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BROADVIEW ACCESS MANAGEMENT REVIEW

US 211/US17/29 BUS (BROADVIEW AVENUE), WARRENTON, VA

Date:	August 27, 2018	Project #: 21905
To:	Brandie Schaeffer, Town of Warrenton	
From:	Chris Tiesler, PE; Bradley Reynolds, PE; and Andy Butsick, PE	

At the request of the Town of Warrenton, Kittelson & Associates, Inc. (Kittelson) performed a re-evaluation and review of Broadview Avenue access management improvements along US 211/US 17/29 BUS (Broadview Avenue) from south of Frost Avenue to south of Winchester Street in Warrenton, Virginia. The purpose of this assessment is to aid in identifying potential transportation solutions that improve corridor safety, mobility, and multi-modal operations while maintaining business access, accommodating aesthetic enhancements, and supporting economic development. Kittelson reviewed project information, reports and Preliminary Field Inspection (PFI) plans provided by the Town of Warrenton and Virginia Department of Transportation (VDOT).

Kittelson reviewed the following information, reports, and PFI plans:

- Comprehensive Plan 2000 - 2025, Town of Warrenton, June 11th, 2002
- Comprehensive Plan 2040 updates, Town of Warrenton, March 13th, 2018
- Broadview Access Management Study, VDOT, February 2013
- ADA/Access Management/Traffic Assessment Report, VDOT, April 2015
- Intersection Traffic Analysis (Broadview Avenue at Frost Avenue / Waterloo Street), VDOT, September 2015
- Smart Scale Technical Guide, August 2017
- Walkability Audit Report, September 2017
- Complete Streets Report, September 2017
- Broadview Avenue Presentation (Business Owner's Focus Group), VDOT, January 25th, 2018
- Traffic Sampling on Broadview Avenue Memorandum, Town of Warrenton, May 4th, 2018
- VDOT 30 Percent PFI Plans, VDOT, *Received April 4th, 2018*
- VDOT 30 Percent PFI Plans, VDOT, May 14th, 2018

Kittelson's re-evaluation and review of Broadview Avenue access management improvements focused on the following four (4) components:

- Intersection Improvements at Broadview Avenue and Frost Avenue / Waterloo Street
- Access Management Improvements
- Interparcel Connectivity
- Signal Warrant Review at Broadview Avenue and Gold Cup Drive

1.0 INTERSECTION IMPROVEMENTS AT BROADVIEW AVENUE AND FROST AVENUE

At Broadview Avenue and Frost Avenue / Waterloo Street intersection, the following reports, plans, or concepts were reviewed, analyzed, or developed as part of this intersection assessment:

- ADA/Access Management/Traffic Assessment Report, VDOT, April 2015
- Intersection Traffic Analysis (Broadview Avenue at Frost Avenue / Waterloo Street), VDOT, September 2015
- Walkability Audit Report, September 2017
- Complete Streets Report, September 2017
- VDOT 30 Percent PFI Plans, VDOT, May 14th, 2018
- Town of Warrenton Preferred Intersection Concept
- Partial Displaced Left-Turn Intersection Concept

The *ADA/Access Management/Traffic Assessment Report, VDOT, April 2015* and *Intersection Traffic Analysis, VDOT, September 2015* recommended to construct Alternative 2 geometric improvements to provide more safety for pedestrians and access along westbound Frost Avenue, while improving operations at the study intersection. Intersection improvements to mitigate operational deficiencies include:

- Provide signalized southbound dual right-turn lanes on Broadview Avenue.
- Provide signalized northbound dual left-turn lanes on Shirley Avenue.
- Provide pedestrian accommodations based on modified geometry.
- Install median on Broadview Avenue. Provide first median break approximately 425 feet north of intersection for northbound left-turns/U-turns.
- Install median on Shirley Avenue. Provide first median break approximately 250 feet south of intersection for Wawa and Waterloo Station Shopping Center.

The *VDOT 30 Percent PFI Plans, VDOT, May 14th,* 2018 provided designs very similar to Alternative 2 geometric improvements but with the following notable modifications:

- Install median on Broadview Avenue. Provide first median break approximately 800 feet north of intersection for northbound left-turns/U-turns.
- Install median on Shirley Avenue. Provide first median break approximately 600 feet south of intersection for southbound left-turns/U-turns.

Town of Warrenton Preferred Intersection Design

In consultation with the Town of Warrenton's decision makers and staff, the Town's preferred intersection design is consistent with VDOT's recommended Alternative 2 geometric improvements to provide more safety for pedestrians and access along westbound Frost Avenue while improving operations at the study intersection, with minor access break modifications. In **Appendix A**, **Figures 1A**

and 1B illustrate the Town's preferred concept at Broadview Avenue at Frost Avenue. Intersection improvements to mitigate operational deficiencies include (proposed geometric modifications in **bold**):

- Provide signalized southbound dual right-turn lanes on Broadview Avenue.
- Provide signalized northbound dual left-turn lanes on Shirley Avenue.
- Provide pedestrian accommodations based on modified geometry.
- Install median on Broadview Avenue. Provide first median break approximately **400 feet north of intersection for southbound left-turns/U-turns to access Frost properties.**
- Install median on Shirley Avenue. Provide first median break approximately 250 feet south of intersection **for left-in/right-in/right-out access to Wawa. Install driveway island at Wawa to restrict left-out movement.**

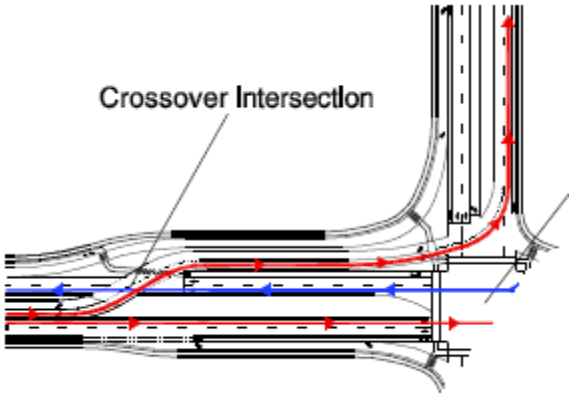
Partial Displaced Left-Turn Intersection Concept

Future traffic volumes and operations of the Broadview Avenue at Frost Avenue / Waterloo Street intersection were reviewed and re-evaluated to identify potential intersection improvements or modifications that can provide safe, efficient, and acceptable operations while maintaining access to businesses.

The VDOT Junction Screening Tool (vJuST) was utilized to screen alternative intersections to assess planning-level feasibility. Based on the initial screening using future 2040 weekday a.m., weekday p.m., and Saturday midday peak hour volumes and a review of the study area intersection, a partial displaced left-turn (DLT) intersection, also referred to as a continuous flow intersection (CFI) appeared to be a competitive improvement option from a congestion, pedestrian, and safety perspective. A DLT was previously screened out in the 2015 VDOT study.

A one-leg partial DLT intersection concept was developed to evaluate its operational feasibility, while considering its footprint, impacts to adjacent businesses, and cost. This concept relocates the Frost Avenue eastbound left-turn movements to the other side of the opposing Frost Avenue eastbound traffic flow and provides a southbound right-turn bypass lane. Crossing over the heavy eastbound left-turns allows this movement to proceed simultaneously with the through movements and eliminates the left-turn phase for this approach (or split phase), thereby reducing the number of existing signal phases. This configuration also reduces the number of conflict points from a conventional intersection, which can result in improved traffic operations and safety performance. The signal green time previously allocated for the left turns under existing conditions could be reallocated, including to accommodate pedestrian crossings.

- Partial DLT (Frost Avenue eastbound approach) – Provide signalized two-phase eastbound dual left-turns in advance of main intersection. Provide signalized dual southbound right-turns via bypass lane. Provide northbound dual left-turns. Restrict westbound left-turn or only allow permitted westbound left-turns. Realign Rappahannock Street as right-in/right-out to right-turn bypass lane. Accommodates pedestrian crossings with protected phasing.



In **Appendix A**, **Figure 2** illustrates the partial displaced left-turn intersection preliminary concept (illustration does not reflect analyzed geometry). **Figure 3** shows an example of a similar partial displaced left-turn intersection at Beechmont Avenue and Five Mile Road in Ohio.

Operational analysis of the future 2040 weekday a.m., weekday p.m., and Saturday midday peak hour volumes were developed for the study intersection in accordance with the Highway Capacity Manual (HCM) for signalized intersections using Synchro 9 and SimTraffic software. Overall, the DLT is projected to operate at LOS B in 2040 for the weekday a.m., weekday p.m., and Saturday peak hours with minimal queues. Comparatively, the DLT provides greatly improved operations and reduced queues over the No-Build condition and the recommended Alternative 2 from the VDOT 2015 study.

Table 1 summarizes the HCM Level of Service (LOS). **Table 2** summarizes the resulting 95th percentile queues based Synchro analysis. **Table 3** provides a general list of DLT advantages and disadvantages for consideration in revaluation. **Appendix B** provides detailed Synchro analysis results and queuing results. **Appendix C** provides vJuST worksheet results.

Table 1. 2040 Capacity Analysis Results

Intersection	Alternative	Weekday AM Peak Hour			Weekday PM Peak Hour			Saturday Midday Peak Hour		
		LOS	Delay (sec.)	v/c	LOS	Delay (sec.)	v/c	LOS	Delay (sec.)	v/c
Broadview Avenue / Frost Avenue / Waterloo Street / W Shirley Avenue	No-Build	E	59.0	0.72	F	192.7	1.44	F	173.9	1.32
	VDOT Alternative 2[1]	D	44.8	0.68	E	55.7	0.83	E	69.9	0.91
	Partial DLT[2]	B	18.1	0.37	B	20.0	0.53	B	19.4	0.45
Frost Avenue / Eastbound DLT Crossover	Partial DLT[2]	B	16.1	0.37	B	14.5	0.67	B	12.8	0.56
Broadview Avenue / Eastbound DLT Crossover	Partial DLT[2]	A	7.8	0.47	A	9.9	0.85	A	9.9	0.88

[1]Includes dual-SBRT lanes and dual-NBLT lanes, as outlined in September 2015 study
[2]Includes partial displaced left-turn intersection with dual-SBRT lanes, dual-NBLT lanes, and restricted westbound left-turns

Table 2. 2040 Peak Hour 95th Percentile Queue Lengths

Alternative	Approach	Lane Group	Storage Available (ft)	95th Percentile Queue Length (ft)		
				AM	PM	SAT
VDOT Alternative 2	EB	L	-	496	539	808
		LT	-	481	483	755
		R	605	-	-	507
	WB	LT	290	164	355	216
		T	-	111	303	165
		R	225	64	88	111
	NB	L	500	197	504	212
		T	-	259	356	257
		R	-	226	348	234
	SB	L	250	174	202	265
		T	-	217	347	228
		R	400	-	355	206
Partial DLT	EB	L	350	102	222	275
		T	-	138	105	104
		R	605	44	8	45
	WB	T	-	41	125	60
		R	225	31	51	51
	NB	L	500	93	155	113
		TR	-	144	231	216
	SB[1]	L	250	337	332	361
		T	-	117	232	180
		R	-	-	-	-

[1]Cumulative SB queues between main intersection and adjacent DLT intersection

Table 3. Summary of DLT Advantages and Disadvantages*

Advantages	Disadvantages
Non-Motorized Users	
Bicycles and pedestrians can be accommodated at-grade	Pedestrians may require 2-stage crossings
Bicyclists have refuge (room for bicycle box) in making two-stage left turns	Some indirect movements may be necessary for pedestrians
	Longer pedestrian crossings
	Unique challenges for visually impaired pedestrians
Safety	
Fewer conflict points than interchanges (ramp terminals, exit/entrance ramps) and conventional intersections	Drivers may be less familiar with intersection
Lower delay and fewer stops on major street could reduce rear-end crash rates	Potential for wrong-way movements
	Issues with signal in flashing mode / going dark
Operations	
Increase in lane-by-lane capacity due to efficient 2-phase or 3-phase signal operation	Complex signal operations
Compatible with high-volume turning movements	Pedestrian crossing time and phasing may limit cycle length flexibility
More green time for major movements offers better progression when used as a corridor solution	Potential for additional user delay during off-peak periods
	No right-turn on red without bypass right-turn lane
Access Management	
Compatible with access-restricted corridors	May change ingress/egress patterns to corner businesses or development
	Medians and wide separators required
Cost and Right-of-Way Impact	
Smaller footprint than interchange	Required right of way likely larger than conventional intersection
Lower cost than interchange	More traffic signals, pavement, curbs and median/refuge islands

*Exhibit 2-6, FHWA Displaced Left Turn Intersection Informational Guide, August 2014

While a one-leg partial DLT intersection concept provides certain advantages, this alternative intersection design is not recommended for further study or implementation at this location due to the disadvantages and the ability of conventional geometric improvements to meeting desired project goals.

