



Part 1

Foundations of Understanding

Review of Traffic Volumes + Patterns

The Rio Road Corridor provides access to and from residential neighborhoods, several shopping centers and convenience stores, places of worship as well as educational institutions and commercial properties. Which is to say, it is a diverse and multi-faceted corridor. The high traffic volumes are associated with the trips generated by these properties but also largely due to the nature of this corridor as a direct connection between US 29 and Downtown Charlottesville.

Current traffic patterns are largely dictated by the vehicle-oriented nature of how patrons and citizens arrive to the many destinations along the corridor.

The study area for this project is approximately 1.5 miles of Rio Road between John W. Warner Parkway and the Rio/29 Small Area Plan (indicated within Figure 1.1 and Figure 1.2. The zone of influence (engineering speak: cordon line) is an approximation of residential properties where the corridor likely supports the routine daily activities of the residents. The location of this cordon line has been estimated based on a general understanding of the corridor and serves as a larger boundary for project considerations.

As can be seen from the roadway network image (Map 1A) on this page, the study area exhibits a diverse set of roadway typologies and traffic volumes.

The length of the Rio Road Corridor through this study area there are 5 signalized intersections within the limits and 13 unsignalized intersections.

Traffic along the corridor is expected to continue to grow. The comprehensive plan suggests increased density in the area which will contribute a small portion of traffic increases. And, Albemarle County continues to grow which suggests that users commuting and "passing through" the corridor will also grow over time.

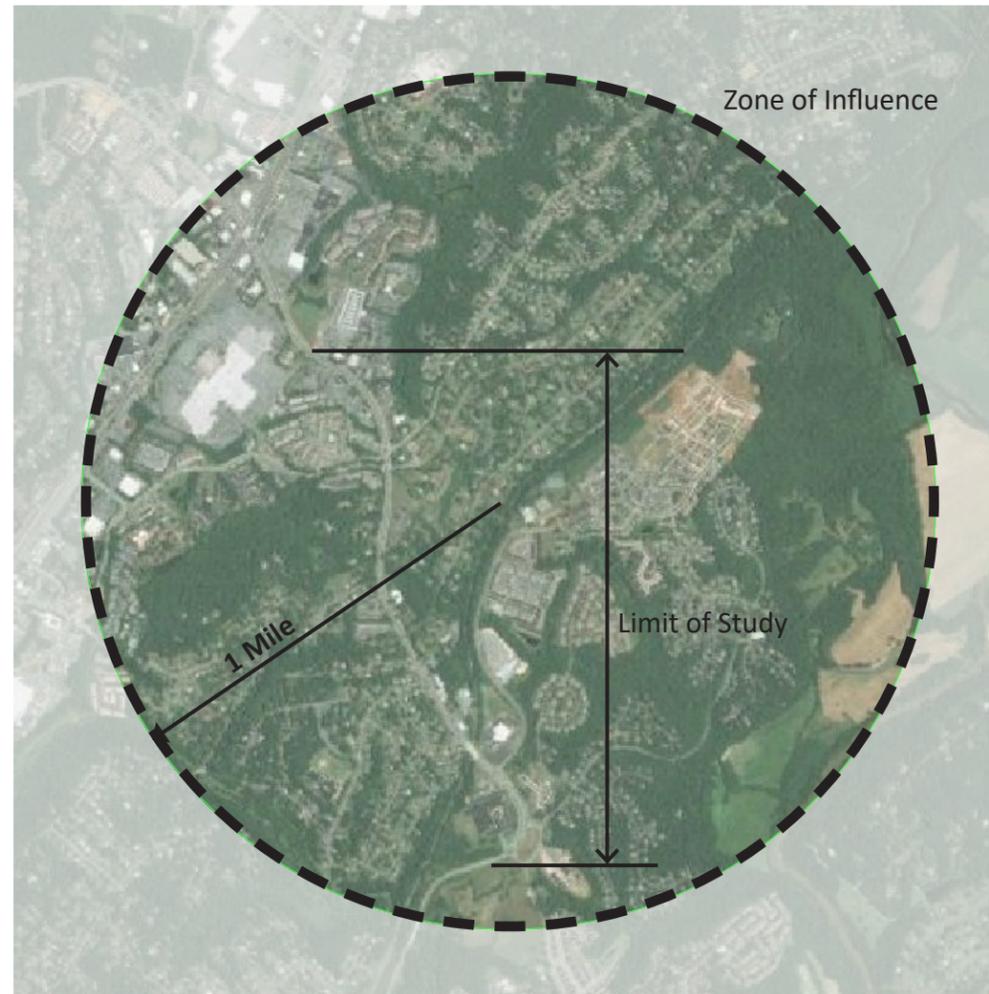
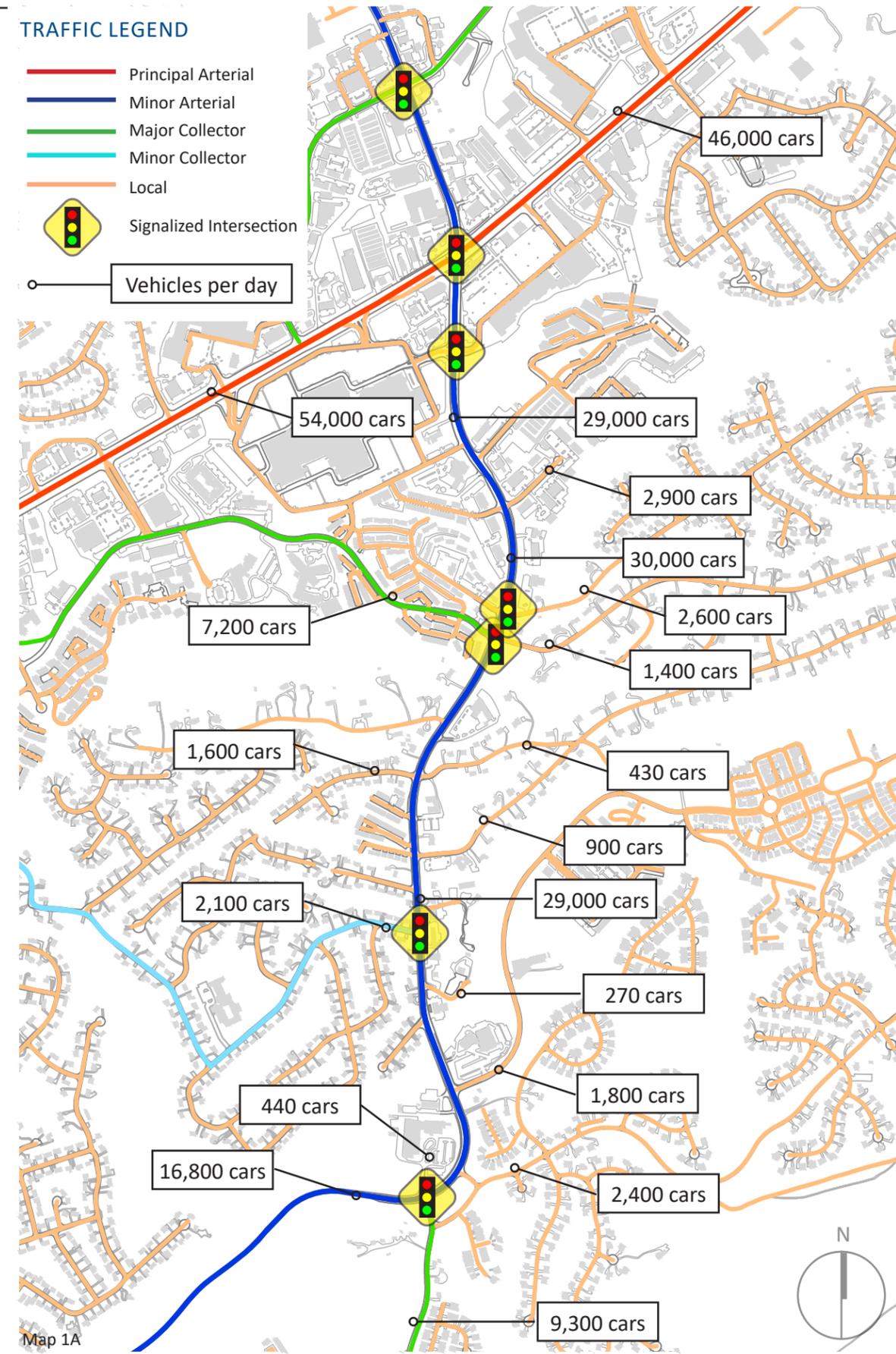


Figure 1.1 - Traffic Shed, or Cordon-Line



CORRIDOR INVENTORY

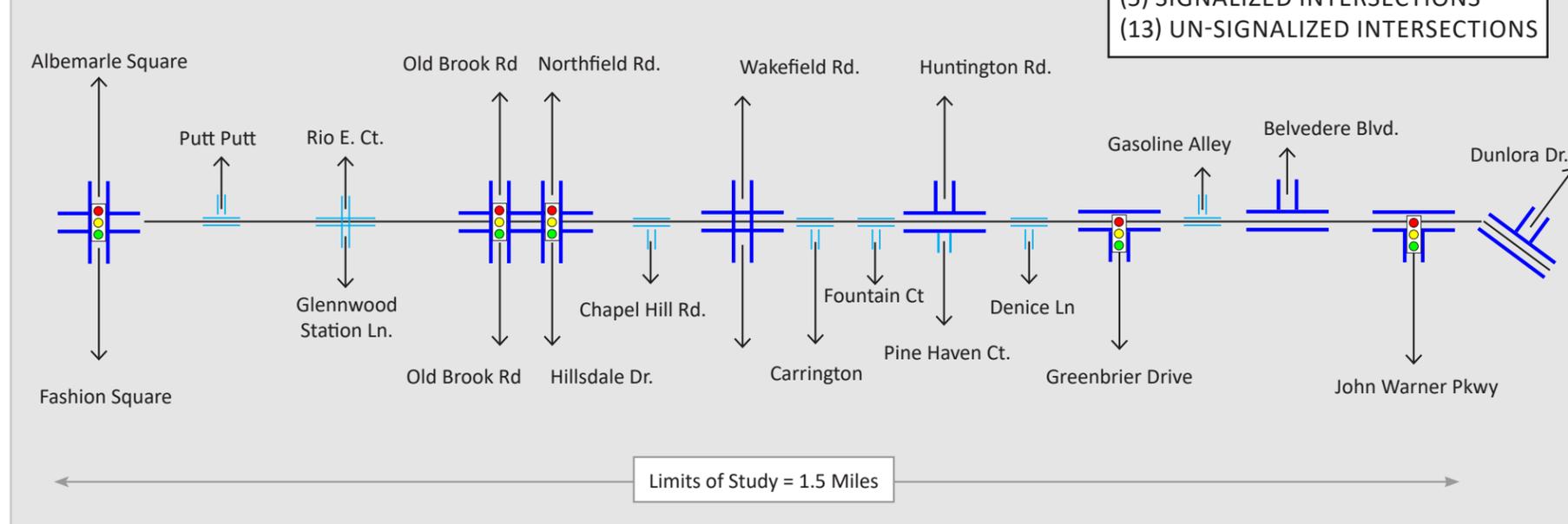


Figure 1.2 - Corridor Inventory

Review of Access Management

The Virginia Department of Transportation (VDOT) regulates the access management standards for the design of intersections, turning lanes and entrances and provides guidance for the spacing of these entrances, intersections, traffic signals and median crossings.

The intent of this regulation is to enhance public safety by decreasing traffic crashes, support economic development by promoting the efficient movement of people and goods, reduce traffic congestion and promote the high performance of existing corridors and reduce the need to widen existing roadways. (Source VDOT Appendix F)

The image at right is a graphic overlay of the VDOT access management criteria with regard to the spacing of intersections along the corridor. The size and intensity of the red areas within the overlay serve to highlight the lack of access management standard compliance along the corridor. This graphic also serves to highlight the integrated nature of traffic movements. That is to say, the inability of one entrance or intersection to meet the spacing and access management requirement standards has a direct and adverse effect on other nearby entrances.

