Chatfield Avenue Corridor Traffic Study

Pierce Street to Kendall Boulevard

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Table of Contents

EXECUTIVE SUMMARY **1**
1.0 Introduction **2**
1.1 Study Area 2
2.0 Corridor Characteristics **4**
2.1 Functional Classification 4
2.2 Traffic Control 4
2.3 Access 4
2.4 Parking 7
2.5 Bicycle and Pedestrian Facilities 7
2.6 Transit 7
3.0 Crash Analysis **10**
4.0 Existing Traffic Conditions **14**
4.1 Daily Traffic Volumes 14
4.2 Peak Hour Intersection Traffic Volumes 14
4.3 Operational Analysis 14
4.4 Evaluation of Alternatives 17
5.0 Future Traffic Conditions **20**
5.1 Projected Traffic Volumes 20
5.2 Operational Analysis 20
5.3 Evaluation of Alternatives 20
6.0 Recommendations **23**
6.1 Traffic Operations 23
6.2 Intersection Control 23
6.3 Traffic Safety 23
6.4 Bicycle Facilities 24
6.5 Pedestrian Facilities 24
6.6 Typical Sections 25

Appendices

Appendix A. Level of Service Analysis
Appendix B. Traffic Signal Warrant Analysis—Chatfield Avenue and Pierce Street
Appendix C. Traffic Signal Warrant Analysis—Chatfield Avenue and Kendall Boulevard

List of Figures

Figure 1. Chatfield Avenue Study Area 3
Figure 2. Intersection Traffic Control 5
Figure 3. Access Points 6
Figure 4. Existing Bicycle and Pedestrian Facilities 8
Figure 5. Transit 9
Figure 6. Kendall Boulevard Intersection Collision Diagram 11
Figure 7. Pierce Street Intersection Collision Diagram 12
Figure 8. Chatfield Avenue Segment Collision Diagram 13
Figure 9. Existing and Projected Daily Traffic Volumes 15
Figure 10. Existing Intersection Volumes 16
Figure 11. Projected Intersection Volumes 21
Figure 12. Proposed Typical Sections 26

List of Tables

Table 1. Existing Intersection Delay and Level of Service 17
Table 2. Alternative Intersection Delay and Level of Service--Pierce Street 18
Table 3. Alternative Intersection Delay and Level of Service--Kendall Boulevard 19
Table 4. Future Intersection Delay and Level of Service 20
Table 5. Future Alternative Intersection Delay and Level of Service--Pierce Street 22
Table 6. Future Alternative Intersection Delay and Level of Service--Kendall Boulevard 22

EXECUTIVE SUMMARY

This study evaluates the traffic operations and safety characteristics of Chatfield Avenue between Pierce Street and Kendall Boulevard in order to provide recommendations for the Chatfield Avenue project design. Chatfield Avenue is a two-lane roadway located in the southeast area of unincorporated Jefferson County and is classified as a major collector on the County's Major Thoroughfare Plan. Major collectors typically include two through lanes of travel, medians for left-turn lanes, bicycle lanes, and sidewalks.

Traffic volumes along this segment of Chatfield Avenue are expected to grow to about 11,600 vehicles per day by year 2035. A major collector template with left-turn lanes at intersections will provide adequate capacity for the projected volumes. Existing traffic control at Pierce Street and Kendall Boulevard provides acceptable levels of service with current volumes, but the installation of roundabouts is recommended to improve operations now and in the future.

A review of the crash history revealed a total of nine crashes, including three injury crashes, along the corridor between 2010 and 2012. Five of these crashes were broadsides or left-turn crashes and occurred at the Kendall Boulevard intersection. Two pedestrian related crashes occurred at the Pierce Street intersection.

Improvements to the bicycle and pedestrian facilities along Chatfield Avenue are recommended based on the County's Bicycle and Pedestrian Plans. The addition of these facilities would further enhance the existing network of bicycle lanes and shared use paths.

Recommendations include the following:

- Chatfield Avenue should be designed using a major collector template that incorporates two through lanes, center left-turn lanes, and bicycle lanes in both directions.
- Left-turn lanes should be provided at Newland Street and Marshall Court.
- The existing traffic signal at Pierce Street should be replaced with a single-lane roundabout.
- The existing all-way stop at Kendall Boulevard should be replaced with a single-lane roundabout.
- From Pierce Street to Lamar Court, an 8-foot detached sidewalk should be installed on the north side of Chatfield Avenue and a 5-foot attached sidewalk should be considered on the south side.
- A pedestrian refuge island should be constructed at the Columbine Trail crossing near Lamar Court.
- A 6-foot parking lane should be maintained on the south side of the roadway from Pierce Street to Lamar Court.

1.0 Introduction

The Jefferson County Transportation and Engineering Division has initiated a project to complete the reconstruction of Chatfield Avenue from Pierce Street to Kendall Boulevard. This project will upgrade the roadway to the County's appropriate standard template and provide the opportunity to implement alternative traffic control, safety improvements, and bicycle and pedestrian facilities as needed. This study evaluates the study area and provides traffic engineering recommendations for the project design. A previous study of the corridor was completed in 2004.

1.1 Study Area

Chatfield Avenue is located in the southeast area of unincorporated Jefferson County. The project study area, Pierce Street to Kendall Boulevard, is located on the east end of Chatfield Avenue and is shown in **Figure 1**. On the west end, the study area is bounded by the signalized intersection with Pierce Street. One the east end, Chatfield Avenue intersects with Kendall Boulevard to the north and a ramp to and from westbound C-470 on the south side. East of Kendall Boulevard, Chatfield Avenue becomes S. Platte Canyon Road, a state highway maintained by the Colorado Department of Transportation (CDOT).

Land uses within the study area include residential areas, religious institutions, and vacant land zoned for agricultural use. Major residential areas include the Columbine Hills subdivision to the north and the Herrick Dale subdivision to the south. The vacant land on the south side of Chatfield Avenue is owned by the U.S. Army Corps of Engineers.

Figure 1. Chatfield Avenue Study Area

2.0 Corridor Characteristics

2.1 Functional Classification

Between Pierce Street and Kendall Boulevard, Chatfield Avenue is classified as a major collector in the Jefferson County Major Thoroughfare Plan. The Major Thoroughfare Plan establishes the functional classification of all roadways at build out of current zoning.

Major collectors are typically designed to carry approximately 8,000 to 15,000 vehicles per day (vpd) and have a design speed of 35 miles per hour (mph). The County's standard template for a major collector includes two 11-foot travel lanes, a raised, depressed, or painted 15-foot median with left-turn lanes at intersections, 4-foot bicycle lanes in each direction, and 8-foot detached sidewalks on both sides of the street.

The segment of Chatfield Avenue between Pierce Street and Kendall Boulevard is currently a two-lane roadway without left-turn lanes. The posted speed limit is 30 mph between Pierce Street and Lamar Court and 35 mph between Lamar Court and Kendall Boulevard.
A westbound right-turn lane is provided at the intersection with Pierce Street. A two-lane roadway without turn lanes can be expected to accommodate up to about 10,800 vpd. Currently, Chatfield Avenue carries about 9,200 vpd east of Pierce Street.

2.2 Traffic Control

The existing intersection traffic control is shown in **Figure 2**. A traffic signal is located at the intersection of Chatfield Avenue and Pierce Street. This signal is coordinated with the other traffic signals on Chatfield Avenue during peak hours. The presence of overhead power lines on the north side of Chatfield Avenue requires the use of diagonal span wire mounted signal heads for the eastbound direction.

The intersection of Chatfield Avenue and Kendall Boulevard is controlled with all-way stop signs. The intersections of Newland Street, Marshall Court, and Lamar Court are all controlled by stops signs on the minor street approaches.

2.3 Access

Chatfield Avenue provides access to residential areas as well as the adjacent churches and land owned by the U.S. Army Corps of Engineers. **Figure 3** shows the access points on Chatfield Avenue. On the west end of the corridor, Chatfield Avenue has 12 residential access points. In addition, one institutional access point on the north side provides access to both St. Frances Cabrini Parish and St. Gregory's Episcopal Church. The Parish also has several access points on Pierce Street. On the east end of the corridor, one access point on the south side connects to the U.S. Army Corps of Engineers' land.

