontaine Avenue.

- Alignment Alternative 4 follows Alignment 3, but before reaching the intersection of Piedmont Avenue and Fontaine Avenue the alignment turns east to run along Price Avenue then south along Lewis Street to the intersection of Lewis Street and Fontaine Avenue. This route avoids the utility congestion at the intersection of Piedmont Avenue and Fontaine Avenue.

- Alignment Alternatives 5 and 6 both connect to the 24-inch Observatory Water Line south of OBSWTP on University of Virginia property west of Alderman Road. Both Alignment Alternatives 5 and 6 will require an easement request on the properties present on Table 2 and Figure 11. They run south along Maury Avenue. Alignment Alternative 6 stays on Maury Avenue while Alternative 5 enters Lewis Street; both arrive at Fontaine Avenue.

3.1.2. South of Fontaine Avenue Sub-Segment (Alignment Alternatives "a-c")

The South of Fontaine Avenue Sub-Segment includes three Alignment Alternatives "a", "b", and "c". This sub-segment also includes several options for locations to cross the Norfolk-Southern railroad, each requiring a trenchless crossing and a Norfolk-Southern permit.

- Alignment Alternative "a" begins from the intersection of Fontaine Avenue and Piedmont Avenue and continues south on Piedmont Avenue towards the railroad. The existing water line, gas line and a recently installed sanitary sewer do create utility congestion on Piedmont Avenue. The railroad crossing at Piedmont Avenue is further described in Section 3.1.3. Crossing the railroad at Piedmont Avenue, the alignment lands in the of private residential property between the railroad and Stribling Avenue, and turns east to traverse eleven (11) private residential properties (See Table 2 and Figure 12) before reaching Jefferson Park Avenue. Alignment Alternative "a" therefore requires a significant amount of easements, and therefore coordination and outreach to private property owners due to the disturbance to their properties. When the water main reaches the City right of way, it heads south along Jefferson Park Avenue, then east along Cleveland Avenue and Cherry Avenue. This portion of the alignment ends at the intersection of Shamrock Road and Cherry Avenue, beginning of the Middle Segment. Based on the available width of these streets and the apparent location of existing utilities, there is ample space for the installation of the proposed water main. Routing options that include Alignment Alternative "a" are generally less preferable due to the need for easements on approximately 11 private residential parcels.

- Alignment Alternative "b" is parallel to Alternative "a", but crosses the railroad further east, at Lewis Street. Alternative "b" continues the proposed 30-inch water pipe at the intersection of Fontaine Avenue and Lewis Street, heading south towards the railroad. As shown in Section 3.1.3, a trenchless crossing of the railroad at Lewis Street requires a tunnel receiving pit at the corner of the private commercial property at the south end on Lewis Street. The launching pit and alignment on the south side of the railroad will impact two or three private properties (See Table 2 and Figure 12) before transitioning into public right-of-way along Jefferson Park Avenue. Upon entering Jefferson Park Avenue and heading south, Alignment Alternative "b" follows the same route as Alignment Alternative "a" to the intersection of Cherry Avenue and Shamrock Road.

- Alignment Alternative "c" follows an eastern route, starting at the intersection of Maury Avenue and Jefferson Park Avenue (Fontaine Avenue). This option runs east on Jefferson Park Avenue east and then turns south along Shamrock Road. Alignment Alternative "c" includes a trenchless crossing of the railroad at Shamrock Road. As shown in Section 3.1.3, the narrow road and topography at the railroad crossing necessitates impact on two or three residential and commercial properties. For the open-cut portion of the alignment north and south of the railroad, Shamrock Road is a two-lane local street which is tight compared to westerly route

Jefferson Park Avenue and Cleveland Avenue followed by Alignment Alternatives "a" and "b". Existing gas line, water line, and sanitary sewer are present on Shamrock Road south of the railroad, with several portions of the road already heavily congested for utility installation. Some relocation of existing water main, gas main, and/or sanitary main are almost certain along this route.

Table 2 – West Segment Potential Easement Requirements

P.I. #	PIN	Owner	Address
1	07600-00-00-00500	Rectors & Visitors of the UVA C/o Management	2504 Stadium Rd
2	076A0-00-00-000H0	Rectors & Visitors of the UVA C/o Management	2015 Stadium Rd
3	07600-00-00-00800	Rectors & Visitors of the UVA C/o Management	575 Alderman Ro
4	180008 000	Lea, Luther D Jr	139 Stribling Ave
5	180007 000	Mills, Stacey E & Lindae	135 Stribling Ave
6	180006 000	Neis, Gertrude M, Trustee	133 Stribling Ave
7	180005 200	RM Partners, LC	125 Stribling Ave
8	180005 000	Maupin, Margaret T	123 Stribling Ave
9	180004 300	Arnold, David S & Mae E	121 Stribling Ave
10	180005 400	Int'l Church of Four Square Gospel	119 Stribling Ave
11	180004 000	White, Adrienne M	115 Stribling Ave
12	180003 100	Thompson, Ertle & June J	113 Stribling Ave
13	180003 000	Marion, Patsy & Susan H Teeter	111 Stribling Ave
14	180002 100	Donalson, Christonpher & Jenifer	105 Stribling Ave
15	180001 000	Romer, Thomas H ET. AL.	2205-07 Jefferson Park Ave
16	180002 000	Kudravetsz, David W ET AL Trustees	2209 Jefferson Park Ave
17	170071000	CBR LLC	107 Lewis St
18	170072000	CBR LLC	108 Lewis St
19	160100 000	Shamrock Corporation	1904 Jeffereson Park Ave
20	160101 000	Catherine L Smith & Thea N Bertola	1900 Jefferson Park Ave
21	160102 000	Shamrock Corporation	103 Shamrock Rd
22	220072 000	Addington, Hobart M Jr &Amanda	201 Shamrock Rd

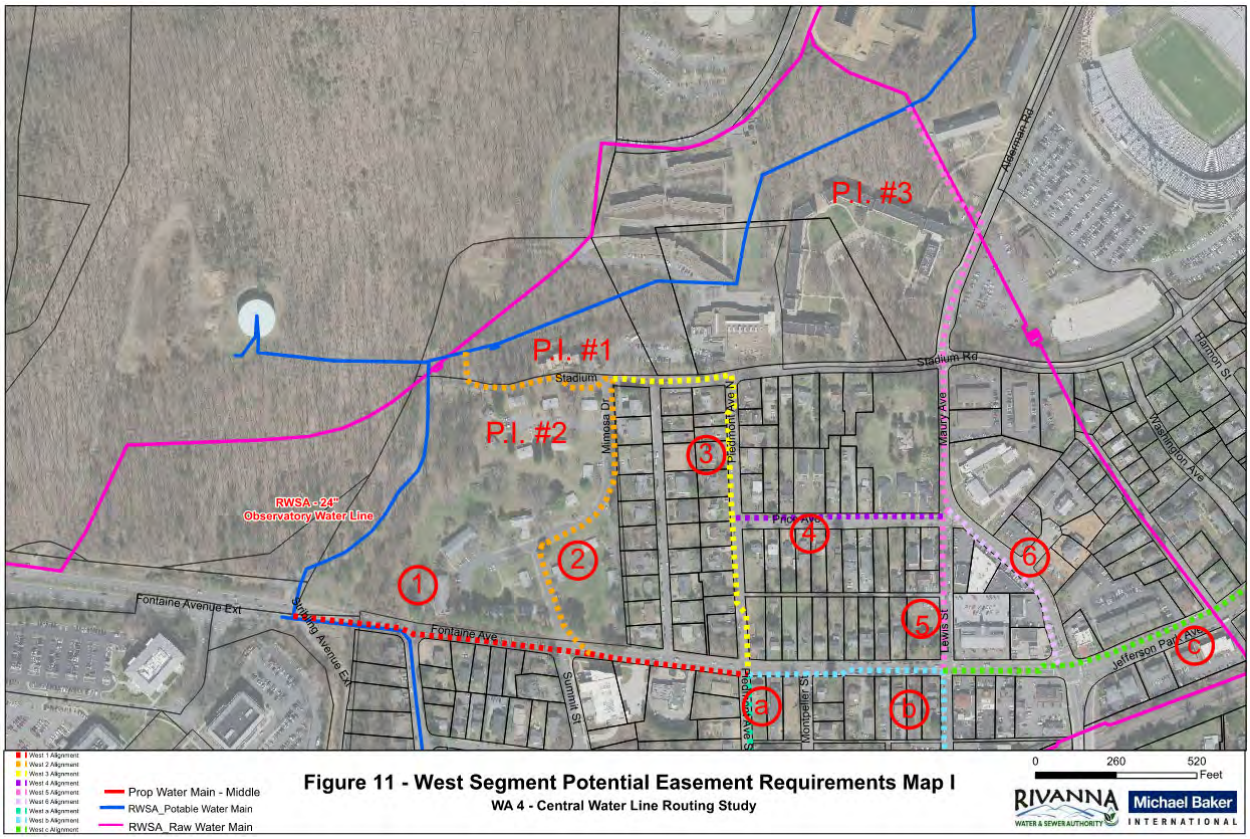


Figure 11 - West Segment Potential Easement Requirements Map I

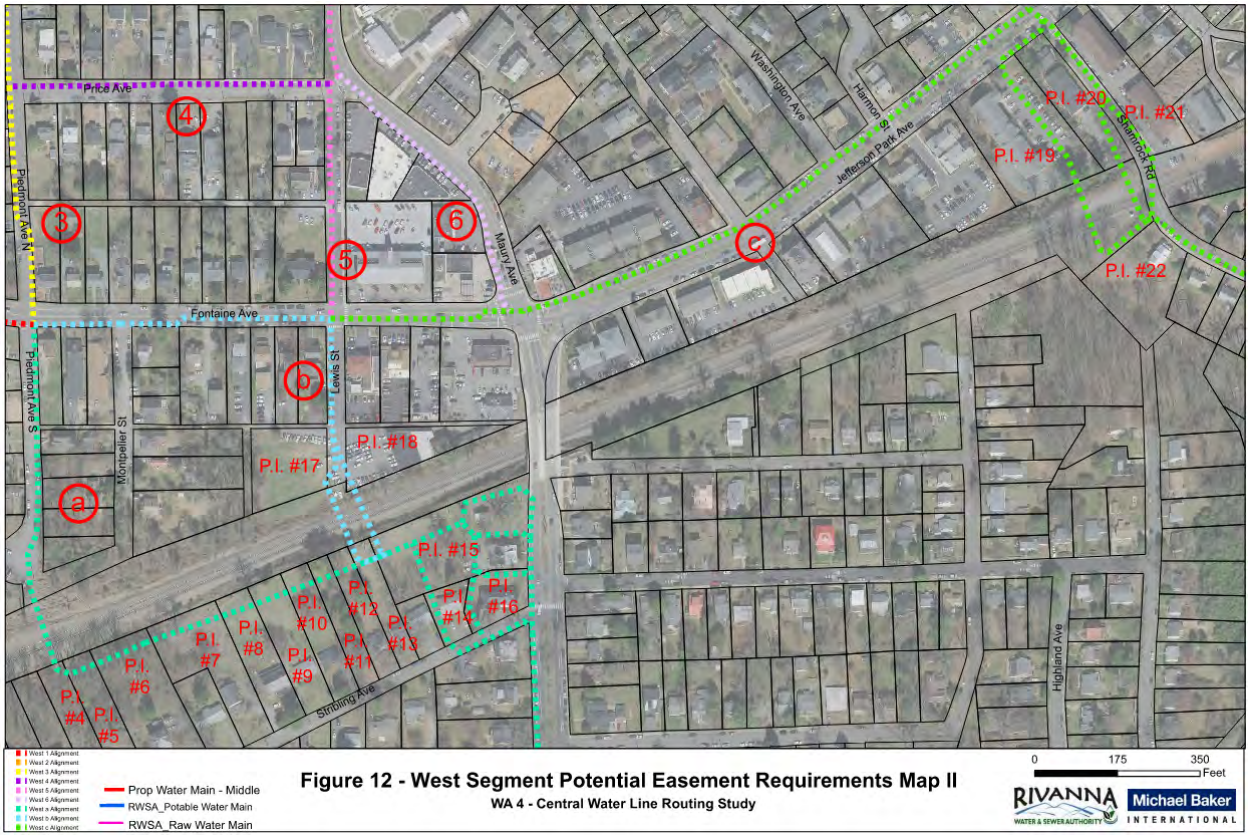


Figure 12 - West Segment Potential Easement Requirements Map II

3.1.3. West Segment Railroad Crossing

After eliminating Alignment Alternative "a" as less preferable, the routing study evaluated railroad crossings at Lewis Street (Alignment Alternative "b") and Shamrock Road (Alignment Alternative "c") in more detail.