These zones of influence, when taken in aggregate, create a corridor riddled with access management challenges. Pragmatically, these challenges translate into congestion, traffic accidents and an under-performing corridor. Furthermore, these areas of the corridor with the greatest intensity are areas where this study should focus specific energy to remedy these conditions.

For the purposes of this evaluation the roadway typology is a Minor Arterial and the posted speeds are 35 to 40 MPH. As can be seen from the data sources below, currently 32.4% of the entrances or intersections along the corridor conform with the VDOT standards. The remaining 67.6% of the access points do not conform.

Required Spacing Available	# Entrances/ Intersections	Percentage of Corridor
100%	12	32.4%
99-80%	2	5.4%
79-60%	5	13.5%
59-40%	7	18.9%
39-20%	8	21.6%
19-0%	3	8.1%

Table 1.1 - Breakdown of Entrance Standards along Rio Road

To that end, 29.7% percent of the access points are extremely non-compliant, that is less than 40% of the required spacing.

Access Management Standards also consider the **Entrance Throat** of a commercial property as well as the entrance spacing. The minimum entrance throat depth for a commercial property is 26'. This distance is needed to safely transition vehicles to the internal circulation systems of the site. Image 1.1 and Image 1.2 below show examples of throat length from entrances along the corridor.

The existing conditions along the Rio Road Corridor as related to entrance throat length will be a determining factor in the case with which new amenities are introduced to the corridor. Imagine trying to expand a sidewalk into a shared use path along a site where the throat length is similar to that shown in Image 1.1.



Image 1.1 - Non-Compliant Throat Length



Image 1.2 - Compliant Throat Length



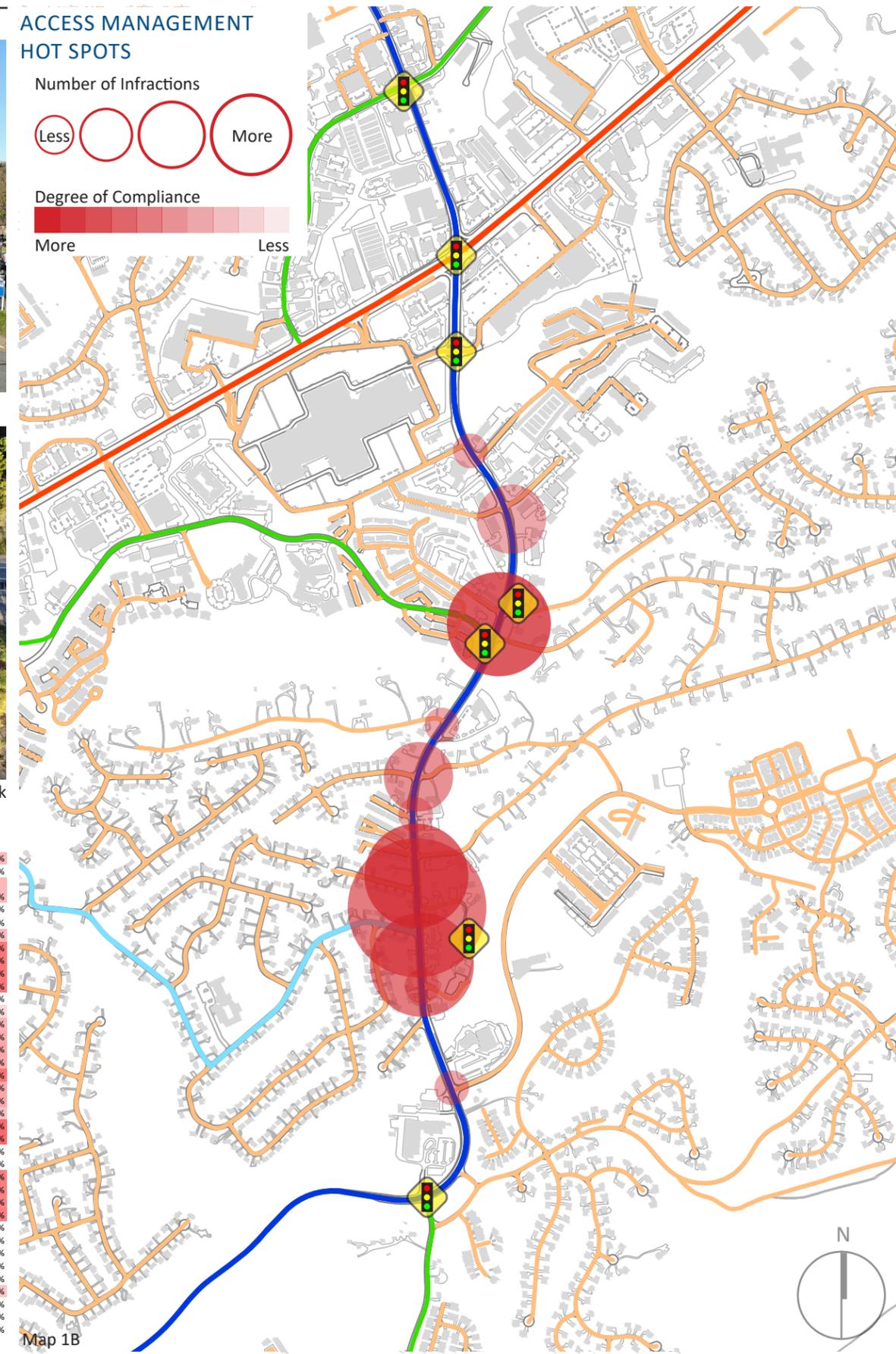
Image 1.3 - Rio Road at Gasoline Alley



Image 1.4 - Intersection Spacing at Hillsdale + Old Brook

Entrance/Intersection	VDOT Type 1-4	Ex. Spacing (ft)	Spacing Requirement (ft)	Required Spacing Available
(Back Entrance of Fashion Square Mall)	3	282	470	60%
Putt Putt Pl	3	483	470	100%
(Charlottesville Aldersgate United Methodist Church)	3	282	470	60%
Rio E Ct	2	956	660	100%
Glenwood Station Ln	2	908	660	100%
(Rio Center)	3	279	470	59%
Old Brook Rd (E)	1	220	1050	21%
Old Brook Rd (W)	1	216	1050	21%
Northfield Rd	1	220	1050	21%
Hillsdale Dr	1	216	1050	21%
Chapel Hill Rd	3	537	470	100%
(Northside Baptist Church)	3	372	470	79%
Wakefield Rd (E)	2	375	660	49%
Wakefield Rd (W)	2	343	660	52%
(Charlottesville Church of the Brethren)	2	326	660	49%
Carrington Pl	2	334	660	51%
Fountain Ct	3	85	470	18%
Huntington Rd	2	326	660	49%
Pine Haven Ct	2	334	660	51%
Denice Ln	3	305	470	65%
Rio School Ln	3	61	470	13%
(Zoomcash Consumer Loans)	3	61	470	13%
(Marathon Gas)	1	2538	1050	100%
Greenbrier Dr	1	2454	1050	100%
(Kangaroo Express N)	3	121	470	26%
(Kangaroo Express S)	3	121	470	26%
Gasoline Alley	3	136	470	29%
(Exxon N)	3	116	470	25%
(Exxon S)	2	672	660	100%
Greenbrier Terrace	2	651	660	99%
(Covenant Church)	4	259	250	100%
Belvedere Blvd	2	672	660	100%
(City Church N)	2	651	660	99%
(City Church S)	4	169	250	68%
Dunlora Dr	4	390	250	100%
Rio Rd E (at JWP)	1	1804	1050	100%
(CATEC)	1	1672	1050	100%

Table 1.2 - Comprehensive Evaluation of Entrances



Review of Safety Criteria

The goal of any safety assessment is to reduce the number and severity of accidents. The types of accidents experienced in a roadway corridor can be classified in two general categories: vehicle-vehicle accidents, and vehicle-pedestrian (or vehicle-bicycle) accidents. The factors contributing to the frequency and severity of accidents are numerous and many are highly variable, such as weather and driver attentiveness. This review seeks to identify the most prevalent of these factors along the Rio Road corridor.

Vehicle-Vehicle Accident Factors

Conflict Points

As can be seen on the map on this sheet, most vehicle-vehicle accidents occur at intersections. This is due to the increased number of conflict points in intersections. Conflict points are areas where traffic either merges, diverges, or crosses. Larger intersections handling higher traffic volumes have more conflict points, each representing a potential collision point. Therefore, accident likelihood is directly correlated with the number of conflict points. The Rio Road corridor handles a high volume of traffic, and has five (5) signalized intersections, thirteen (13) unsignalized intersections, and numerous entrances within the study area. As such, the potential for accidents is high, as is reflected in VDOT's accident data.

Sight Distance

Providing adequate sight distance is crucial to allow the motorist enough time to react and maneuver to avoid a collision. A limited ability to see approaching vehicles at intersections, or objects within the roadway, will yield higher accident rates. Although the horizontal design appears to allow for adequate sight distance at most locations, there are intersections at which the required sight distance is not met due to either grade or objects (vegetation) obscuring motorist views. As intersections are improved, adequate right-of-way or sight distance easements should be captured at intersection corners to ensure sight distance can be maintained.

Speed

Speed is one of the main criteria that define the design standards of the roadway. Speed is proportional to severity of accidents but is also proportional to capacity of the roadway. Therefore, it is important to design for a speed that limits accident severity but preserves roadway capacity. Higher vehicle speed lengthens the required sight distance and makes it harder for merging vehicles to safely maneuver into traffic.

The posted speed along Rio Road varies from 35 mph to 40 mph. Real vehicle speeds can be expected to be in the range of [do we have data on average speeds along this road? Do we have speed data on crash reports?]. On minor arterials (such as Rio Road) speed should be controlled by visual cues, (medians and street trees), signage (posted speed signs, also neighborhood gateway signs and speed feedback signs), or roadway geometry.

Roadway Geometry

Geometry is important to safety, as it affects and defines the other safety considerations listed above. VDOT guidance provides geometric standards (GS) to ensure minimum safety criteria are met if the standards are met. The standards are based on design speed of the roadway, and provide lane widths (including bike lanes), road centerline radii, road grades, clear zones, road grades, buffer strip widths, etc. VDOT classifies this roadway as an Urban Minor Arterial, with a posted speed of 35 to 40 mph.

When compared to the VDOT geometric standards for this classification (GS-6), Rio Road... [check existing against VDOT GS-6 (urban minor arterial)], [mention bike lane safety/width/buffer]

Entrance/Intersection	Crashes	
	2013-2020	(Pixel Size)
Mall Dr	2	0
Putt Putt Pl	35	7
(Charlottesville Aldersgate United Methodist Church)	1	0
Rio E Ct / Glenwood Station Ln	7	1
(Rio Center)	0	0
Old Brook Rd	20	4
Northfield Rd / Hillsdale Dr	43	9
Chapel Hill Rd	6	1
(Northside Baptist Church)	1	0
Wakefield Rd	4	1
(Charlottesville Church of the Brethren) / Carrington Pl	1	0
Fountain Ct	3	1
Huntington Rd / Pine Haven Ct	6	1
Denice Ln	5	1
Rio School Ln	0	0
(Zoomcash Consumer Loans)	4	1
(Marathon Gas) / Greenbrier Dr	30	6
(Kangaroo Express N)	0	0
(Kangaroo Express S)	6	1
Gasoline Alley	4	1
(Exxon N)	0	0
(Exxon S) / Greenbrier Terrace	5	1
(Covenant Church)	0	0
Belvedere Blvd / (City Church N)	18	4
(City Church S)	1	0
Dunlora Dr	0	0
Rio Rd E (at JWP) / CATEC	38	8
Total	240	

Table 1.3 - Comprehensive Evaluation of Accidents (2013-2020)

Vehicle-Pedestrian/Bicycle Accident Factors

When analyzing the safety of cyclists and pedestrians in a roadway corridor, many of the same safety considerations listed above can be applied. One factor that is not mentioned is driver expectation or perception. Motorists will reasonably expect to interact with other vehicles as they navigate traffic. However, a motorist may not expect a crossing pedestrian, especially across a major road or in an unmarked location. While pavement markings delineate crosswalks in some areas, in others curb ramps direct users into an ambiguous trajectory or into an unmarked crossing (See Image 1.4, below). Marked or signalized crossings of Rio Road are rare, which could prompt a pedestrian to attempt a dangerous mid-block crossing. Bicycle lanes, while marked, are not buffered. All of these conditions put non-motorized users in close proximity to high speed vehicular traffic in ways that the motorist may not expect. These conditions are most likely the reason that the non-motorized transportation facilities are under-utilized along Rio Road.