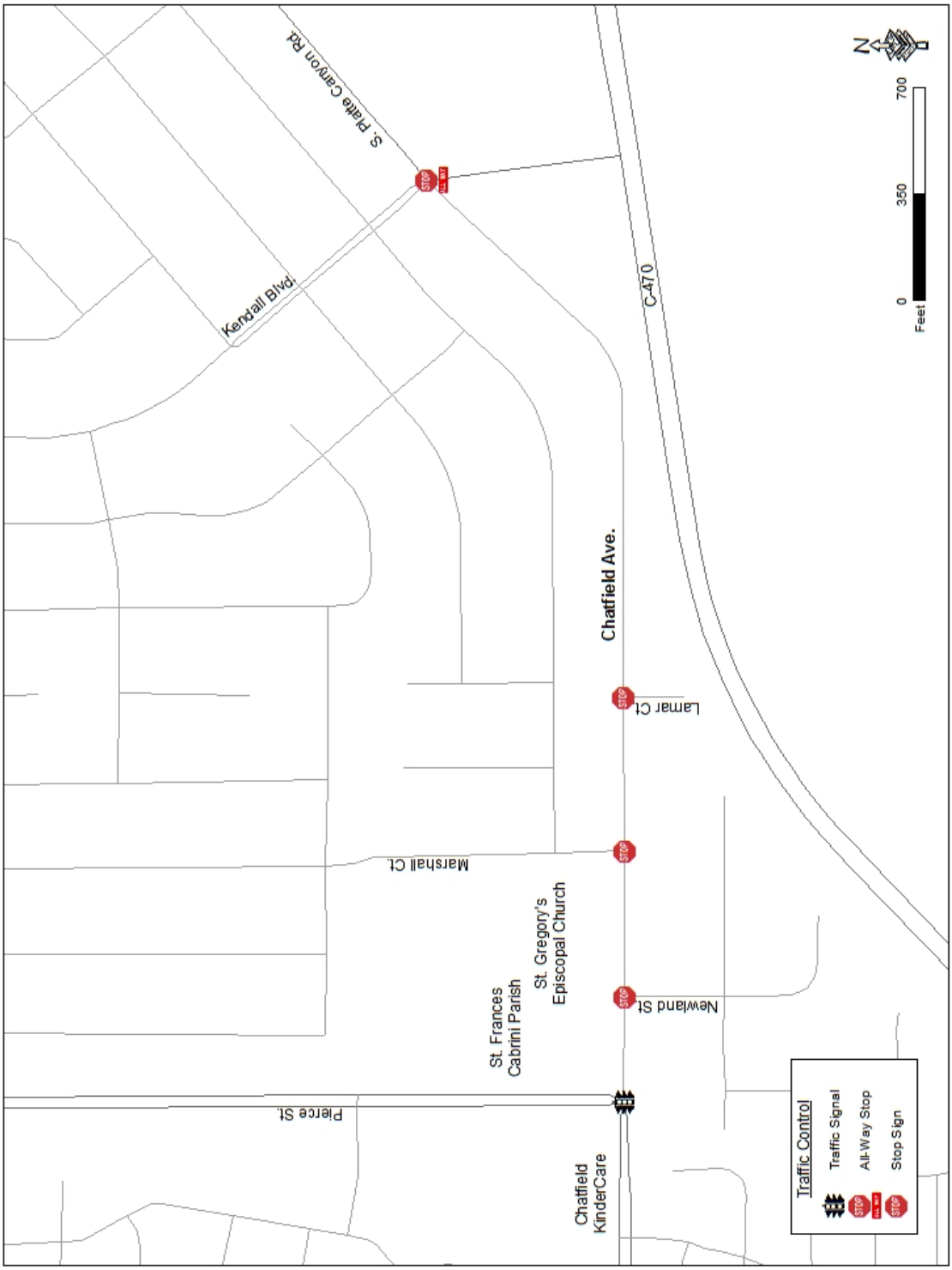


Figure 2. Intersection Traffic Control

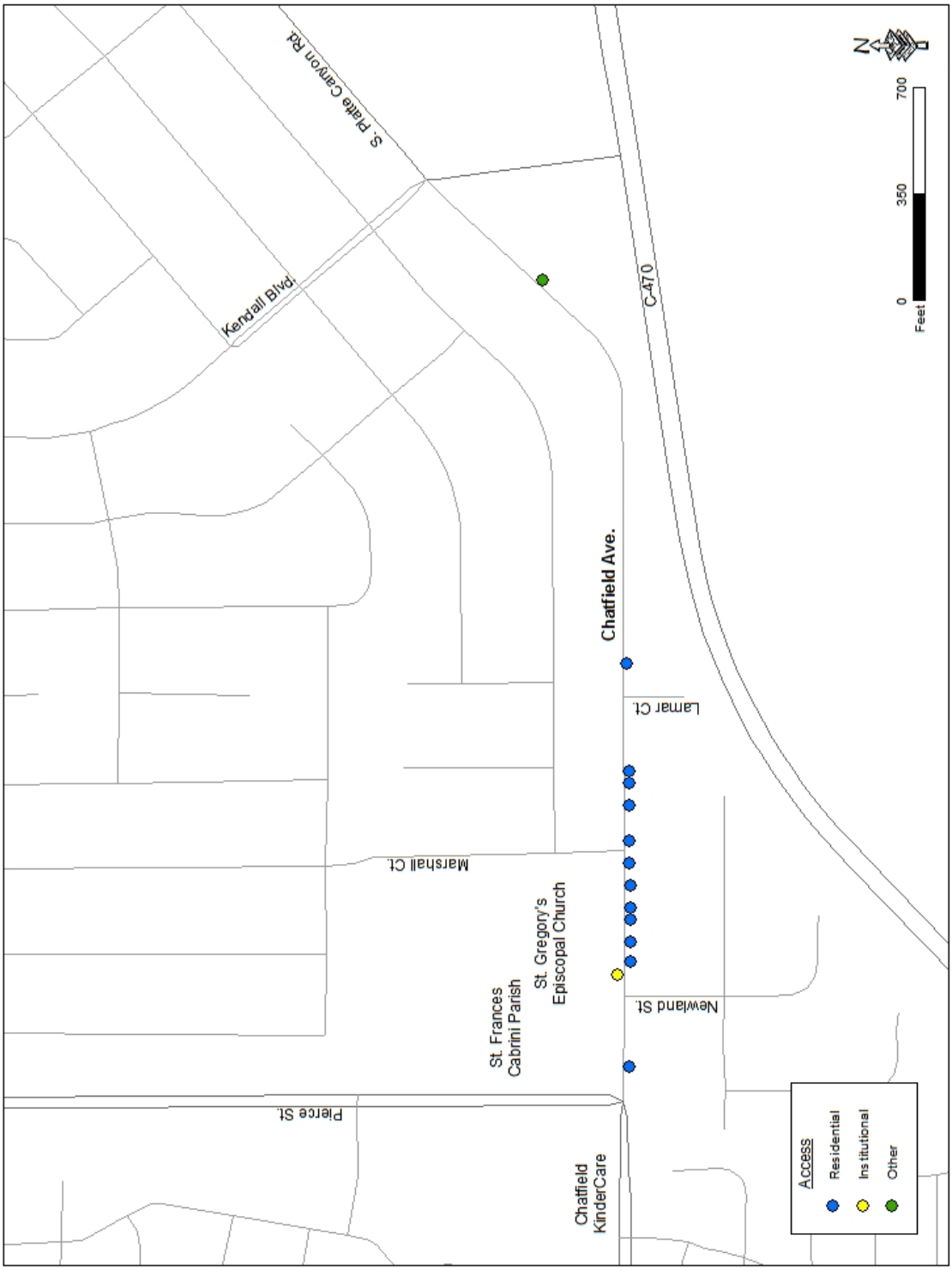


Figure 3. Access Points

2.4 Parking

On-street parking is currently provided on the south side of Chatfield Avenue in the vicinity of the homes fronting Chatfield Avenue. The parking lane extends from Pierce Street past Lamar Court and ends about 600 feet to the east of Lamar Court. This parking lane is utilized by the residents who live on the west end of the corridor.

In addition, the gravel shoulder on the north side of Chatfield Avenue, between the church access and Marshall Court, is utilized for parking by members of the nearby churches, especially on Sunday mornings. The paved shoulders on Pierce Street, just north of Chatfield Avenue, are also used for this purpose. While the St. Frances Cabrini Parish has adequate off-street parking available, some members prefer the on-street parking due to its convenience and proximity to the church entrance.

2.5 Bicycle and Pedestrian Facilities

Currently, limited bicycle and pedestrian facilities exist on Chatfield Avenue between Pierce Street and Kendall Boulevard. Sidewalk is present on Chatfield Avenue to the west of Pierce Street and on Pierce Street to the north of Chatfield Avenue. The Columbine Trail, an eight-foot shared use path maintained by the Foothills Parks and Recreation District, crosses Chatfield Avenue at Lamar Court and continues eastward along the north side of Chatfield Avenue.

Existing bicycle facilities connect to each end of the corridor and include paved shoulders on Pierce Street and a bicycle route on Kendall Boulevard. A recent study of the Pierce Street corridor recommended the implementation of bicycle lanes on Pierce Street from Portland Place south to Chatfield Avenue. **Figure 4** shows the nearby existing bicycle and pedestrian facilities.

2.6 Transit

Existing transit service provided by the Regional Transportation District (RTD) is shown in **Figure 5**. Route 401 currently provides service between the Ken Cary Park-n-ride, the Littleton Mineral Light Rail Station, and the Highlands Ranch Town Center Park-n-Ride. This route has three bus stop locations within the Chatfield Avenue study area. Busses arrive every 30 minutes during morning and afternoon peak periods.