2.0 ACCESS MANAGEMENT IMPROVEMENTS

The *ADA/Access Management/Traffic Assessment Report, VDOT, April 2015* provided access management recommendations and indicated the proposed improvements of installing a raised median with left-turn lanes at the median openings and intersections, capacity improvements at Frost Avenue / Waterloo Street, driveway and turning movement restrictions, and improving pedestrian and bicycle accommodations will effectively improve safety along the corridor. In general, the study recommended the following:

- Installation of medians – A total of 10 median breaks within the Broadview Avenue study corridor, the same number of median breaks proposed in the *Broadview Access Management Study, VDOT, February 2013.*
- Installation of left-turn lanes.
- Turning movement restrictions.
- Driveway access restrictions.
- Improved lighting.
- Improved pedestrian and bicycle facilities – Improved sidewalk, ADA facilities, and 5' bike lanes.
- Driveway consolidation (4 driveways consolidated).
- U-turn geometry to accommodate passenger cars.
- Restrict Broadview Avenue at Gold Cup Drive / Stuyvesant Street to left-in/right-in/right-out.
- Restrict Broadview Avenue at Old Broadview Avenue / Roebling Street to left-in/right-in/right-out.
- Install marked uncontrolled pedestrian crossing between Gold Cup Drive and Stuyvesant Street intersections.
- South of Frost Avenue, median break to access Wawa and Waterloo Station Shopping Center.

Since completion of the 2015 study, VDOT's most recent 30 Percent PFI Plan is dated May 14th, 2018. This plan is similar to the 2015 study but has the following general modifications:

- A total of 9 median breaks from 10 (removal of the median break at Burger King and Frost Diner) with two median breaks no longer shown with back-to-back left-turns.
- Removed uncontrolled pedestrian crossing between Gold Cup Drive and Stuyvesant Street intersections.
- South of Frost Avenue, removed median break to access Wawa and Waterloo Station Shopping Center and extended median further south to Fox Den Antique Mall.
- Restricted all median breaks to directional left-in/right-in/right-out.

Town of Warrenton Preferred Access Management Concept

Overall, the VDOT 30% PFI Plan design approach is an appropriate traffic engineering solution to improve safety, mobility, and operations but can be in conflict with local interests and business access. The Broadview corridor includes unique challenges such as a high-volume corridor, local versus thru trips, corridor travel speeds, maintaining acceptable business access, right-of-way constraints, lack of interconnectivity, numerous driveway cuts, intersection spacing limitations, U-turn design vehicle

accommodations, bicycle accommodations, pedestrian crossing accommodations, and maintaining the Town's vision of this corridor.

In consultation with the Town of Warrenton's decision makers and staff, Kittelson has prepared an access management concept plan reflective of the Town of Warrenton's preferred concept that modifies VDOT's plan to provide a four-lane facility with landscape medians and center two-way left-turn lanes (CTWLTL) and buffered bike lanes along the Broadview Avenue corridor. This conceptual plan attempts to incorporate developed design studies and established project goals, as detailed in the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, along with the Town of Warrenton's vision for the corridor and complete street initiatives by implementing the following:

- Installation of medians and center two-way left-turn lanes – A total of approximately 8 median breaks/CTWLTL segments within the Broadview Avenue study corridor, a similar number of median breaks proposed in the *Broadview Access Management Study, VDOT, February 2013.*
- Installation of left-turn lanes.
- Turning movement restrictions.
- Driveway access restrictions.
- Installation of two segments of CTWLTL. The southern segment is approximately 650' in length from Station 128+50 to Station 134+50. The northern segment is approximately 450' in length from Station 151+00 to Station 155+50.
- Improved lighting.
- Improved pedestrian and bicycle facilities – Improved sidewalk, ADA facilities, buffered bike lanes, and on-road bike lane to sidewalk transitions.
- Install two (2) marked controlled pedestrian crossings (i.e. Pedestrian Hybrid Beacon) with median refuge islands. Install Pedestrian Hybrid Beacons between Gold Cup Drive and Stuyvesant Street intersections and at Chappel Street, approximately 900 feet apart.
- U-turn geometry to accommodate passenger cars.
- South of Frost Avenue, provide median break for left-in/right-in/right-out access to Wawa. Install driveway island at Wawa to restrict left-out movement.
- Provide median break for left-in/right-in/right-out access to Frost properties approximately 400 feet north of Frost Avenue. Align access for future cross connectivity to Sullivan Street.
- Provide left/U-turn median break approximately 700 feet north of Frost Avenue for properties in southwest quadrant of Broadview Avenue corridor.
- Maintain full movement access on Broadview Avenue at Church Street, Gold Cup Drive, and Stuyvesant Street. Monitor intersections for signal warrants and future signalization.
- Restrict Broadview Avenue at Chappel Street to left-in/right-in/right-out.
- Restrict Broadview Avenue at Old Broadview Avenue / Roebling Street to left-in/right-in/right-out.
- Reduce the posted speed limit on Broadview Avenue from 40 mph to 35 mph in the corridor study area.

In **Appendix A**, **Figure 1A** comparatively illustrates three (3) concepts: 1) Town of Warrenton's preferred concept, 2) VDOT's 30% PFI Plan (dated May 14th, 2018), and 3) VDOT's previous

recommended geometric improvements concept per the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, by Wallace Montgomery. **Figure 1B** illustrates the Town of Warrenton's preferred concept.

Exhibit 1. Cross-Section Concept with Landscaped Medians with Openings and Buffered Bike Lanes

Posted Speed Limit

The Town's preferred access management concept proposes a reduction in the speed limit on Broadview Avenue from 40 mph to 35 mph. Per the Complete Streets Report, September 2017, Broadview Avenue is a Boulevard Street and serves as a Gateway Street, serving as a point of transition for the way in which different modes of transportation are accommodated and to encourage a change in travel behavior. Gateway Streets provide street treatments that instill the changing context of the street from a higher speed, rural character to a slower speed, urban character where pedestrians and bicyclists can be expected.

Based on available data, per the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, a spot speed study indicated that the 85th percentile speed does not exceed the posted speed limit of 40 mph and shall be considered as both the posted and design speed for proposed improvements. A traffic sampling memo dated May 4, 2018, indicates average travel speeds on Broadview Avenue were generally 40 mph and that four of six 85% speeds were higher than 45 mph.

As part of the Town's preferred concept and vision for the corridor as a complete street Boulevard, consideration should be given to lowering the posted speed limit from 40 mph to 35 mph in the Broadview Avenue corridor study area.

Center Two-Way Left-Turn Lanes

The Town's preferred access management concept proposes two segments of center two-way left-turn lanes to maintain full movement access for multiple businesses along the corridor. To help inform the location of CTWLTL's, Broadview Avenue crash data from the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, was reviewed. Per the crash data, the majority of crashes occur at the southern end of corridor between Frost Avenue and Church Street and at the northern end of the corridor at Roebling Street and Business US 17. Therefore, in these areas of highest crash frequency, medians and channelized turn lanes are recommended. CTWLTL segments are proposed in the areas with fewer reported crashes and away from existing major signalized intersections.

Pedestrian Crossings

The Town's preferred access management concept proposes installation of two (2) marked controlled pedestrian crossings (i.e. Pedestrian Hybrid Beacon) with median refuge islands. The Pedestrian Hybrid Beacons are located between Gold Cup Drive and Stuyvesant Street intersections and at Chappel Street, approximately 900 feet apart. These crossings are intended to allow pedestrians and bicyclists to stop traffic to cross high volume arterial streets, like Broadview Avenue, where it is necessary to provide assistance to safely cross.

Maple Avenue Corridor Example

The Town of Vienna's Maple Avenue in the urban core provides a comparable example of the Town of Warrenton's vision for the Broadview Avenue corridor. While these two corridors are different, they share many similarities. Both corridors are urban principal arterials, four-lane facilities with continuous left-turn lanes and raised medians at the ends of both corridors, serve over 30,000 ADT, serve local and regional trips, serve multimodal trips, serve local businesses, serve nearby schools, have many driveway access points, have existing sidewalk, experience bicycle and pedestrian traffic, and have right-of-way constraints. Maple Avenue is different in that it is a continuous five-lane undivided section with a 30 mph speed limit, pedestrian hybrid beacons, signalized intersections throughout the corridor, and a more connected roadway network. Per the Town of Vienna's Comprehensive Plan, transportation goals include provide efficient and reliable movement for all transportation modes, manage impact of regional and local traffic, maximize safety and dependability, encourage people to walk and bicycle, reduce congestion, manage effects of regional development and travel trends. The Plan provides transportation choices for residents, employees, visitors, and firms doing business in Vienna, with a balanced multimodal transportation system to support neighborhood livability and economic development.