A potential railroad crossing at Lewis Street has two options – receiving on the commercial property east or on the commercial property west of Lewis Street, both of which share the same owner. An overhead electrical pole line in the middle of the Lewis Street public-right-of-way drives the need to place a receiving pit on private property. Of the two options, entering the western parcel ("Lewis Street Alignment 1" on Figure 13) results in a longer trenchless crossing, as depicted in the plan and profile shown on Figures 13 and 14. Either option can work; survey and underground utility designation will support detailed design for selection of the preferred crossing configuration at Lewis Street.

The routing study identified three options to cross the railroad at Shamrock Road. The western-most option ("Shamrock Road Alignment 1" on Figure 15) launches from a commercial parking lot, crosses the railroad at approximately 30 feet of depth, and lands in a residential property parallel to the railroad. The middle option ("Shamrock Road Alignment 2" on Figure 15) launches from a different commercial parking lot and lands in the same residential property, though with a smaller easement footprint; it crosses under the railroad at a depth of approximately 20 feet. The eastern-most option ("Shamrock Road Alignment 3" on Figure 15) is the shallowest at the depth of 10 feet, but the receiving pit requires installation in the middle of Shamrock Road and a private (apartment complex) parking lot entrance to avoid a private residential driveway, thereby requiring a temporary road closure and complicating access to the private lot (apartment complex). Figures 15 and 16 show the plan and profiles of railroad crossing at Lewis St. Each crossing option appears feasible to construct, though survey and underground utility designation are recommended to support detailed design before confirming a preferred route.

Figure 13 – Lewis Street Railroad Crossing Plan

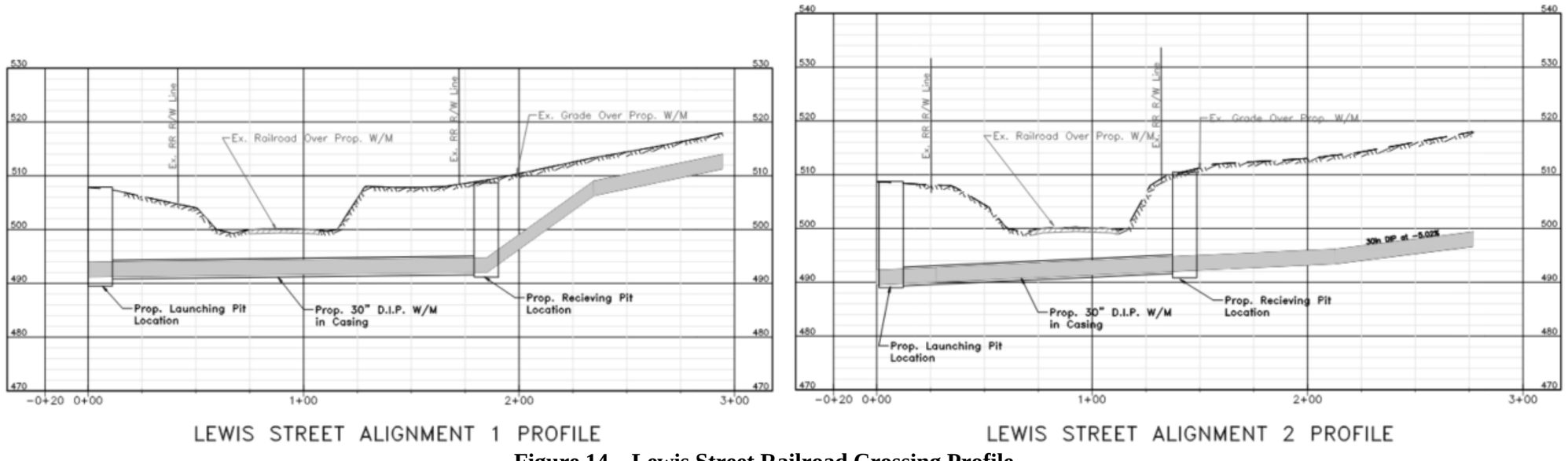


Figure 14 – Lewis Street Railroad Crossing Profile

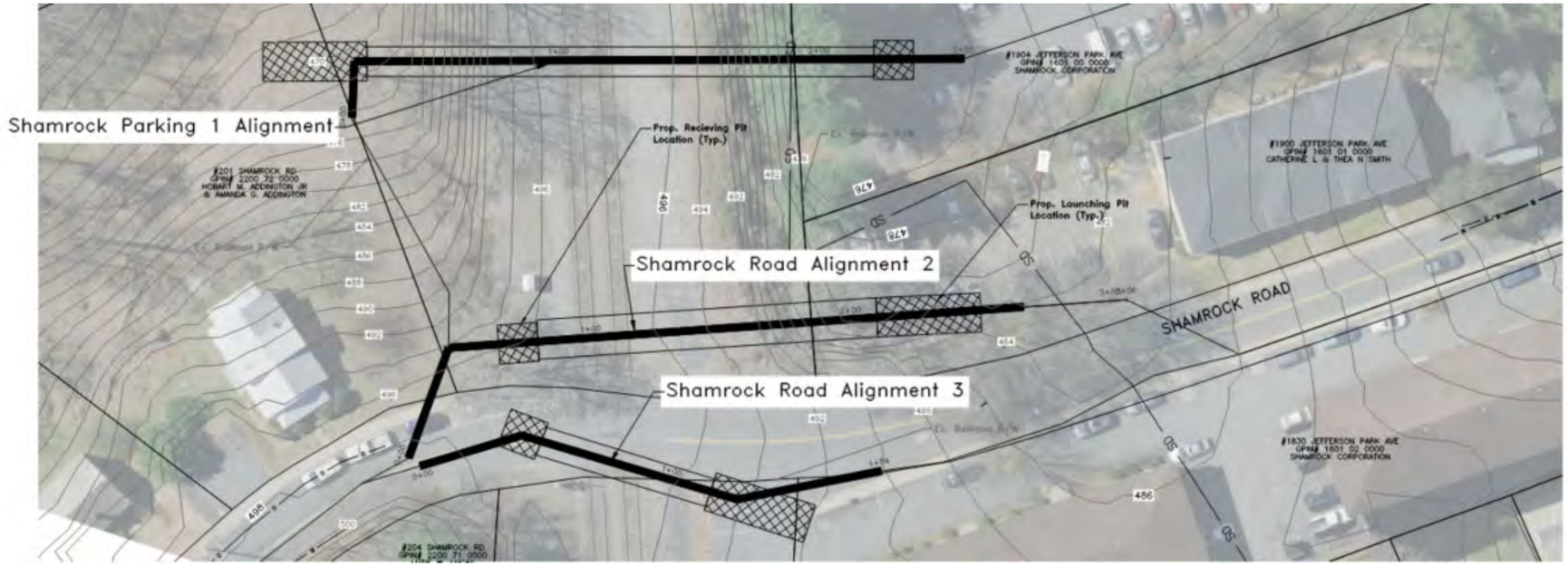


Figure 15 – Shamrock Road Railroad Crossing Plan

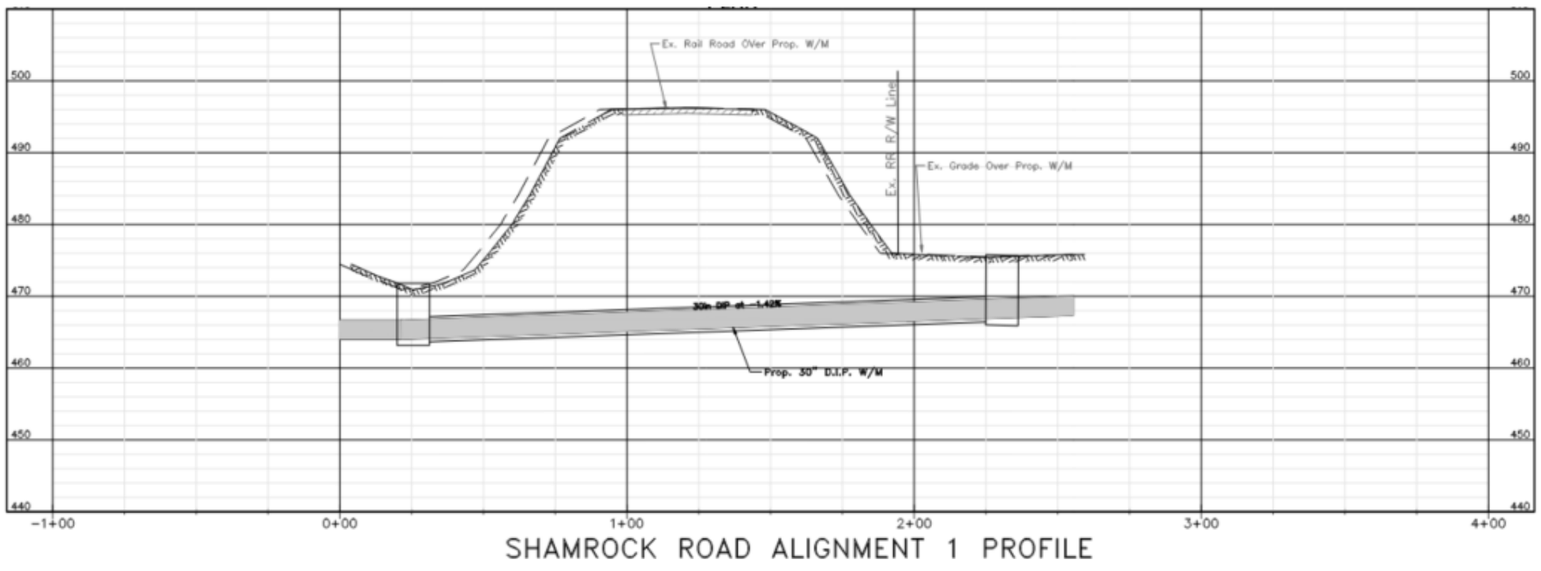
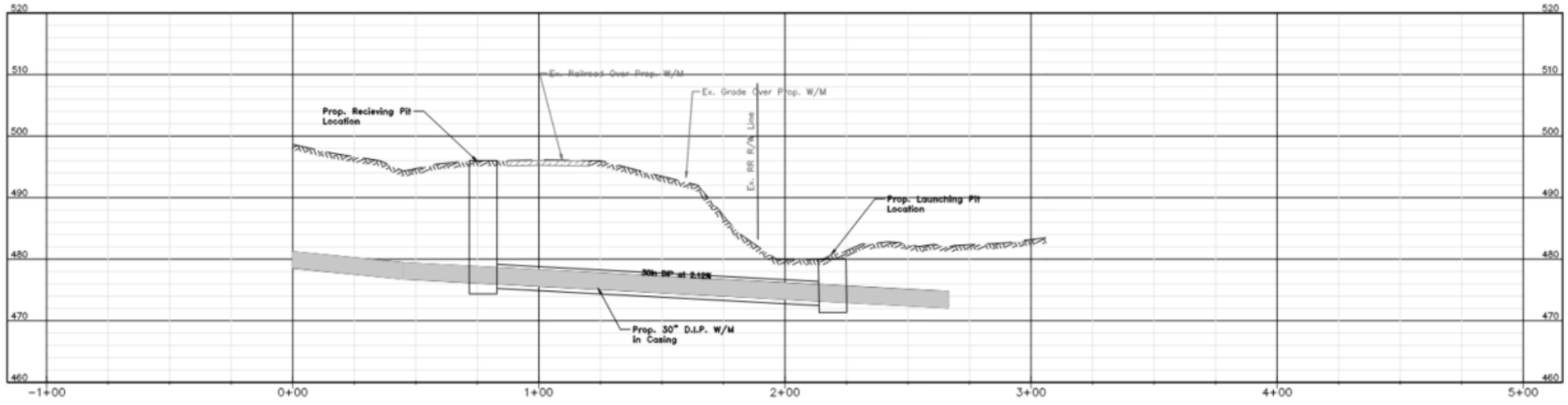
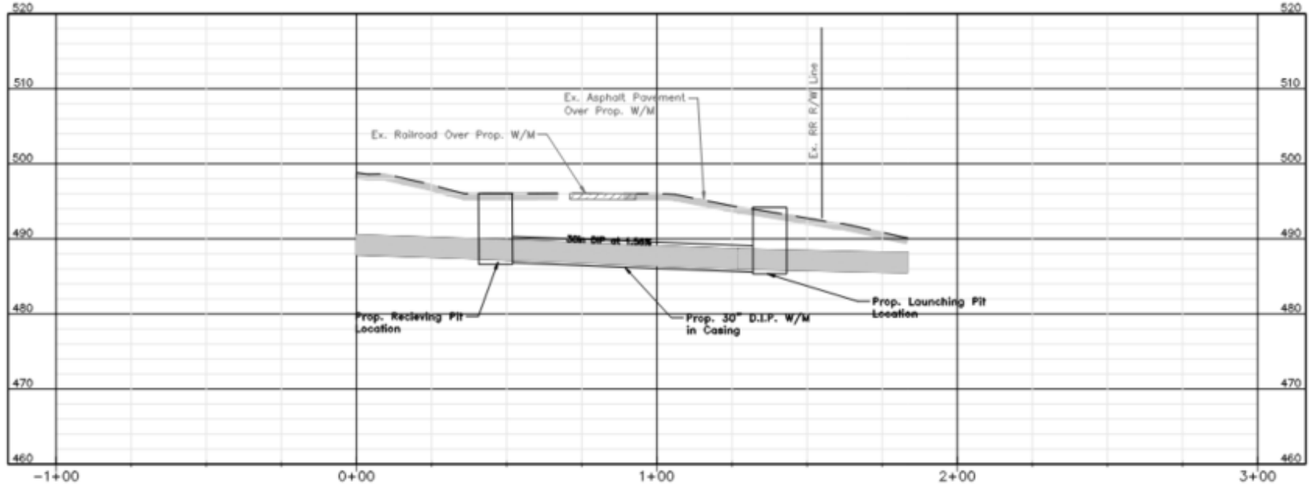


Figure 16 – Shamrock Road Railroad Crossing Profile



SHAMROCK ROAD ALIGNMENT 2 PROFILE



SHAMROCK ROAD ALIGNMENT 3 PROFILE

Figure 16 – Shamrock Road Railroad Crossing Profile (Cont.)