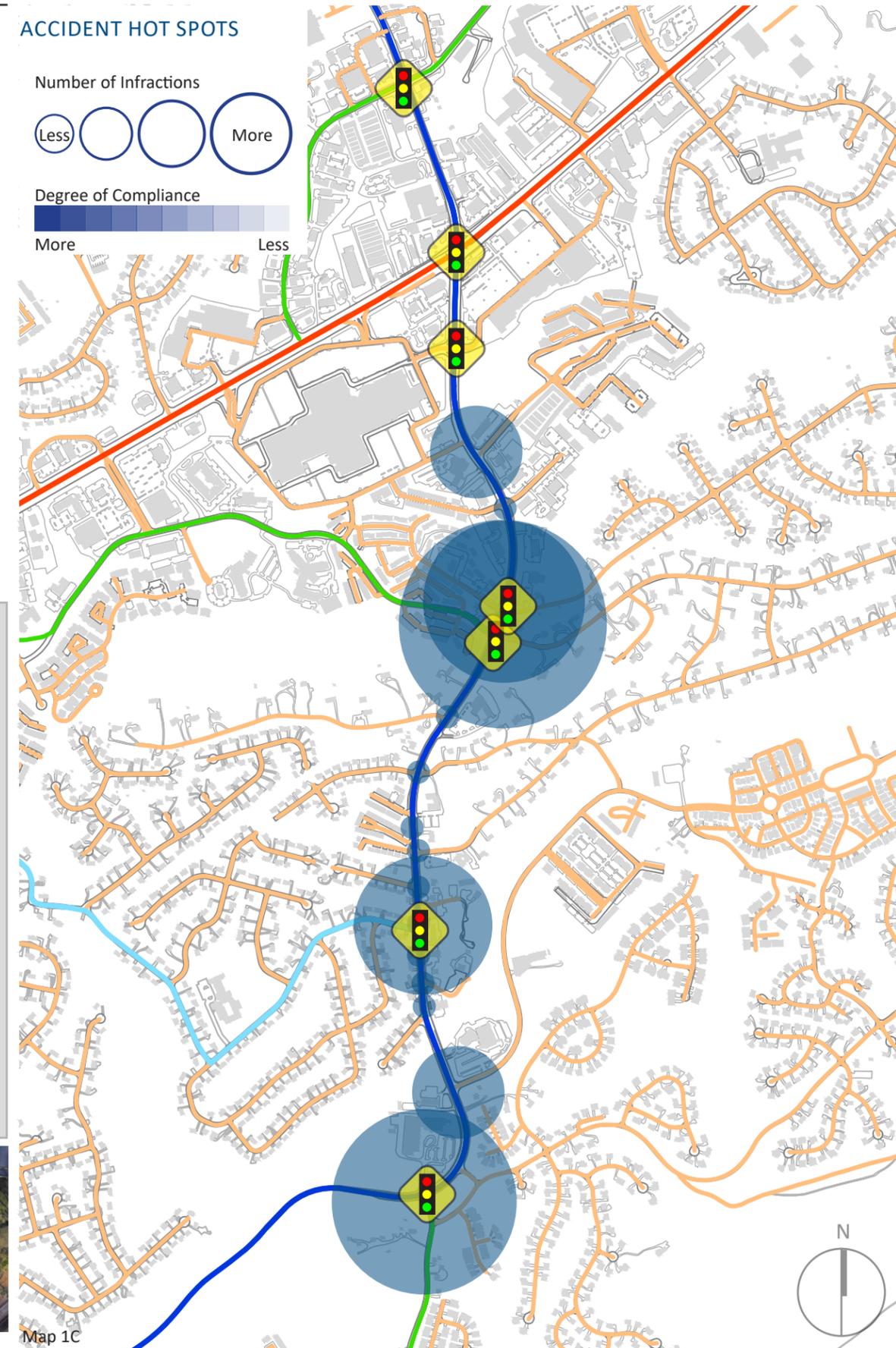
Image 1.4 - Pedestrian Confusion at Greenbrier Terrace

ACCIDENT HOT SPOTS

Number of Infractions



Degree of Compliance



Map 1C

Review of Multi-Modal Transportation Options

Pedestrian Facilities

Apart from the frontage of the Exxon to Gasoline Alley, existing sidewalk facilities are present along both sides of Rio Road within the study area. These are mainly 5-foot-wide sidewalks, however in many instances the effective width is less due to encroachments from dense vegetation, railings, and other objects. The condition of the concrete in many locations is deteriorating as well. In addition to these conditions, all but the newest intersections have non-compliant ADA ramps. In many locations, ramps direct users into unsafe conditions, where pavement markings are not present. (Refer to Image 1.4, previous page)

In addition, pedestrians encounter several conflict points with vehicles at crossings of entrances and intersections. These crossing distances are often lengthy, and the majority are not delineated with pavement markings in any way. While a pedestrian-actuated crossing of Rio Road was recently installed at the Greenbrier intersection, there are no other safe crossings of the corridor except towards the ends of the study area. **This is a major barrier to pedestrian activation along the corridor.**

Bicycle Facilities

A relatively new existing shared-use-path serves to connect the Belvedere intersection with John W. Warner Parkway. This serves both pedestrians and cyclists alike. Also, bike lanes can be found along the length of the corridor on both sides of the road, as can be seen in the typical sections. However, these bike lanes are unbuffered, which creates a harrowing condition for the cyclist when in close proximity with vehicles exceeding 40 mph. In addition, many conflict points between vehicle movements and cyclist movements, such as where the bike lane crosses an entrance, are not delineated or protected in any way.

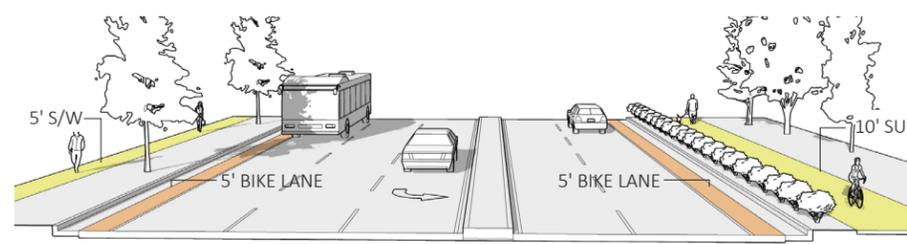
This creates very hazardous conditions, which lead to few cyclists using the facilities. Another barrier to use is the design of the bike lanes themselves. In many locations, bike lanes are less than 5-feet in width. In all cases, two feet of the bike lane is taken up by a gutter pan, which presents a lateral grade break near the center of the bike lane which is frustrating for cyclists. Lastly, most portions of the bike lanes are adjacent to a 6-inch curb, which can interfere with the pedaling of shorter cyclists (VDOT recommends a 4-inch curb adjacent to bike lanes).

Transit Facilities

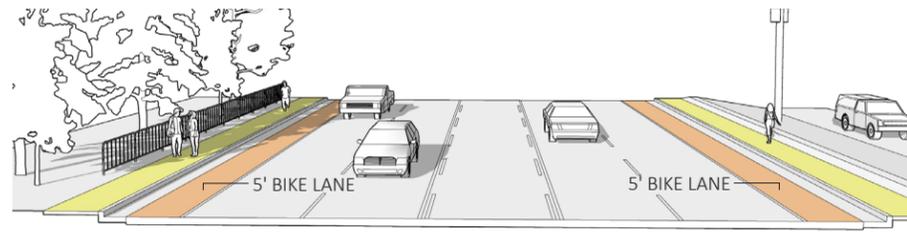
There are a commendable amount of transit stops in place within the study area, ranging from a ¼ - ½ mile apart. These facilities are well placed to serve the communities directly adjacent to Rio Road. However, many of these stops consist of nothing more than signage along the corridor. A lack of bus pull-off locations in combination with sub-standard lane widths (in some areas) yield unsafe conditions for transit vehicles. The lack of bus stop accommodations such as benches, lighting, and shelters also create undesirable conditions for users of transit services.

Facility Use

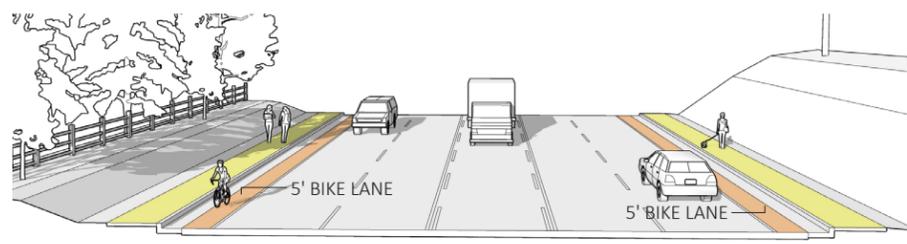
The corridor does not see much multi-modal use. This is likely a result of two factors: safety issues (as mentioned above), and a lack of pedestrian destinations along the corridor. As new development occurs, these two factors should be addressed in design to enhance and increase the use of multi-modal transportation alternatives.