Exhibit 2. Maple Avenue Corridor at Washington and Old Dominion Trail, Vienna, VA

Source: Google Maps

3.0 INTERPARCEL CONNECTIVITY

Interparcel vehicular connections provide a number of benefits to drivers, businesses, and highway operations. Some of the benefits include allowing vehicles to access adjacent land uses without having to access the highway, maximizing the use of unsignalized intersections, and providing access to signalized intersections. The Broadview Avenue corridor, from south of Frost Avenue to south of Winchester Street, has poor overall interparcel connectivity with a majority of businesses not providing cross access. The following comments provide a general assessment of interparcel interconnectivity along the corridor, divided up into four segments:

- Southwest (West of Broadview Avenue between Gold Cup Drive and Frost Avenue)
    - Limited cross access, shared access, and on-site circulation.
    - Key interparcel connection opportunities between Foster's Grille and Burger King, Burger King and Auto Plus Auto Parts, and Subway to Oak View National Bank to Sherwin-Williams.
    - Barriers for enhanced interconnectivity are between Warrenton Foreign Car and El Toro, Sherwin-Williams and Murphy's Motorsports, and Rappahannock Street neighborhood.
- Southeast (East of Broadview Avenue between Stuyvesant Street and Waterloo Street)
    - Limited cross access, shared access, and on-site circulation.
    - Sullivan Street and Church Street provide additional access and roadway connectivity benefits for drivers, businesses, and highway operations.
    - Roadway connectivity, and interconnectivity, would be enhanced if Sullivan Street connected to Stuyvesant Street.
    - Key interparcel and roadway connectivity opportunities exist with the Frost properties. Evaluate opportunities to maintain access and create future connection from Broadview Avenue to Sullivan Street.
- Northwest (West of Broadview Avenue between Roebling Street and Gold Cup Drive)
    - Limited cross access, shared access, and on-site circulation.
    - Norfolk Drive and residential neighborhood provides barrier to additional roadway connectivity.
- Northeast (East of Broadview Avenue between Roebling Street and Stuyvesant Street)
    - Limited cross access, shared access, and on-site circulation.
    - Jackson Street, Stuyvesant Street, Chappell Street, and Roebling Street provide additional access and roadway connectivity benefits for drivers, businesses, and highway operations. Benefit is limited due to residential units accessing Jackson Street.

Overall, this corridor has many individual businesses with multiple driveway cuts and no or limited cross access. The existing limited roadway connectivity, high number of individual lots/driveways, and adjacent residential abutting to commercial development, make it very challenging to retrofit interparcel connectivity into the corridor without major redevelopment or access modifications. In **Appendix A**, Figure 4 illustrates interconnectivity opportunities and interconnectivity barriers for the southwest segment of the corridor and Frost Properties in the southeast segment of the corridor.

4.0 SIGNAL WARRANT REVIEW AT BROADVIEW AVENUE AND GOLD CUP DRIVE

In the *Intersection Traffic Analysis (Broadview Avenue at Frost Avenue / Waterloo Street), VDOT, September 2015*, signal warrant analyses were performed at the following five unsignalized intersections in accordance to the 2011 Virginia Manual on Uniform Traffic Control Devices (VaMUTCD):

- Broadview Avenue at Church Street
- Broadview Avenue at Gold Cup Drive
- Broadview Avenue at Stuyvesant Street
- Broadview Avenue at Chappell Street
- Broadview Avenue at Roebling Street / Old Broadview Avenue

The Broadview Avenue at Roebling Street / Old Broadview Avenue intersection was the only location that met one signal warrant (eight-hour vehicle volume). However, this location would not meet any signal warrants if right turns were separated from the shared through and left-turn movements or the minor streets were restricted to right-turns only.

2018 Traffic Volumes at Broadview Avenue and Gold Cup Drive

Design year 2018 traffic volumes from the 2018 VDOT Signal Warrant Analysis report were used to determine whether a traffic signal is warranted at the Broadview Avenue/Gold Cup Drive intersection. **Table 4** shows the volume profile for the intersection from the VDOT study.

Table 4. Design Year 2018 Volume Profile – Broadview Avenue/Gold Cup Drive

Hour Beginning	Total Approach Volume[1]			
	Northbound (Broadview Avenue)	Southbound (Broadview Avenue)	Eastbound (Gold Cup Drive)	Westbound (Private Driveway)
6:00 AM	910	555	42	0
7:00 AM	1,192	802	53	0
8:00 AM	1,026	870	36	2
9:00 AM	941	787	36	1
10:00 AM	965	909	46	1
11:00 AM	1,118	1,054	41	2
12:00 AM	1,117	1,134	34	1
1:00 PM	991	1,108	42	0
2:00 PM	1,090	1,304	41	0
3:00 PM	1,002	1,481	33	1
4:00 PM	1,082	1,634	34	3
5:00 PM	994	1,549	50	0
6:00 PM	892	568	31	0

[1]Volumes obtained from Appendix A of 2018 VDOT Signal Warrant Analysis Report

Signal warrants found in the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) are evaluated below.

Warrant 1 – Eight-Hour Vehicle Volume

Warrant 1 determines the need for a traffic signal based on conditions for each of any eight hours of an average day. Two conditions, Condition A and Condition B, can be evaluated, and the warrant is considered met if either one is met.

The eight highest hours were determined through eight-hour turning movement counts collected at Elden Street and Dulles Park Shopping Center. Mid-week, hourly traffic volumes were used for the analysis. Because the posted speed limit on Broadview is above 40 mph, the warranting volume thresholds for Warrants 1A and 1B are considered using the 70 percent thresholds (per MUTCD Section 4C.02).

Table 5 below summarizes the comparison of intersection volumes to the volume thresholds for MUTCD Warrants 1A and 1B. As shown, the major street hourly volumes exceed the Warrant 1A threshold of 420 vehicles-per-hour for all 13 hours of the study period; however, the minor street volumes do not meet the 105 vehicles-per-hour threshold during any of the hours. Similarly, the major street volumes exceed the Warrant 1B threshold of 630 vehicles-per-hour, but the minor street threshold of 53 vehicles is only met during one hour during the study period. Further, the optional thresholds for considering the combination of Conditions A and B after adequate trial or other remedial measures are not met. Therefore, the vehicular volumes at Broadview Avenue/Gold Cup Drive do not satisfy the requirements for signal Warrant 1A or Warrant 1B.

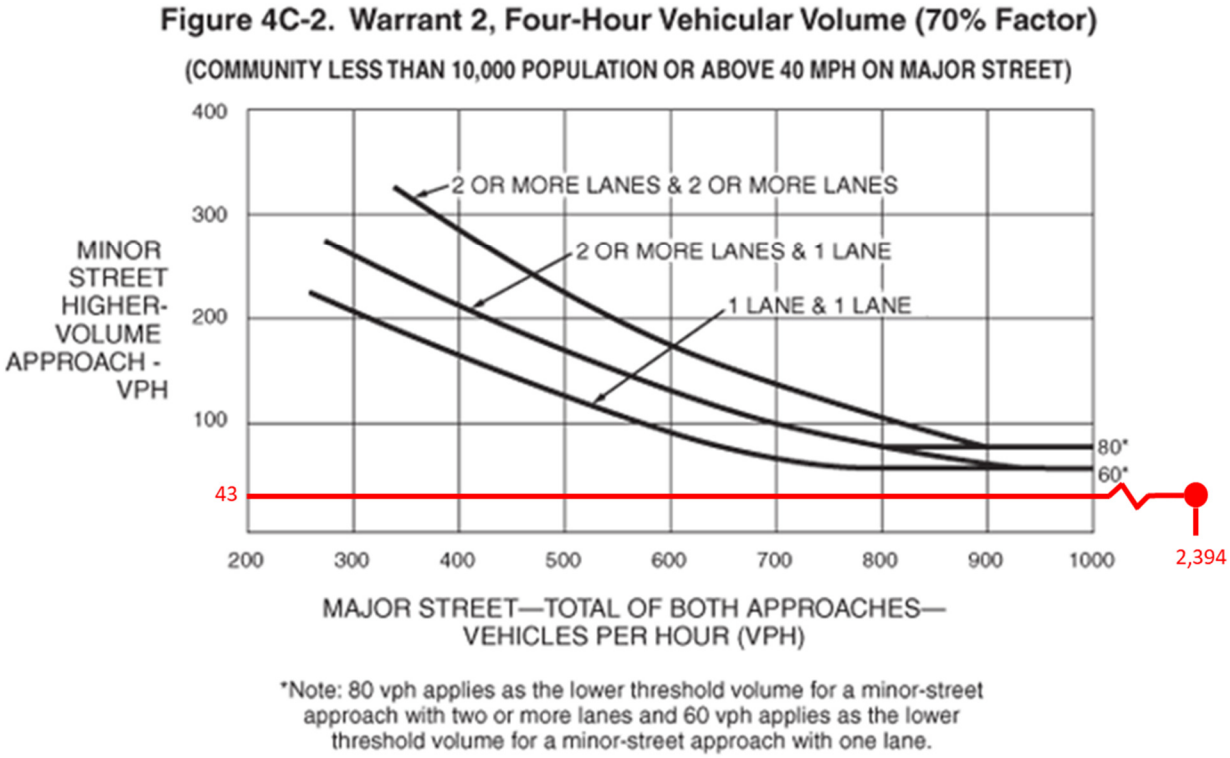
Table 5. Warrant 1A and Warrant 1B Evaluation (Eight Hour Vehicular Volume) – Broadview Avenue/Gold Cup Drive

			Warrant 1A Volume Thresholds (70%) [vph]	Warrant 1B Volume Thresholds (70%) [vph]
		Major Street (both directions):	420	630
		Minor Street (peak direction only):	105	53
Hour Beginning	**Major Street Volumes [vph] (both directions)**	**Minor Street Volumes [vph] (peak direction only)**	**Warrant 1A Met?**	**Warrant 1B Met?**
6:00 AM	1,465	42	No	No
7:00 AM	1,994	53	No	**Yes**
8:00 AM	1,896	36	No	No
9:00 AM	1,728	36	No	No
10:00 AM	1,874	46	No	No
11:00 AM	2,172	41	No	No
12:00 AM	2,251	34	No	No
1:00 PM	2,099	42	No	No
2:00 PM	2,394	41	No	No
3:00 PM	2,483	33	No	No
4:00 PM	2,716	34	No	No
5:00 PM	2,543	50	No	No
6:00 PM	1,460	31	No	No
		Total Hours Met	0	1

Warrant 2 – Four-Hour Vehicular Volume

In accordance with the MUTCD, *Warrant 2, Four-Hour Vehicular Volume* is to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic signal. The warrant requires that any four (4) hours (i.e., the 4th highest hourly volume) on an average day plotted on the applicable curve to determine the need for a traffic signal. **Exhibit 3** shows the 4th highest hour volumes plotted on Figure 4C-1 of the MUTCD.

Exhibit 3. Warrant 2 (Four-Hour Vehicular Volume) – Broadview Avenue/Gold Cup Drive



As shown in **Exhibit 3**, the 4th highest hour volumes do not exceed the minimum thresholds and do not warrant a traffic signal.