3.1.4. West Segment Evaluation

The routing study evaluated a total of 14 combined routes. The evaluation criteria are described in Section 2, but the qualitative rating system for each segment is slightly different. The detailed evaluation criteria and rating method is listed in Table 3 below.

Table 3 – West Segment Evaluation Criteria Rating System

Criteria	Description
Public Impact	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Utility Congestion	0 – Extensive impact (greater than 1,000 LF) 1 – Medium impact (between 100 LF and 1,000 LF) 2 – Smallest impact (less than 100 LF)
Private Property Impact	0 – Extensive impact (more than 5 parcels) 1 – Medium impact (1 to 5 parcels) 2 – No impact (0 parcels)
Permitting Requirements	0 – Extensive impact (More than 2 permits required) 1 – Medium impact (City street and Railroad permits only) 2 – Smallest impact (no permits required)
Future Maintenance Access	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Trenchless Crossings	0 – At least two of: challenging grade; pit depth greater than/equal to 20-feet; utility relocations required 1 – At least two of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required 2 – At most one of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required
Any Miscellaneous Challenges	0 – More than two additional route-specific challenges 1 – One or Two additional route-specific challenges 2 – No additional route-specific challenges
Construction Costs	0 – Cost greater than $10M 1 – Cost between $7.5M and $10M 2 – Cost less than $7.5M

Table 4 summarizes the results of the West Segment Alignment Alternatives evaluation process. This matrix documents the measurement method and the performance of each alternatives with scores.

There are six combined Alignments with higher scores – 1b, 2b, 4b, 4c, 5b and 5c. Table 5 provides the details of the key evaluation factor and pros/cons for each of these six Alignments.

Following meetings with stakeholders, all the alignment routes involving Alignment Alternative "a" were excluded, due to the disturbance of the backyards of eleven (11) residential parcels. Based on City input regarding anticipated adverse impacts to neighborhoods and traffic along the routes using Shamrock Road (Alignment Alternative "c"), RWSA and stakeholders agreed that Alignment Alternative "b" – following Jefferson Park Avenue, Cleveland Avenue, and Cherry Avenue is the preferred route south of the railroad. This route also includes the short and direct crossing of the railroad along Lewis Street.

North of the railroad, Alignment Alternatives 1, 2, 4, and 5 all have similar overall lengths, and therefore have estimated construction costs in a similar order of magnitude. Selection of the route north of the railroad is therefore driven by location of proposed connection to the 24-inch Observatory Water Line. The three identified locations are each feasible:

1) Near the intersection of Fontaine Avenue and Stribling Avenue, in City street right-of-way. This option (shown in Alignment Alternative 1) results in water main installation along Fontaine Avenue. The City has a planned streetscape improvements project along Fontaine Avenue which overlaps this alignment route. Coordination with the City's streetscape project team is required to determine if this creates a conflict, or if installing water main as a betterment is an option. Challenges for this tie-in location include a) installation of approximately 2,000 linear feet of pipe in heavily trafficked Fontaine Avenue; and b) connecting to the Observatory Water Line this far south provides the least hydraulic benefit of the three identified locations, as hydraulic capacity (head, system pressure) improves the closer to OBSWTP the connection is made.
2) Near RWSA's Royal raw water pump station, on UVA property. This option (shown in Alignment Alternatives 2, 3, and 4) ties in at an area already disturbed by existing utilities, pedestrian paths, and roadways (Mimosa Drive in Alternative 2 and Stadium Road in Alternatives 3 and 4). While this option does create further disturbance to a residential area for UVA, it does avoid the busy streets impacted by the other two options. Both options on UVA property present some likely impact to UVA students and staff during construction. Consultation with UVA is required to determine UVA's willingness to grant easement in this location.
3) Near OBSWTP, west of Alderman Road on UVA property. This option (shown in Alignment Alternatives 5 and 6) ties in along existing RWSA and City easements on UVA property south of OBSWTP and west of Alderman Road. Of the three options, this option provides the connection point closest to OBSWTP – and therefore the greatest hydraulic benefit. The existing water easements may facilitate installation here, though existing development (including a pedestrian bridge on UVA property) may present design and construction challenges. This

option also impacts heavily trafficked Alderman Road and Maury Street. Both options on UVA property present some likely impact to UVA students and staff during construction. Consultation with UVA is also required to determine UVA's willingness to grant additional easement (if needed) and to permit the water line in Alderman Road.

Follow-up meetings and coordination with the City and UVA regarding potential tie-in locations and alignments with regard to their respective projects (Fontaine Streetscape) and property (UVA parcels) are required in order to finalize the western tie-in location and alignment north of the railroad.

Table 4 – West Segment Alignment Alternatives Evaluation Result

	Evaluation Factor								
Alignment	Impacts on Public During Construction (Traffic, Parking, Access)	Impacts on existing utilities (Congested underground utilities)	Impacts on private properties (Number of Parcels requiring easement)	Environmental Impacts/ Permitting Requirements	Future maintenance consideration (access, traffic, etc)	Trenchless Crossing - Required and Difficulty	Miscellaneous Challenges	Construction costs	Total Score
West 1a	1	2	0	1	1	1	1	1	8
West 1b	1	2	1	1	1	2	1	1	10
West 1c	0	1	1	1	0	1	1	2	7
West 2a	2	2	0	1	2	1	1	1	10
West 2b	1	2	1	1	1	2	1	1	10
West 2c	0	1	1	1	0	1	1	2	7
West 3a	2	1	0	1	2	1	1	1	9
West 3b	1	1	1	1	1	2	1	1	9
West 3c	0	1	1	1	0	1	1	2	7
West 4b	2	1	1	1	2	2	1	1	11
West 4c	1	1	1	1	1	1	1	2	9
West 5b	2	2	1	1	2	2	1	1	12
West 5c	1	1	1	1	1	1	1	2	9
West 6c	0	1	1	1	0	1	1	2	7

Table 5 – West Segment Alignment Alternatives Evaluation – Key Comparisons

	Evaluation Factor					
Alignment	Fontaine Tie-In-->Lewis RR Crossing-->JPA-->Cleveland (1b)	Royal PS Tie-in-->Mimosa-->Fontaine-->Lewis RR Crossing-->JPA-->Cleveland (2b)	Royal PS Tie-in --> Stadium-->Piedmont/Price-->Lewis RR Crossing -->JPA->Cleveland (4b)	Royal PS Tie-in-->Stadium-->Piedmont/Price-->Fontaine/JPA->Shamrock RR Crossing (4c)	Alderman/OBS Tie-in-->Maury-->Lewis RR Crossing-->JPA-->Cleveland (5b)	Alderman/OBS Tie-in-->Maury->Fontaine/JPA-->Shamrock RR Crossing (5c)
Length	7,650 LF	8,320 LF	8,200 LF	6,650 LF	7,480 LF	6,000 LF
Preliminary Cost Estimate	$7.7M	$8.3M	$8.3M	$6.6M	$7.5M	$6.0M
Areas of Major Traffic Impact	Fontaine, JPA (south)	Fontaine, JPA (south)	JPA (South)	Fontaine/JPA (north), Shamrock	Alderman, JPA (South)	Alderman, Fontaine/JPA (North), Shamrock
Parcels Impacted	3 (residential)	5 (3 residential, 2 UVA)	5 (3 residential, 2 UVA)	4 (2 residential, 2 UVA)	4 (3 residential, 1 UVA)	3 (1 residential, 1 commercial, 1 UVA)
Miscellaneous Impacts	Fire Station Along Fontaine	Footprint on UVA (Mimosa); Fire Station Along Fontaine	Footprint on UVA (pedestrian trail)	Footprint on UVA (pedestrian trail)	Footprint on UVA (Alderman Rd)	Footprint on UVA (Alderman Rd)
Pros	No UVA Impact; follows lesser traffic route of JPA-Cleveland	Lewis RR Crossing - straightforward; follows lesser traffic route of JPA-Cleveland	Lewis RR Crossing - straightforward; follows lesser traffic route of JPA-Cleveland	Shamrock Routes are shorter and less expensive	Best hydrulic benefit (tie-in closest to OBSWTP); Lewis RR Crossing - straightforward; follows lesser traffic route of JPA-Cleveland	Best hydraulic benefit (tie-in closest to OBWTP); Shamrock Routes are shorter and less expensive
Cons	Fontaine Traffic/Parking Impacts; Least Hydraulic Benefit (furthest from OBSWTP); Fontaine routes are medium length/expense	Royal/Lewis routes are longer/more expensive; Residential yard impacts south of RR	Royal/Lewis routes are longer/more expensive; Residential yard impacts south of RR	Follows heavier traffic route of JPA-Shamrock; tight corridor and congested utilities along Shamrock	Footprint on UVA (Alderman Rd); Residential yard impacts south of RR	Footprint on UVA (Alderman Rd); follows heavier traffic route of JPA-Shamrock; tight corridor and congested utilites on Shamrock

3.1.5. West Segment Detailed Cost Estimates

Table 6 presents the detailed cost estimates for each combined Alignment Alternative in the West Segment. Open-cut installation is assumed other than at the proposed railroad crossings; the railroad crossings assume jack-and-bore trenchless construction.

Table 6 – Detailed Cost Estimates for West Segment Alignment Alternatives

RWSA Central Water Line Routing - Water Main Installation West Alignment Alternatives - Opinion of Probable Cost										
		Option West 1a			Option West 1b			Option West 1c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
30" D.I.P. W/M Installation - Open Cut	LF	7970	$ 700.00	5,579,000.00	7650	700.00	5,355,000.00	6100	$ 700.00	$ 4,270,000.00
48" Diameter (Min.) Jack and Bore Trenchless Crossing for 30" W/M	LF	100	$ 2,200.00	220,000.00	160	2,200.00	352,000.00	110	$ 2,200.00	$ 242,000.00
Pavement Restoration	SY	8890	$ 25.00	222,250.00	9530	25.00	238,250.00	8130	$ 25.00	$ 203,250.00
Seeding and Fertilizing	SY	1730	$ 4.00	6,920.00	670	4.00	2,680.00	0	$ 4.00	$ -
Subtotal				**$ 6,028,170.00**			**$ 5,947,930.00**			**$ 4,715,250.00**
Contingency (30%)				$ 1,808,451.00			1,784,379.00			$ 1,414,575.00
Total Cost of Construction				**$ 7,836,621.00**			**$ 7,732,309.00**			**$ 6,129,825.00**
Easement Acquisition (Approximate Easement Value)	LS	0	$ -	$ -	0	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**7,836,621.00**			**$ 7,732,309.00**			**$ 6,129,825.00**

RWSA Central Water Line Routing - Water Main Installation West Alignment Alternatives - Opinion of Probable Cost										
		Option West 2a			Option West 2b			Option West 2c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
30" D.I.P. W/M Installation - Open Cut	LF	8660	$ 700.00	$ 6,062,000.00	8320	$ 700.00	$ 5,824,000.00	6780	$ 700.00	$ 4,746,000.00
48" Diameter (Min.) Jack and Bore Trenchless Crossing for 30" W/M	LF	100	$ 2,200.00	$ 220,000.00	160	$ 2,200.00	$ 352,000.00	110	$ 2,200.00	$ 242,000.00
Pavement Restoration	SY	9680	$ 25.00	$ 242,000.00	10290	$ 25.00	$ 257,250.00	8910	$ 25.00	$ 222,750.00
Seeding and Fertilizing	SY	1870	$ 4.00	$ 7,480.00	800	$ 4.00	$ 3,200.00	130	$ 4.00	$ 520.00
Subtotal				**$ 6,531,480.00**			**$ 6,436,450.00**			**$ 5,211,270.00**
Contingency (30%)				$ 1,959,444.00			$ 1,930,935.00			$ 1,563,381.00
Total Cost of Construction				**$ 8,490,924.00**			**$ 8,367,385.00**			**$ 6,774,651.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**$ 8,490,000.00**			**$ 8,370,000.00**			**$ 6,770,000.00**

Table 6 – Detailed Cost Estimates for West Segment Alignment Alternatives (Cont.)