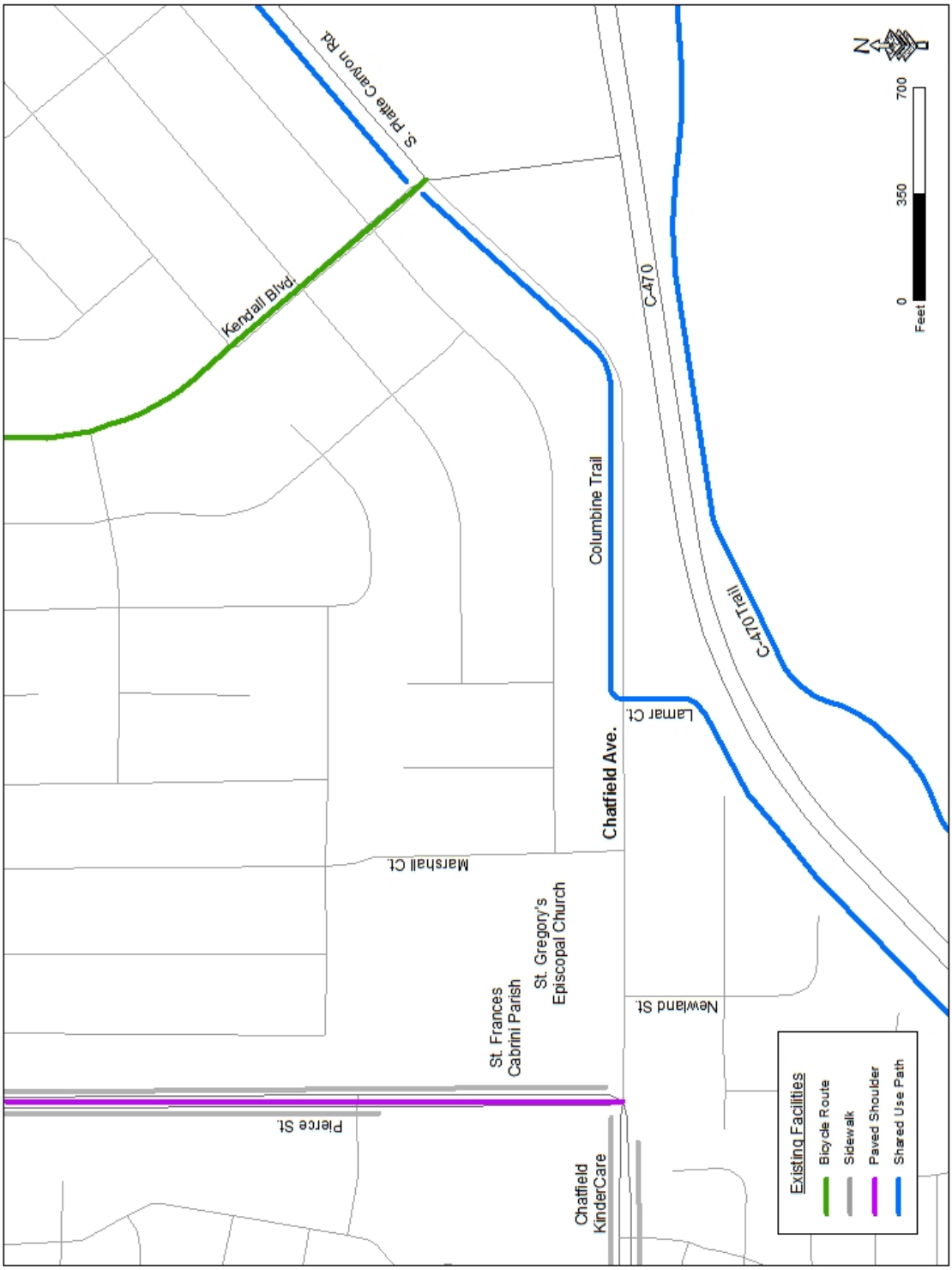


Figure 4. Existing Bicycle and Pedestrian Facilities

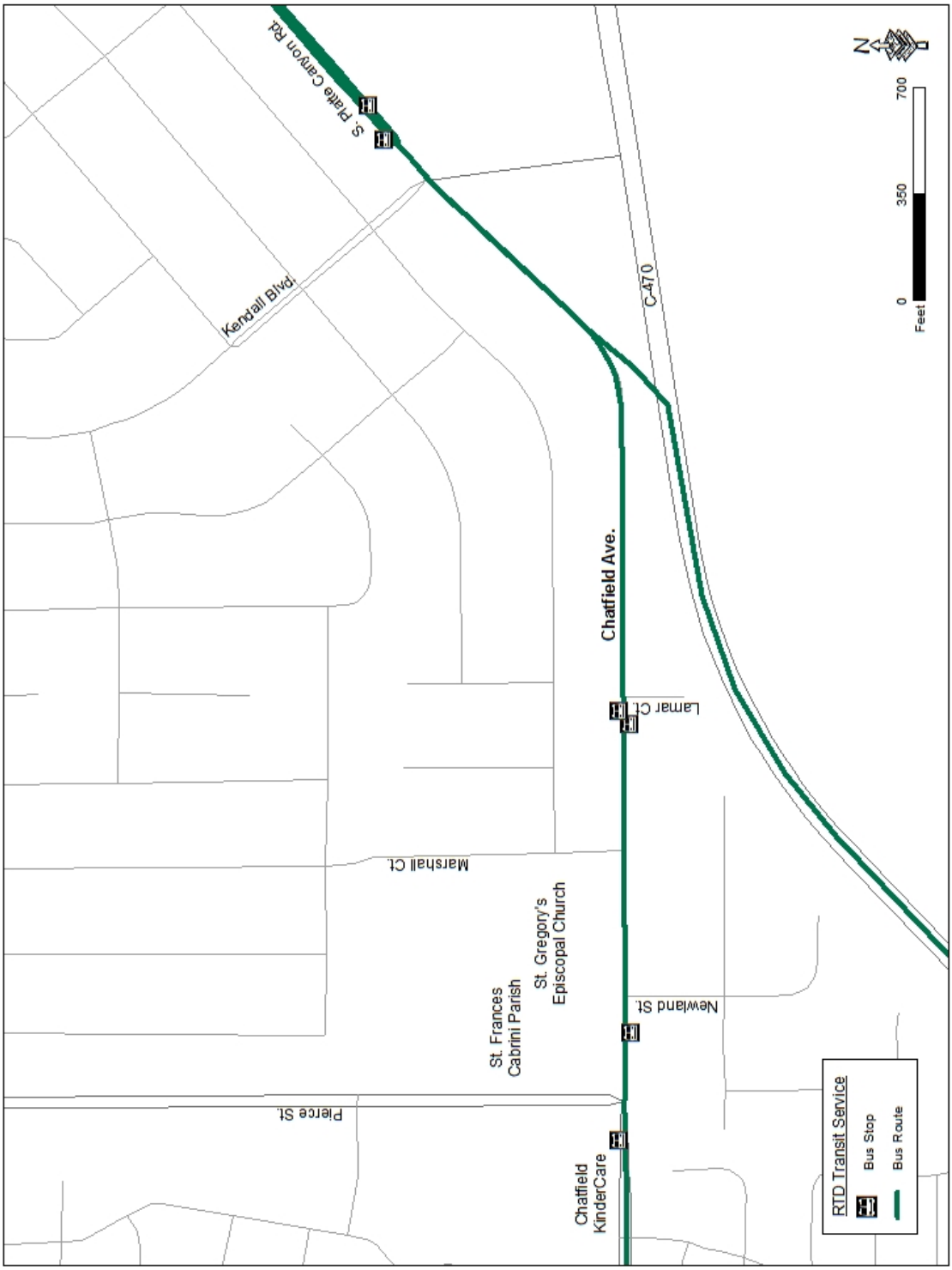


Figure 5. Transit

3.0 Crash Analysis

An analysis of crash history was completed for Chatfield Avenue from Pierce Street to Kendall Boulevard in order to evaluate the safety of the existing roadway and the need for improvements. Crash data used for this analysis included all recorded crashes resulting in damages greater than $1,000 that occurred between January 1, 2010 and December 31, 2012.

A total of nine crashes occurred during the three year period including three injury crashes and six property damage only (PDO) crashes. The crashes were primarily left-turns (4) and broadsides (2). Two of the crashes involved pedestrians.

Five of the nine crashes occurred at the all-way stop controlled intersection of Chatfield Avenue and Kendall Boulevard. A collision diagram for this intersection is shown in **Figure 6**. These crashes were primarily left-turns and broadsides. Many of these crashes occurred as a result of confusion over who had the right-of-way at the all-way stop. Only one crash resulted in injury, as many of these crashes likely occurred at relatively low speeds.

Two of the nine crashes occurred at the signalized intersection of Chatfield Avenue and Pierce Street. A collision diagram for this intersection is shown in **Figure 7**. Both of these crashes involved pedestrians being struck by turning vehicles and resulted in injury to the pedestrians.

The remaining two crashes occurred at non-intersection locations. A segment collision diagram for Chatfield Avenue is shown in **Figure 8**. One of the crashes involved a motorist hitting a vehicle parked along the south side of Chatfield Avenue. The other crash occurred when a westbound motorist pulled onto the shoulder to make a u-turn and struck another westbound motorist.