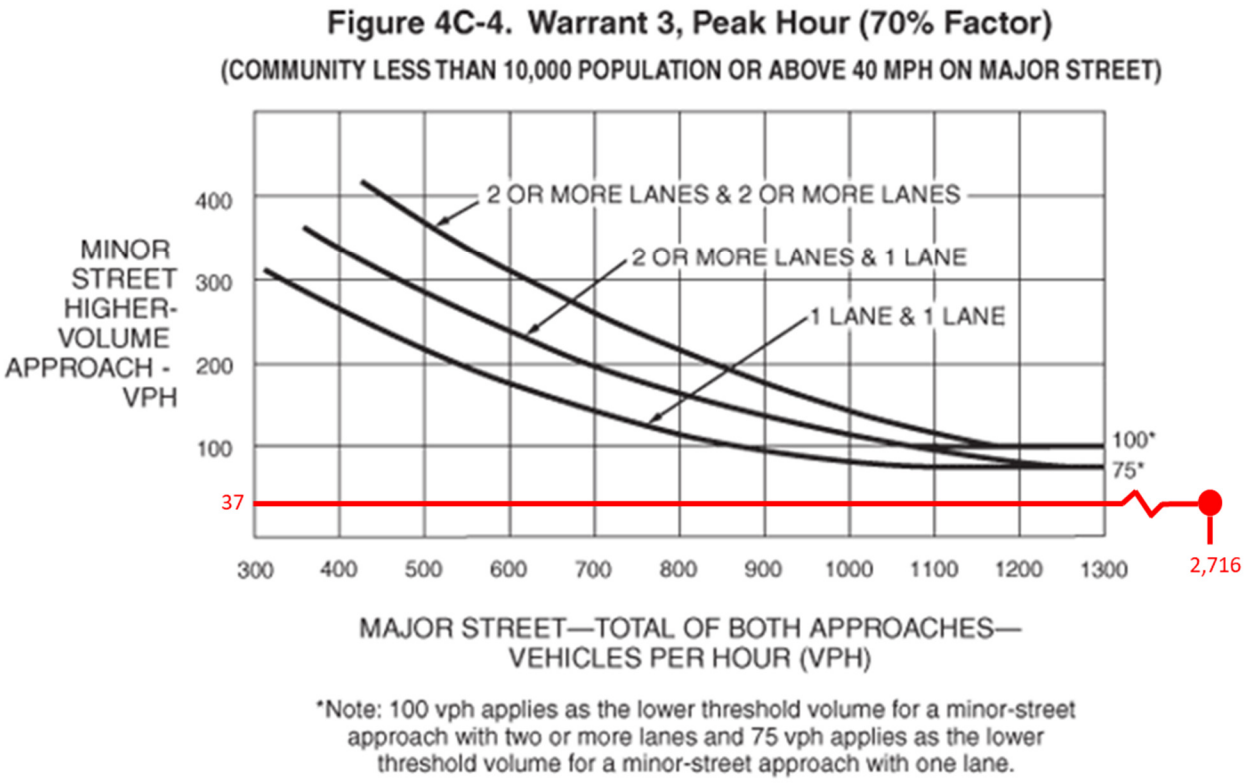
Warrant 3 – Peak Hour

Warrant 3 is intended for used at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

While VDOT does not commonly apply this warrant as the primary basis for justifying a signal, its evaluation is provided as additional support of Warrants 1 and 2.

Error! Reference source not found.**4** shows the peak hour volumes as plotted on Figure 4C-3 of the MUTCD.

Exhibit 4. Warrant 3 (Peak Hour Volume Volume) – Broadview Avenue/Gold Cup Drive



As shown in **Exhibit 4**, peak hour volumes do not exceed the minimum thresholds for an intersection with a one-lane minor street and do not warrant a traffic signal.

Warrant 4 – Pedestrian Volume

Warrant 4 is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. Because the posted speed limit on Broadview is above 35 mph, the warranting volume thresholds for Warrant 4 are considered using the 70 percent thresholds (per MUTCD Section 4C.05).

For the 4th highest hour volume of 1,000 vehicles-per-hour on the major street, 75 pedestrians-per-hour (PPH) is required to meet the signal warrant threshold. As illustrated in the April 2015 VDOT Broadview Avenue Access Management Improvements report, only five (5) pedestrians were observed crossing Broadview Avenue at Gold Cup Drive during a single weekday. Therefore, the intersection does not meet the minimum requirements under Warrant 4 for a traffic signal.

Warrant 5 – School Crossing

Warrant 5 is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

The nearest school in the area, Fauquier High School to the southwest is approximately 0.7 miles away, and major street crossing volumes suggest that pedestrian traffic is not influenced by the school.

Engineering judgement concludes that the intersection does not meet the requirements for Warrant 5.

Warrant 6 – Coordinated Signal System

Warrant 6 determines justification of a traffic signal where progressive movement in a coordinated system necessitates installation of traffic control where they would not otherwise be needed to maintain proper platooning of vehicles.

To help quantify the potential coordinatability of a traffic signal at the Broadview Avenue/Gold Cup Drive with the existing signals at Broadview Avenue/Lee Highway/Winchester Avenue and Broadview Avenue/Frost Avenue/West Shirley Avenue/Waterloo Street, the proprietary *coordinatability factor* (CF) in Synchro was evaluated. Based on a scale of zero to 100, the Synchro coordinatability factor is based on factors such as travel time, signal spacing, link volume, vehicle platooning, vehicle queueing, and natural cycle length. A coordinatability factor less than 20 generally indicate coordination is not desirable, while values greater than 80 indicate coordination is critical to avoid blocking issues. A coordinatability factor between those thresholds (i.e., greater than 20 and less than 80) indicates coordination may be desirable. Table 6 illustrates the coordinatability factors for the weekday a.m. and weekday p.m. peak hours at the Broadview Avenue/Gold Cup Drive intersection.

Table 6. Synchro Coordinatability Factor – Broadview Avenue/Gold Cup Drive

Analysis Period	Coordinatability Factor With:	
	Broadview Avenue/Lee Highway/Winchester Street	Broadview Avenue/ Frost Avenue/West Shirley Avenue/Waterloo Street
Weekday AM Peak Hour	31	71
Weekday PM Peak Hour	47	89

As shown, developing coordination in the southbound direction between the Broadview Avenue/Gold Cup Drive and Broadview Avenue/Frost Avenue/West Shirley Avenue/Waterloo Street intersections is desirable with regards to platooning and progressing traffic along the corridor.

Warrant 7 – Crash Experience

Warrant 7 is intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Upon review of the crash data summarized in the April 2015 VDOT Broadview Avenue Access Management Improvements report, conditions do not meet the requirements for Warrant 7, Crash Experience.

Warrant 8 – Roadway Network

Warrant 8 determines justification of a traffic signal where the concentration and organization of traffic flow is encouraged on a roadway network.

To meet Warrant 8, the major street must meet at least one of the following characteristics:

- It is part of the street or highway system that serves as the principal roadway network for through traffic flow.
- It includes rural or suburban highways outside, entering, or traversing a city.
- It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

Gold Cup Drive, classified as a local roadway, does not meet these requirements. As such, the intersection does not meet Warrant 8.

Warrant 9 – Intersection Near a Grade Crossing

In accordance with the MUTCD, Warrant 9 is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

These conditions are not present in areas immediately surrounding the Broadview Avenue/Gold Cup Drive intersection; the intersection does not meet the requirements for Warrant 9.

Traffic Signal Considerations

While a traffic signal may not be warranted at Gold Cup Drive or other individual intersection locations, these intersections should continue to be monitored for signal warrants and potential signalization. Additional benefits of considering traffic signals at select locations along the Broadview Avenue corridor include:

- Traffic progression – While traffic signals are not installed to control speed, two or more adjacent traffic signals can be coordinated as a system to progress traffic at a posted or desired speed. For these types of signal systems, it is counterproductive to exceed the speed limit.
- Traffic gaps – Traffic signals create gaps in traffic that allow for downstream minor street turning movements or major street left-turns or U-turns. With a projected AADT of approximately 40,000 in 2040, gaps in traffic will be increasingly difficult to find and navigate safely.
- Traffic weaving – In an access management scenario, traffic signals create gaps in traffic that should allow for safer and more efficient cross weaving maneuvers.
- U-turns – In an access management scenario, traffic signals may be necessary to safely accommodate the U-turn of a design vehicle.
- Signal Phasing – Two-phase and three-phase signals along a corridor can operate efficiently and in relatively close proximity while providing corridor mobility, safety, progression, and multimodal accommodations.
- Pedestrians and bicycles crossings – Traffic signals can have the added benefit of providing protected pedestrian and bicycle crossings at full movement, directional left-turn, or U-turn intersections.

5.0 SUMMARY AND CONCLUSION

Kittelson's re-evaluation and review of Broadview Avenue access management improvements along US 211/US 17/29 BUS (Broadview Avenue) from south of Frost Avenue to south of Winchester Street in Warrenton, Virginia provides the following summary and conclusion.

<u>Intersection Improvements at Broadview Avenue and Frost Avenue / Waterloo Street</u>

The Town's preferred intersection design is consistent with VDOT's recommended Alternative 2 geometric improvements to provide more safety for pedestrians and access along westbound Frost Avenue while improving operations at the study intersection. Intersection improvements to mitigate operational deficiencies include (proposed geometric modifications in **bold**):

- Provide signalized southbound dual right-turn lanes on Broadview Avenue;
- Provide signalized northbound dual left-turn lanes on Shirley Avenue;
- Provide pedestrian accommodations based on modified geometry;
- Install median on Broadview Avenue. Provide first median break approximately **400 feet north of intersection for southbound left-turns/U-turns to access Frost properties.**

- Install median on Shirley Avenue. Provide first median break approximately 250 feet south of intersection **for left-in/right-in/right-out access to Wawa. Install driveway island at Wawa to restrict left-out movement.**

Access Management Improvements

In coordination with the Town of Warrenton, Kittelson has prepared an access management concept plan that modifies VDOT's plan to provide a four-lane facility with landscape medians and center two-way left-turn lanes (CTWLTL) and buffered bike lanes along the Broadview Avenue corridor. The Town's preferred access management concept attempts to incorporate developed design studies and established project goals, as detailed in the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, along with the Town of Warrenton's vision for the corridor and complete street initiatives. Notable differences in the Town's preferred concept versus VDOT's 30 Percent PFI Plan include center two-way left turn lanes in two sections, pedestrian crossings, buffered bike lanes, modified median breaks and restricted driveway access, and consideration of a reduced posted speed limit. Additional concept details are listed in **Section 2**. This concept references the Town of Vienna's Maple Avenue as a comparable example of the Town of Warrenton's vision for the Broadview Avenue corridor.

In **Appendix A**, **Figure 1A** comparatively illustrates three (3) concepts: 1) Town of Warrenton's preferred concept, 2) VDOT's 30% PFI Plan (dated May 14th, 2018), and 3) VDOT's previous recommended geometric improvements concept per the ADA/Access Management/Traffic Assessment Report, VDOT, April 2015, by Wallace Montgomery. **Figure 1B** illustrates the Town of Warrenton's preferred concept.

Interparcel Connectivity

Overall, this corridor has many individual businesses with multiple driveway cuts and no or limited cross access. The existing limited roadway connectivity, high number of individual lots/driveways, and adjacent residential abutting to commercial development, make it very challenging to retrofit interparcel connectivity into the corridor without major redevelopment or access modifications. In **Appendix A**, Figure 4 illustrates interconnectivity opportunities and interconnectivity barriers for the southwest segment of the corridor and Frost Properties in the southeast segment of the corridor.