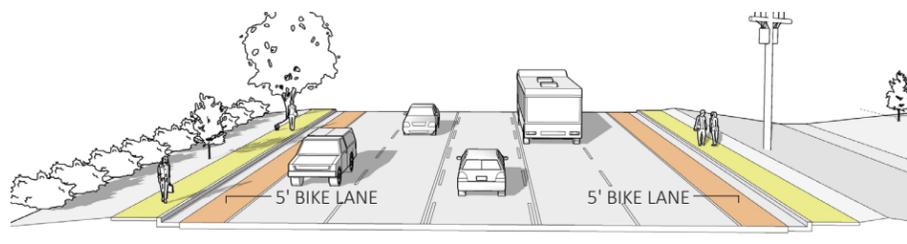
Section 01



Section 02



Section 03



Section 04



Image 1.5 - Multi-Modal Infrastructure

TRAFFIC LEGEND



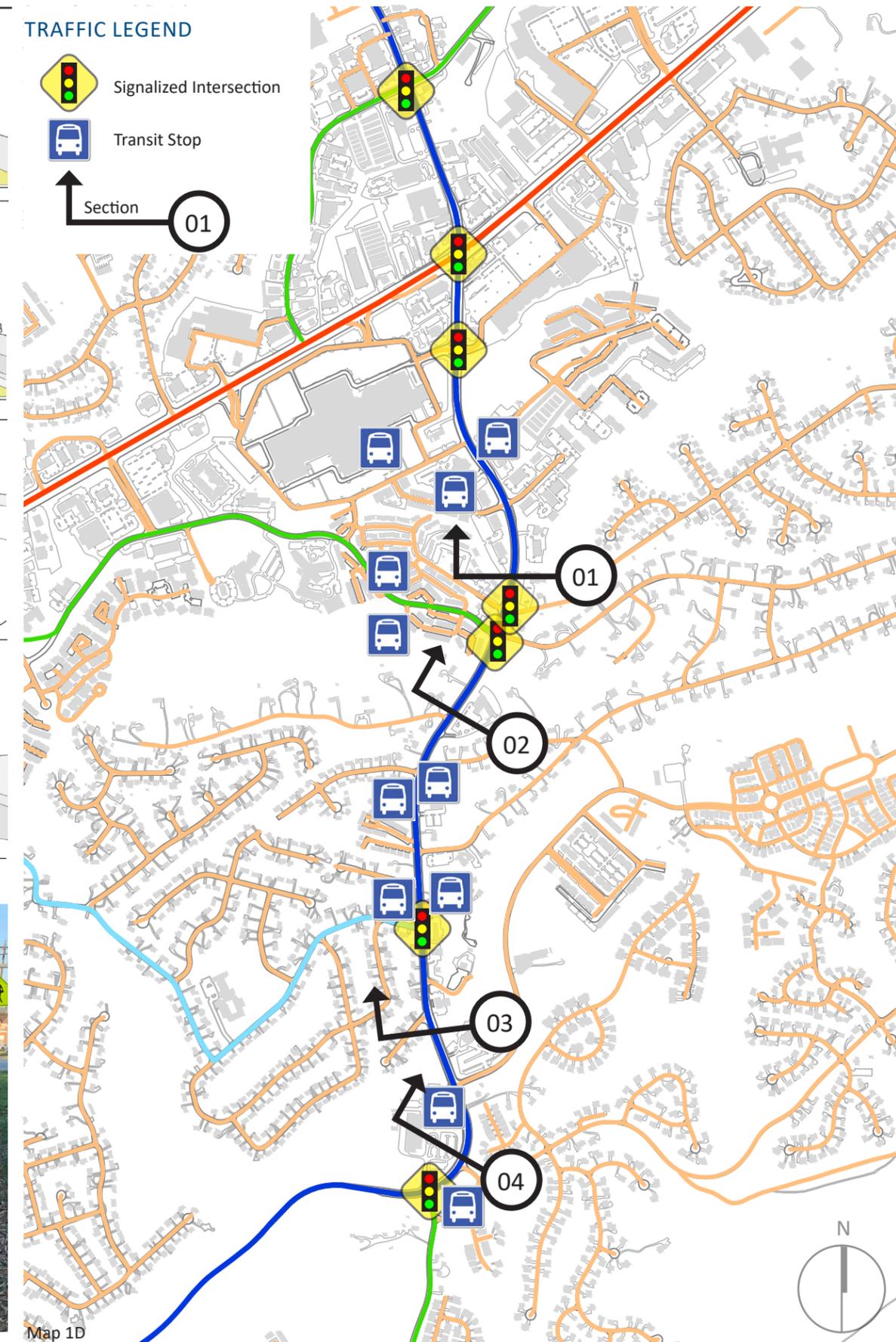
Signalized Intersection



Transit Stop



Section 01



Map 1D

Review Land Use + Comprehensive Plan Guidance

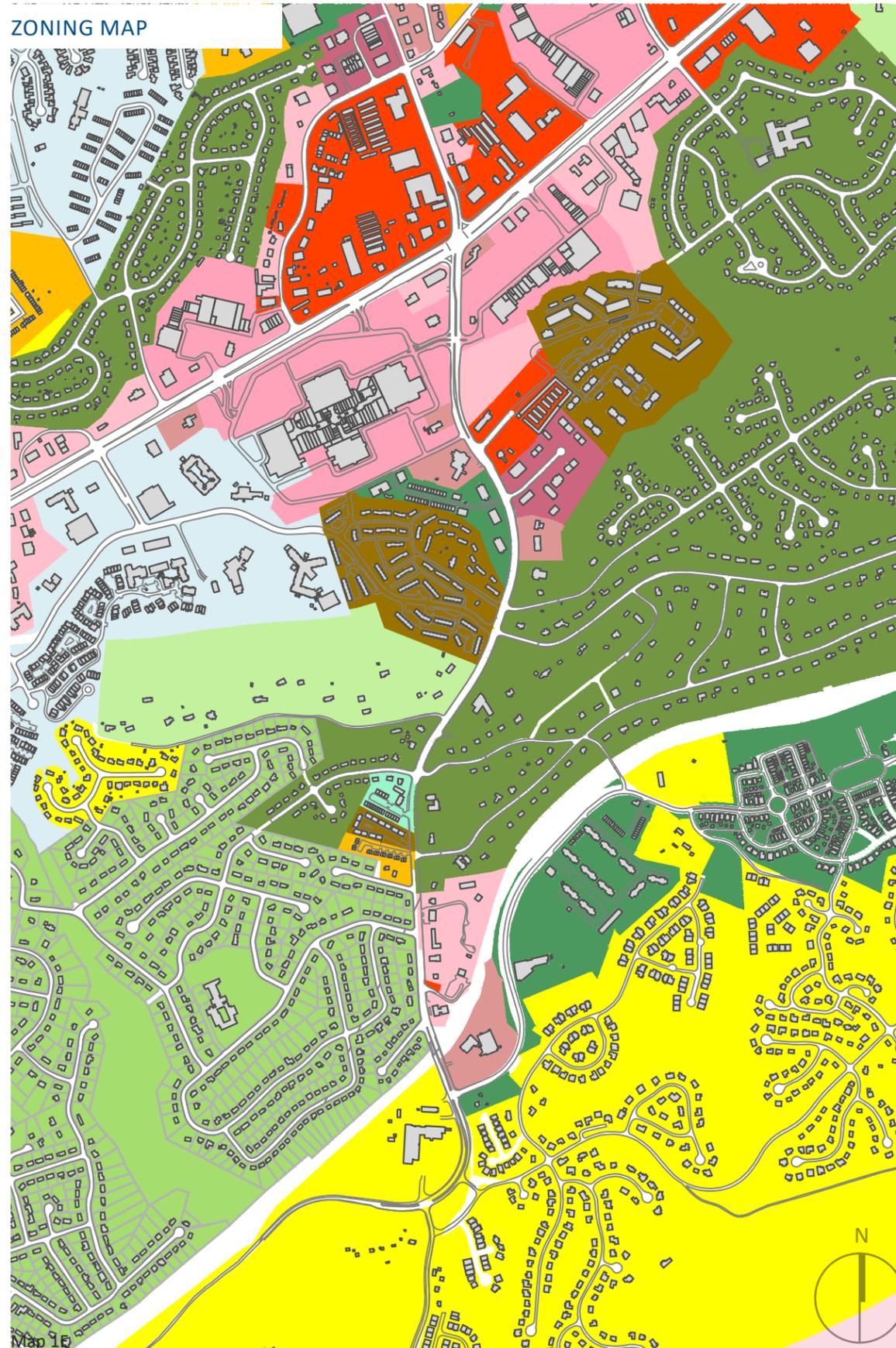
The current zoning boundaries (Shown in Map 1E, left image) within the Rio Road Corridor predominately cater to residential zoning classifications with varying degrees of density, ranging from 0.97 dwelling units per acre under the R1 classification, to 15+ dwelling units per acre under the Planned Unit Development classification. Along Gasoline Alley, and the stretches of Rio Road nearest Route 29, C1, Commercial Office, Highway Commercial, and Planned Development Mixed Commercial zoning classifications comprise the other non-residential uses.

The Comprehensive Plan Boundary map (Map 1F, right image) indicates the future of the corridor plans to simplify the myriad of current residential zoning classifications. In essence corralling them under the Neighborhood Density Residential classification which allows for 3 to 6 dwelling units per acre, comparable to a R4 zoning designation.

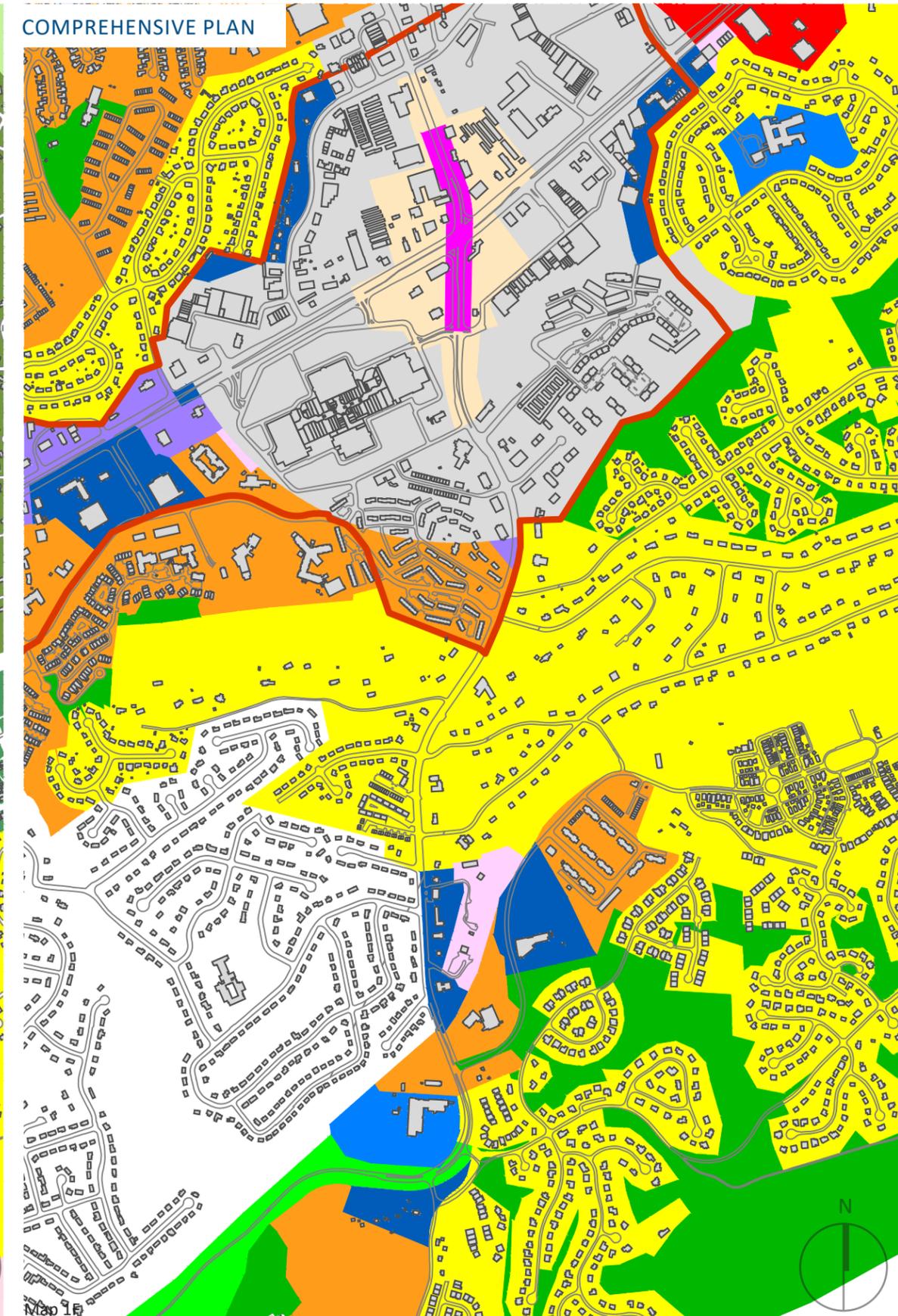
Select areas of the Comprehensive Plan call for Urban Density Residential which allows for higher density developments in the range of 6.01 to 34 dwelling units per acre and a small portion of Retail within the developments. Along Gasoline Alley, the plan calls for an Urban Mixed Use classification which caters to a similar density pattern as Urban Density Residential, but allows for higher concentrations of Retail, and additional Office and Light Industrial uses not permitted in UDR and NDR classifications.

As Rio Road approaches Route 29, the Comprehensive Plan gives way to the Rio 29 Small Area Plan which shifts from the traditional Euclidean Zoning patterns into a Form-Based Code that focuses on a development's form to promote a cohesive, human scaled, mixed-use environment. Within the study area, the Rio 29 Small Area Plan calls for the parcel's character to fall under the Flex typology that allows for 2-5 story buildings with minimal setbacks, and discrete parking areas.