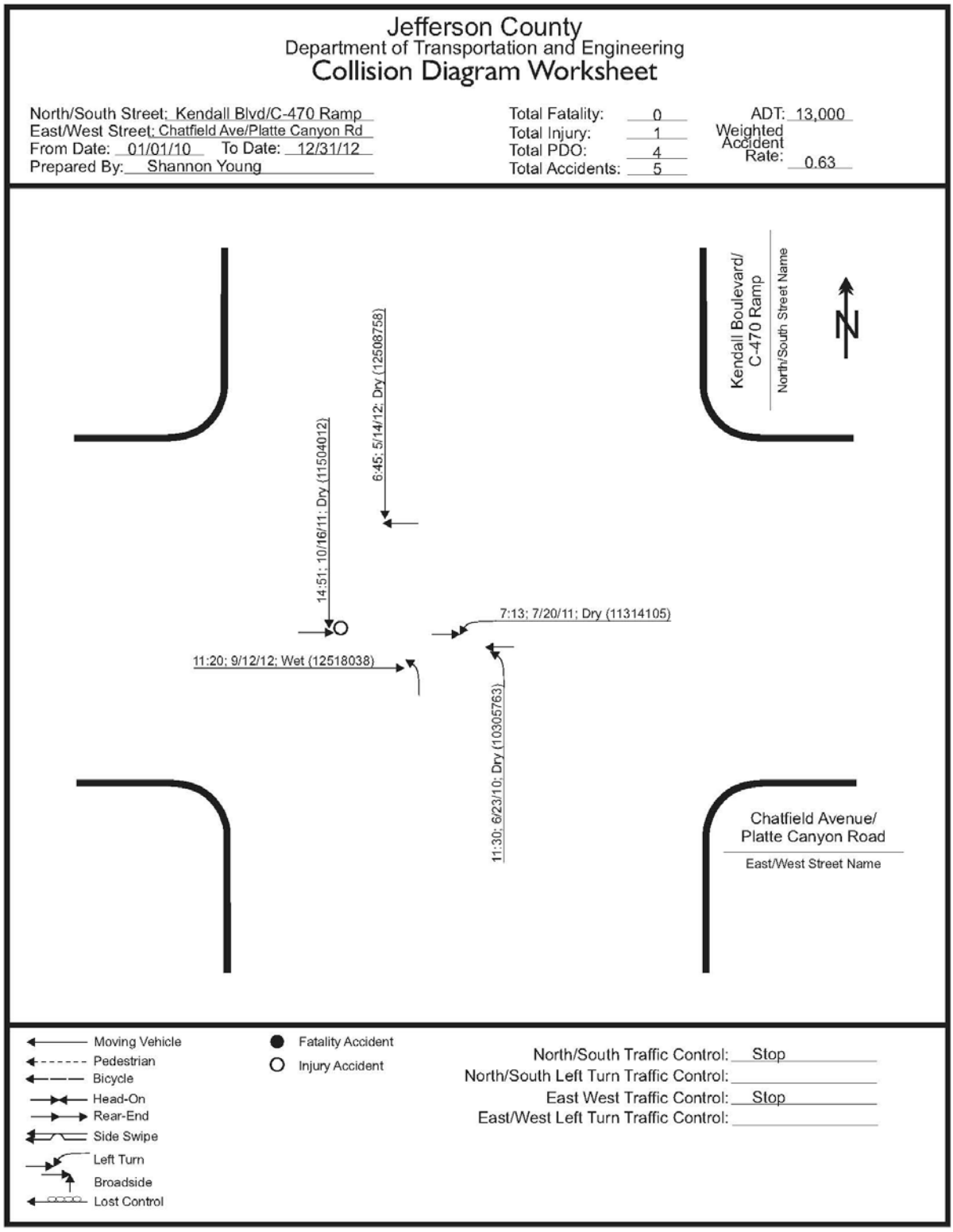


Figure 6. Kendall Boulevard Intersection Collision Diagram

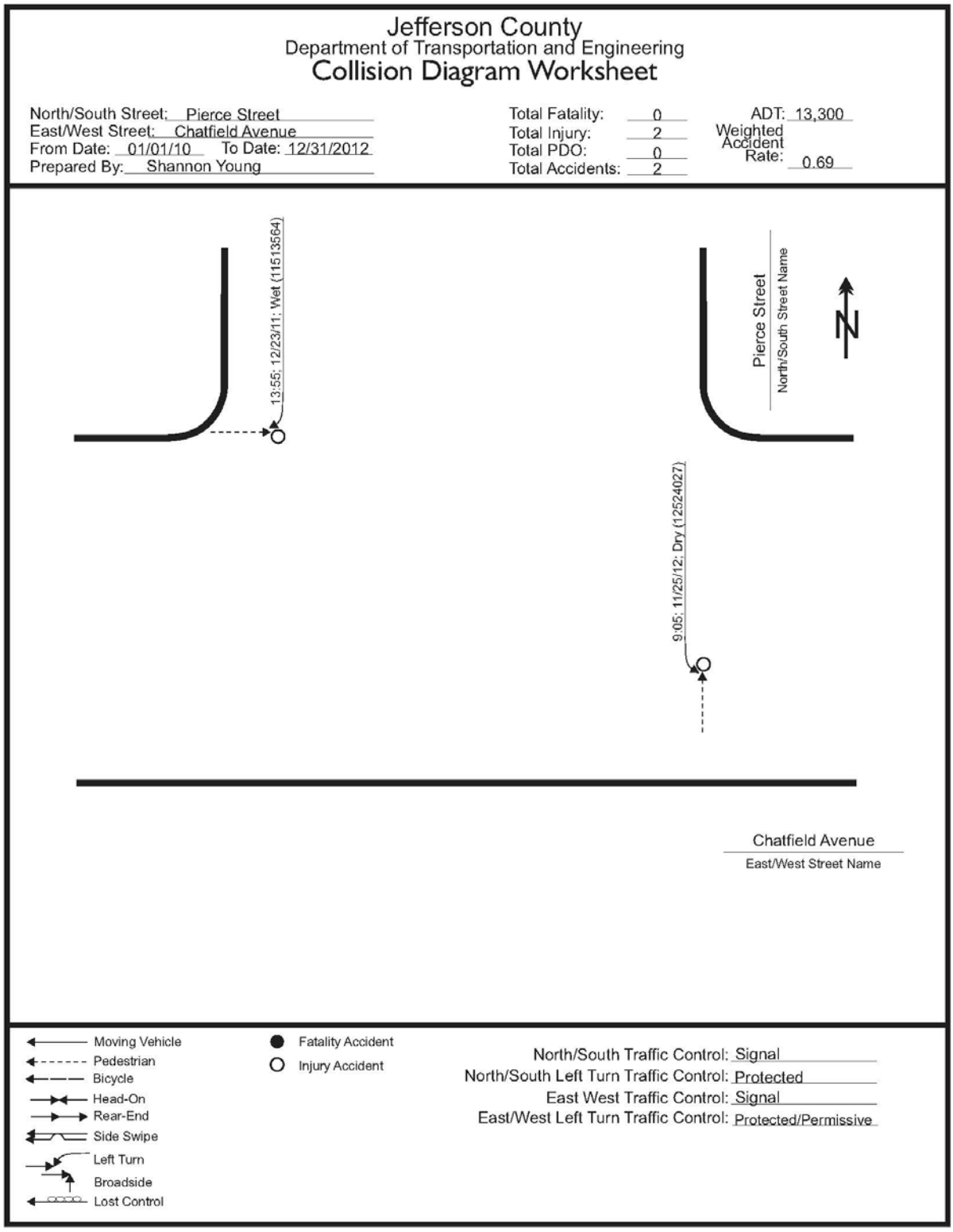


Figure 7. Pierce Street Intersection Collision Diagram

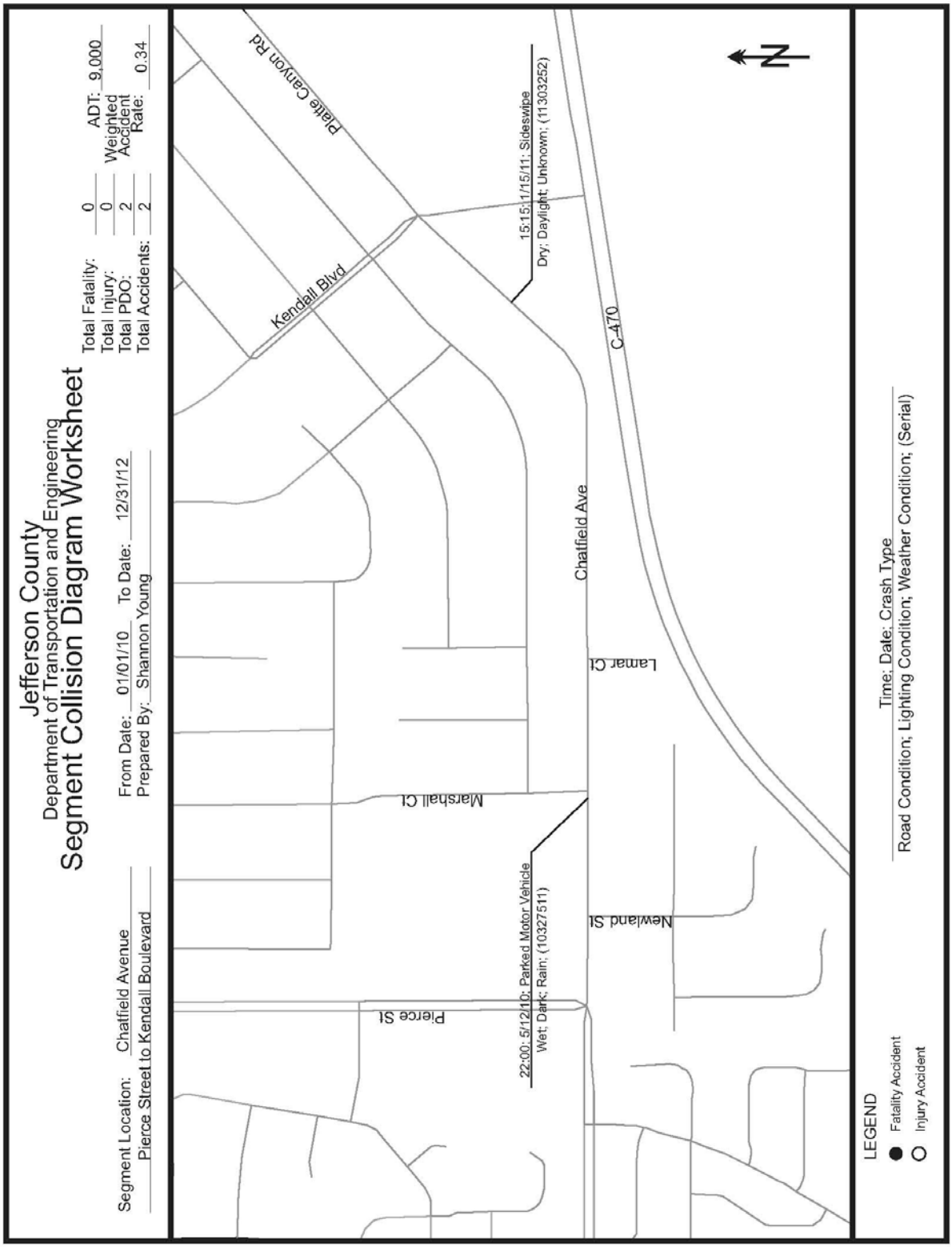


Figure 8. Chatfield Avenue Segment Collision Diagram

4.0 Existing Traffic Conditions

4.1 Daily Traffic Volumes

Daily traffic volumes were collected at several locations throughout the study area. The current daily volumes and projected future volumes for year 2035 are shown in **Figure 9**. Between Pierce Street and Kendall Boulevard, Chatfield Avenue currently carries approximately 9,200 vpd. Chatfield Avenue carries about 11,600 vpd west of Pierce Street, and S. Platte Canyon Road carries about 8,700 vpd east of Kendall Boulevard.

Peak hour traffic volumes generally occur between 7:00 a.m. and 8:00 a.m. and 5:00 p.m. and 6:00 p.m. Eastbound volumes are generally higher during the morning, and westbound volumes are higher during the afternoon and evening.

4.2 Peak Hour Intersection Traffic Volumes

Morning and afternoon peak hour turning movement counts were collected in 2014 on Chatfield Avenue at the Pierce Street and Kendall Boulevard intersections. The morning peak hour counts were conducted from 7:00 a.m. to 8:00 a.m., and the afternoon peak hour counts were conducted from 5:00 p.m. to 6:00 p.m. These intersection traffic volumes are shown in **Figure 10**. Turning movements to and from the minor street intersections were also collected during peak hours.

The turning movement counts also indicate that vehicles are primarily traveling eastbound through the corridor onto S. Platte Canyon Road during the morning and westbound through the corridor during the afternoon. During the afternoon, approximately equal volumes of westbound vehicles access the corridor from C-470 and S. Platte Canyon Rd.

4.3 Operational Analysis

The existing intersection operations were analyzed using a Level of Service analysis based on the 2010 Highway Capacity Manual (2010 HCM) methodology. This methodology assigns a qualitative measure (level of service A through F) based on quantitative results such as intersection delay. Level of service (LOS) A represents free flow conditions and LOS F represents conditions with higher demand than capacity. Levels of service A through D are considered good levels of service, while level of service E is considered acceptable.

The LOS of a corridor like Chatfield Avenue is controlled by the intersections with traffic control devices. These intersections include Chatfield Avenue at Pierce Street and Kendall Boulevard. Therefore, an operation analysis was completed for these two intersections

The Chatfield Avenue corridor with existing traffic control was modeled and analyzed using Synchro, a traffic analysis software. The delay and corresponding levels of service were determined at Pierce Street and Kendall Boulevard for both the morning and afternoon peak hours. The results of this analysis are summarized in **Table 1**. The detailed LOS results are included in **Appendix A**.

Figure 9. Existing and Projected Daily Traffic Volumes

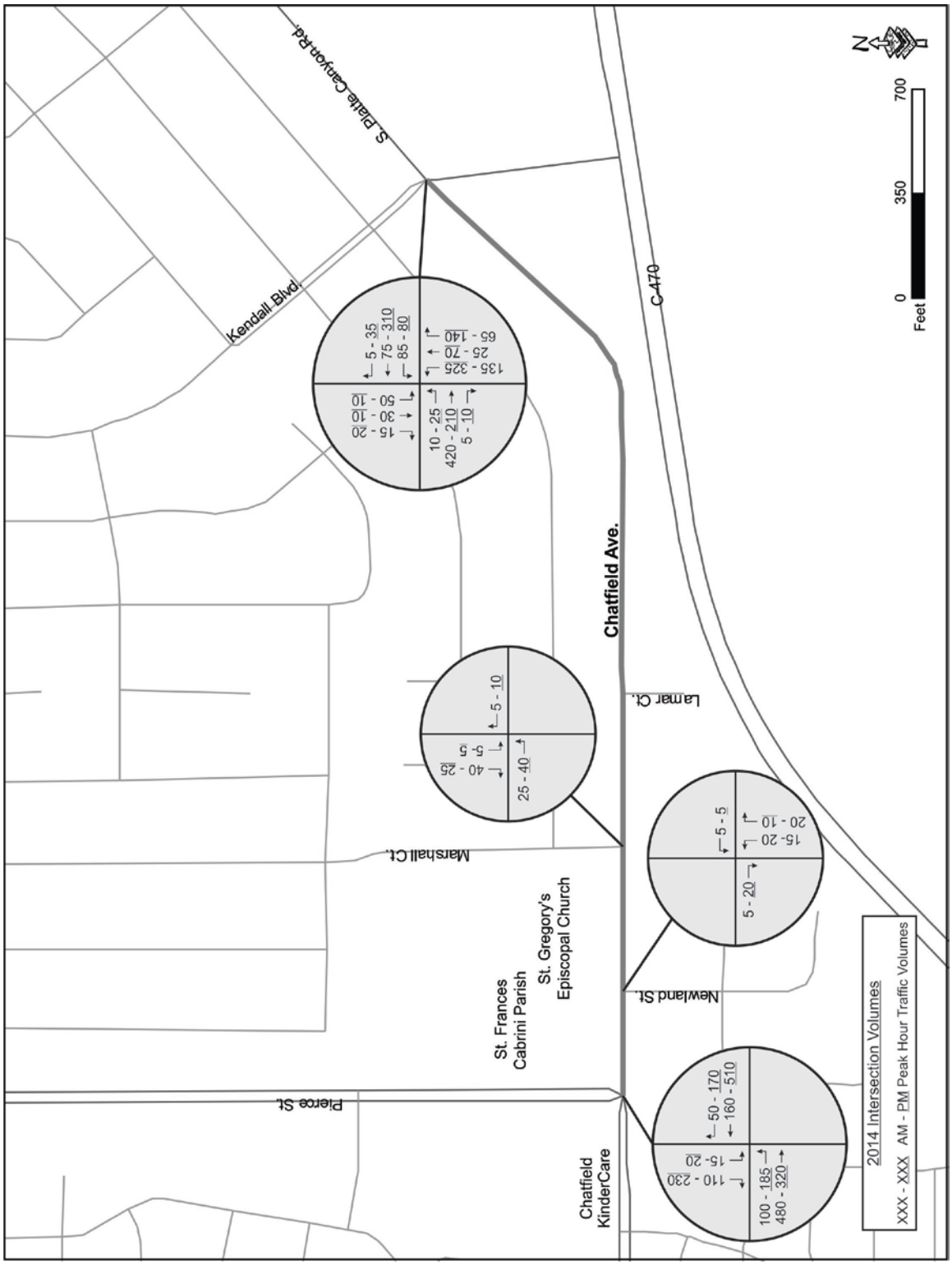


Figure 10. Existing Intersection Volumes

Table 1. Existing Intersection Delay and Level of Service

Intersection	Control Type	Existing Condition-2014			
		AM Peak		PM Peak	
		Delay (sec)	LOS	Delay (sec)	LOS
Pierce Street	Signal	6.6	A	10.6	B
Kendall Boulevard	All-Way Stop	19.3	C	31.2	D

As Table 1 shows, both intersections are operating at LOS D or better in the morning and afternoon peak hours. The signalized intersection at Pierce Street is operating with better levels of service than the all-way stop controlled intersection at Kendall Boulevard.

4.4 Evaluation of Alternatives

Modifications and alternatives to the existing traffic control at Pierce Street and Kendall Boulevard were evaluated. These alternatives were also modeled in Synchro to determine the intersection delay and corresponding level of service for the morning and afternoon peak hours.

Chatfield Avenue and Pierce Street

The intersection of Chatfield Avenue and Pierce Street currently operates as a signalized intersection with good levels of service. During peak hours, this signal is coordinated with the other signals on Chatfield Avenue. During the afternoon peak hour, the signal runs on a half-cycle which allows the phases to be serviced twice as often as the other coordinated signals.

Peak hour turning movement counts indicated that the majority of southbound vehicles on Pierce Street turn right onto eastbound Chatfield Avenue. Southbound left-turn volumes on Pierce Street are relatively low during the peak hours (15-20 vehicles per hour). Due to the low approach volumes on Pierce Street, a signal warrant analysis was conducted to evaluate the need for the existing signal. None of the traffic signal warrants were met, so the signal may need to be considered for removal. Copies of the traffic signal warrant worksheets are included in **Appendix B**.