RWSA Central Water Line Routing - Water Main Installation West Alignment Alternatives - Opinion of Probable Cost										
		Option West 3a			Option West 3b			Option West 3c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
30" D.I.P. W/M Installation - Open Cut	LF	8460	$ 700.00	$ 5,922,000.00	8130	$ 700.00	$ 5,691,000.00	6580	$ 700.00	$ 4,606,000.00
48" Diameter (Min.) Jack and Bore Trenchless Crossing for 30" W/M	LF	100	$ 2,200.00	$ 220,000.00	160	$ 2,200.00	$ 352,000.00	110	$ 2,200.00	$ 242,000.00
Pavement Restoration	SY	9210	$ 25.00	$ 230,250.00	9840	$ 25.00	$ 246,000.00	8440	$ 25.00	$ 211,000.00
Seeding and Fertilizing	SY	2070	$ 4.00	$ 8,280.00	1000	$ 4.00	$ 4,000.00	330	$ 4.00	$ 1,320.00
Subtotal				**$ 6,380,530.00**			**$ 6,293,000.00**			**$ 5,060,320.00**
Contingency (30%)				$ 1,914,159.00			$ 1,887,900.00			$ 1,518,096.00
Total Cost of Construction				**$ 8,294,689.00**			**$ 8,180,900.00**			**$ 6,578,416.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1		$ -	1		$ -
Alignment Total Cost				**$ 8,290,000.00**			**$ 8,180,000.00**			**$ 6,580,000.00**

RWSA Central Water Line Routing - Water Main Installation West Alignment Alternatives - Opinion of Probable Cost							
		Option West 4b			Option West 4c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
30" D.I.P. W/M Installation - Open Cut	LF	8200	$ 700.00	$ 5,740,000.00	6650	$ 700.00	$ 4,655,000.00
48" Diameter (Min.) Jack and Bore Trenchless Crossing for 24" W/M	LF	160	$ 2,200.00	$ 352,000.00	110	$ 2,200.00	$ 242,000.00
Pavement Restoration	SY	9930	$ 25.00	$ 248,250.00	8530	$ 25.00	$ 213,250.00
Seeding and Fertilizing	SY	1000	$ 4.00	$ 4,000.00	330	$ 4.00	$ 1,320.00
Subtotal				**$ 6,344,250.00**			**$ 5,111,570.00**
Contingency (30%)				$ 1,903,275.00			$ 1,533,471.00
Total Cost of Construction				**$ 8,247,525.00**			**$ 6,645,041.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1		$ -
Alignment Total Cost				**$ 8,247,525.00**			**$ 6,645,041.00**

RWSA Central Water Line Routing - Water Main Installation West Alignment Alternatives - Opinion of Probable Cost							
		Option West 5b			Option West 5c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
30" D.I.P. W/M Installation - Open Cut	LF	7480	$ 700.00	$ 5,236,000.00	6000	$ 700.00	4,200,000.00
48" Diameter (Min.) Jack and Bore Trenchless Crossing for 24" W/M	LF	160	$ 2,200.00	$ 352,000.00	110	$ 2,200.00	$ 242,000.00
Pavement Restoration	SY	8710	$ 25.00	$ 217,750.00	7400	$ 25.00	$ 185,000.00
Seeding and Fertilizing	SY	1270	$ 4.00	$ 5,080.00	600	$ 4.00	$ 2,400.00
Subtotal				**$ 5,810,830.00**			**$ 4,629,400.00**
Contingency (30%)				$ 1,743,249.00			$ 1,388,820.00
Total Cost of Construction				**$ 7,554,079.00**			**$ 6,018,220.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**$ 7,554,079.00**			**$ 6,018,220.00**

3.2. Middle Segment

The Middle Segment connects the East and West Segments. and consists of approximately 4,000 linear feet (LF) of 30-inch water transmission main along Cherry Avenue between Shamrock Road and Roosevelt Brown Boulevard and approximately 2,200 LF of 24-inch water transmission main along Cherry Avenue between Roosevelt Brown Boulevard and Ridge Street. It also includes 24-inch water transmission main on Roosevelt Brown Boulevard to West Main Street, connecting to the RWSA 24-inch Urban Water Line at the intersection of West Main Street and 9th Street SW. Figure 17 shows an overview of the Middle Segment alignments evaluated.

Cherry Avenue is a two- and three-lane local street with a moderate amount of traffic, and with curbside street parking available along most of the route. Existing sanitary sewer, water main, gas line and storm sewer are present on Cherry Avenue. There appears to be ample space to install water transmission main, with only a couple apparent areas of apparent congestion. The vicinity of the intersection of Cherry Avenue / Rockcreek Road and the intersection of Cherry Avenue / 10th Street SW are congested with existing utilities, including sanitary sewer, storm water, gas line; relocation of one or more utilities may be required to facilitate sufficient clearance for the proposed water main.

The Middle segment includes a northern spur, or branch line, that extends proposed 24-inch water main north along Roosevelt Brown Boulevard at the intersection with Cherry Avenue. The alignment runs north and crosses under the railroad, which is carried by an overpass bridge above Roosevelt Brown Boulevard. North of the railroad, there are two options to reach a connection to the Urban Water Line at West Main Street and 9th Street SW:

- One option includes installation on Roosevelt Brown Boulevard north to West Main Street, then heading east along West Main Street to the Urban Water Line. This option remains within public right-of-way, though it requires installation through the heavily trafficked intersection of Roosevelt Brown Boulevard and West Main Street. The congested utilities on West Main Street will also create challenges for installation of the new water main and would need to be reviewed carefully following detailed survey.

- The second option includes installation of the alignment through the south parking lot of the Hampton Inn hotel property, then north on former 9th Street SW (now a service road on private property) to West Main Street and the Urban Water Line. This option thus minimizes traffic impacts on West Main Street but adds the need for easement on two private parcels (the hotel parcel, and the 9th Street SW service road) on Table 7 and Figure 18. Based on as-built drawings, 9th Street SW appears highly congested with utilities. Table 8 below lists the evaluation results.

A connection to the 24-inch Urban Water Line at West Main Street is ultimately required to meet the hydraulic requirements of projected future demands. If the 24-inch northern spur is to be constructed with the City streetscape projects along West Main Street, the Middle

Segment could connect, in the short term, to the City‘s18-inch water main on Roosevelt Brown Boulevard south of the railroad; with extension to West Main Street to follow later. Further discussions about the tie-in connection with RWSA and City are required to determine the preferred option.