ZONING MAP



COMPREHENSIVE PLAN



CITY ZONING LEGEND		RIO 29 SMALL AREA PLAN	
[Light Green]	R1 RESIDENTIAL	[Pink]	URBAN CORE
[Light Yellow]	R2 RESIDENTIAL	[Light Blue]	CORE
[Light Orange]	R3 RESIDENTIAL	[Light Purple]	FLEX
[Light Red]	HIGHWAY CORRIDOR	[Light Green]	EDGE
[Light Blue]	RURAL AREAS	[Light Orange]	URBAN MIXED USE (IN CENTERS)
[Light Green]	R1 RESIDENTIAL	[Light Red]	URBAN MIXED USE (AROUND CENTERS)
[Light Yellow]	R2 RESIDENTIAL	[Light Blue]	COMMERCIAL MIXED USE
[Light Orange]	R4 RESIDENTIAL	[Light Green]	URBAN DENSITY RESIDENTIAL
[Light Red]	R6 RESIDENTIAL	[Light Orange]	NEIGHBORHOOD DENSITY RESIDENTIAL
[Light Blue]	R10 RESIDENTIAL	[Light Red]	OFFICE / R10 / FLEX / LIGHT INDUSTRIAL
[Light Green]	R15 RESIDENTIAL	[Light Blue]	INSTITUTIONAL
[Light Orange]	PLANNED UNIT DEVELOPMENT	[Light Green]	PUBLIC OPEN SPACE
[Light Red]	PLANNED RESIDENTIAL DEVELOPMENT	[Light Orange]	PRIVATE OPEN SPACE
[Light Blue]	NEIGHBORHOOD MODEL DISTRICT		
[Light Green]	C-1 COMMERCIAL		
[Light Orange]	COMMERCIAL OFFICE		
[Light Red]	HIGHWAY COMMERCIAL		
[Light Blue]	PLANNED DEVELOPMENT SHOPPING CENTER		
[Light Green]	PLANNED DEVELOPMENT MIXED COMMERCIAL		
[Light Orange]	LIGHT INDUSTRY		

Review of Form of the Built Environment



Image 1.6 - Urban Form Precedent



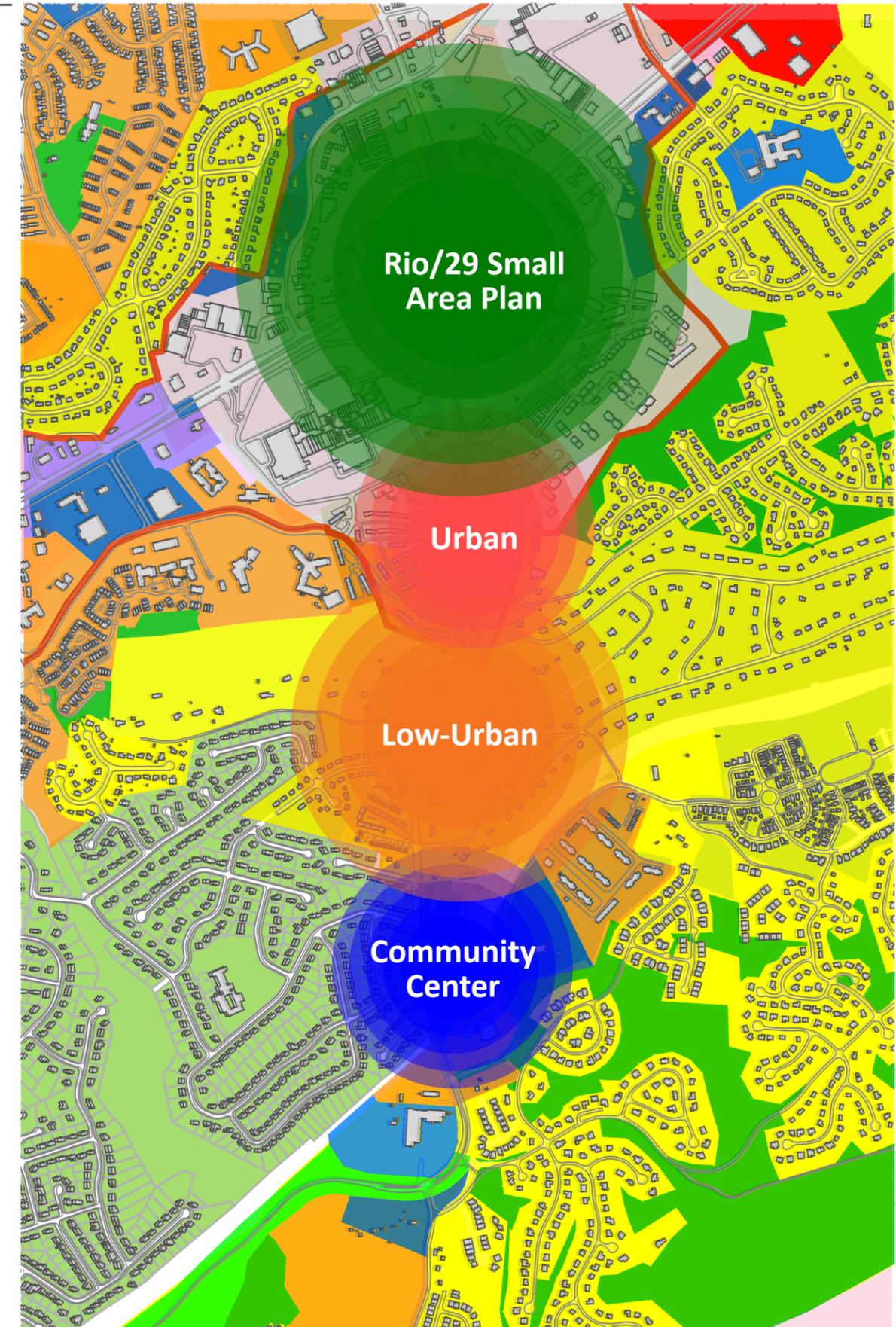
Image 1.7 - Low-Urban Form Precedent

Unmistakably, all of the current parcels and developments along the corridor predominately cater to vehicular thorough-fare which leaves the built environment lacking in human scale and urban character. In an attempt to provide clear direction for future developments along the Rio Road Corridor, rules and principals of the Rio 29 Small Area Plan regarding the form and character of future developments shall be borrowed and overlaid atop the Comprehensive Plan.

Based on the parallels between the current Zoning Map, and Comprehensive Plan, three distinct zones have evolved along the Rio Road Corridor and by adopting the Form-Based Code of the Rio 29 Small Area Plan, we can begin to classify the distinctions through Form-Based descriptions and aspirations: **Urban**, **Low-Urban**, and **Community Center** which each distinctly cater to different densities and uses while moving developments forward with human-scaled, mixed-use principles.



Image 1.8 - Community Center Precedent





Part 2

Current Traffic Conditions

Introduction: Comprehensive Review of Current Traffic Conditions



TRAFFIC STUDY LEGEND

- Formal Traffic Study Completed (by others)
- Cursory Review by Line and Grade



TRAFFIC STUDY INVENTORY

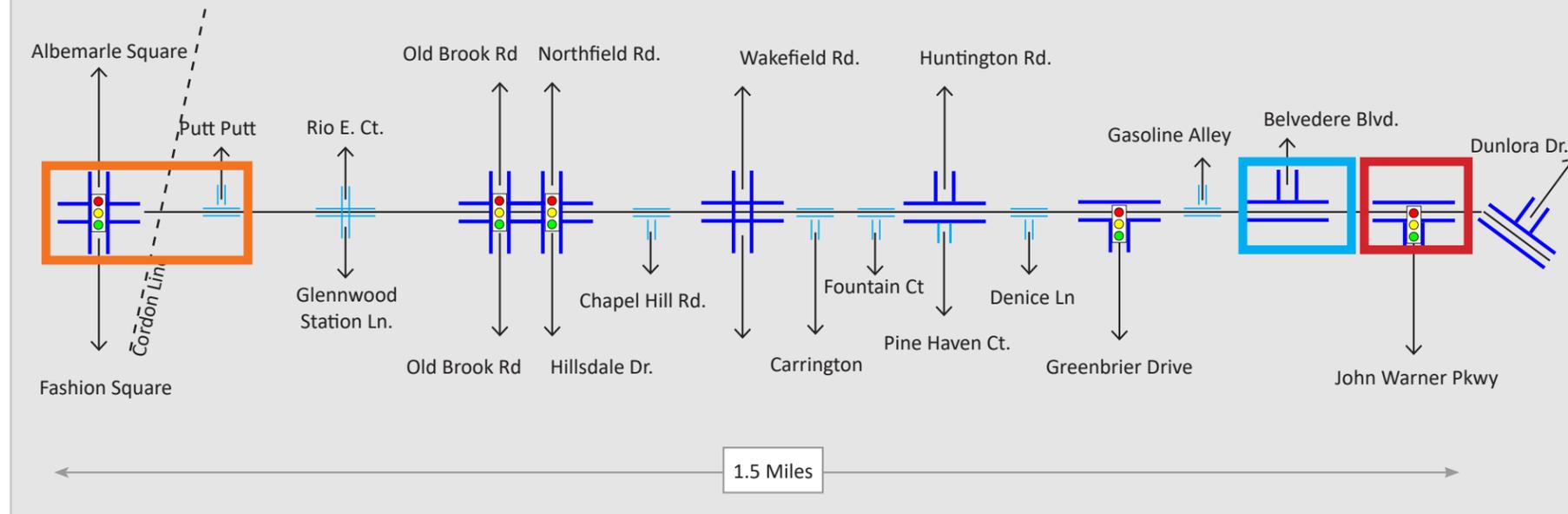


Figure 2.1 - Traffic Study Inventory

John W. Warner Parkway

Summary of the March 6, 2020 Study By VDOT, Kimley-Horn and Kittelson & Assoc.

Background

The intersection of the John W. Warner Parkway (JWP) and Rio Road East is a recent addition to the County's infrastructure. The intersection serves as a primary link along the Rio Road Corridor directly conveying a mix of traffic types toward the City of Charlottesville's urban core.

The intersection also has a unique and often over-looked attribute: the intersection is nearly surrounded by City and or County owned land, which would make improvements to the intersection much simpler than if the land were held by private parties.

Known Operational Deficiencies

The intersection is currently rated at a Level of Service (LoS) E for both the morning and evening peak hours. Turning movements from CATEC and Rio Road East have the worst individual LoS with delays over 300 seconds (Page 3 Rio Road & Belvedere VDOT Analysis) and queue lengths stretching up to 675 feet.

The high volume of turning movements (347 and 566 vehicles per hour for AM and PM, respectively) from Rio Road Southbound, contribute to long delays.

As expounded upon in the Safety Criteria portion of this study, this intersection has had the second-most-high reported crash incidents along the corridor study area. The most common crash is a rear-end collision.

Multi-Modal Accommodations

Given the fact that this intersection was installed in 2011, the multi-modal accommodations of the intersection are modern. That is to say, the intersection includes pedestrian crossing intervals and integration with a Shared Use Path (SUP) which runs the entire length of the JWP.