One alternative to the existing intersection configuration is the channelization of southbound right-turns, allowing right-turning vehicles to freely enter eastbound Chatfield Avenue. This intersection modification would reduce delays for southbound right-turning vehicles and would also reduce delays for vehicles on Chatfield Avenue as southbound right-turning vehicles would not trigger a signal phase change. This alternative was analyzed using Synchro, and the results are shown in **Table 2**. However, this modification would remove all of the southbound right-turn volume from the approach volume and further reduce the need for a traffic signal.

Since traffic volumes on Pierce Street are relatively low and Chatfield Avenue transitions to a two-lane roadway east of Pierce Street, another alternative is a single-lane roundabout.

Because Pierce Street has two lanes approaching the intersection with Chatfield Avenue, a southbound right-turn bypass lane would be preferred to eliminating a lane in advance of the roundabout. A single-lane roundabout with southbound and westbound right-turn bypass lanes was analyzed using Synchro, and the results are shown in **Table 2**.

Table 2. Alternative Intersection Delay and Level of Service--Pierce Street

		Existing Condition-2014			
		AM Peak		PM Peak	
Intersection	**Control Type**	**Delay (sec)**	**LOS**	**Delay (sec)**	**LOS**
Pierce Street	Signal	6.6	A	10.6	B
Pierce Street	Modified Signal	3.2	A	6.5	A
Pierce Street	Roundabout	7.7	A	8.0	A

As shown in Table 2, a modified signalized intersection with channelized southbound right-turn lane would slightly improve intersection level of service in both the morning and afternoon peak hours. On the other hand, a single-lane roundabout with right-turn bypass lanes would improve operations over the existing control during the afternoon peak hour, but not during the morning peak hour. However, all of the above control types would provide good levels of service for current traffic volumes.

Chatfield Avenue and Kendall Boulevard

The all-way stop controlled intersection at Chatfield Avenue and Kendall Boulevard currently operates at LOS C during the morning peak hour and LOS D during the afternoon peak hour. While these levels of service are considered good, the afternoon peak hour delay is approaching LOS E.

Because of the existing intersection volumes and delay, a signal warrant analysis was completed for this intersection. Copies of the traffic signal warrant worksheets are included in **Appendix C**. Warrants 2 (Four Hour Vehicular Volume), 3 (Peak Hour Vehicular Volume), and 8 (Roadway Network) were satisfied, but the primary warrant, Warrant 1 (Eight-Hour Vehicular Volume), was not. The results of the signal warrant analysis indicate that a higher level of traffic control may be appropriate for the intersection of Chatfield Avenue and Kendall Boulevard.

Since Chatfield Avenue intersects S. Platte Canyon Road at Kendall Boulevard, a traffic signal at this intersection would fall under the jurisdiction of CDOT for operations and maintenance. In addition, the moderate traffic volumes and intersecting angles of the roadways make this intersection a better candidate for a roundabout.

As an alternative to the existing all-way stop controlled intersection, a single-lane roundabout was analyzed using Synchro. Due to the geometry of the intersection, a channelized eastbound

right-turn lane with yield control was included. In addition, a northbound right-turn bypass lane was included for the analysis. The intersection delay and LOS for this alternative are shown in **Table 3**.

Table 3. Alternative Intersection Delay and Level of Service--Kendall Boulevard

		Existing Condition-2014			
		AM Peak		PM Peak	
Intersection	**Control Type**	**Delay (sec)**	**LOS**	**Delay (sec)**	**LOS**
Kendall Boulevard	All-Way Stop	19.3	C	31.2	D
Kendall Boulevard	Roundabout	8.1	A	11.2	B

As Table 3 shows, a roundabout at Chatfield Avenue and Kendall Boulevard would provide lower delay and improved levels of service compared to the existing all-way stop.

5.0 Future Traffic Conditions

5.1 Projected Traffic Volumes

Future traffic conditions for year 2035 were projected using growth rates provided by the Denver Regional Council of Governments (DRCOG). By year 2035, Chatfield Avenue is expected to carry approximately 11,600 vpd between Pierce Street and Kendall Boulevard, which represents an approximate 26% increase in volumes. This volume would exceed the capacity of the existing two-lane roadway, but is still within the design volume range for a major collector. Projected daily traffic volumes for the study area are shown in **Figure 9**.

Growth factors were also applied to the peak hour intersection volumes. The projected volumes for both the morning and afternoon peak hours are shown in **Figure 11**.

5.2 Operational Analysis

Using the projected peak hour intersection volumes, the expected 2035 delay and levels of service for the Pierce Street and Kendall Boulevard intersections were analyzed without modifications to the existing traffic control devices. The results of this analysis are summarized in **Table 4**.

Table 4. Future Intersection Delay and Level of Service

		Future Condition-2035			
		AM Peak		PM Peak	
Intersection	**Control Type**	**Delay (sec)**	**LOS**	**Delay (sec)**	**LOS**
Pierce Street	Signal	7.1	A	15.5	B
Kendall Boulevard	All-Way Stop	38.5	E	51.7	F

As Table 4 shows, the Pierce Street intersection would continue to operate with good levels of service in the future with the existing traffic signal. However, the level of service at Kendall Boulevard is expected to degrade to unacceptable levels by 2035, especially in the afternoon peak hour, if the all-way stop control is maintained. Thus, an alternative type of control is recommended at Kendall Boulevard.

5.3 Evaluation of Alternatives

The alternative intersection controls discussed previously were also evaluated using the projected peak hour intersection volumes. The results of the analysis of alternatives compared to the existing control are summarized for each intersection in **Table 5** and **Table 6**.

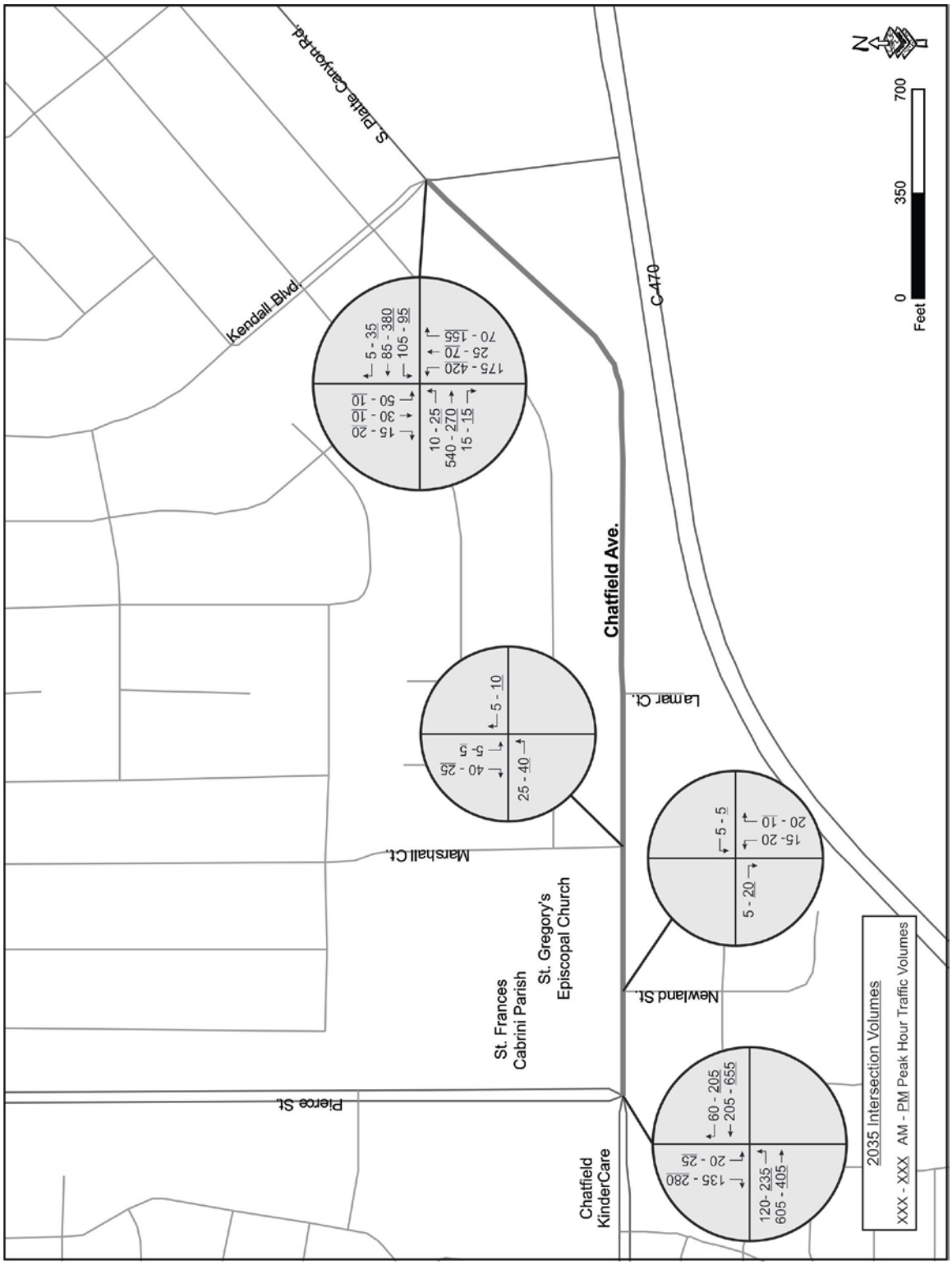


Figure 11. Projected Intersection Volumes

Table 5. Future Alternative Intersection Delay and Level of Service--Pierce Street

Intersection	Control Type	Future Condition-2035			
		AM Peak		PM Peak	
		Delay (sec)	LOS	Delay (sec)	LOS
Pierce Street	Signal	7.1	A	15.5	B
Pierce Street	Modified Signal	3.7	A	9.1	A
Pierce Street	Roundabout	10.8	B	13.8	B

All of the above intersection control types would provide good levels of service for Pierce Street in the future. A modified signalized intersection would provide slightly better levels of service than a roundabout.

Table 6. Future Alternative Intersection Delay and Level of Service--Kendall Boulevard

Intersection	Control Type	Future Condition-2035			
		AM Peak		PM Peak	
		Delay (sec)	LOS	Delay (sec)	LOS
Kendall Boulevard	All-Way Stop	38.5	E	51.7	F
Kendall Boulevard	Roundabout	11.1	B	20.4	C

The installation of a roundabout at the intersection of Chatfield Avenue and Kendall Boulevard would provide good levels of service for future traffic volumes. Operations would be significantly improved by a roundabout compared to the existing all-way stop control.

6.0 Recommendations

6.1 Traffic Operations

Daily traffic volumes on Chatfield Avenue are expected to increase from approximately 9,200 vpd to 11,600 vpd by year 2035. A major collector template with left-turn lanes at intersections will provide adequate capacity for the projected volumes. Left-turn lanes should be provided at Newland Street and Marshall Court.

6.2 Intersection Control

Chatfield Avenue and Pierce Street

The existing traffic signal at Pierce Street should be replaced with a single-lane roundabout. While a traffic signal would continue to provide good levels of service at this intersection both now and in future years, current traffic conditions do not currently warrant its use. In addition, traffic volumes within the next five years are not expected to warrant its use. The installation of a roundabout will also provide desirable traffic calming effects as Chatfield Avenue transitions to a more residential nature with home frontage and a 30 mph speed limit.

A single-lane roundabout with southbound and westbound right-turn bypass lanes will provide similar levels of service as a traffic signal and will reduce delay for southbound motorists. The inclusion of right-turn bypass lanes provides improved level of service and easier transitions from existing roadway geometry, but these benefits should be weighed against the costs associated with additional right-of-way, construction, and removal of available parking.