Signal Warrant Review at Broadview Avenue and Gold Cup Drive

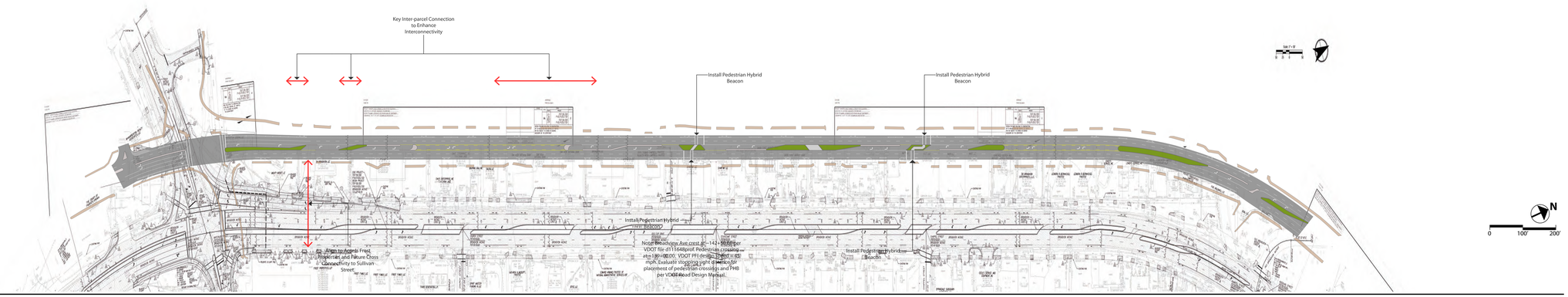
While a traffic signal may not be warranted at Gold Cup Drive or the other four intersection locations evaluated, these intersections should continue to be monitored for signal warrants and potential signalization.

In conclusion, this re-evaluation and review provides a comparison of similar designs and the Town of Warrenton's preferred concepts for VDOT's consideration in the design of the Broadview Avenue corridor project.

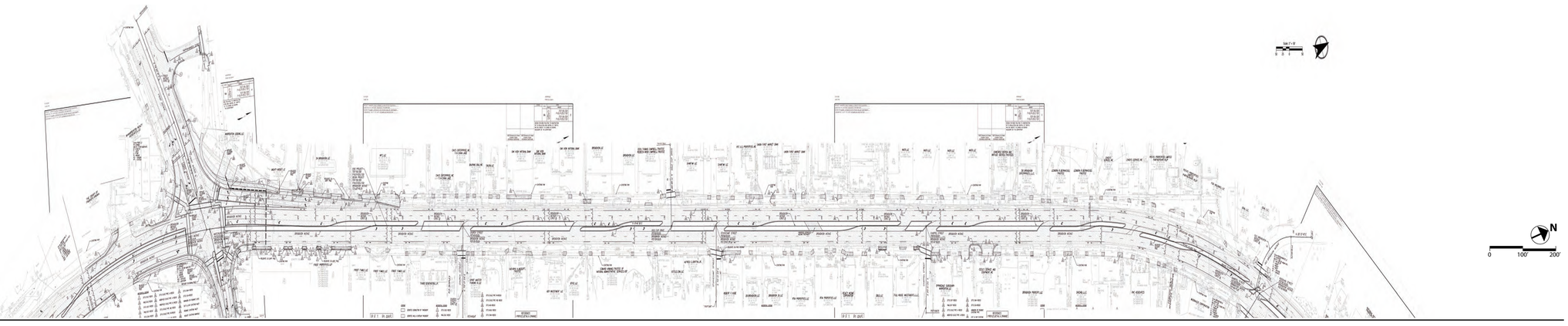
Appendix A
Figures

Town Concept Overlay on VDOT Concept

FIGURE 1A



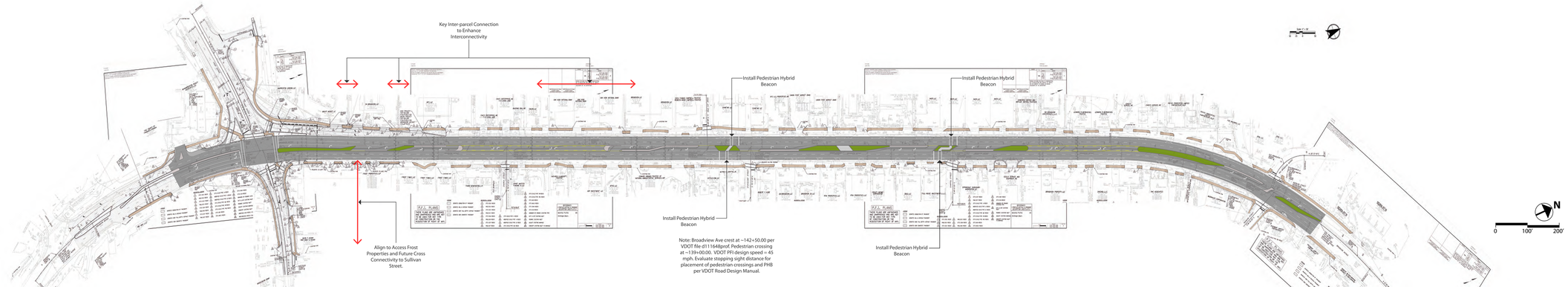
VDOT Concept (May 2018)

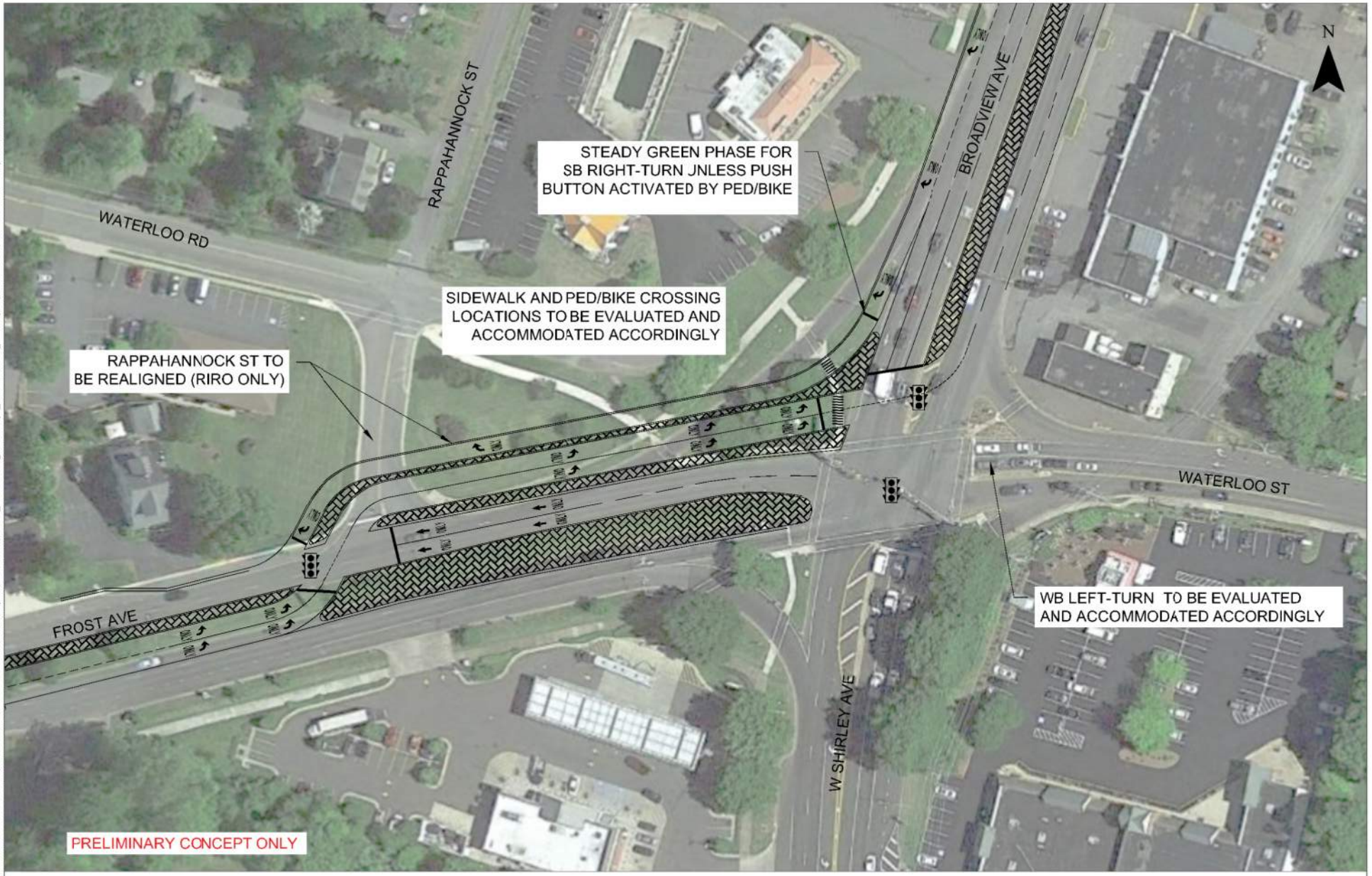


VDOT / WM Concept (April 2015)