The LOS shown in the study below is a worst-case scenario: it includes delays incurred as a result of pedestrian crossings in each leg of the intersection. **(Citation Needed)**

Recommendations of the Study

The current low-level of service, the high crash frequency and the land ownership surrounding the intersection increase the viability of improving this intersection. Kittelson & Associates released a study of this intersection and recommended the intersection be improved with a dual-lane roundabout. The dual-lane roundabout suggestion seems rooted in the ability

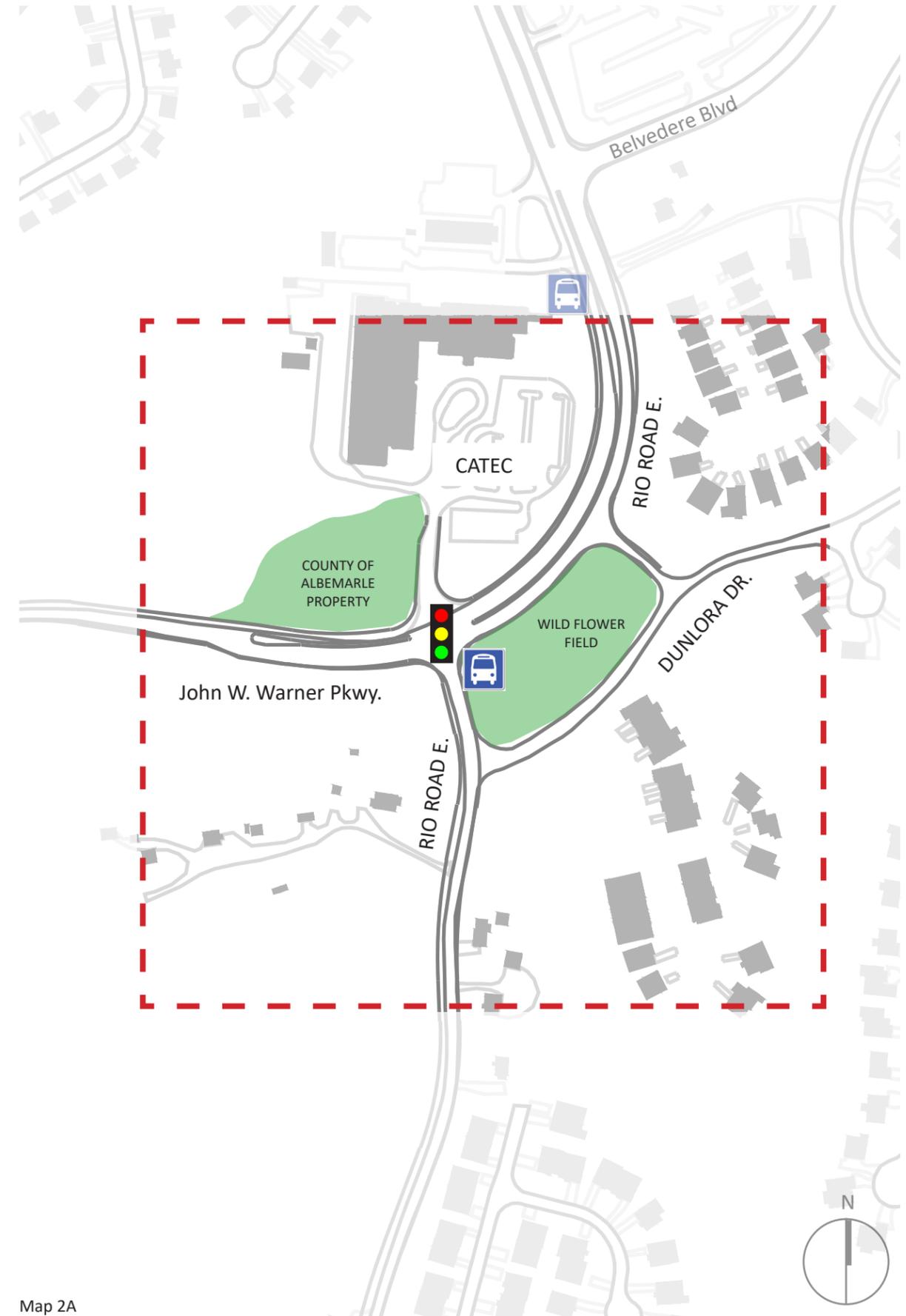
to alleviate the high-volume of turning movements and improve the overall performance of the intersection.

Planned Improvements

The roundabout concept was submitted as a VDOT's Smart Scale Application (insert date). **Confirm with Kevin McDermott as we cannot find the application on SS.**



Figure 2.2 - Concept Plan From Study



Map 2A



Image 2.1 - John W. Warner Parkway and Rio Road East Intersection

Approach	Movement	AM Peak Hour: 7:00 - 8:00 AM			PM Peak Hour: 4:45 - 5:45 PM		
		V/C	Delay (s) [LOS]	95 % Queue (ft)	V/C	Delay (s) [LOS]	95 % Queue (ft)
Eastbound (Driveway)	Left-Through	0.11	97.7 [F]	25	0.24	91.7 [F]	50
	Right	0.0	0.0 [A]	0	0.01	65.8 [E]	0
	Approach	-	97.7 [F]	-	-	87.0 [F]	-
Westbound (Rio)	Left	>1.0	305.7 [F]	200	>1.0	390.1 [F]	125
	Through	0.0	0.0 [A]	225	0.0	0.0 [A]	650
	Right	>1.0	203.1 [F]	225	>1.0	204.0 [F]	650
Approach	-	223.7 [F]	-	-	217.9 [F]	-	
Northbound (John Warner)	Left	0.01	13.2 [B]	25	0.04	16.2 [B]	25
	Through-Right	0.27	16.4 [B]	325	0.43	24.9 [C]	675
	Approach	-	16.4 [B]	-	-	24.7 [C]	-
Southbound (Rio)	Left	0.72	11.4 [B]	275	0.96	40.2 [D]	600
	Through	0.55	12.7 [B]	550	0.49	12.7 [B]	525
	Right	0.01	6.6 [A]	0	0.03	7.6 [A]	0
	Approach	-	12.2 [B]	-	-	25.2 [C]	-
Overall Intersection		-	68.6 [E]	-	-	72.5 [E]	-

Table 2.1 - Level of Service for Turning Movements at Intersection

Belvedere Boulevard

Summary of the March 6, 2020 Study By VDOT, Kimley-Horn and Kittelson & Assoc.

Background

Belvedere Boulevard at Rio Road is an unsignalized intersection primarily serving the Belvedere Development. The Belvedere Development currently services [##] residential properties and the current plan is that [##] more homes will be added in addition to a sports complex and a [##].

Despite the continued development plans the Belvedere community currently has only one location for egress and that is this intersection. The property is effectively land-locked between the Norfolk-Southern Railroad right of way, the Rivanna River and the Dunlora residential community.

Known Operational Deficiencies

The intersection currently experiences delays and safety issues, both of which are likely to increase with the continued development unless corrective actions can be taken. The intersection has an overall LoS of C in the morning peak hour and a LoS E in the evening peak hour. The left turn movements from Belvedere onto Rio Road Southbound can experience delays exceeding 500 seconds (8 minutes and 20 seconds!). Between 2013 and 2020 at least 18 crashes were reported in the functional area of the intersection (citation needed), most of the reported vehicle incidents were rear-end crashes.

Multi-Modal Accommodations

This intersection marks the end of the buffered shared use path along the north side of Rio Road. Presumably this is an existing portion of what will become the North-town Trail and was built with the JWP project. There is an existing transit stop on the south side of Rio Road, adjacent to City Church and CATEC, but there is no safe way for pedestrians to cross Rio Road in order to get to or from this transit stop from the Belvedere neighborhood.

Recommendations of the Study

A traffic analysis performed by Kittelson and Associates suggested a roundabout or a Restricted Crossing U-Turn (RCUT) for this intersection. An example of the RCUT design is shown at right in Figure ##. According to the Kittelson Analysis the RCUT was preferred due to concerns of disturbing the existing bridge just northwest of the intersection. The RCUT may be a good solution purely from a traffic management perspective; however, it works best with other improvements suggested by the report, namely a roundabout at the JWP intersection. Furthermore, the RCUT solution would also require modification of the Greenbrier Terrace intersection.

Planned Improvements

Though a conceptual design for this intersection was completed by Kittelson, it has not yet been funded and it is dependent on the results of the final plans at the JWP intersection. (Decision expected January 2021)

Approach	Movement	AM Peak Hour: 7:00 - 8:00 AM			PM Peak Hour: 4:45 - 5:45 PM		
		V/C	Delay (s) [LOS]	95 % Queue (ft)	V/C	Delay (s) [LOS]	95 % Queue
Eastbound (Driveway)	Left-Through-Right	0.0	0.0 [A]	-	0.01	15.9 [C]	0
	Approach	-	0.0 [A]	-	-	15.9 [C]	-
Westbound (Belvedere)	Left - Through	>1.0	>500.0 [F]	225	8	>500.0 [F]	175
	Right	0.17	15.0 [C]	25	0.42	30.1 [D]	50
Northbound (Rio)	Approach	-	313.9 [F]	-	-	>500.0 [F]	-
	Left	-	0.0 [A]	0	-	0.0 [A]	0
Southbound (Rio)	Through-Right	-	0.0 [A]	0	-	0.0 [A]	0
	Approach	-	0 [A]	-	-	0 [A]	-
Southbound (Rio)	Left	0.04	12.7 [B]	25	0.26	25.1 [D]	25
	Through	-	0.0 [A]	-	-	0.0 [A]	0
	Right	-	0.0 [A]	-	-	0.0 [A]	0
	Approach	-	0.2 [A]	-	-	1.0 [A]	-

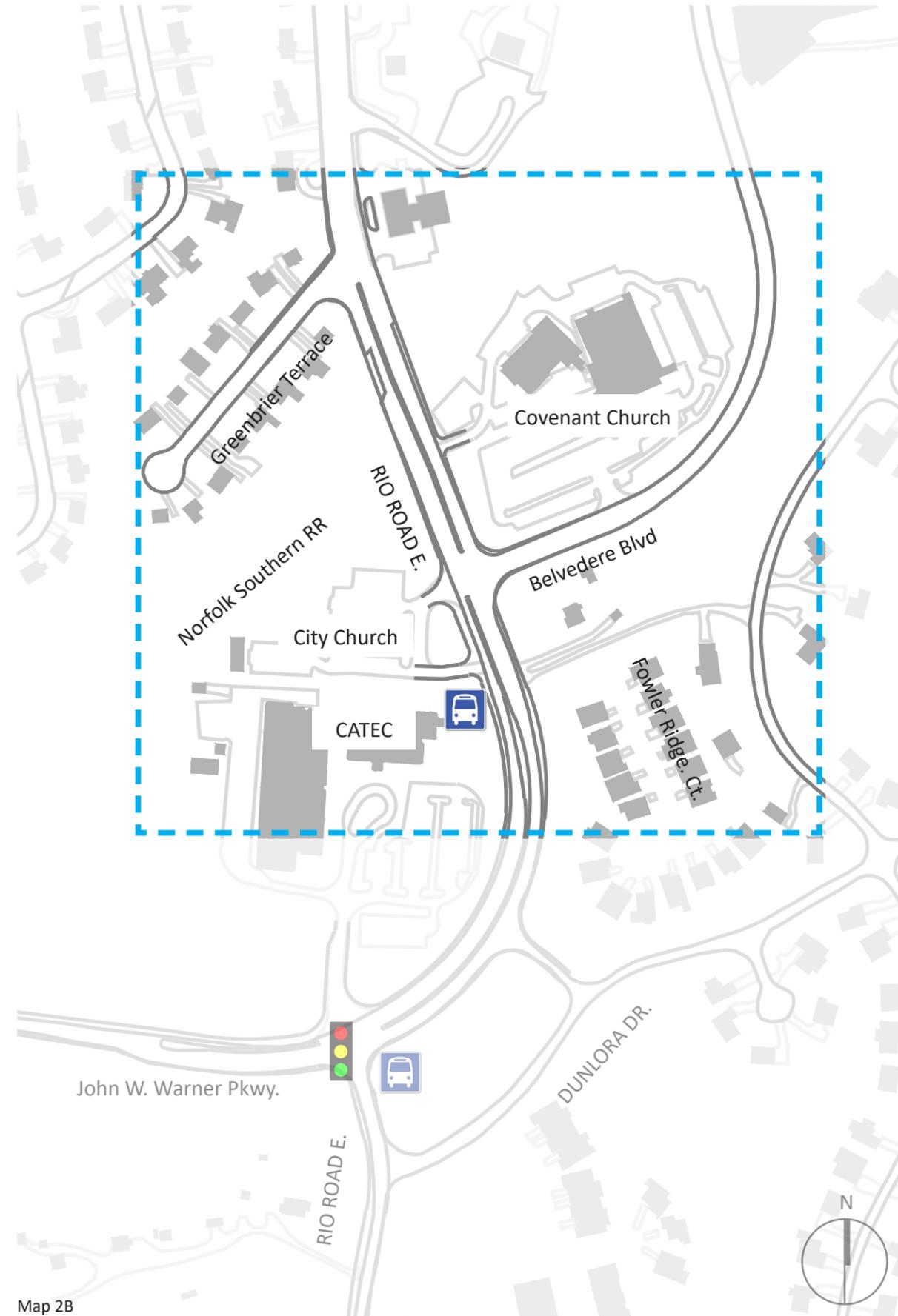
Table 2.2 - Level of Service for Turning Movements at Intersection



Figure 2.3 - Concept Plan From Study



Image 2.2 - Belvedere Boulevard and Rio Road East Intersection



Map 2B

Gasoline Alley

No Formal Traffic Study has been performed for this area. These are general observations.