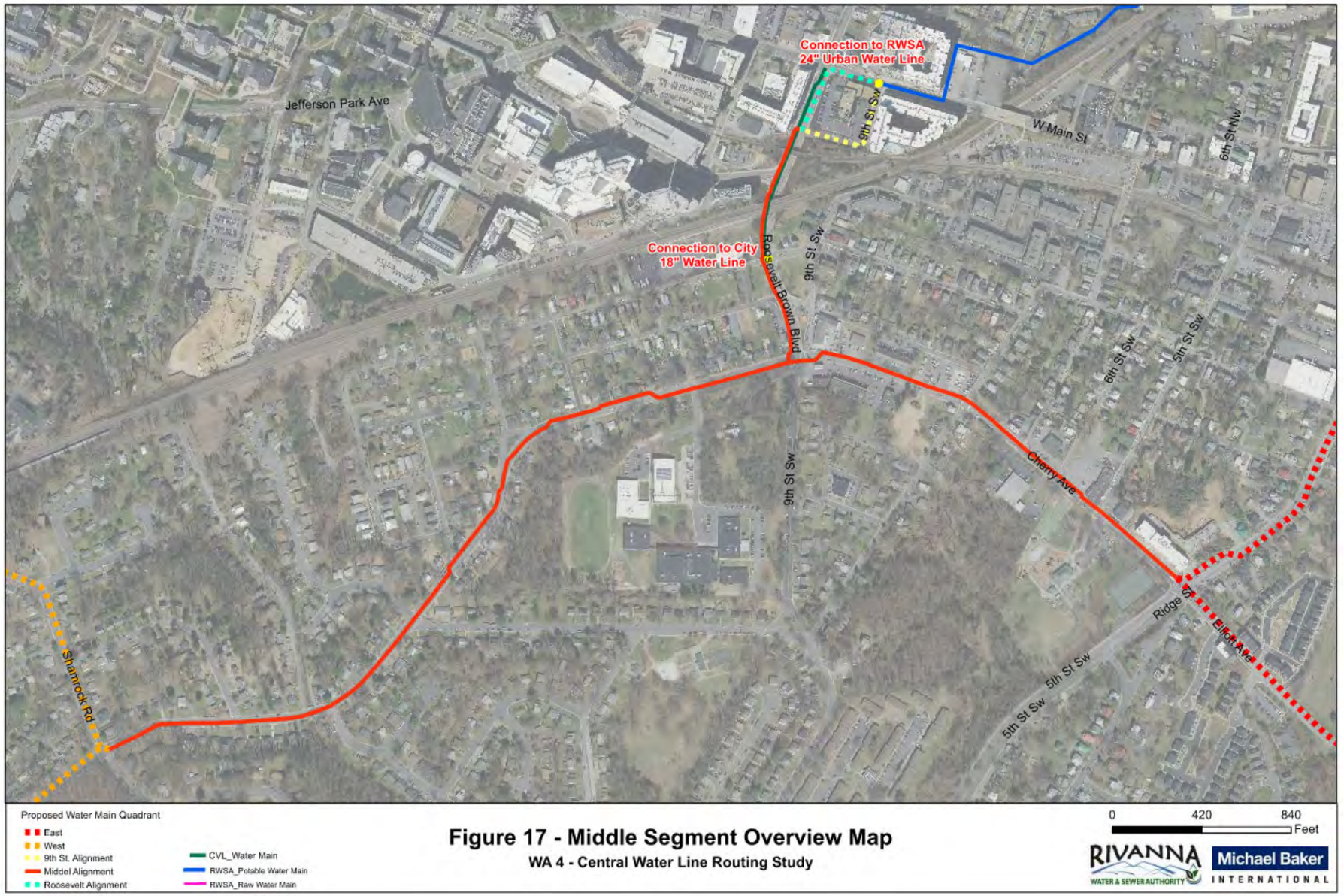


Figure 17 – Middle Segment Overview Map

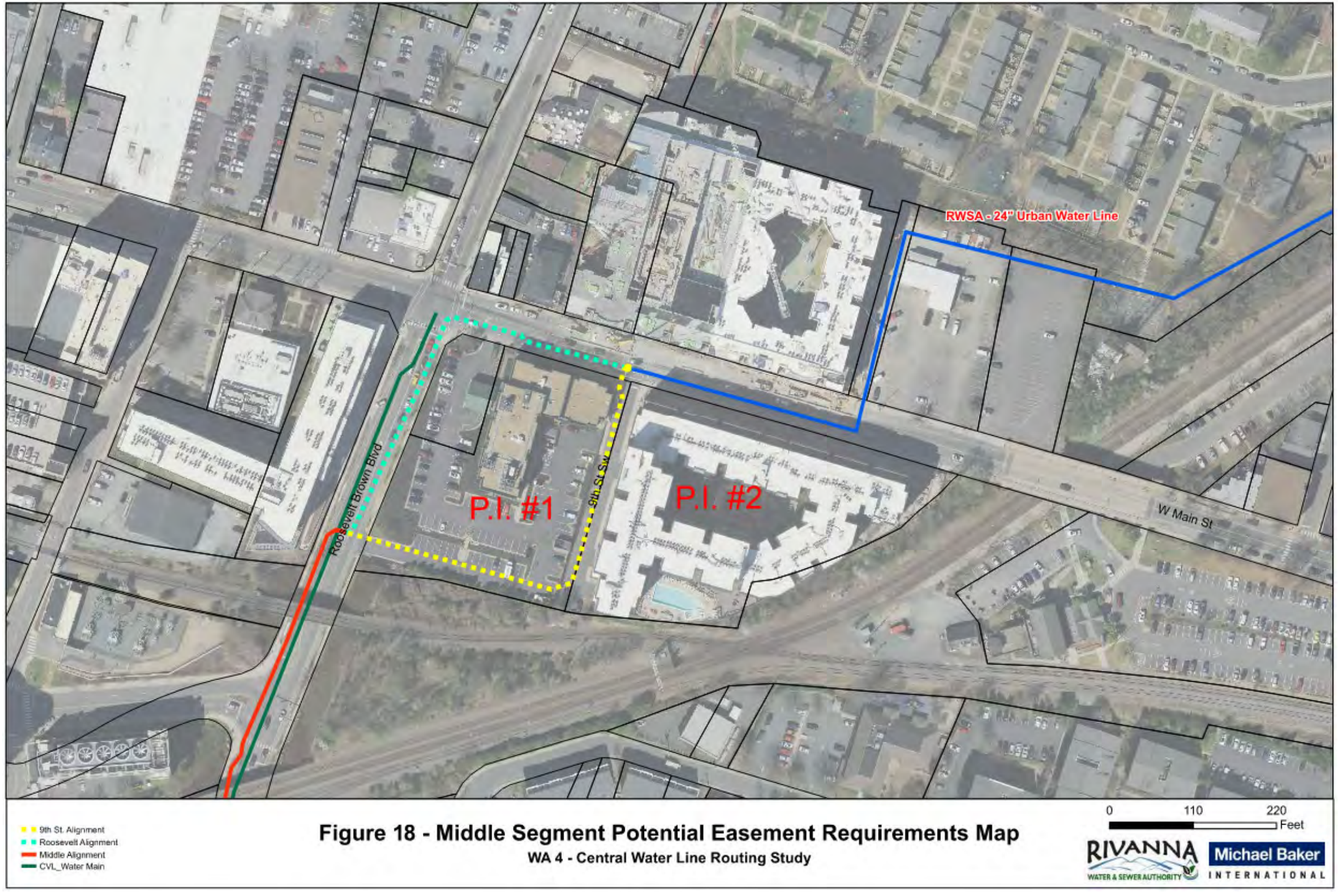


Figure 18 - Middle Segment Potential Easement Requirements Map

Table 7 – Middle Segment Potential Easement Requirements

P.I. #	PIN	Owner	Address
1	100078000	Midtown LLC	900 W Main St
2	300003000	Madison Loft LLC	852-854 W Main St

Table 8 – West Segment Alignment Alternatives Evaluation – Key Comparisons

Evaluation Factor		
Alignment	Cherry; Roosevelt Brown-->West Main Tie-in	Cherry; 9th St SW-->West Main Tie-in
Length	8,490	8,530
Preliminary Cost Estimate	$7.5M	$7.5M
Areas of Major Traffic Impact	Roosevelt Brown, W. Main	Roosevelt Brown, W. Main
Parcels Impacted	None	2 (commercial)
Miscellaneous Impacts	None	None
Pros	Avoids private property	Minmizes footprint in West Main
Cons	Disruption of West Main	9th St SW (Private) appears highly congested with utilities

3.3. East Segment

The East Segment options were split into two sub-segments, similar to the West Segment: in the East, the sub-segments are north of railroad and south of railroad. There are three Alignment Alternatives (1-3) in the sub-segment north of railroad, and three Alignment Alternatives (a-c) in the sub-segment south of the railroad. This leads to 9 possible route combinations in the East Segment for the 24-inch water transmission main. Figure 19 illustrates an overview of the Alignment Alternatives in the East Segment. The East Segment continues the proposed 24-inch water main from the intersection of Ridge Street and Cherry Avenue/Elliott Avenue in the west to the proposed connection to the existing 18-inch Pantops Water Line at the intersection of East High Street and Long Street in the east. Potential railroad crossings for tracks owned by Buckingham Branch are identified near the intersection of Water Street and 10th Street NE.

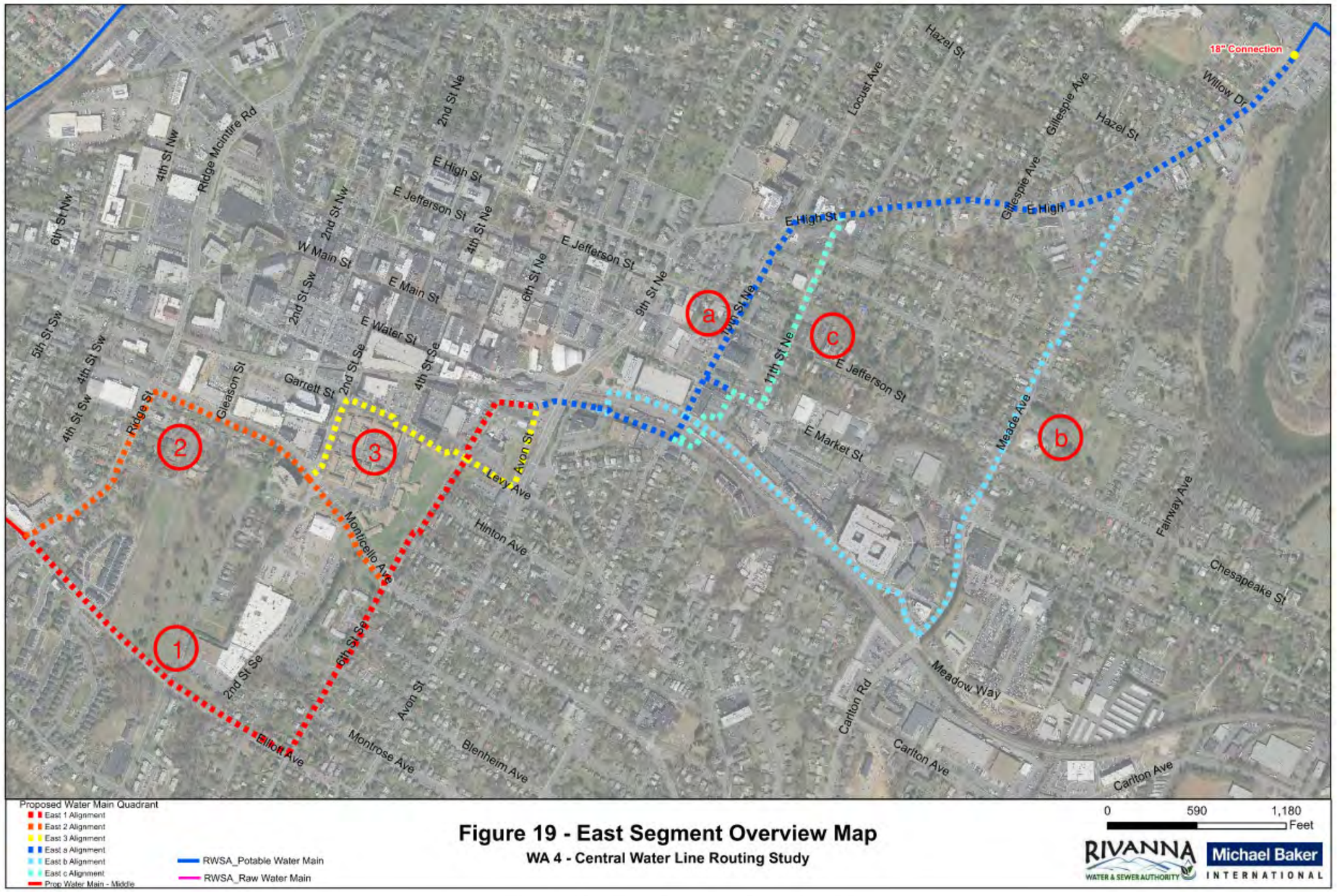


Figure 19 – East Segment Overview Map

3.3.1. South of Railroad Sub-segment (Alignment Alternatives 1-3)

The three Alignment Alternatives, numbered 1-3, consist of 24-inch water transmission main from the intersection of Ridge Street and Cherry Avenue, to the vicinity Avon Street and 9th Street just south of the railroad.

- Alignment Alternative 1 continues the proposed 24-inch water main from the Middle Segment through the intersection of Ridge Street and Cherry Avenue, and then continues east on the north side of Elliott Avenue. Elliott Avenue is a two-lane local street with two bike lanes on each side, which provides sufficient space for the installation of the water main while still maintaining through traffic. Alternative 1 then turns north and heads along 6th Street SE to the railroad. Several existing utilities are identified on 6th Street. The utilities are particularly congested near the intersection of Blenheim Avenue and 6th Street SE, such that a portion of the existing sanitary sewer or water line may need to be relocated to accommodate sufficient clearance. Construction on 6th Street SE will cause some disturbance to the residential neighborhoods along the route. Before reaching the railroad, the alignment turns east (running parallel to the railroad) and enters a private commercial property, creating the need for at least one easement (See Figure 20 and Table 9). The alignment runs east through a portion of the parking lot until reaching Avon Street under the 9th Street SE overpass.

- Alignment Alternative 2 turns north to run along on Ridge Street, and then turns east to run along Monticello Avenue. The alignment stays on the south side of Monticello Avenue until 6th Street SE, then heading north on 6th Street SE and following Alignment Alternative 1. Ridge Street is a heavily trafficked collector street, and Monticello Avenue is moderately trafficked with bike lanes and street parking; construction would have a significant temporary impact on traffic and parking along both streets. There does, however, appear to be sufficient space for the proposed water main amongst the various existing utilities along both streets; existing utilities here include sanitary sewer, storm water, water line and gas.

- Alignment Alternative 3 follows Alignment Alternative 2 until the intersection of Monticello Avenue and 2nd Street SE; then turns north to run along 2nd Street SE to Garrett Street/Levy Street. The alignment then turns east to run along Garrett Street/Levy Street until turning north to run along Avon Street to the railroad. Heading up Avon Street instead of 6th Street SE (as in Alignment Alternative 1) avoids private property.

3.3.2. North of Railroad Sub-segment (Alignment Alternatives "a-c")

The three Alignment Alternatives, denoted "a", "b" and "c", consist of 24-inch water main transmission main crossing the Buckingham Branch railroad near the intersection of Water Street and 10th Street NE, and heading north toward the proposed connection to the Pantops Water Line at the intersection of East High Street and Long Street.

- Alignment Alternative "a" continues the proposed water main east on Avon Street through a cul-de-sac and into a parking lot on private commercial property (See Figure 20 and Table 9). A trenchless crossing would be required where the water main crosses the railroad at 10th Street NE; more details on the East Segment trenchless crossing options are presented in Section 3.3.3. Alignment alternative "a" then runs along 10th Street NE and turns east to East High Street. The congestion of the existing utilities at the intersection of East High Street and 10th Street NE could require extensive relocation of utilities to provide sufficient clearance for installation of the water main. East High Street (VA-20) is a busy collector street, so the installation of the water main on East High Street will require careful maintenance of traffic. The construction footprint overlaps, however, with the City's planned streetscape and water main installation work on East High Street, between Market Street and Long Street. Alternative "a" continues on East High Street to the proposed connection to the Pantops Water Line at the intersection of East High Street and Long Street.

- Alignment Alternative "b" continues the proposed water main on Avon Street and then turns north to cross the railroad at the cul-de-sac of Avon Street, to avoid running through the commercial property parking lot. More details on the East Segment trenchless crossing options are presented in Section 3.3.3. The proposed water main then runs east along Water Street and past a developed residential area that superseded an abandoned coal plant. The City indicated encounters with remnants of coal cinders in the soil during previous construction work in this area. Remnants of coal cinders in the excavated soil could have corrosive impact on ductile iron pipe; although Alignment Alternative "b" is in Water Street for a longer stretch than "a" or "c", a corrosive soils study during design phase is recommended for any alignment in this area in order to identify any recommended protective or mitigating actions during construction. Alignment Alternative "b" then turns north along Meade Avenue, following Meade Avenue until the road merges into East High Street. Meade Avenue is a well-traveled commuter road, similar to East High Street. Alignment Alternative "b" is longer than other alternatives, and creates new construction impacts along Meade Avenue – compared to overlapping with already-planned City construction impacts along East High Street.

- Alignment Alternative "c" parallels Alternative "a", heading north in 11th Street NE instead of 10th Street NE after crossing the railroad. East Segment railroad crossing options are presented in Section 3.3.3. The intersection of 11th Street NE and Market Street is congested with existing utilities, including sanitary sewer, storm water, gas line; relocation of one or more utilities may be required to facilitate sufficient clearance for the proposed water main. Then Alignment Alternative "c" follows East High Street east to the proposed connection point to the Pantops Water Line at the intersection of East High Street and Long Street.