Town Concept Overlay on VDOT Concept

FIGURE 1B

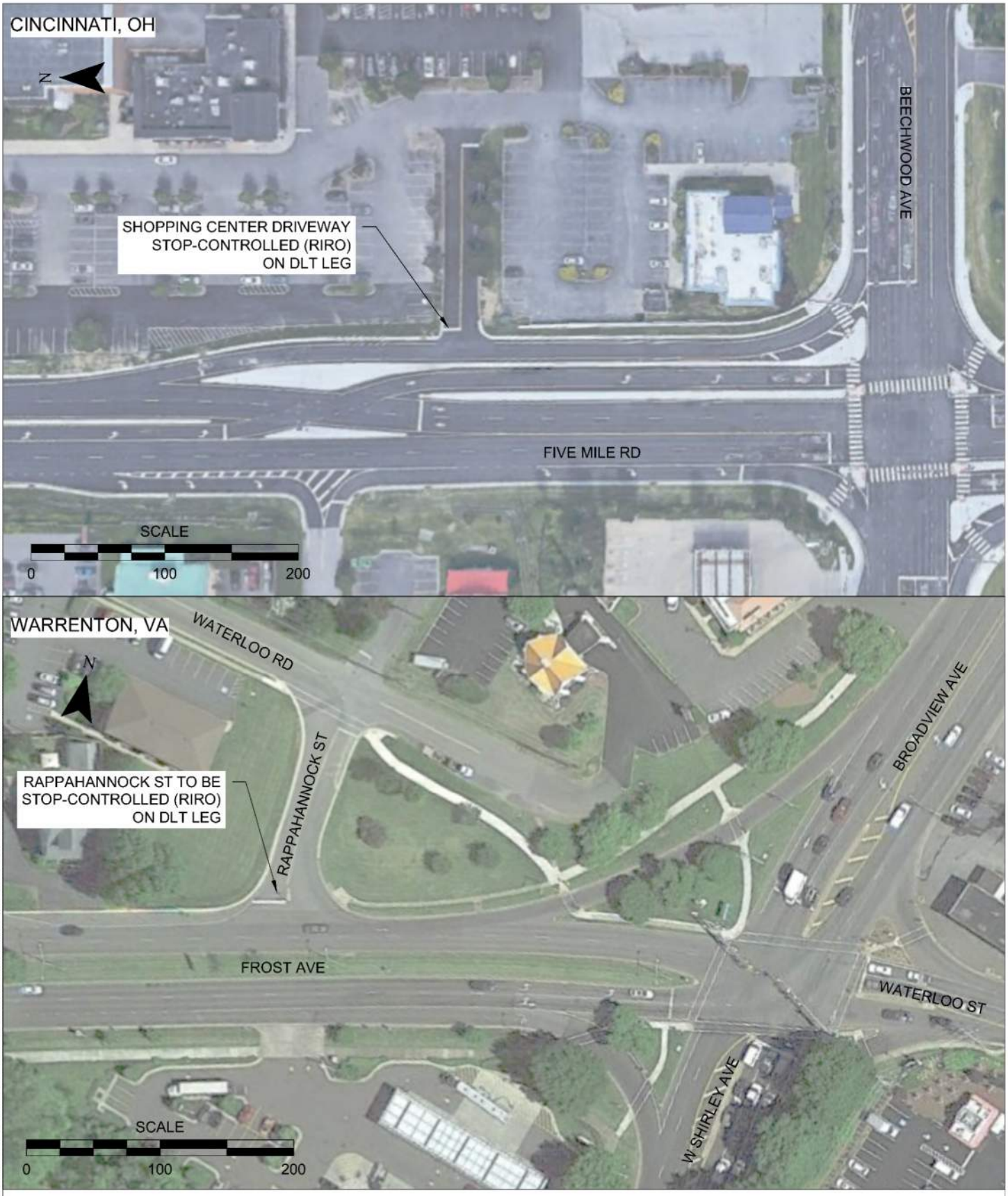




SCALE
0 100 200

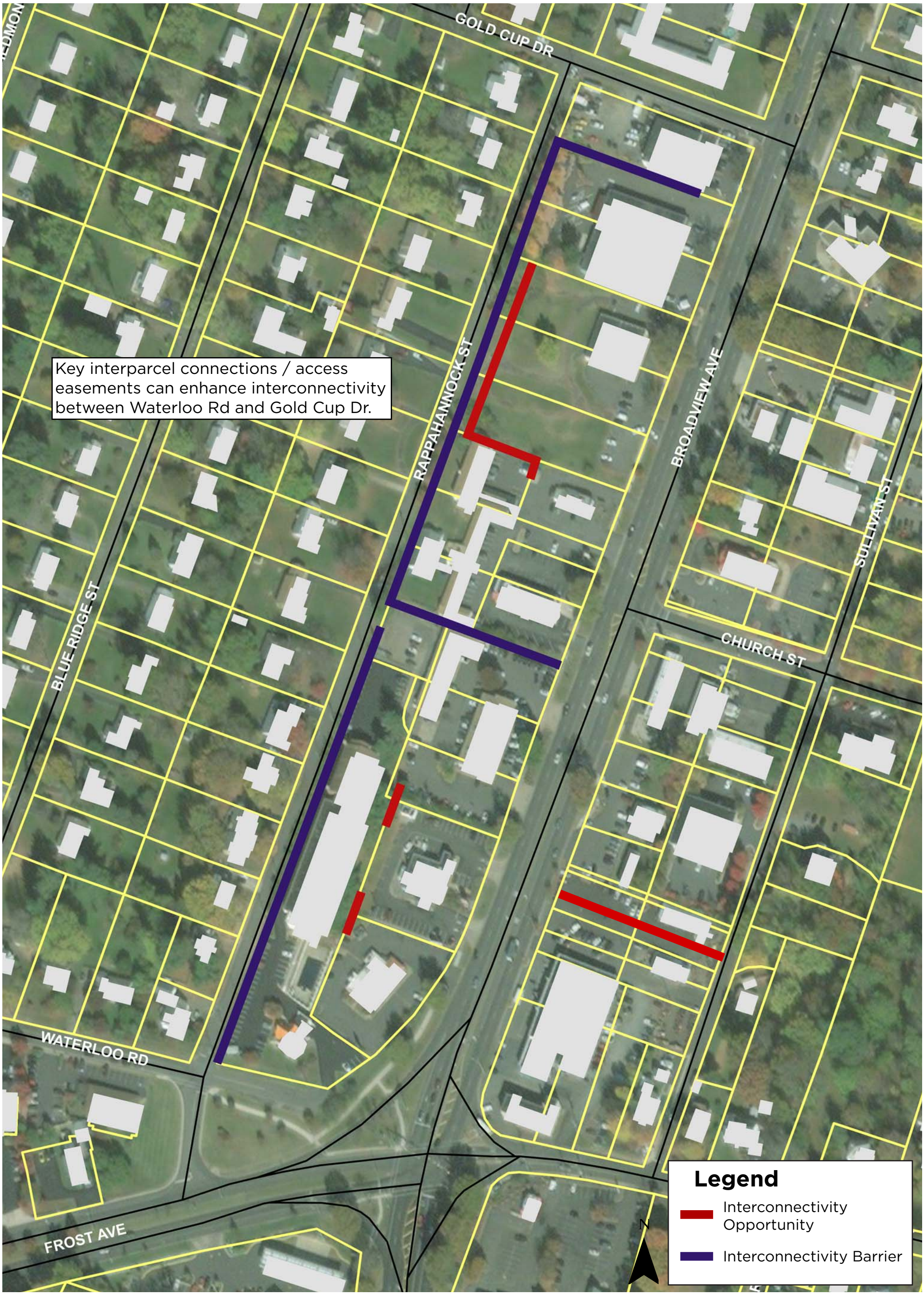
Conceptual Partial Displaced Left-Turn
Broadview Ave/Frost Ave/Waterloo St/W Shirley Ave
Warrenton, VA

Figure 2



Existing DLT with Restricted Access (Cincinnatti, OH)
Relative to Existing Study Intersection (Warrenton, VA)

Figure
3



KITTELSON & ASSOCIATES

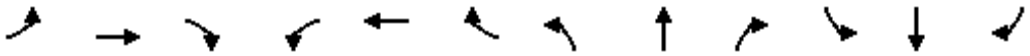
Interparcel Connectivity Review

Figure **4**

Appendix B
Synchro Operational Worksheets

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	212	216	119	139	207	454	130	441
v/c Ratio	0.22	0.24	0.07	0.16	0.57	0.56	0.58	0.48
Control Delay	16.0	3.4	14.8	3.2	44.7	32.4	21.4	4.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.1
Total Delay	16.0	3.4	14.8	3.2	44.7	32.4	23.8	4.2
Queue Length 50th (ft)	65	0	17	0	58	120	52	4
Queue Length 95th (ft)	138	44	41	31	93	144	126	6
Internal Link Dist (ft)	547		899			763		85
Turn Bay Length (ft)				225	400			
Base Capacity (vph)	943	911	1771	870	387	1163	262	1331
Starvation Cap Reductn	0	0	0	0	0	0	56	115
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.22	0.24	0.07	0.16	0.53	0.39	0.63	0.36

Intersection Summary



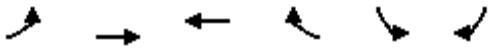
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	212	216	0	119	139	207	422	32	130	441	0
Future Volume (vph)	0	212	216	0	119	139	207	422	32	130	441	0
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Total Lost time (s)		4.0	4.0		4.5	4.5	4.5	6.0		4.5	5.0	
Lane Util. Factor		1.00	1.00		0.95	1.00	0.97	0.95		1.00	0.95	
Frt		1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	
Flt Protected		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1912	1625		3632	1625	3523	3594		1816	3632	
Flt Permitted		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1912	1625		3632	1625	3523	3594		1816	3632	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	212	216	0	119	139	207	422	32	130	441	0
RTOR Reduction (vph)	0	0	109	0	0	71	0	7	0	0	0	0
Lane Group Flow (vph)	0	212	107	0	119	68	207	447	0	130	441	0
Turn Type		NA	Perm		NA	Perm	Prot	NA		Prot	NA	
Protected Phases		1			2		3	8		7	4	
Permitted Phases			1			2						
Actuated Green, G (s)		44.4	44.4		43.9	43.9	9.4	20.0		11.1	22.7	
Effective Green, g (s)		44.4	44.4		43.9	43.9	9.4	20.0		11.1	22.7	
Actuated g/C Ratio		0.49	0.49		0.49	0.49	0.10	0.22		0.12	0.25	
Clearance Time (s)		4.0	4.0		4.5	4.5	4.5	6.0		4.5	5.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		943	801		1771	792	367	798		223	916	
v/s Ratio Prot		c0.11			0.03		0.06	c0.12		c0.07	0.12	
v/s Ratio Perm			0.07			0.04						
v/c Ratio		0.22	0.13		0.07	0.09	0.56	0.56		0.58	0.48	
Uniform Delay, d1		13.0	12.4		12.2	12.3	38.4	31.1		37.3	28.6	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00		0.30	0.09	
Incremental Delay, d2		0.1	0.1		0.1	0.2	2.0	0.9		3.7	0.4	
Delay (s)		13.1	12.4		12.3	12.5	40.3	32.0		14.8	2.9	
Level of Service		B	B		B	B	D	C		B	A	
Approach Delay (s)		12.8			12.4			34.6			5.6	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM 2000 Control Delay	18.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	42.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	SBR
Lane Group Flow (vph)	855	428	326	440
v/c Ratio	0.70	0.12	0.17	0.34
Control Delay	28.2	0.1	2.3	1.6
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	28.2	0.1	2.3	1.6
Queue Length 50th (ft)	213	0	22	0
Queue Length 95th (ft)	237	0	37	18
Internal Link Dist (ft)		1207	547	
Turn Bay Length (ft)	250			
Base Capacity (vph)	2035	3632	1971	1859
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.42	0.12	0.17	0.24

Intersection Summary



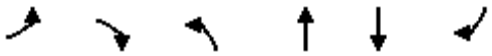
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	855	428	326	0	0	440
Future Volume (vph)	855	428	326	0	0	440
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	5.0	4.0	5.0			5.0
Lane Util. Factor	0.97	0.95	0.95			0.88
Frt	1.00	1.00	1.00			0.85
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3523	3632	3632			2860
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3523	3632	3632			2860
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	855	428	326	0	0	440
RTOR Reduction (vph)	0	0	0	0	0	288
Lane Group Flow (vph)	855	428	326	0	0	152
Turn Type	Prot	NA	NA			Over
Protected Phases	1	Free	2			1
Permitted Phases						
Actuated Green, G (s)	31.1	90.0	48.9			31.1
Effective Green, g (s)	31.1	90.0	48.9			31.1
Actuated g/C Ratio	0.35	1.00	0.54			0.35
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	1217	3632	1973			988
v/s Ratio Prot	c0.24	0.12	c0.09			0.05
v/s Ratio Perm						
v/c Ratio	0.70	0.12	0.17			0.15
Uniform Delay, d1	25.5	0.0	10.3			20.4
Progression Factor	1.00	1.00	0.18			1.00
Incremental Delay, d2	1.9	0.1	0.2			0.1
Delay (s)	27.3	0.1	2.1			20.4
Level of Service	C	A	A			C
Approach Delay (s)		18.2	2.1		20.4	
Approach LOS		B	A		C	

Intersection Summary			
HCM 2000 Control Delay	16.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.37		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	40.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	NBT	SBT	SBR
Lane Group Flow (vph)	855	561	571	440
v/c Ratio	0.50	0.20	0.43	0.27
Control Delay	2.4	0.8	28.3	0.4
Queue Delay	0.0	0.1	0.0	0.0
Total Delay	2.4	1.0	28.3	0.4
Queue Length 50th (ft)	0	9	101	0
Queue Length 95th (ft)	102	8	111	0
Internal Link Dist (ft)	417	85	659	
Turn Bay Length (ft)				200
Base Capacity (vph)	1718	3203	1913	1625
Starvation Cap Reductn	0	1613	0	0
Spillback Cap Reductn	0	0	124	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.50	0.35	0.32	0.27