Background

Gasoline Alley is a useful term for the segment of Rio with three gas stations and a car wash directly adjacent to one another, but it is also the name of one of the roads within this area of interest. The segment referred to in this section begins at Greenbrier Terrace and ends at Rio School Lane. Within this segment is Greenbrier Drive, which intersects with Rio Road East across from the Marathon gas station with a traffic signal in place. On top of the relatively high turning movements generated by the gas stations, Greenbrier Drive experiences condensed traffic in the morning and afternoon due to Greenbrier Elementary School and the residential properties in the neighborhood.

Known Operational Deficiencies

No formal traffic study has been performed for this area, though Google Maps traffic data shows congestion most times of day centered around the traffic signal at Greenbrier Drive. Over 40 crashes were recorded from 2013-2020, thirty (30) of which occurred at the Greenbrier Drive intersection. As observed in the Access Management Overlay map in Part 1 of this study, the unsignalized entrances in this segment of road do not meet commercial spacing standards, with less than 30% of the required spacing available. Additionally, though Greenbrier Drive meets spacing standards for a signalized intersection, it is surrounded by commercial entrances which are within the intersection's functional area, meaning vehicles queued at the traffic signal are backing up past the surrounding entrances.

The substandard spacing of entrances in this area contributes to numerous vehicular crashes, refer to Figure 2.4 for a graphic display of recorded accidents. As discussed in the Safety Criteria section, crashes are most likely at the conflict points of the intersection. The increased number of conflict points leads to increased crashes as shown in Image 2.4. The short, or non-existent throat lengths for commercial entrances contributes to the high crash volume as well. Refer to the "Review of Access Management" in Part 1 for more information on entrance throat standards.

Multi-Modal Accommodations

The recent installation of signalized crosswalks at Greenbrier Drive has significantly increased pedestrian access in this area, especially since the nearest crosswalk is almost a half-mile away. A transit stop is located on either side of the road in this location. Often time transit operators prefer to locate a bus stop after an intersection rather than prior to the intersection, where the southbound stop is currently located. Given the high-volume of crashes in the vicinity the transit stop location and integration with the roadway should be reconsidered.

Sidewalks and bicycle lanes exist, though the cluster of entrances and high number of turning movements make it unsafe for pedestrians and cyclists. For example, a pedestrian headed north on the east of Rio Road will need to cross 8 entrances/intersections within a span of 970 ft. Within this span, the total unprotected length that the pedestrian must cross (without crosswalks) is approximately 520 ft (!).

Gas stations the size of those within this area each generate 49-59 trips in peak hour traffic, meaning a pedestrian walking across the three different gas station entrances is almost certain to encounter a potential for conflict with a vehicle (ITE Trip Generation Manual, 10th Edition).

Line + Grade Recommendations

Most of the businesses in this segment of road have two entrances to Rio Road East. Limiting access to these entrances or eliminating them completely will create less conflict points within the functional area of the intersection at Greenbrier Drive, meaning less chance for collisions. Space permitting, this segment is a great candidate for shared entrances and internal site connection (VDOT Appendix F).

Planned Improvements

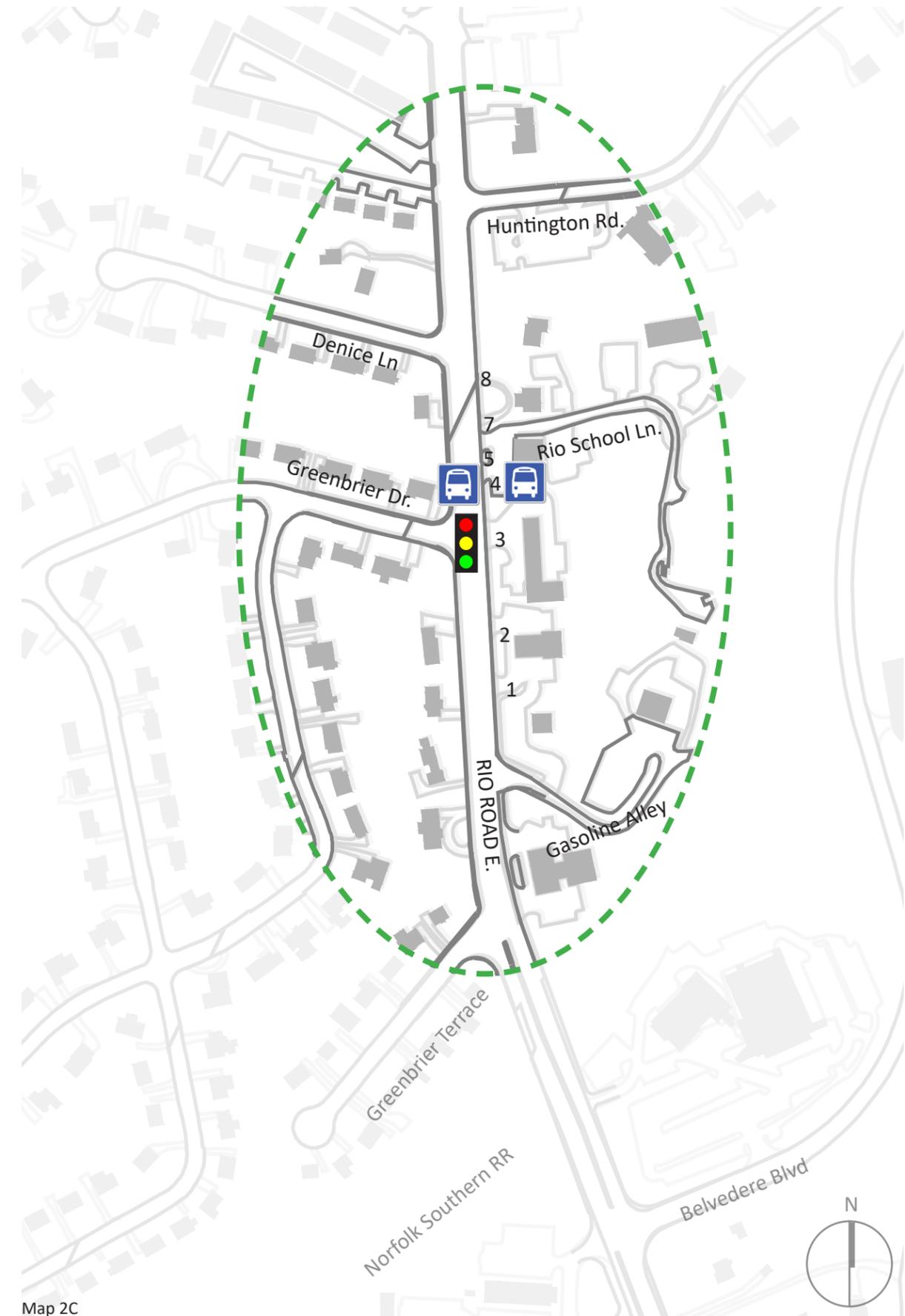
None.



Image 2.3 - Gasoline Alley and Rio Road



Figure 2.4 - Recorded Crash Data (VDOT)



Map 2C

Old Brook Road + Northfield Road + Hillsdale Drive

No Formal Traffic Study has been performed for this area. These are general observations.

Background

In every practical sense the Old Brook Road, Northfield Road and Hillsdale Drive intersections at Rio Road act as a single intersection. The spacing is so close that these intersections cannot act independently. This fact has, in part, contributed to the lack of safety and predictability of this intersection.

Old Brook Road and Northfield Road predominantly serve the residential communities of Raintree, Westmoreland, Still Meadow, Bending Branch and Carrsbrook. Collectively these communities contain ## residential properties.

Hillsdale Drive, by contrast, connects Rio Road and Hydraulic Road and was part of the Route 29 Solutions project to expand and create parallel road networks adjacent to Route 29.

Recent VDOT data indicates that Hillsdale Drive carries 7,200 vehicles per day.

Known Operational Deficiencies

As of this writing, no formal traffic analysis has been performed for this intersection. Which is

surprising given that it has the highest count of vehicle crashes in the County.

Due to the odd geometry of the intersection, certain turning movements are given an "extended green" signal in order to keep the intersection clear of traffic jams. Even though the intersection has posted signage that seeks to alert drivers of this condition, certainly the high crash volume at this intersection is associated with the lack of clarity and predictability of the traffic movements.

As was expounded upon in the "Access Management" portion of this study, these intersections are spaced approximately 220 feet apart (measured center to center). Put another way, this spacing is approximately 20% of what VDOT standards recommend. This also indicates that the turn lane storage lengths, taper lengths and intersection sight distances do not meet the minimum requirements.

Multi-Modal Accommodations

The intersection integrates several multi-modal transportation options with bicycle lanes and signalized pedestrian crossings available.

(See image below). However, a number of factors prohibit a fully functioning multi-modal intersection. The lane widths in this area are 10 feet, which is 2 feet below the recommended lane width to accommodate a high percentage of buses (pg 18 VDOT Appendix A-1, figure GS-6). The high public transit traffic in this area combined with substandard lane widths and unbuffered bicycle lanes creates an unsafe, or at the very least unpleasant, condition for bicyclists. Picture yourself as a cyclist in Image 2.4 below.

Recommendations

These intersections should be comprehensively evaluated and redesigned.

Planned Improvements

None currently planned.

The Rio/29 Small Area Plan does suggest that Hillsdale should be re-routed to intersect with Putt Putt Place. This recommendation could substantially help the geometry and access management requirements at this intersection.