Table 9 – East Segment Potential Easement Requirements

P.I. #	PIN	Owner	Address
1	580289 100	National Optronics Incorporated	100 Avon St
2	540277 000	Ten Market LLC	100 10th St NE
3	540277 100	ALC Limited Partnership	1006 East Market St
4	580358 000	The Belmont Loft Company, LLC	200-202 Douglas Ave
5	58000 1000	Lewis LLC of Troy	201 Avon St

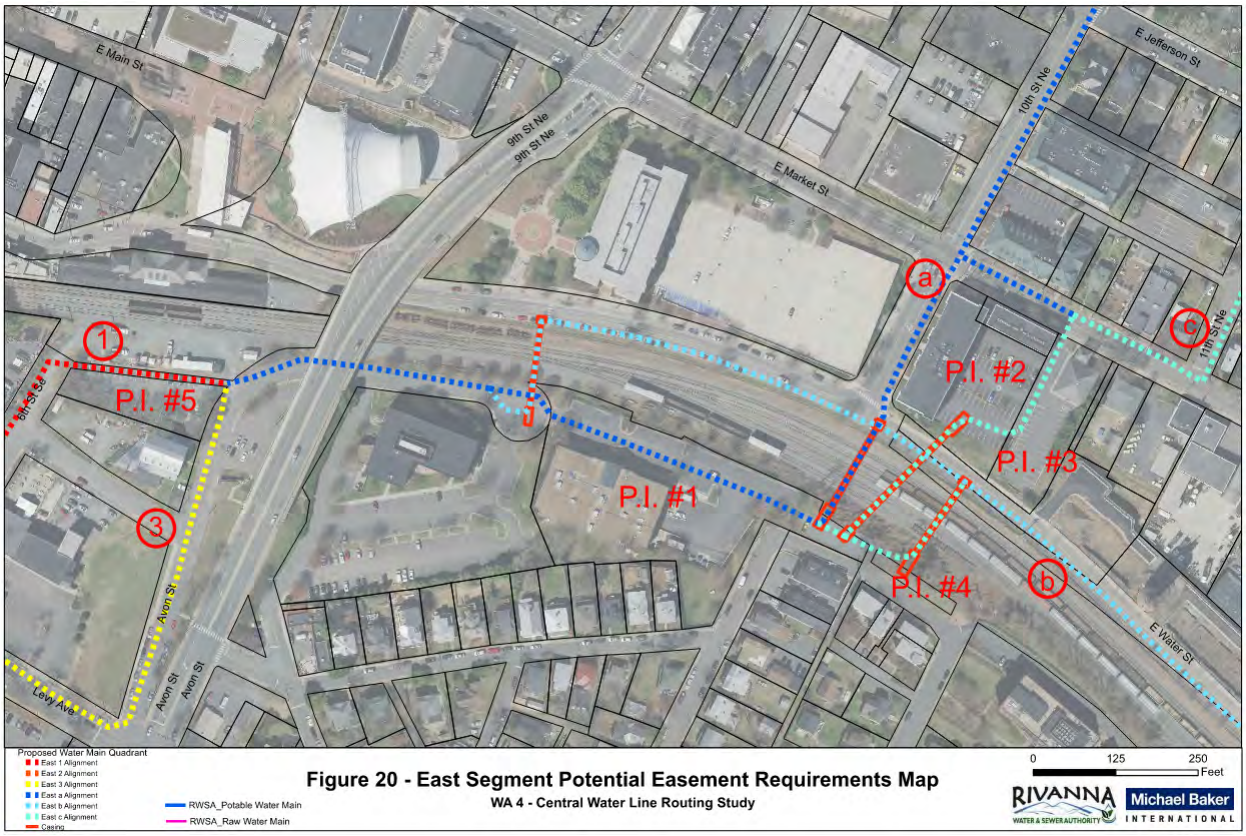


Figure 20 - East Segment Potential Easement Requirements Map

3.3.3. East Segment Railroad Crossing

The potential Buckingham Branch railroad crossing at the Avon Street cul-de-sac is shown in Figures 22 and 22. The cul-de-sac provides ample space for a jack-and-bore launching pit and clear the existing storm sewer pipeline and water line. The receiving pit can be placed in the eastbound travel lane and parking lane of Water Street; while this will require temporary closure and detour of Water Street, the lack of congestion of utilities in this area of Water Street presents a constructible crossing option. The "Avon Street Railroad Crossing" avoid impacts on private properties.

The routing study identified three options to cross the railroad at the vicinity of the intersection of Water Street and 10th Street. The plans and profiles of these three options at 10th Street are depicted in Figures 23 and 24. The western-most railroad crossing ("10th Street Alignment 1" in Figure 23) launches from the commercial property south of the railroad at a depth of 10 feet. An existing 8-inch water main will need to be supported across the launching pit, or possibly relocated around the footprint of the pit. The receiving pit falls at the intersection of East Market Street and Water Street, requiring temporary road closure and detour and careful design and survey to avoid conflicts with existing utilities in the road. Excavation for the launching pit will need to be approximately 20 feet deep, as the property south of the railroad sits at higher elevation above the railroad.

The middle option ("10th Street Alignment 2" in Figure 23) launches from a commercial building parking lot north of East Water Street, with receiving pit on the same commercial property south of East Water Street. "10th Street Alignment 2" does not impact on the traffic of Water Street, but does introduce private property impact north of Water Street (See Figure 20 and Table 9 for property information). This option requires a longer trenchless crossing as shown on Figure 16. Excavation of approximately 20 feet will be required at the receiving pit on the property south of the railroad.

The eastern-most option ("10th Street Alignment 3" in Figure 23) avoids the abrupt grade change, and therefore deep excavation, by placing the launching pit on a narrow strip of undeveloped private property east of the commercial parking lot and a receiving pit within the travel lanes of Water Street east of the intersection with 10th Street NE. See Figure 20 and Table 9 for property information. Similar to "10th Street Alignment 1" in Figure 23, the receiving pit will require temporary road closure and detour. The City has indicated that the private property impacted by the launching pit may be slated for redevelopment, which may preclude the ability to secure easement for installation of "10th Street Alignment 3".

The "Avon Street Railroad Crossing" as well as "10th Street Alignment 1" and "10 Street Alignment 2" each appear to be feasible based on information evaluated during the routing study, each with different impacts on private property and different impacts to traffic during construction. Detailed survey of this entire railroad crossing corridor is recommended to confirm location of existing utilities before finalizing the crossing location.