Chatfield Avenue and Kendall Boulevard

The existing all-way stop at Kendall Boulevard should be replaced with a single-lane roundabout. The installation of a roundabout will reduce the overall intersection delay and improve levels of service for all movements. In addition, a roundabout is expected to provide a reduction in the number and severity of crashes.

A northbound right-turn bypass lane should be considered to reduce delay for northbound vehicles and reduce the possibility of northbound vehicles backing up onto the C-470 ramp. However, other factors such as right-of-way and construction costs should be considered in the final design. A channelized eastbound right-turn will likely be required to provide an adequate turning radius.

6.3 Traffic Safety

A review of the crash history on Chatfield Avenue indicated a pattern of left-turn and broadside crashes at the Kendall Boulevard intersection. The installation of a roundabout at this intersection will reduce the number of conflict points and simplify the traffic flow, reducing or eliminating the occurrence of these types of crashes.

The crash analysis also indicated a conflict between pedestrians and turning vehicles at Chatfield Avenue and Pierce Street. The installation of a roundabout at this intersection should

reduce the chance of pedestrians being struck by turning vehicles, as vehicles will have a better view of crossing pedestrians. In addition, pedestrians will be provided with median refuges and will only have to cross one lane of traffic at a time. The final design should include adequate pedestrian crossing facilities on all legs of the intersection.

6.4 Bicycle Facilities

The Jefferson County Bicycle Plan proposes a facility consisting of a combination of bicycle lanes, paved shoulders, and wider outside lanes along Chatfield Avenue. In addition, the County's major collector template includes 4-foot bicycle lanes in both directions. Therefore, the roadway design should include 4-foot wide bicycle lanes on both sides of the roadway between Pierce Street and Kendall Boulevard.

A bicycle facility on Chatfield Avenue between Pierce Street and Kendall Boulevard would provide a connection between the paved shoulders on Pierce Street and the bicycle route on Kendall Boulevard as well as access to the Columbine Trail and C-470 Trail. A recent study of Pierce Street recommended conversion of the paved shoulders to bicycle lanes from Portland Place south to Chatfield Avenue. Thus, a facility on Chatfield Avenue would further enhance the existing network of bicycle lanes and shared use paths.

6.5 Pedestrian Facilities

The Jefferson County Pedestrian Plan proposes a sidewalk connection on Chatfield Avenue between Pierce Street and the Columbine Trail. The County's major collector template includes 8-foot detached sidewalks on both sides of the street. Because of limited right-of-way, the roadway design should consider a 5-foot attached sidewalk on the south side of Chatfield Avenue from Pierce Street to Lamar Court and an 8-foot detached sidewalk on the north side from Pierce Street to the Columbine Trail.

The width of the detachment on the north side may vary based on available right-of-way. Should right-of-way constraints or public input require the omission of sidewalk on the south side, a 5-foot attached sidewalk should at least be provided from Pierce Street to the bus stop east of Pierce Street.

To improve pedestrian and cyclist safety where the Columbine Trail crosses Chatfield Avenue at Lamar Court, a pedestrian refuge island should be included in the design.

6.6 Typical Sections

Typical sections should be based on the County's Major Collector Street Template with some modifications due to right-of-way constraints and the nature of the roadway. Proposed templates are shown in **Figure 12**.

West of Lamar Court, 11-foot through lanes and left-turns should be provided. Left-turn lanes are required at the intersections of Newland Street and Marshall Court. A raised median should not be installed since access to the fronting residences should be maintained. A 6-foot wide parking lane should be maintained on the south side of the roadway from Pierce Street to Lamar Court. Bicycle lanes should be included in both directions as well as sidewalk on both the north and south sides of the roadway.

East of Lamar Court, center turn lanes are not needed, as there are no intersections or home frontage. Travel lanes may be widened to 12-feet and 4-foot bicycle lanes should be provided all the way to Kendall Boulevard. Sidewalk on the south side of Chatfield Avenue should not be continued past Lamar Court. The 8-foot detached sidewalk on the north side of the roadway should connect with the Columbine Trail.

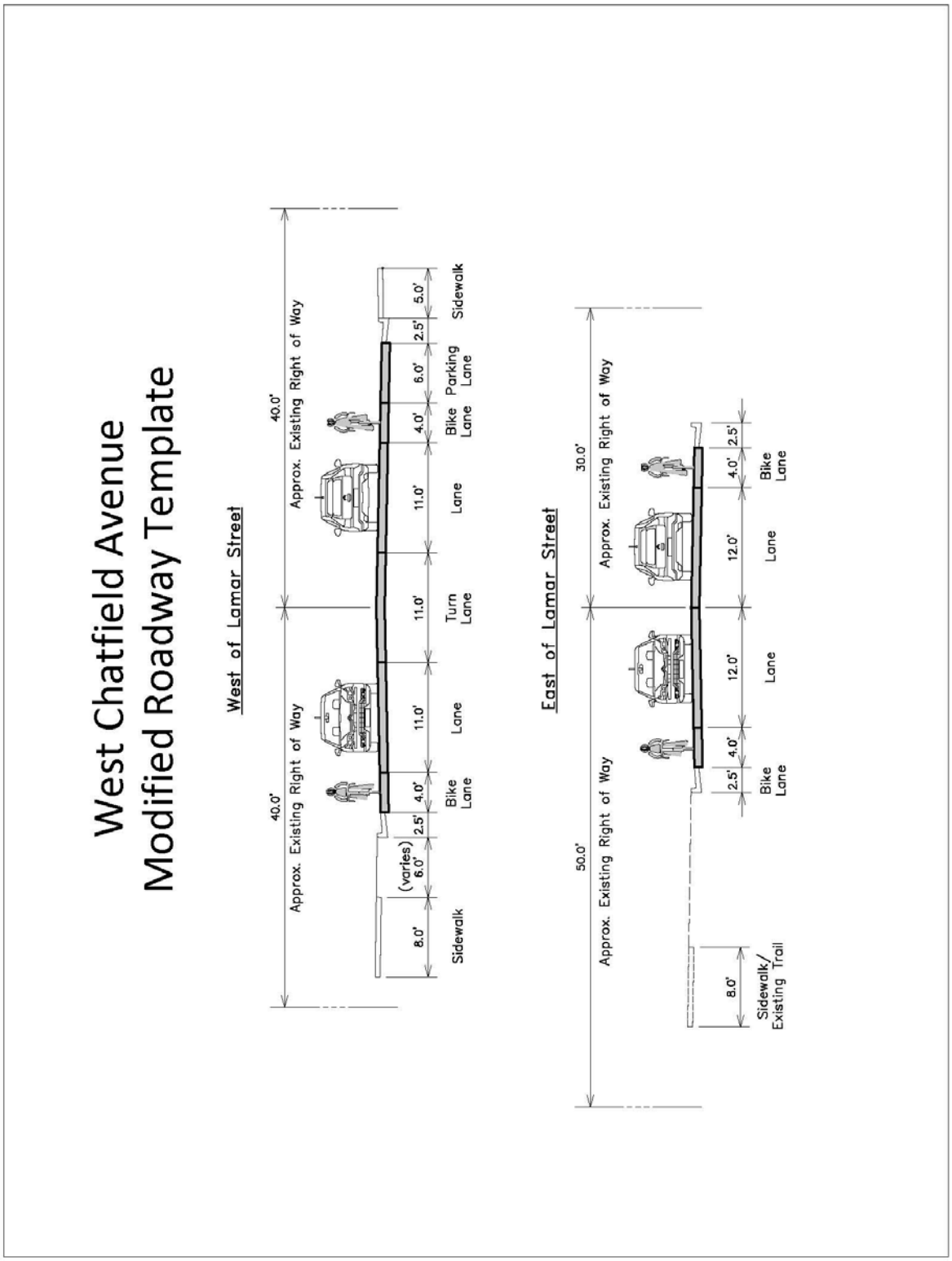


Figure 12. Proposed Typical Sections

Appendix A

Level of Service Analysis

		Existin Condition-2014									
		Eastbound		Westbound		Northbound		Southbound		Overall	
INTERSECTION	SCENARIO	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS
Pierce Street	AM Signal (Existing)	2.5	A	3.9	A	-	-	48.4	D	6.6	A
	AM Modified Signal	1.8	A	3.1	A	-	-	59.9	E	3.2	A
	AM Roundabout	10.6	B	4.0	A	-	-	0.5	A	7.7	A
	PM Signal (Existing)	4.9	A	11.6	B	-	-	27.2	C	10.6	B
	PM Modified Signal	3.3	A	8.2	A	-	-	35.7	D	6.5	A
	PM Roundabout	9.2	A	9.9	A	-	-	0.5	A	8.0	A
Kendall Boulevard	AM All-Way Stop (Existing)	27.2	D	12.8	B	11.8	B	12.0	B	19.3	C
	AM Roundabout	10.3	B	5.9	A	6.3	A	5.8	A	8.1	A
	PM All-Way Stop (Existing)	19.6	C	49.4	E	23.4	C	12.1	B	31.2	D
	PM Roundabout	6.1	A	18.2	C	8.2	A	8.2	A	11.2	B

		Future Condition-2035									
		Eastbound		Westbound		Northbound		Southbound		Overall	
INTERSECTION	SCENARIO	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS	DELAY	LOS
Pierce Street	AM Signal (Existing)	3.2	A	4.4	A	-	-	46.6	D	7.1	A
	AM Modified Signal	2.2	A	3.3	A	-	-	58.2	E	3.7	A
	AM Roundabout	15.3	C	4.6	A	-	-	0.5	A	10.8	B
	PM Signal (Existing)	7.4	A	19.9	B	-	-	26.4	C	15.5	B
	PM Modified Signal	4.7	A	11.8	B	-	-	34.4	C	9.1	A
	PM Roundabout	12.4	B	19.4	C	-	-	0.6	A	13.8	B
Kendall Boulevard	AM All-Way Stop (Existing)	62.7	F	15.0	B	13.9	B	12.9	B	38.5	E
	AM Roundabout	14.5	B	6.6	A	9.0	A	6.3	A	11.1	B
	PM All-Way Stop (Existing)	30.5	D	69.4	F	50.4	F	12.8	B	51.7	F
	PM Roundabout	7.0	A	38.9	E	12.8	B	10.2	B	20.4	C

Appendix B

Traffic Signal Warrant Analysis:
Chatfield Avenue and Pierce Street

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

Date: 4/24/2014

Major Street: Chatfield Avenue Approach Lanes: 1 Approach Speed: 30/35

Minor Street: Pierce Street Approach Lanes: 2 Approach Speed: 40

Posted, statutory, or 85% speed of major street traffic > 40 mph ----- No

URBAN / RURAL

In isolated community of < 10,000 population ---------- No

WARRANT 1: Eight-Hour Vehicular Volume **SATISFIED?** No

Condition A - Minimum Vehicular Volume					0 hr	Satisfied?		No
Number of lanes for moving traffic on each approach		Vehicles per hour on Major Street (total all approaches)				Vehicles per hour on Minor Street (Highest Approach)		
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1.....	1.....	500	400	350	280	150	120	105	84
2 or more	1.....	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1.....	2 or more	**500**	400	350	280	**200**	160	140	112
Hour Beginning:		9:00 AM	12:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM
Major Street:		482	557	731	943	1,057	1,146	876	615
Minor Street:		77	74	81	104	106	136	101	77

Condition B - Interruption of Continuous Traffic					4 hr	Satisfied?		No
Number of lanes for moving traffic on each approach		Vehicles per hour on Major Street (total all approaches)				Vehicles per hour on Minor Street (Highest Approach)		
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1.....	1.....	750	600	525	420	75	60	53	42
2 or more	1.....	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1.....	2 or more	**750**	600	525	420	**100**	80	70	56
Hour Beginning:		9:00 AM	12:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM
Major Street:		482	557	731	943	1,057	1,146	876	615
Minor Street:		77	74	81	104	106	136	101	77

Condition C - Combination of Warrants		Satisfied?	Urban (80%)	Rural (56%)
Conditions A and B	Condition A - Minimum Vehicular Volume	0 hr	No	
	Condition B - Interruption of Continuous Traffic	5 hr	No	

The satisfaction of a warrant is not necessarily justification for signal control. A traffic signal should not be installed unless traffic study indicates that installing traffic signal control will improve overall safety and/or operations of the intersection.