Intersection Summary



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	855	0	0	561	571	440
Future Volume (vph)	855	0	0	561	571	440
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	4.5			4.0	5.0	4.0
Lane Util. Factor	0.97			0.95	0.91	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	0.95			1.00	1.00	1.00
Satd. Flow (prot)	3523			3632	5219	1625
Flt Permitted	0.95			1.00	1.00	1.00
Satd. Flow (perm)	3523			3632	5219	1625
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	855	0	0	561	571	440
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	855	0	0	561	571	440
Turn Type	Prot			NA	NA	Free
Protected Phases	2!			1 8!	4	
Permitted Phases						Free
Actuated Green, G (s)	43.9			68.4	22.7	90.0
Effective Green, g (s)	43.9			68.4	22.7	90.0
Actuated g/C Ratio	0.49			0.76	0.25	1.00
Clearance Time (s)	4.5				5.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1718			2760	1316	1625
v/s Ratio Prot	c0.24			0.15	c0.11	
v/s Ratio Perm						c0.27
v/c Ratio	0.50			0.20	0.43	0.27
Uniform Delay, d1	15.6			3.1	28.3	0.0
Progression Factor	0.09			0.25	1.00	1.00
Incremental Delay, d2	1.0			0.0	0.2	0.4
Delay (s)	2.3			0.8	28.5	0.4
Level of Service	A			A	C	A
Approach Delay (s)	2.3			0.8	16.3	
Approach LOS	A			A	B	

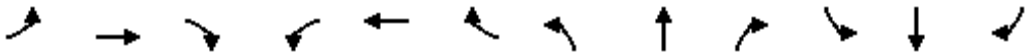
Intersection Summary			
HCM 2000 Control Delay	7.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.0
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	140	91	372	227	404	733	146	803
v/c Ratio	0.21	0.14	0.30	0.32	0.69	0.63	0.49	0.66
Control Delay	23.2	1.2	23.9	4.8	41.4	27.8	15.1	5.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0
Total Delay	23.2	1.2	23.9	4.8	41.4	27.8	18.9	5.7
Queue Length 50th (ft)	59	0	86	0	111	174	75	24
Queue Length 95th (ft)	105	8	125	51	155	231	135	35
Internal Link Dist (ft)	547		899			763		85
Turn Bay Length (ft)				225	400			
Base Capacity (vph)	668	667	1230	700	685	1286	313	1270
Starvation Cap Reductn	0	0	0	0	0	0	100	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.21	0.14	0.30	0.32	0.59	0.57	0.69	0.63

Intersection Summary



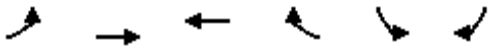
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	140	91	0	372	227	404	701	32	146	803	0
Future Volume (vph)	0	140	91	0	372	227	404	701	32	146	803	0
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Total Lost time (s)		4.0	4.0		5.0	5.0	4.5	6.0		4.5	5.0	
Lane Util. Factor		1.00	1.00		0.95	1.00	0.97	0.95		1.00	0.95	
Frt		1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	
Flt Protected		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1912	1625		3632	1625	3523	3609		1816	3632	
Flt Permitted		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1912	1625		3632	1625	3523	3609		1816	3632	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	140	91	0	372	227	404	701	32	146	803	0
RTOR Reduction (vph)	0	0	59	0	0	150	0	4	0	0	0	0
Lane Group Flow (vph)	0	140	32	0	372	77	404	729	0	146	803	0
Turn Type		NA	Perm		NA	Perm	Prot	NA		Prot	NA	
Protected Phases		1			2		3	8		7	4	
Permitted Phases			1			2						
Actuated Green, G (s)		31.5	31.5		30.5	30.5	15.1	29.1		14.9	29.9	
Effective Green, g (s)		31.5	31.5		30.5	30.5	15.1	29.1		14.9	29.9	
Actuated g/C Ratio		0.35	0.35		0.34	0.34	0.17	0.32		0.17	0.33	
Clearance Time (s)		4.0	4.0		5.0	5.0	4.5	6.0		4.5	5.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		669	568		1230	550	591	1166		300	1206	
v/s Ratio Prot		0.07			c0.10		0.11	c0.20		0.08	c0.22	
v/s Ratio Perm			0.02			0.05						
v/c Ratio		0.21	0.06		0.30	0.14	0.68	0.63		0.49	0.67	
Uniform Delay, d1		20.5	19.4		21.9	20.6	35.2	25.8		34.1	25.8	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00		0.30	0.12	
Incremental Delay, d2		0.2	0.0		0.6	0.5	3.3	1.1		1.1	1.2	
Delay (s)		20.7	19.4		22.5	21.2	38.5	26.9		11.2	4.4	
Level of Service		C	B		C	C	D	C		B	A	
Approach Delay (s)		20.2			22.0			31.0			5.4	
Approach LOS		C			C			C			A	

Intersection Summary			
HCM 2000 Control Delay	20.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.5
Intersection Capacity Utilization	55.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	SBR
Lane Group Flow (vph)	657	231	776	1139
v/c Ratio	0.39	0.06	0.52	0.80
Control Delay	15.0	0.0	8.1	20.9
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	15.0	0.0	8.1	20.9
Queue Length 50th (ft)	113	0	104	266
Queue Length 95th (ft)	136	0	145	320
Internal Link Dist (ft)		1207	547	
Turn Bay Length (ft)	250			
Base Capacity (vph)	1918	3632	1479	1599
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.34	0.06	0.52	0.71

Intersection Summary



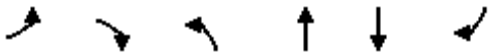
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	657	231	776	0	0	1139
Future Volume (vph)	657	231	776	0	0	1139
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	5.0	4.0	5.0			5.0
Lane Util. Factor	0.97	0.95	0.95			0.88
Frt	1.00	1.00	1.00			0.85
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3523	3632	3632			2860
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3523	3632	3632			2860
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	657	231	776	0	0	1139
RTOR Reduction (vph)	0	0	0	0	0	49
Lane Group Flow (vph)	657	231	776	0	0	1090
Turn Type	Prot	NA	NA			Over
Protected Phases	1	Free	2			1
Permitted Phases						
Actuated Green, G (s)	43.3	90.0	36.7			43.3
Effective Green, g (s)	43.3	90.0	36.7			43.3
Actuated g/C Ratio	0.48	1.00	0.41			0.48
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	1694	3632	1481			1375
v/s Ratio Prot	0.19	0.06	c0.21			c0.38
v/s Ratio Perm						
v/c Ratio	0.39	0.06	0.52			0.79
Uniform Delay, d1	14.9	0.0	20.1			19.6
Progression Factor	1.00	1.00	0.32			1.00
Incremental Delay, d2	0.1	0.0	1.2			2.3
Delay (s)	15.0	0.0	7.6			21.9
Level of Service	B	A	A			C
Approach Delay (s)		11.1	7.6		21.9	
Approach LOS		B	A		C	

Intersection Summary			
HCM 2000 Control Delay	14.5	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	68.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	NBT	SBT	SBR
Lane Group Flow (vph)	657	928	949	1139
v/c Ratio	0.55	0.35	0.55	0.70
Control Delay	14.1	1.2	25.6	2.5
Queue Delay	0.0	0.2	0.1	0.0
Total Delay	14.1	1.4	25.7	2.5
Queue Length 50th (ft)	164	18	150	0
Queue Length 95th (ft)	222	15	197	0
Internal Link Dist (ft)	417	85	659	
Turn Bay Length (ft)				200
Base Capacity (vph)	1193	2804	1825	1625
Starvation Cap Reductn	0	892	0	0
Spillback Cap Reductn	0	0	140	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.55	0.49	0.56	0.70

Intersection Summary



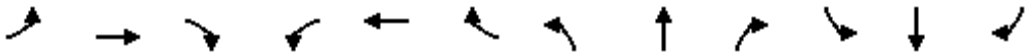
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	657	0	0	928	949	1139
Future Volume (vph)	657	0	0	928	949	1139
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	5.0			4.0	5.0	4.0
Lane Util. Factor	0.97			0.95	0.91	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	0.95			1.00	1.00	1.00
Satd. Flow (prot)	3523			3632	5219	1625
Flt Permitted	0.95			1.00	1.00	1.00
Satd. Flow (perm)	3523			3632	5219	1625
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	657	0	0	928	949	1139
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	657	0	0	928	949	1139
Turn Type	Prot			NA	NA	Free
Protected Phases	2!			1 8!	4	
Permitted Phases						Free
Actuated Green, G (s)	30.5			64.6	29.9	90.0
Effective Green, g (s)	30.5			64.6	29.9	90.0
Actuated g/C Ratio	0.34			0.72	0.33	1.00
Clearance Time (s)	5.0				5.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1193			2606	1733	1625
v/s Ratio Prot	0.19			0.26	0.18	
v/s Ratio Perm						c0.70
v/c Ratio	0.55			0.36	0.55	0.70
Uniform Delay, d1	24.2			4.8	24.5	0.0
Progression Factor	0.48			0.22	1.00	1.00
Incremental Delay, d2	1.8			0.1	0.4	2.5
Delay (s)	13.4			1.1	24.9	2.5
Level of Service	B			A	C	A
Approach Delay (s)	13.4			1.1	12.7	
Approach LOS	B			A	B	

Intersection Summary			
HCM 2000 Control Delay	9.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.5
Intersection Capacity Utilization	50.8%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.
c Critical Lane Group

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	140	189	168	242	265	657	220	682
v/c Ratio	0.19	0.26	0.13	0.32	0.61	0.62	0.73	0.54
Control Delay	21.7	4.5	21.0	4.5	43.7	29.7	26.3	3.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0
Total Delay	21.7	4.5	21.0	4.5	43.7	29.7	29.8	3.8
Queue Length 50th (ft)	56	0	34	0	73	161	118	7
Queue Length 95th (ft)	104	45	60	51	113	216	191	10
Internal Link Dist (ft)	547		899			763		85
Turn Bay Length (ft)				225	400			
Base Capacity (vph)	725	733	1337	751	469	1167	353	1432
Starvation Cap Reductn	0	0	0	0	0	0	67	7
Spillback Cap Reductn	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.19	0.26	0.13	0.32	0.57	0.56	0.77	0.48