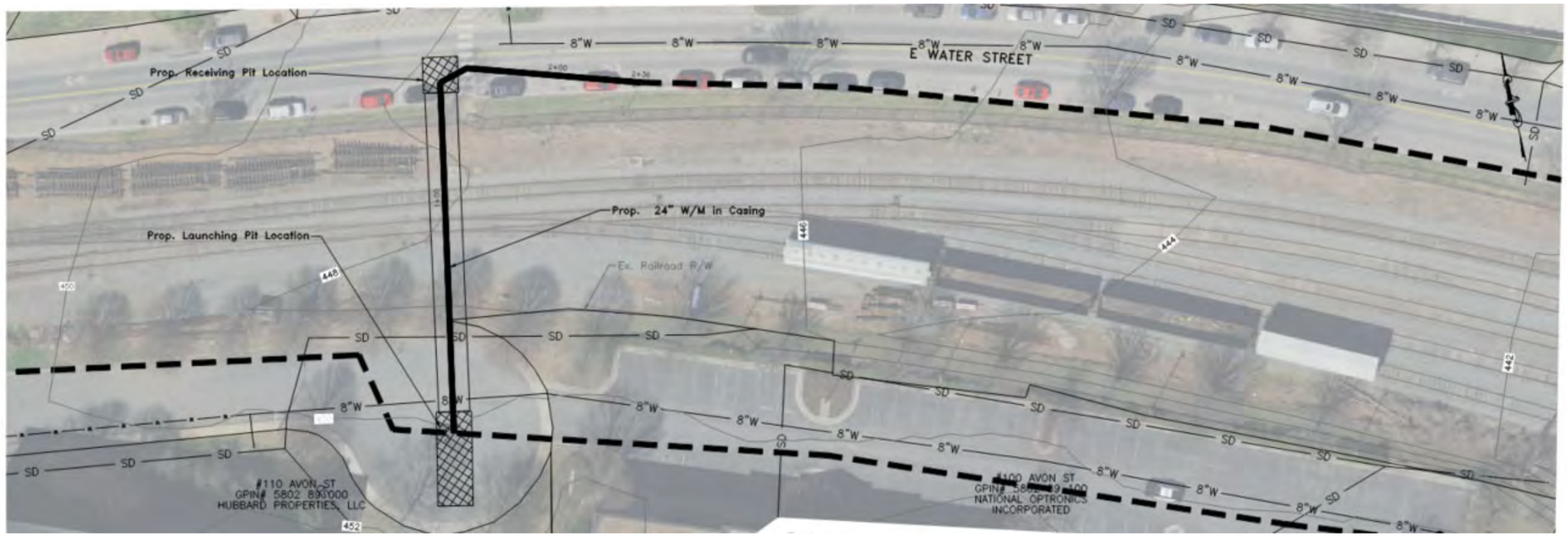


Figure 21 – Avon Street Railroad Crossing Plan

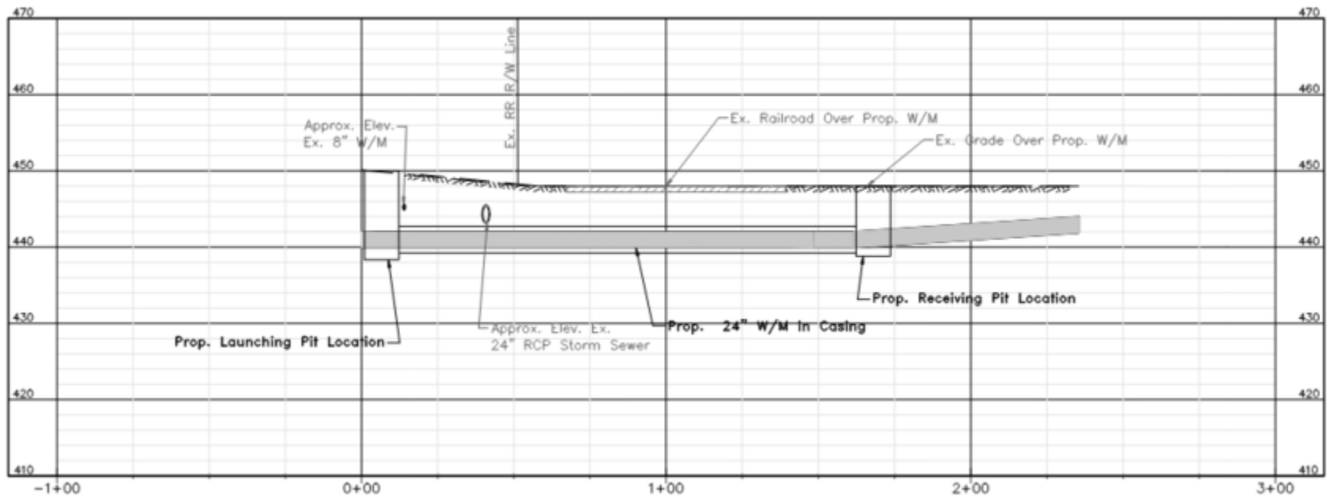


Figure 22 – Avon Street Railroad Crossing Profile

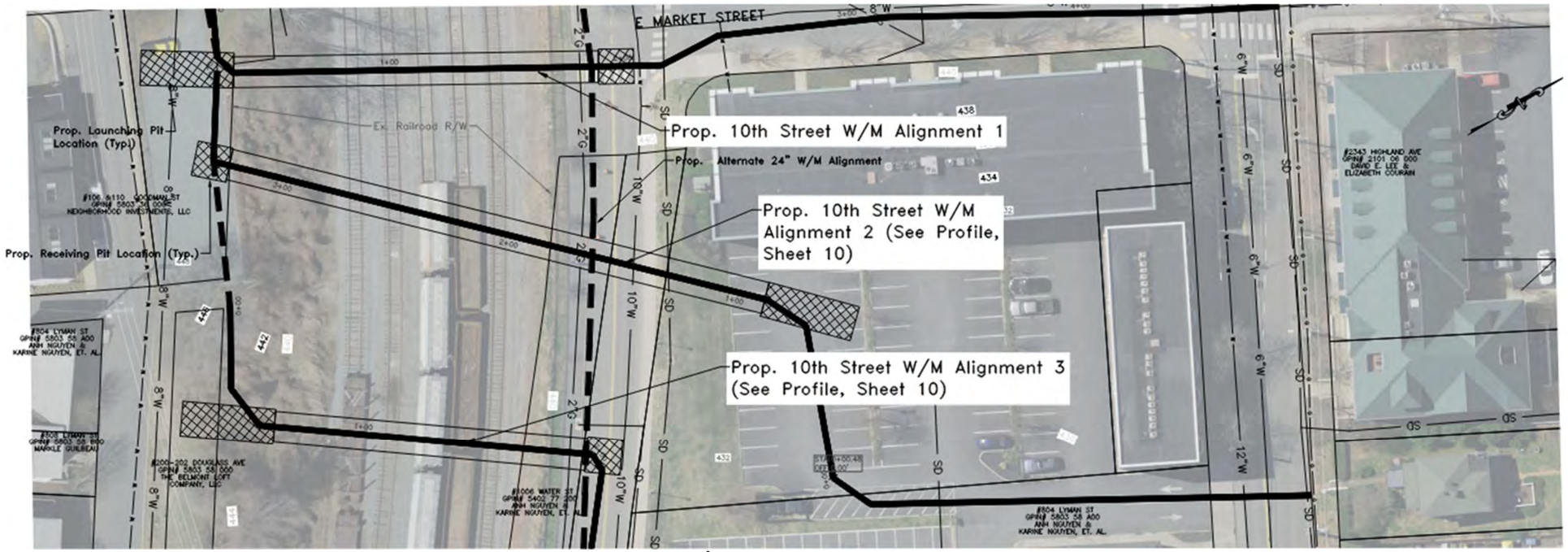


Figure 23 – 10th Street Railroad Crossing Plan

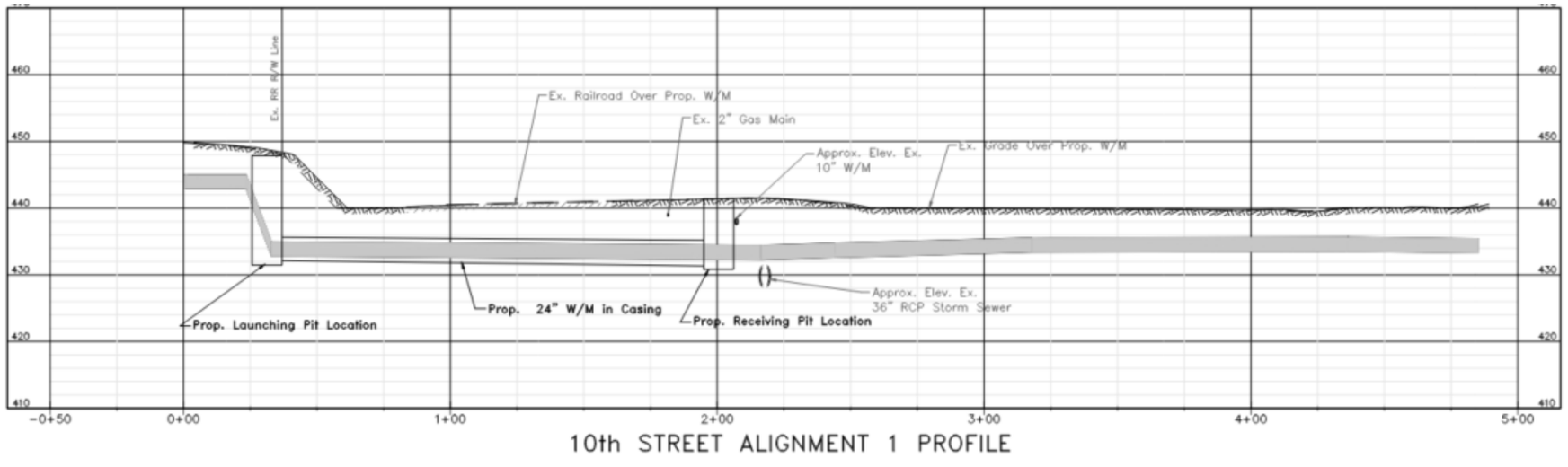


Figure 24 – 10th Street Railroad Crossing Profile

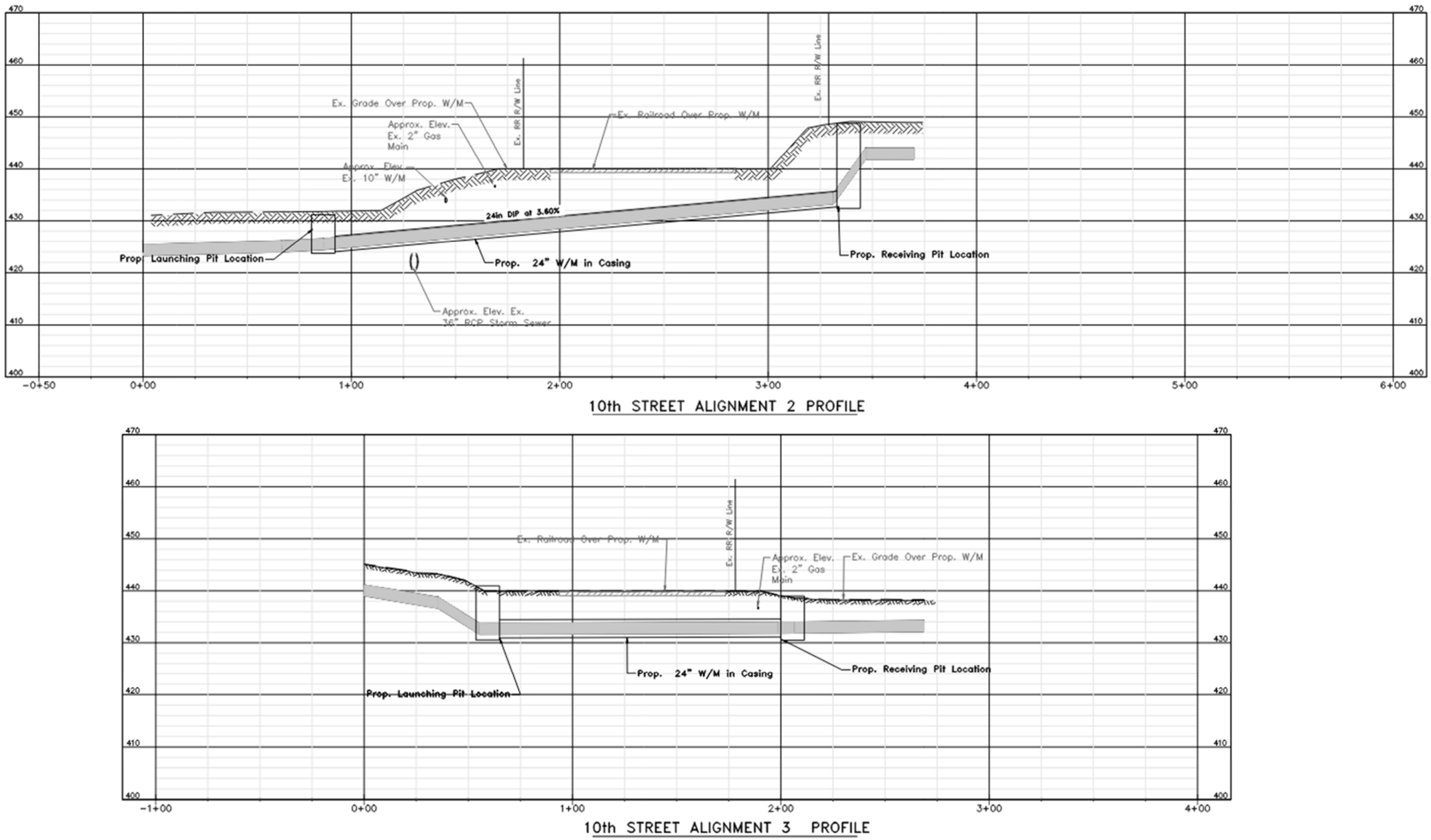


Figure 24 – 10th Street Railroad Crossing Profile (Cont.)

3.3.4. East Segment Evaluation

The routing study evaluated a total of nine (9) combined routes for the 24-in water main– 1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b and 3c. Table 10 lists the detailed evaluation criteria and rating method for the East Segment.

Table 10 – East Segment Evaluation Criteria Rating System

Criteria	Description
Public Impact	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Utility Congestion	0 – Extensive impact (greater than 1,000 LF) 1 – Medium impact (between 100 LF and 1,000 LF) 2 – Smallest impact (less than 100 LF)
Private Property Impact	0 – Extensive impact (more than 5 parcels) 1 – Medium impact (1 to 5 parcels) 2 – No impact (0 parcels)
Permitting Requirements	0 – Extensive impact (More than 2 permits required) 1 – Medium impact (City street and Railroad permits only) 2 – Smallest impact (no permits required)
Future Maintenance Access	0 – Extensive impact (more than 4,000 LF) 1 – Medium impact (between 3,000 LF and 4,000 LF) 2 – Smallest impact (less than 3,000 LF)
Trenchless Crossings	0 – At least two of: challenging grade; pit depth greater than/equal to 20-feet; utility relocations required 1 – At least two of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required 2 – At most one of: challenging grade; pit depth greater than/equal to 10-feet; utility relocations required
Any Miscellaneous Challenges	0 – More than two additional route-specific challenges 1 – One or Two additional route-specific challenges 2 – No additional route-specific challenges
Construction Costs	0 – Cost greater than $10M 1 – Cost between $7.5M and $10M 2 – Cost less than $7.5M

The results of the East Segment Alignment Alternatives evaluation are listed in Table 11 including the criteria and the performance with scores. The scores for each Alternative are similar, each with either 8 or 9 points. All Alternatives with 9 points and some Alternatives with 8 points were compared in Table 12 to provide the key evaluation details and pros/cons for each of these six Alignment Alternatives.

With Alternatives scoring roughly equally, the factors that drive the alignment recommendation are:

- South of the Railroad, Alignment 1 (along Elliot Avenue and 6th Street SE) is preferable as it avoids the more significant traffic impacts to City residents and commuters along Ridge Street and Monticello Avenue (Alignments Alternatives 2 and 3).
- North of the Railroad, following 10th Street NE or 11th Street NE to East High Street (per Alignment Alternatives "a" and "c") coincides with the City's planned East High Street CIP projects, and therefore avoids creating disturbance along a second corridor (Meade Avenue, per Alignment Alternative "b"). Alignment Alternatives "a" and "c" also avoid extended length along Water Street, where the City has noted coal cinder remnants may be present in the soil.

As such, either combined Alignment 1a or 1c is recommended. Survey and detailed design will inform the specific location of the railroad crossing, as well as the final route along 10th Street NE and/or 11th Street NE.

Table 11 – East Segment Alignment Alternatives Evaluation Result

East Alternative Alignment Evaluation									
Alignment	Impacts on Public During Construction (Traffic, Parking, Access)	Impacts on existing utilities (Congested underground utilities)	Impacts on private properties (Number of Parcels requiring easement)	Environmental Impacts/ Permitting Requirements	Future maintenance consideration (access, traffic, etc)	Trenchless crossing required	Miscellaneous Challenges	Construction costs	Total Score
East 1a	1	1	1	1	1	0	1	2	8
East 1b	1	1	1	1	1	1	1	1	8
East 1c	1	1	1	1	1	2	1	1	9
East 2a	1	1	1	1	1	0	1	2	8
East 2b	1	2	1	1	1	1	1	1	9
East 2c	1	1	1	1	1	2	1	1	9
East 3a	1	1	1	1	1	0	1	2	8
East 3b	1	1	1	1	1	1	1	1	8
East 3c	1	1	1	1	1	2	1	1	9

Table 12 – East Segment Alignment Alternatives Evaluation – Key Comparisons

	Evaluation Factor				
Alignment	Elliott-->6th SE-->Water-->Meade (1b)	Elliott-->6th SE-->11th St-->E. High (1c)	Ridge-->Monticello-->6th SE-->Water-->Meade (2b)	Ridge-->Monticello-->6th SE-->11th St-->E. High (2c)	Ridge-->Monticello-->2nd SE-->Garrett/Levy-->6th St SE-->11th St-->E. High (3c)
Length	13,410 LF	11,840 LF	13,190 LF	11,620 LF	11,490 LF
Preliminary Cost Estimate	$11.4M	$10.4M	$11.1M	$10.2M	$10.1M
Areas of Major Traffic Impact	6th (Parking); Meade	6th (Parking); 11th (parking); E. High	Ridge; Monticello; Meade	Ridge; Monticello; 11th (parking); E. High	Ridge; Monticello; 11th (parking); E. High
Parcels Impacted	2 (commercial)	2 (commercial)	2 (commercial)	3 (commercial)	3 (commercial)
Miscellaneous Impacts	Long stretch in Water St (coal cinders)	Short stretch in Water St (coal cinders)	Long stretch in Water St (coal cinders)	Short stretch in Water St (coal cinders)	Short stretch in Water St (coal cinders)
Pros	Avoids heavier traffic route on Ridge/Monticello; Reduces utility congestion and construction conflicts in E. High	E. High routes are shorter/less expensive; Avoids heavier traffic route on Ridge/Monticello; Coordination with City project (E. High) minimizes impact to Meade	Avoids most of 6th St SE neighborhood impact; Reduces utility congestion and construction conflicts in E. High	E. High routes are shorter/less expensive; Avoids most of 6th St SE neigborhood impact; Coordination with City project (E. High) minimizes impact to Meade	E. High routes are shorter/less expensive; Avoids part of heavy traffic route on Monticello; avoids most of 6th St SE neighborhood impacts; Coordination with City project (E. High) minmizes impact to Meade
Cons	Meade alignments are longer/more expensive; Neighborhood Impacts on 6th St SE	Neigborhood Impacts on 6th St SE; adds 2nd water main to E. High	Meade alignments are longer/more expensive; follows heavier traffic route on Ridge/Monticello	Follows heavier traffic route on Ridge/Monticello; adds 2nd water main to E. High	Follows heavier traffic route on Ridge/Monticello; adds 2nd water main to E. High

3.3.5. East Segment Detailed Cost Estimates

Table 13 presents the detailed cost estimates for each combined Alignment Alternative in the East Segment. Open-cut installation is assumed other than at the proposed railroad crossings; the railroad crossings assume jack-and-bore trenchless construction.