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

WARRANT 2: Four-Hour Vehicular Volume **SATISFIED?** No

Hour Beginning:	3:00 PM	4:00 PM	5:00 PM	6:00 PM			
Major Street - Total both approaches:	943	1,057	1,146	876			
Minor Street - Highest approach:	104	106	136	101			

Refer to MUTCD Figure 4C-1, Four-hour Vehicular Volume or Figure 4C-2, Four-hour Vehicular Volume (70% Factor)

WARRANT 3: Peak Hour Vehicular Volume **SATISFIED?** No

A) Delay	Satisfied?	No
1) The total stopped time delay experienced by the traffic on one minor street approach (one direction only) controlled by a STOP-sign equal or exceeds: 4 vehicle-hours for a one lane approach; or 5 vehicle-hours for a two-lane approach, and		
Calculation: (19 sec x 250 veh)/3600=1.3 veh-hr	Satisfied?	No
2) The volume on the minor street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane or 150 vph for two moving lanes, and		
Volume: 136<150	Satisfied?	No
3) The total entering volume serviced during the hour equals or exceeds 650 vph for intersections with three approaches or 800 vph for intersections with four or more approaches.		
Volume: 1146+136=1282>650	Satisfied?	Yes

B) Volume					Satisfied?		No
Hour Beginning:	3:00 PM	4:00 PM	5:00 PM	6:00 PM			
Major Street - Total both approaches:	943	1,057	1,146	876			
Minor Street - Highest approach:	104	106	136	101			

Refer to MUTCD Figure 4C-3, Peak Hour or Figure 4C-4, Peak Hour (70% Factor)

WARRANT 4: Pedestrian Volume **SATISFIED?** No

A) Four-Hour Volume			Satisfied?	
Hour Beginning:	7:00 AM	5:00 PM		
Major Street - Total both approaches:	772	1146		
Pedestrians - Total of all pedestrians crossing major street:	2	1		

Refer to MUTCD Figure 4C-5, Pedestrian Four-Hour Volume or Figure 4C-6, Pedestrian Four-Hour (70% Factor)

B) One-Hour Volume		Satisfied?	No
Hour Beginning:	7:00 AM	5:00 PM	
Major Street - Total both approaches:	772	1146	
Pedestrians - Total of all pedestrians crossing major street:	2	1	

Refer to MUTCD Figure 4C-7, Pedestrian Peak Hour or Figure 4C-8, Pedestrian Peak Hour (70% Factor)

The satisfaction of a warrant is not necessarily justification for signal control. A traffic signal should not be installed unless traffic study indicates that installing traffic signal control will improve overall safety and/or operations of the intersection.

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

WARRANT 5: School Crossing **SATISFIED?** N/A

Frequency and adequacy of gaps in the vehicular traffic stream related to the size and number of school children at an established major street school crossing are less than the number of minutes in the same period with a minimum of 20 students during the highest crossing hour.			
	Hour Beginning:		
	Number of pedestrians:		
	Number of adequate gaps:		

WARRANT 6: Coordinated Signal System **SATISFIED?** N/A

A) On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.
B) On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

WARRANT 7: Crash Experience **SATISFIED?** N/A

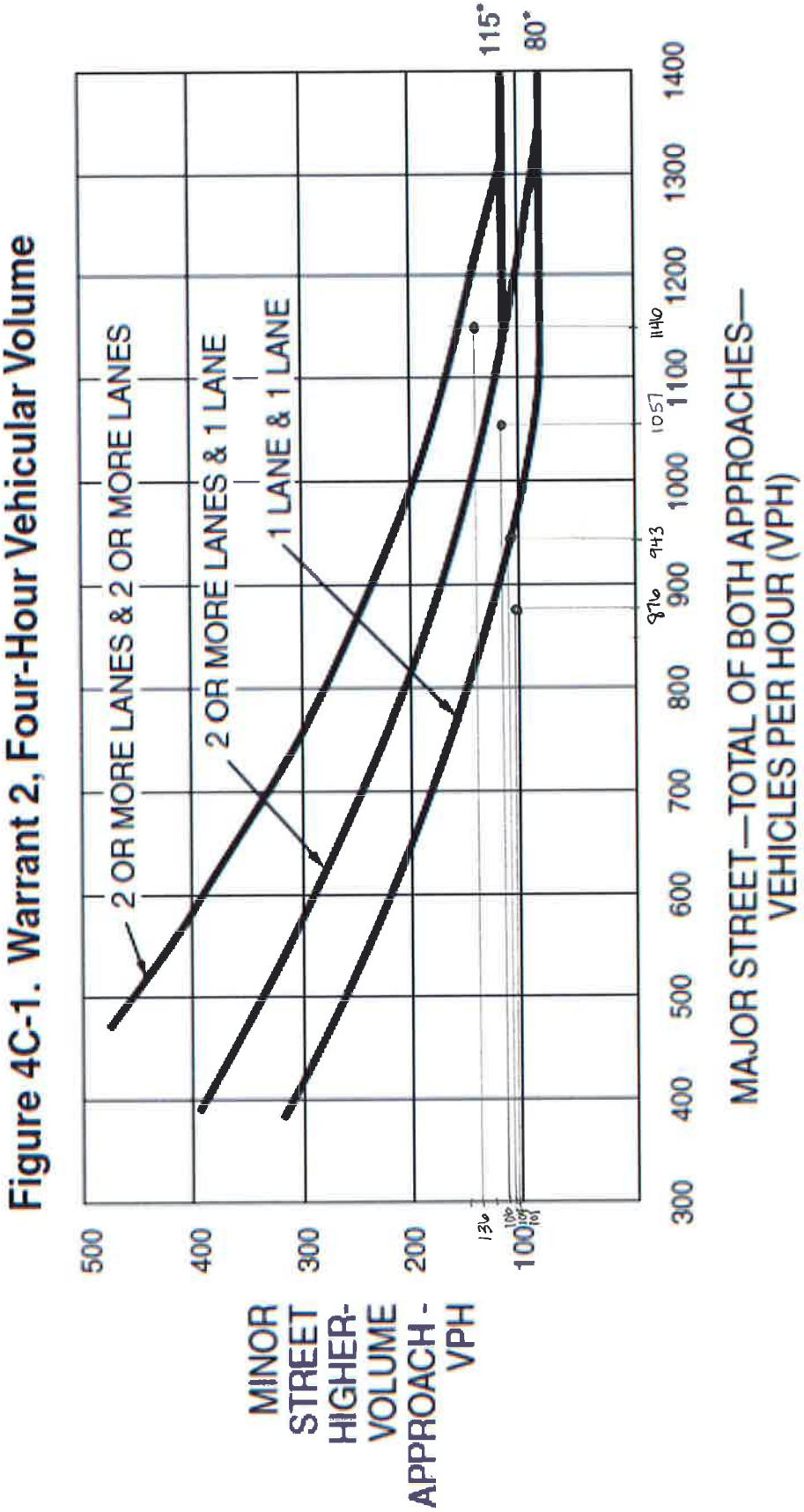
A) Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and		
Measure:	Satisfied?	
B) Five or more crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage exceeding applicable requirements for a reportable crash; and		
Number of correctable crashes: 0	Satisfied?	
C) For each of any 8 hours of an average day, either the vehicles per hour (vph) given in Warrant 1 or pedestrians given in Warrant 4 are satisfied at 80 percent.		
Warrant 1, Condition A, Minimum Vehicular Volume (80 percent)	Satisfied?	
Warrant 1, Condition B, Interruption of Continuous Traffic (80 percent)	Satisfied?	
Warrant 4, Pedestrian Volume (80 percent)	Satisfied?	

WARRANT 8: Roadway Network **SATISFIED?** No

A) Intersection with major route has a total existing, or immediately projected, entering volume of 1,000 vpd during the peak hour of a typical weekday and has 5-year projected traffic volumes that meet one or more of Warrants 1, 2, or 3 during the average weekday; or		
Peak hour volume: 1146+136=1282>1000	Satisfied?	Yes
Meets Warrant 1, 2, or 3 in five years:	Satisfied?	No
B) Intersection has a total existing or immediately projected entering volume of at least 1,000 vph for each of any 5 hours of a non-normal business day (Saturday or Sunday.)		
Volume:	Satisfied?	No
Major route shall have at least one of the following characteristics.		
Highway system that serves as the principal network for through traffic, or	Satisfied?	Yes
Highway outside, entering, or traversing city, or	Satisfied?	No
Major route on an official plan.	Satisfied?	Yes

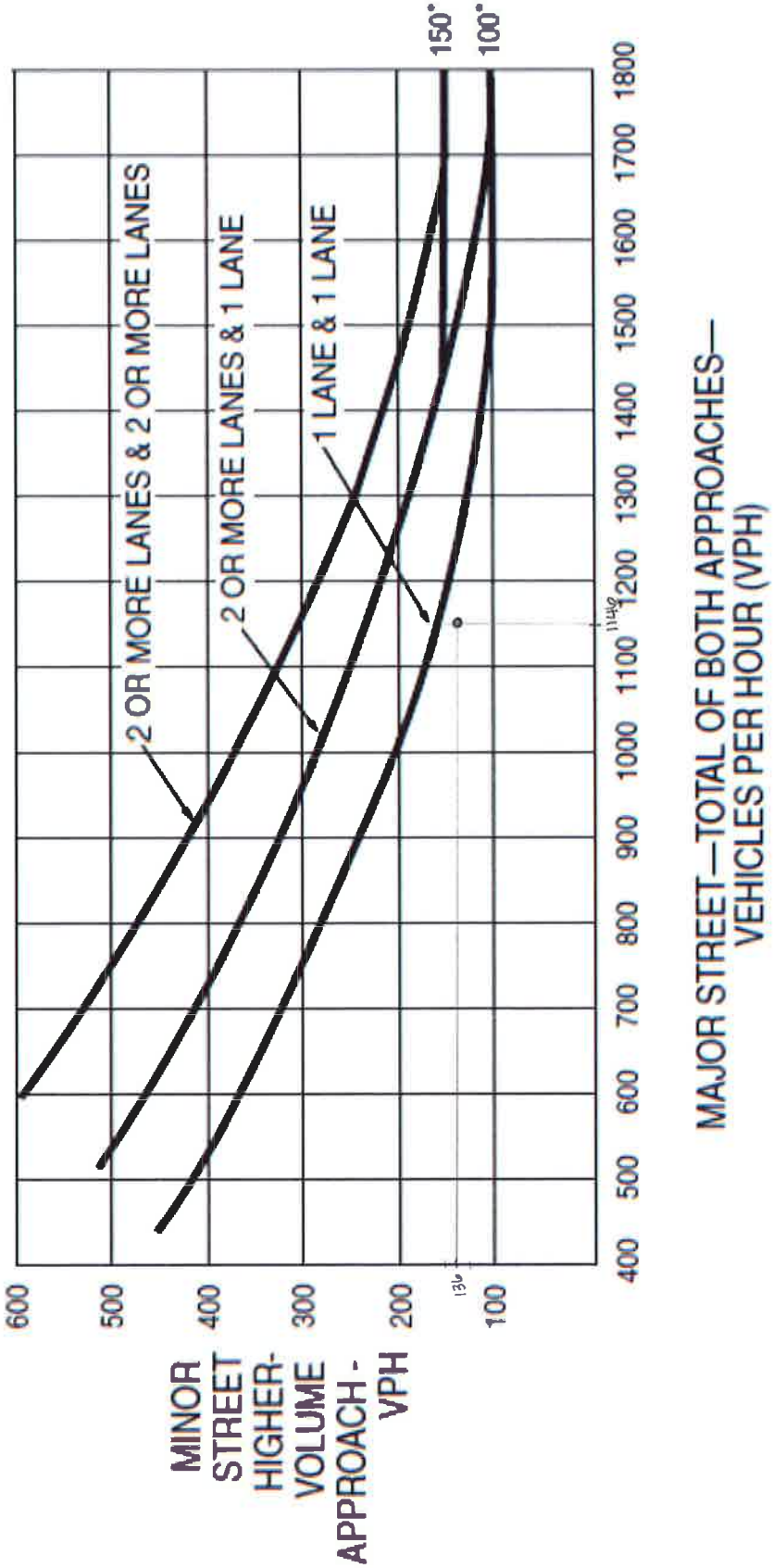
WARRANT 9: INTERSECTION NEAR A GRADE CROSSING **SATISFIED?** N/A

Intersection with major route has a railroad grade crossing within 140', no other signal warrants are met, and consideration has been given to other alternatives. If applicable see additional worksheets.