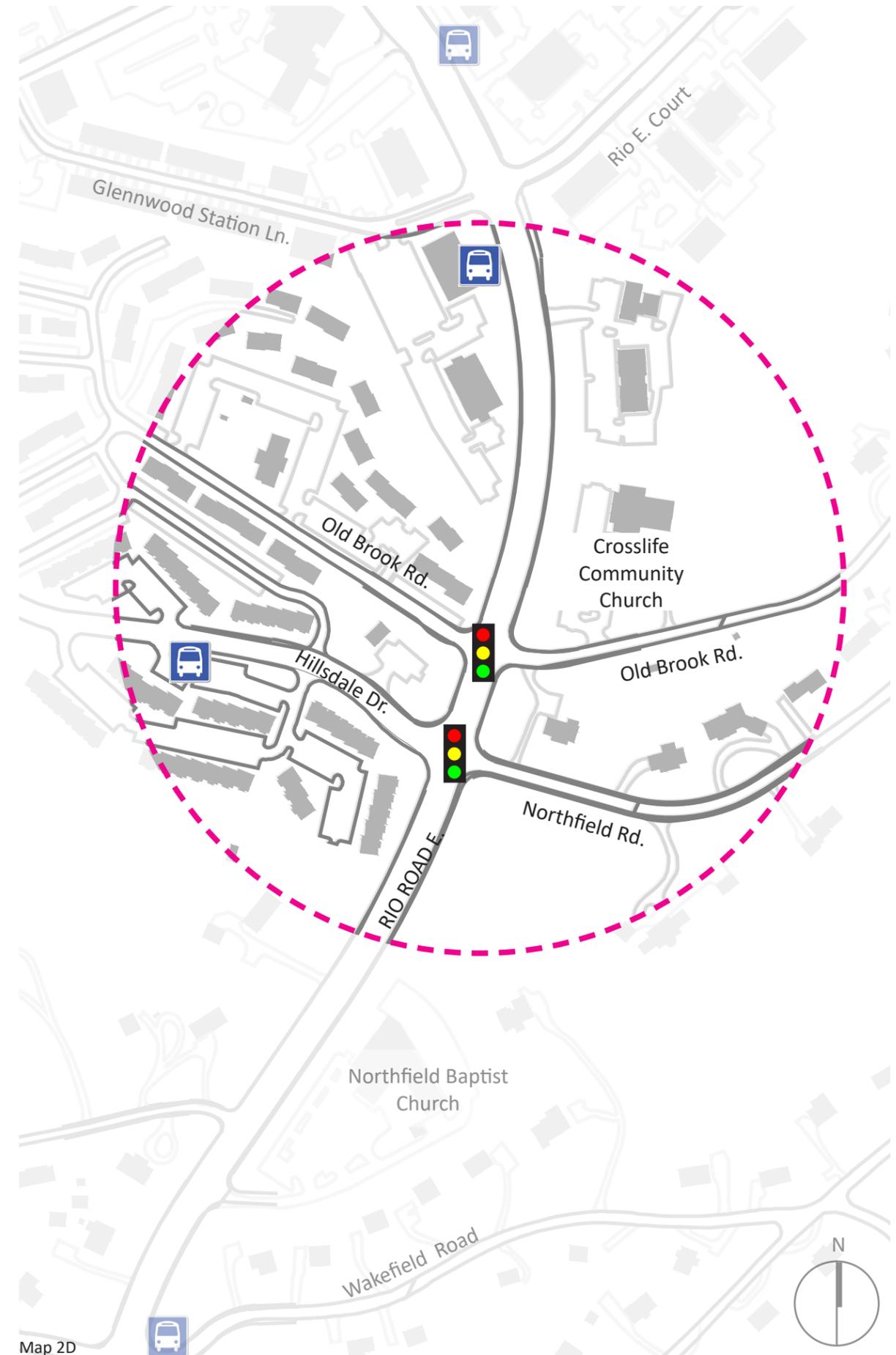


Image 2.4 - Rio Road between Old Brook and Northfield



Image 2.5 - Aerial Image of Rio Road between Old Brook and Northfield

Rio 29 Small Area Plan + Putt Putt Place

Summary of the December 12, 2019 by Kimley-Horn from Within the Rio/29 Small Area Plan Appendix (Page 63-65)

Background

As Rio Road East approaches US 29, it begins to serve more commercial uses in addition to residential. The Rio29 Small Area Plan includes analysis of this portion of Rio Road, recommending it become a Boulevard with buffers for pedestrians and bicyclists and landscaped medians as a traffic calming measure. Redesigning this portion of the road would allow for an urban center, referred to as the core, around US 29 that is more inviting and safe for pedestrians.

Known Operational Deficiencies

Though the Rio29 SAP analyzes traffic in multiple intersections around US 29, only the intersection of Putt Putt Place with Rio Road East is included in this scope of analysis. Congestion around this intersection is currently an issue according to a traffic study performed by Kimley-Horn in 2018. The current LOS for southbound movements is a Level D. The projected LoS in 2045 with existing land use is an E, and when taking into consideration the future land use of the area, it is projected at a LoS F.

In addition to delay times, crashes are concentrated around Putt Putt Place, with more than 30 crashes from 2013-2020.

Multi-Modal Accommodations

Due to the centralized location of this intersection and its proximity to major shopping centers, pedestrian access and public transit are increasingly important. Currently, a public transit stop is located at Putt Putt Place, but the nearest pedestrian crossing is at Fashion Square Drive, over 900 ft away. According to ?? (we heard this from Rachel Falkenstein) VDOT plans to eventually remove this traffic signal at Fashion Square Drive due to its proximity to US 29, meaning a new pedestrian crossing location will be necessary.

Recommendations

One of the transformative projects that was identified as part of the Rio 29 SAP is the realignment of Hillsdale Drive with Putt Putt Place and the addition of a roundabout (pg 48 Rio29 SAP). This would help alleviate congestion at the problematic intersection of Hillsdale Drive / Northfield Road and Rio Road East, and provide a viable alternative route for Fashion Square Drive traffic if the existing traffic signal is to be removed. This roundabout would improve the current and projected Level of Service of the intersection, according to Kimley-Horn, and would provide an opportunity for another pedestrian crossing.

Planned Improvements

Though a concept for this realignment and roundabout is included in the SAP, it has not been submitted for funding and there are currently no plans for construction.

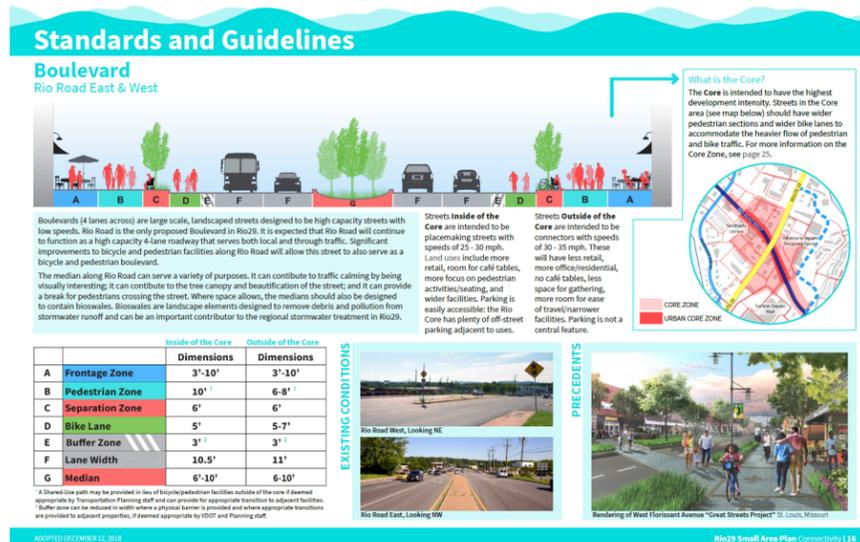


Figure 2.5 - Design and Guidance from the Rio/29 Small Area Plan

TABLE 1: RIO ROAD AT HILLSDALE DRIVE/PUTT PUTT PLACE

Scenario	LOS (Delay [s/veh])	Maximum Volume-to-Capacity Ratio
Base Year No-Build - Unsignalized	SB - D (25.2) EBL - B (14.9)	-
Future Year No-Build (Existing Land Use) - Unsignalized	SB - E (35.0) EBL - C (18.7)	-
Future Year No-Build (Proposed Land Use) - Unsignalized	SB - F (153.3) EBL - C (20.4)	-
No-Build Year of Failure ^A		2025
Future Year Build 1 - Signalized	D (37.5)	0.90
Future Year Build 2 - Roundabout	C (24.6)	0.87

^ABased on two-way stop control and proposed land use

Figure 2.6 - LOS of Revised Rio/Hillsdale Intersection per Plan Recommendations

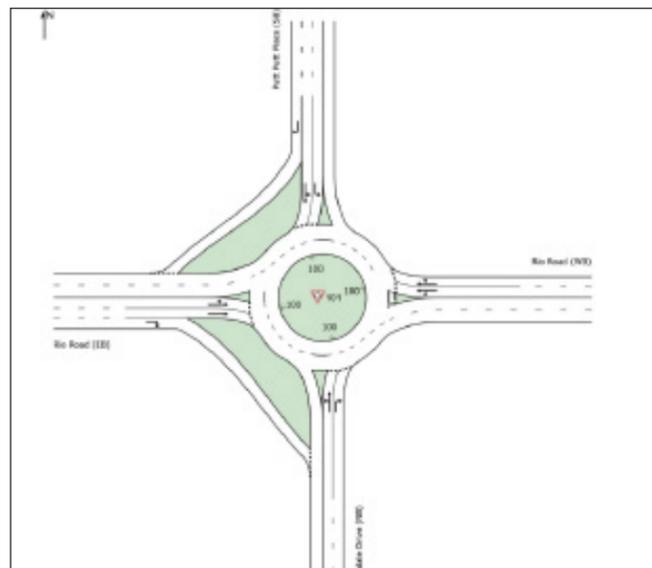
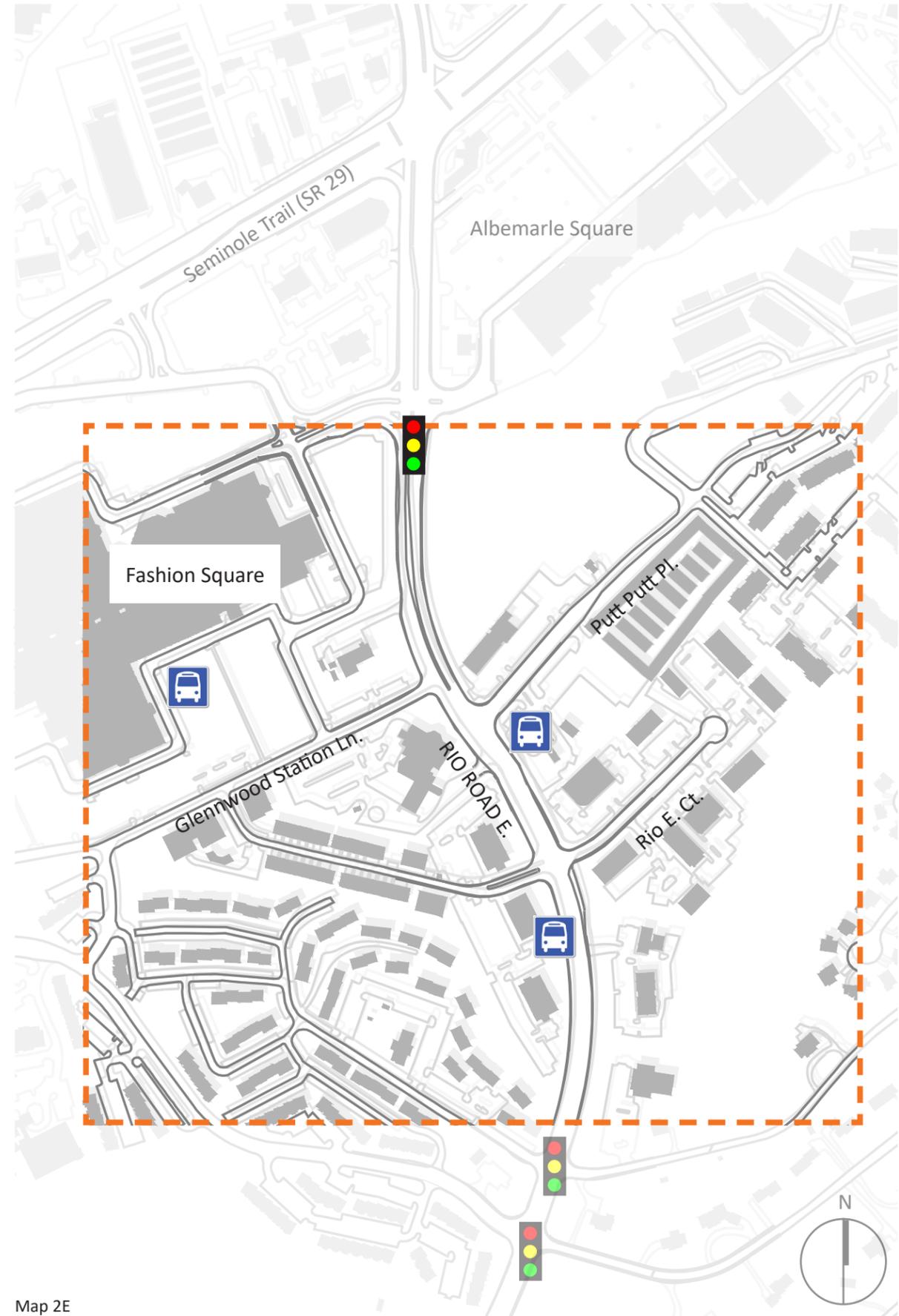


Figure 2.7 - Dual Lane Diagram for Hillsdale / Putt Putt Intersection



Map 2E