Table 13 – Detailed Cost Estimates for East Segment Alignment Alternatives

RWSA Central Water Line Routing - Water Main Installation East Alignment Alternatives - Opinion of Probable Cost										
		Option East 1a			Option East 1b			Option East 1c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
24" D.I.P. W/M Installation - Open Cut	LF	11630	$ 600.00	$ 6,978,000.00	13410	$ 600.00	$ 8,046,000.00	11840	$ 600.00	$ 7,104,000.00
42" Diameter (Min.) Jack and Bore Trenchless Crossing for 24" W/M	LF	150	$ 2,000.00	$ 300,000.00	130	$ 2,000.00	$ 260,000.00	250	$ 2,000.00	$ 500,000.00
Pavement Restoration	SY	15310	$ 25.00	$ 382,750.00	17710	$ 25.00	$ 442,750.00	15450	$ 25.00	$ 386,250.00
Seeding and Fertilizing	SY	0	$ 4.00	$ -	0	$ 4.00	$ -	0	$ 4.00	$ -
Subtotal				**$ 7,660,750.00**			**$ 8,748,750.00**			**$ 7,990,250.00**
Contingency (30%)				$ 2,298,225.00			$ 2,624,625.00			$ 2,397,075.00
Total Cost of Construction				**$ 9,958,975.00**			**$ 11,373,375.00**			**$10,387,325.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**$ 9,958,975.00**			**$ 11,373,375.00**			**$10,387,325.00**

RWSA Central Water Line Routing - Water Main Installation East Alignment Alternatives - Opinion of Probable Cost										
		Option East 2a			Option East 2b			Option East 2c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
24" D.I.P. W/M Installation - Open Cut	LF	11420	$ 600.00	$ 6,852,000.00	13190	$ 600.00	$ 7,914,000.00	11620	$ 600.00	$ 6,972,000.00
42" Diameter (Min.) Jack and Bore Trenchless Crossing for 24" W/M	LF	150	$ 2,000.00	$ 300,000.00	130	$ 2,000.00	$ 260,000.00	250	$ 2,000.00	$ 500,000.00
Pavement Restoration	SY	15030	$ 25.00	$ 375,750.00	17410	$ 25.00	$ 435,250.00	15160	$ 25.00	$ 379,000.00
Seeding and Fertilizing	SY	0	$ 4.00	$ -	0	$ 4.00	$ -	0	$ 4.00	$ -
Subtotal				**$ 7,527,750.00**			**$ 8,609,250.00**			**$ 7,851,000.00**
Contingency (30%)				$ 2,258,325.00			$ 2,582,775.00			$ 2,355,300.00
Total Cost of Construction				**$ 9,786,075.00**			**$ 11,192,025.00**			**$10,206,300.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**$ 9,786,075.00**			**$ 11,192,025.00**			**$10,206,300.00**

Table 13 – Detailed Cost Estimates for East Segment Alignment Alternatives (Cont.)

RWSA Central Water Line Routing - Water Main Installation East Alignment Alternatives - Opinion of Probable Cost										
		Option East 3a			Option East 3b			Option East 3c		
Item	Unit	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal	Unit Quantity	Unit Cost	Subtotal
24" D.I.P. W/M Installation - Open Cut	LF	11290	$ 600.00	$ 6,774,000.00	13070	$ 600.00	$ 7,842,000.00	11490	$ 600.00	$ 6,894,000.00
42" Diameter (Min.) Jack and Bore Trenchless Crossing for 24" W/M	LF	150	$ 2,000.00	$ 300,000.00	130	$ 2,000.00	$ 260,000.00	250	$ 2,000.00	$ 500,000.00
Pavement Restoration	SY	14850	$ 25.00	$ 371,250.00	17250	$ 25.00	$ 431,250.00	14990	$ 25.00	$ 374,750.00
Seeding and Fertilizing	SY	0	$ 4.00	$ -	0	$ 4.00	$ -	0	$ 4.00	$ -
Subtotal				**$ 7,445,250.00**			**$ 8,533,250.00**			**$ 7,768,750.00**
Contingency (30%)				$ 2,233,575.00			$ 2,559,975.00			$ 2,330,625.00
Total Cost of Construction				**$ 9,678,825.00**			**$ 11,093,225.00**			**$10,099,375.00**
Easement Acquisition (Approximate Easement Value)	LS	1	$ -	$ -	1	$ -	$ -	1	$ -	$ -
Alignment Total Cost				**$ 9,678,825.00**			**$ 11,093,225.00**			**$10,099,375.00**

4. CONCLUSION AND RECOMMENDATION

The routing study assumes an overall project duration of 4 years, including 21 months for design, permitting, and easement acquisition; and 27 months for bidding and construction. Table 14 lists the details of overall project schedule.

Table 14- Overall Project Schedule

Project Phase	Period
Design Phase Schedule (Months)	
Survey Design, Permitting, and Easement Acquisition	5 16
Design Phase Total Duration	21 months
Bid Phase and Construction Schedule (Months)	
Bidding Phase Completion of Construction	3 24-36
Total Bid-Construction Phase Duration	27-39 months
Overall Project Duration	48-60 months (4-5 years)

The summaries of the detailed evaluations and advantages/disadvantages of each alignment have been discussed in Section 3.

Following workshops with the City and ACSA stakeholders, all parties agreed that for the West Segment, the water main alignment north of the Norfolk-Southern railroad will be finalized following consultation with the City and UVA regarding possible tie-in locations to the 24-inch Observatory Water Line. From the selected western tie-in location, the alignment will proceed to Lewis Street, crossing the railroad via trenchless methods from a commercial property north of the railroad to residential properties south of the railroad. South of the railroad, Alignment "b", along Jefferson Park Avenue, Cleveland Avenue, and Cherry Avenue is recommended. This route requires easement on up to three residential properties and one commercial property at the railroad crossing; and may require easement on UVA property, depending on location of tie-in to the Observatory Water Line.

The Middle Segment follows Cherry Avenue from Shamrock Road to Ridge Street, and includes a northern branch line along Roosevelt Brown Boulevard. Connection to the RWSA 24-inch Urban Water Line in West Main Street is required to meet ultimate system requirements; however, tie-in to the City's 18-inch water main in Roosevelt Brown Boulevard south of the railroad overpass could serve as an interim connection point and meet current system demands and operational requirements. For the ultimate connection in West Main Street, following Roosevelt Brown Boulevard to West Main Street is recommended compared to the alternative of traversing the Hampton Inn hotel parking lot and private 9th Street SW service road, which is heavily

congested with utilities. Construction will require maintenance of traffic along Roosevelt Brown Boulevard and West Main Street.

For the East Segment, combined Alignment 1a or 1c is recommended. Both routes avoid heavy traffic on Ridge Street and Monticello Avenue south of the Buckingham Branch railroad. North of the railroad, following 10th Street NE (Alignment Alternative "a") and/or 11th Street NE (Alignment Alternative "c") to East High Street is a shorter and therefore less expensive route than following Meade Avenue. The water main will align and coordinate with the City's East High Street 12-inch water main and streetscape projects between 10th Street NE and the tie-in to the 18-inch Pantops Water Line at the intersection of East High Street and Long Street.

Regardless of alignment choice, the proposed Central Water Line requires two trenchless railroad crossings and relevant permits from Norfolk Southern (West Segment railroad crossing near Lewis Street) and Buckingham Branch (East Segment railroad crossing near Water Street and 10th Street NE). Desktop analysis and field review are scheduled to be performed during detailed design to confirm anticipated environmental impacts, if any, and confirm that a Joint Permit Application (JPA) is not required.

A graphic summarizing the recommended alignment and remaining options (three tie-in locations at western terminus; railroad crossing options; and alignment options between Water Street and East High Street) is shown in Figure 25. Estimated overall project cost, presented as a range based on the recommended alignment and remaining options noted above, is presented below in Table 15.

Table 15- Overall Project Cost Estimate of the Recommended Alignments

RWSA Central Water Line Routing - Overall Cost Estimate		
	Subtotal Range	
Item	**Lower Cost**	**Higher Cost**
West Segment (1b, 2b, 3b, 4b, 5b) including 30% Contingency	$ 7,550,000	$ 8,370,000
Middle Segment including 30% contingency	$ 7,500,000	$ 7,500,000
East Segment (1a, 1c) including 30% contingency	$ 9,960,000	$ 10,390,000
Total Cost of Construction	**$ 25,010,000**	**$ 26,260,000**
Engineering Design, Planning, Permitting, and Administration (8%)	**$ 2,000,800**	**$ 2,100,800**
Easement Cost (Based on 30%/10% of Tax-Assessed Land Values)	**$750,000**	**$1,170,000**
Construction Administration & Management (7%)	**$1,750,700**	**$2,100,800**
Total Cost Estimate	**$ 29,510,000**	**$ 31,630,000**

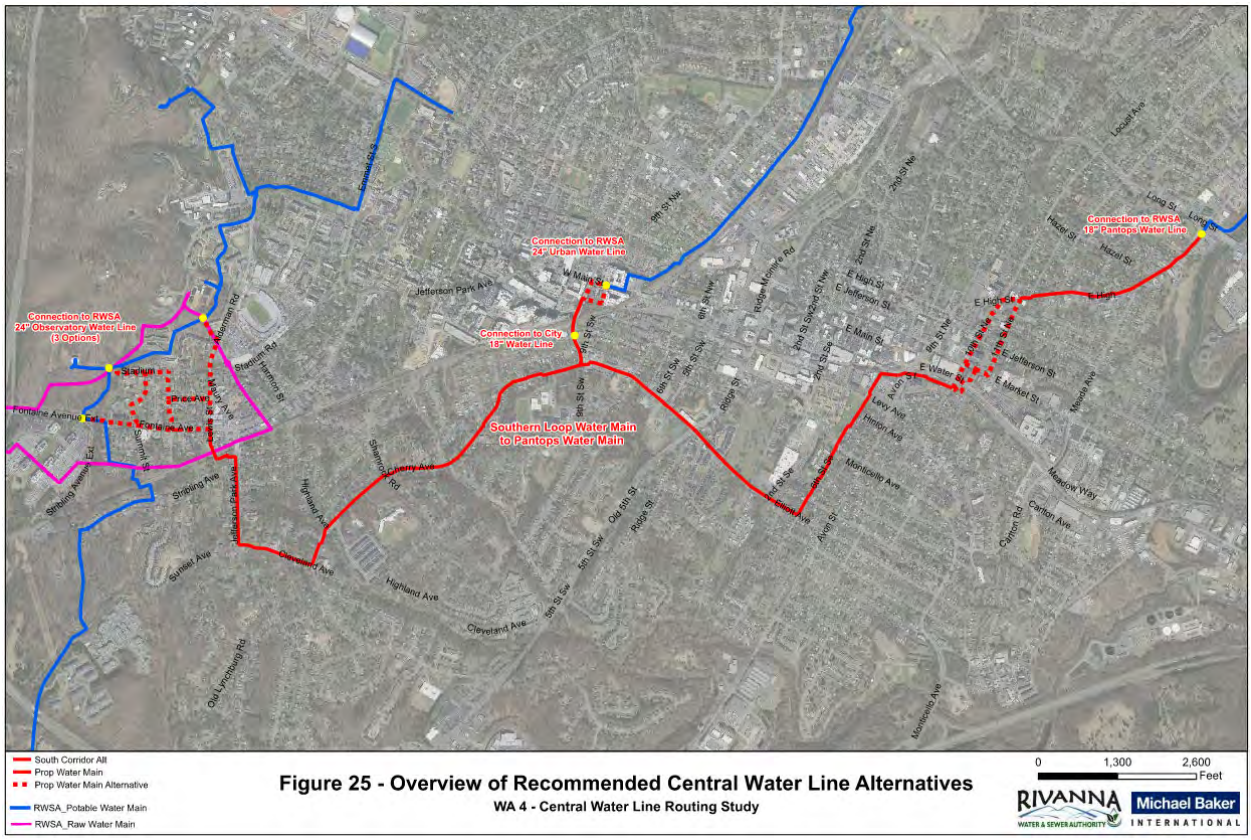


Figure 25 - Overview of Recommended Central Water Line Alternatives