Intersection Summary



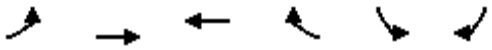
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	140	189	0	168	242	265	637	20	220	682	0
Future Volume (vph)	0	140	189	0	168	242	265	637	20	220	682	0
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950	1950
Total Lost time (s)		4.0	4.0		5.0	5.0	4.5	6.0		4.5	5.0	
Lane Util. Factor		1.00	1.00		0.95	1.00	0.97	0.95		1.00	0.95	
Frt		1.00	0.85		1.00	0.85	1.00	1.00		1.00	1.00	
Flt Protected		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)		1912	1625		3632	1625	3523	3616		1816	3632	
Flt Permitted		1.00	1.00		1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)		1912	1625		3632	1625	3523	3616		1816	3632	
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	0	140	189	0	168	242	265	637	20	220	682	0
RTOR Reduction (vph)	0	0	117	0	0	153	0	3	0	0	0	0
Lane Group Flow (vph)	0	140	72	0	168	89	265	654	0	220	682	0
Turn Type		NA	Perm		NA	Perm	Prot	NA		Prot	NA	
Protected Phases		1			2		3	8		7	4	
Permitted Phases			1			2						
Actuated Green, G (s)		34.1	34.1		33.1	33.1	11.1	26.3		15.1	31.3	
Effective Green, g (s)		34.1	34.1		33.1	33.1	11.1	26.3		15.1	31.3	
Actuated g/C Ratio		0.38	0.38		0.37	0.37	0.12	0.29		0.17	0.35	
Clearance Time (s)		4.0	4.0		5.0	5.0	4.5	6.0		4.5	5.0	
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		724	615		1335	597	434	1056		304	1263	
v/s Ratio Prot		c0.07			0.05		0.08	c0.18		c0.12	0.19	
v/s Ratio Perm			0.04			0.05						
v/c Ratio		0.19	0.12		0.13	0.15	0.61	0.62		0.72	0.54	
Uniform Delay, d1		18.7	18.2		18.9	19.0	37.4	27.5		35.5	23.6	
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00		0.37	0.10	
Incremental Delay, d2		0.1	0.1		0.2	0.5	2.5	1.1		7.6	0.4	
Delay (s)		18.9	18.2		19.1	19.6	39.9	28.6		20.8	2.7	
Level of Service		B	B		B	B	D	C		C	A	
Approach Delay (s)		18.5			19.4			31.9			7.1	
Approach LOS		B			B			C			A	

Intersection Summary			
HCM 2000 Control Delay	19.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.45		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.5
Intersection Capacity Utilization	48.9%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	EBT	WBT	SBR
Lane Group Flow (vph)	804	329	433	1178
v/c Ratio	0.44	0.09	0.32	0.75
Control Delay	13.9	0.0	6.3	15.4
Queue Delay	0.0	0.0	0.0	0.0
Total Delay	13.9	0.0	6.3	15.4
Queue Length 50th (ft)	136	0	44	232
Queue Length 95th (ft)	136	0	68	239
Internal Link Dist (ft)		1207	547	
Turn Bay Length (ft)	250			
Base Capacity (vph)	2231	3632	1356	1886
Starvation Cap Reductn	0	0	0	0
Spillback Cap Reductn	0	0	0	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.36	0.09	0.32	0.62

Intersection Summary



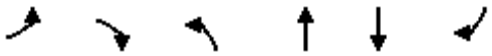
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (vph)	804	329	433	0	0	1178
Future Volume (vph)	804	329	433	0	0	1178
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	5.0	4.0	5.0			5.0
Lane Util. Factor	0.97	0.95	0.95			0.88
Frt	1.00	1.00	1.00			0.85
Flt Protected	0.95	1.00	1.00			1.00
Satd. Flow (prot)	3523	3632	3632			2860
Flt Permitted	0.95	1.00	1.00			1.00
Satd. Flow (perm)	3523	3632	3632			2860
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	804	329	433	0	0	1178
RTOR Reduction (vph)	0	0	0	0	0	99
Lane Group Flow (vph)	804	329	433	0	0	1079
Turn Type	Prot	NA	NA			Over
Protected Phases	1	Free	2			1
Permitted Phases						
Actuated Green, G (s)	46.4	90.0	33.6			46.4
Effective Green, g (s)	46.4	90.0	33.6			46.4
Actuated g/C Ratio	0.52	1.00	0.37			0.52
Clearance Time (s)	5.0		5.0			5.0
Vehicle Extension (s)	3.0		3.0			3.0
Lane Grp Cap (vph)	1816	3632	1355			1474
v/s Ratio Prot	0.23	0.09	c0.12			c0.38
v/s Ratio Perm						
v/c Ratio	0.44	0.09	0.32			0.73
Uniform Delay, d1	13.7	0.0	20.1			17.0
Progression Factor	1.00	1.00	0.26			1.00
Incremental Delay, d2	0.2	0.0	0.6			1.3
Delay (s)	13.9	0.0	5.8			18.3
Level of Service	B	A	A			B
Approach Delay (s)		9.8	5.8		18.3	
Approach LOS		A	A		B	

Intersection Summary			
HCM 2000 Control Delay	12.8	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	60.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBL	NBT	SBT	SBR
Lane Group Flow (vph)	804	879	902	1178
v/c Ratio	0.62	0.33	0.50	0.72
Control Delay	15.4	1.4	23.7	2.9
Queue Delay	0.0	0.2	0.1	0.0
Total Delay	15.4	1.6	23.8	2.9
Queue Length 50th (ft)	201	20	139	0
Queue Length 95th (ft)	275	17	170	0
Internal Link Dist (ft)	417	85	659	
Turn Bay Length (ft)				200
Base Capacity (vph)	1298	2790	2058	1625
Starvation Cap Reductn	0	945	0	0
Spillback Cap Reductn	0	0	267	0
Storage Cap Reductn	0	0	0	0
Reduced v/c Ratio	0.62	0.48	0.50	0.72

Intersection Summary



Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	804	0	0	879	902	1178
Future Volume (vph)	804	0	0	879	902	1178
Ideal Flow (vphpl)	1950	1950	1950	1950	1950	1950
Total Lost time (s)	5.0			4.0	5.0	4.0
Lane Util. Factor	0.97			0.95	0.91	1.00
Frt	1.00			1.00	1.00	0.85
Flt Protected	0.95			1.00	1.00	1.00
Satd. Flow (prot)	3523			3632	5219	1625
Flt Permitted	0.95			1.00	1.00	1.00
Satd. Flow (perm)	3523			3632	5219	1625
Peak-hour factor, PHF	1.00	1.00	1.00	1.00	1.00	1.00
Adj. Flow (vph)	804	0	0	879	902	1178
RTOR Reduction (vph)	0	0	0	0	0	0
Lane Group Flow (vph)	804	0	0	879	902	1178
Turn Type	Prot			NA	NA	Free
Protected Phases	2!			1 8!	4	
Permitted Phases						Free
Actuated Green, G (s)	33.1			64.4	31.3	90.0
Effective Green, g (s)	33.1			64.4	31.3	90.0
Actuated g/C Ratio	0.37			0.72	0.35	1.00
Clearance Time (s)	5.0				5.0	
Vehicle Extension (s)	3.0				3.0	
Lane Grp Cap (vph)	1295			2598	1815	1625
v/s Ratio Prot	0.23			0.24	0.17	
v/s Ratio Perm						c0.72
v/c Ratio	0.62			0.34	0.50	0.72
Uniform Delay, d1	23.3			4.8	23.1	0.0
Progression Factor	0.53			0.25	1.00	1.00
Incremental Delay, d2	2.1			0.1	0.2	2.9
Delay (s)	14.6			1.3	23.4	2.9
Level of Service	B			A	C	A
Approach Delay (s)	14.6			1.3	11.7	
Approach LOS	B			A	B	

Intersection Summary			
HCM 2000 Control Delay	9.9	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.88		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	15.5
Intersection Capacity Utilization	53.5%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Appendix C

VJuST Screening Tool

VDOT Junction Screening Tool

Results Worksheet

General Information	
Project Title:	Broadview Cooridor Evaluation
EW Facility:	Frost Ave/Waterloo St
NS Facility:	Broadview Ave/W Shirely Ave
Date:	May 8, 2018

Volumes (veh/hr)	U-Turn / Left	Through	Right
Eastbound	714	177	180
Westbound	30	99	86
Northbound	174	352	27
Southbound	82	338	367

General Instructions: All intersection and interchange configurations have a default assumption of one exclusive lane per movement. No results shall be interpreted until the user has verified the lane configurations on each worksheet.

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Notes
		Congestion	Pedestrian	Safety	
Conventional	-	0.62		48	
Partial Displaced Left Turn	-	0.46	-	44	
Partial Median U-Turn	-	0.79	+	28	
Restricted Crossing U-Turn	-	0.74		20	
Roundabout	-	1.01		8	

Information

Congestion	The maximum v/c ratio represents the worst v/c of all zones that make up an intersection.
Pedestrian	Compares the potential of each design to accommodate pedestrians based on safety, wayfinding, and delay. Potential is qualitatively defined as better (+), similar (blank cell), or worse (-) than a conventional intersection or traditional diamond interchange.
Safety	Weighted Total = (2 x Crossing Conflicts) + Merging Conflicts + Diverging Conflicts

VDOT Junction Screening Tool

Results Worksheet

General Information	
Project Title:	Broadview Cooridor Evaluation
EW Facility:	Frost Ave/Waterloo St
NS Facility:	Broadview Ave/W Shirely Ave
Date:	May 8, 2018

Volumes (veh/hr)	U-Turn / Left	Through	Right
Eastbound	548	117	76
Westbound	68	310	121
Northbound	337	585	19
Southbound	75	601	950

General Instructions: All intersection and interchange configurations have a default assumption of one exclusive lane per movement. No results shall be interpreted until the user has verified the lane configurations on each worksheet.

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Notes
		Congestion	Pedestrian	Safety	
Conventional	-	0.81		48	
Partial Displaced Left Turn	-	0.91	-	44	
Partial Median U-Turn	-	0.81	+	28	
Restricted Crossing U-Turn	-	1.21		20	
Roundabout	-	1.06		8	

Information

Congestion	The maximum v/c ratio represents the worst v/c of all zones that make up an intersection.
Pedestrian	Compares the potential of each design to accommodate pedestrians based on safety, wayfinding, and delay. Potential is qualitatively defined as better (+), similar (blank cell), or worse (-) than a conventional intersection or traditional diamond interchange.
Safety	Weighted Total = (2 x Crossing Conflicts) + Merging Conflicts + Diverging Conflicts

VDOT Junction Screening Tool

Results Worksheet

General Information	
Project Title:	Broadview Cooridor Evaluation
EW Facility:	Frost Ave/Waterloo St
NS Facility:	Broadview Ave/W Shirely Ave
Date:	May 8, 2018

Volumes (veh/hr)	U-Turn / Left	Through	Right
Eastbound	675	117	159
Westbound	41	140	161
Northbound	222	531	17
Southbound	137	528	983

General Instructions: All intersection and interchange configurations have a default assumption of one exclusive lane per movement. No results shall be interpreted until the user has verified the lane configurations on each worksheet.

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Notes
		Congestion	Pedestrian	Safety	
Conventional	-	0.68		48	
Partial Displaced Left Turn	-	0.84	-	44	
Partial Median U-Turn	-	0.86	+	28	
Restricted Crossing U-Turn	-	1.19		20	
Roundabout	-	1.12		8	

Information

Congestion	The maximum v/c ratio represents the worst v/c of all zones that make up an intersection.
Pedestrian	Compares the potential of each design to accommodate pedestrians based on safety, wayfinding, and delay. Potential is qualitatively defined as better (+), similar (blank cell), or worse (-) than a conventional intersection or traditional diamond interchange.
Safety	Weighted Total = (2 x Crossing Conflicts) + Merging Conflicts + Diverging Conflicts