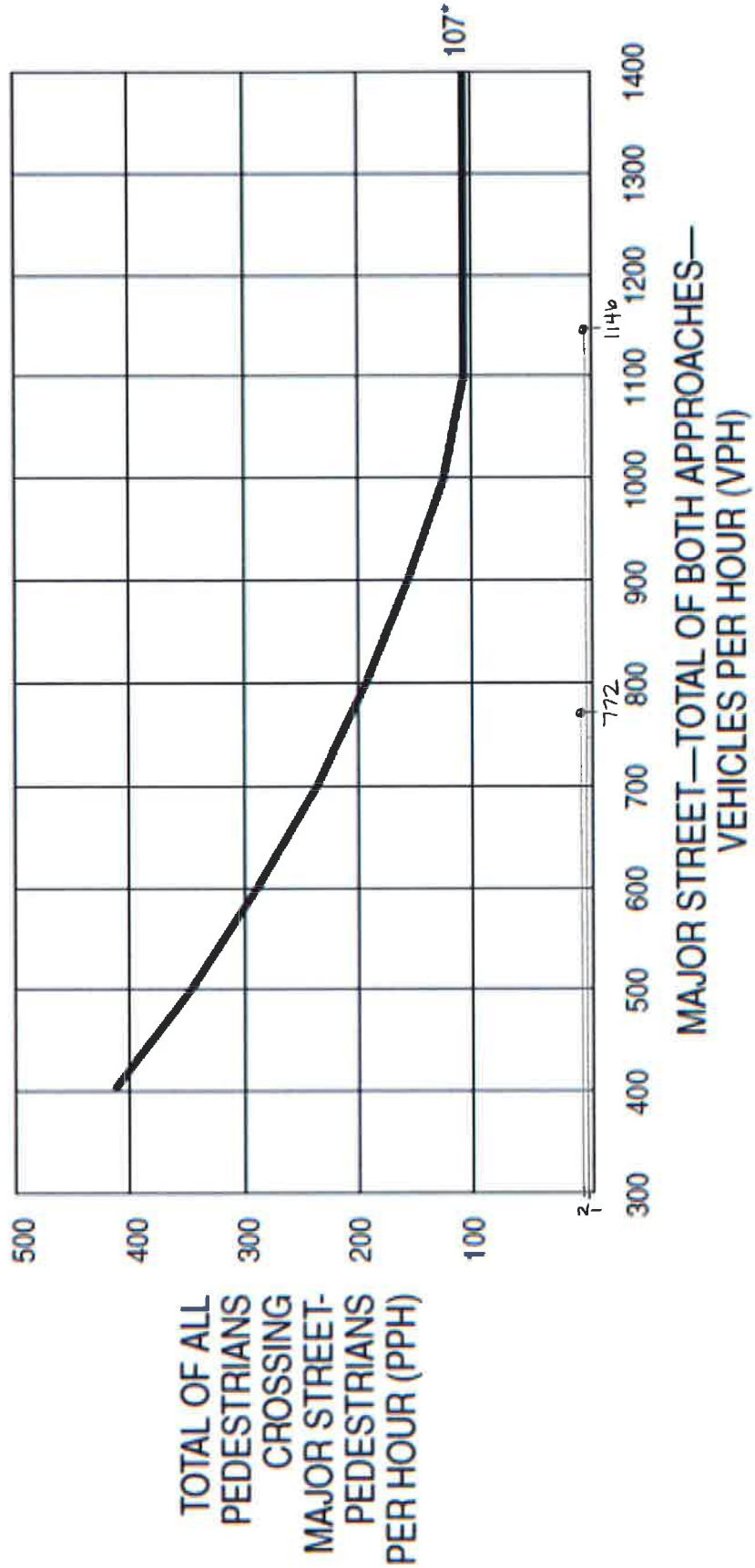
*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



*Note: 107 pph applies as the lower threshold volume.

Appendix C

Traffic Signal Warrant Analysis:
Chatfield Avenue and Kendall Boulevard

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

Date: 4/11/2014

Major Street: Chatfield Avenue — Approach Lanes: 1 — Approach Speed: 30/45

Minor Street: Kendall Boulevard — Approach Lanes: 3 — Approach Speed: 25

Posted, statutory, or 85% speed of major street traffic > 40 mph ----- **No**

URBAN / RURAL

In isolated community of < 10,000 population ---------- **No**

WARRANT 1: Eight-Hour Vehicular Volume — **SATISFIED?** **No**

Condition A - Minimum Vehicular Volume						5 hr	Satisfied?		No
Number of lanes for moving traffic on each approach		Vehicles per hour on Major Street (total all approaches)				Vehicles per hour on Minor Street (Highest Approach)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1.....	1.....	500	400	350	280	150	120	105	84
2 or more	1.....	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1.....	2 or more	**500**	400	350	280	**200**	160	140	112
Hour Beginning:		7:00 AM	8:00 AM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM
Major Street:		592	483	408	516	632	641	552	374
Minor Street:		286	325	287	352	467	481	371	230

Condition B - Interruption of Continuous Traffic						0 hr	Satisfied?		No
Number of lanes for moving traffic on each approach		Vehicles per hour on Major Street (total all approaches)				Vehicles per hour on Minor Street (Highest Approach)			
Major Street	Minor Street	100%	80%	70%	56%	100%	80%	70%	56%
1.....	1.....	750	600	525	420	75	60	53	42
2 or more	1.....	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1.....	2 or more	**750**	600	525	420	**100**	80	70	56
Hour Beginning:		7:00 AM	8:00 AM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM
Major Street:		592	483	408	516	632	641	552	374
Minor Street:		286	325	287	352	467	481	371	230

Condition C - Combination of Warrants		Satisfied?	Urban (80%)	Rural (56%)
Conditions A and B	Condition A - Minimum Vehicular Volume	7 hr	No	
	Condition B - Interruption of Continuous Traffic	2 hr	No	

The satisfaction of a warrant is not necessarily justification for signal control. A traffic signal should not be installed unless traffic study indicates that installing traffic signal control will improve overall safety and/or operations of the intersection.

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

WARRANT 2: Four-Hour Vehicular Volume **SATISFIED?** Yes

Hour Beginning:	3:00 PM	4:00 PM	5:00 PM	6:00 PM			
Major Street - Total both approaches:	516	632	641	552			
Minor Street - Highest approach:	352	467	481	371			

Refer to MUTCD Figure 4C-1, Four-hour Vehicular Volume or Figure 4C-2, Four-hour Vehicular Volume (70% Factor)

WARRANT 3: Peak Hour Vehicular Volume **SATISFIED?** Yes

A) Delay	Satisfied?	No
1) The total stopped time delay experienced by the traffic on one minor street approach (one direction only) controlled by a STOP-sign equal or exceeds: 4 vehicle-hours for a one lane approach; or 5 vehicle-hours for a two-lane approach, and		
Calculation: (25 sec x 535 veh)/3600=3.7 veh-hr	Satisfied?	No
2) The volume on the minor street approach (one direction only) equals or exceeds 100 vehicles per hour (vph) for one moving lane or 150 vph for two moving lanes, and		
Volume: 481>150	Satisfied?	Yes
3) The total entering volume serviced during the hour equals or exceeds 650 vph for intersections with three approaches or 800 vph for intersections with four or more approaches.		
Volume: 641+481+32=1154>800	Satisfied?	Yes

B) Volume					Satisfied?		Yes
Hour Beginning:	4:00 PM	5:00 PM					
Major Street - Total both approaches:	632	641					
Minor Street - Highest approach:	467	481					

Refer to MUTCD Figure 4C-3, Peak Hour or Figure 4C-4, Peak Hour (70% Factor)

WARRANT 4: Pedestrian Volume **SATISFIED?** No

A) Four-Hour Volume			Satisfied?	
Hour Beginning:				
Major Street - Total both approaches:				
Pedestrians - Total of all pedestrians crossing major street:				

Refer to MUTCD Figure 4C-5, Pedestrian Four-Hour Volume or Figure 4C-6, Pedestrian Four-Hour (70% Factor)

B) One-Hour Volume		Satisfied?	
Hour Beginning:			
Major Street - Total both approaches:			
Pedestrians - Total of all pedestrians crossing major street:			

Refer to MUTCD Figure 4C-7, Pedestrian Peak Hour or Figure 4C-8, Pedestrian Peak Hour (70% Factor)

The satisfaction of a warrant is not necessarily justification for signal control. A traffic signal should not be installed unless traffic study indicates that installing traffic signal control will improve overall safety and/or operations of the intersection.

JEFFERSON COUNTY
2009 MUTCD TRAFFIC SIGNAL WARRANT WORKSHEETS

WARRANT 5: School Crossing **SATISFIED?** N/A

Frequency and adequacy of gaps in the vehicular traffic stream related to the size and number of school children at an established major street school crossing are less than the number of minutes in the same period with a minimum of 20 students during the highest crossing hour.

	Hour Beginning:		
	Number of pedestrians:		
	Number of adequate gaps:		

WARRANT 6: Coordinated Signal System **SATISFIED?** N/A

A) On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.

B) On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

WARRANT 7: Crash Experience **SATISFIED?** No

A) Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and

Measure:	Satisfied?	No

B) Five or more crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage exceeding applicable requirements for a reportable crash; and

Number of correctable crashes: 3	Satisfied?	No

C) For each of any 8 hours of an average day, either the vehicles per hour (vph) given in Warrant 1 or pedestrians given in Warrant 4 are satisfied at 80 percent.

Warrant 1, Condition A, Minimum Vehicular Volume (80 percent)	Satisfied?	No
Warrant 1, Condition B, Interruption of Continuous Traffic (80 percent)	Satisfied?	No
Warrant 4, Pedestrian Volume (80 percent)	Satisfied?	No

WARRANT 8: Roadway Network **SATISFIED?** Yes

A) Intersection with major route has a total existing, or immediately projected, entering volume of 1,000 vpd during the peak hour of a typical weekday and has 5-year projected traffic volumes that meet one or more of Warrants 1, 2, or 3 during the average weekday; or

Peak hour volume: 641+481+32=1154>1000	Satisfied?	Yes
Meets Warrant 1, 2, or 3 in five years:	Satisfied?	Yes

B) Intersection has a total existing or immediately projected entering volume of at least 1,000 vph for each of any 5 hours of a non-normal business day (Saturday or Sunday.)

Volume:	Satisfied?	No

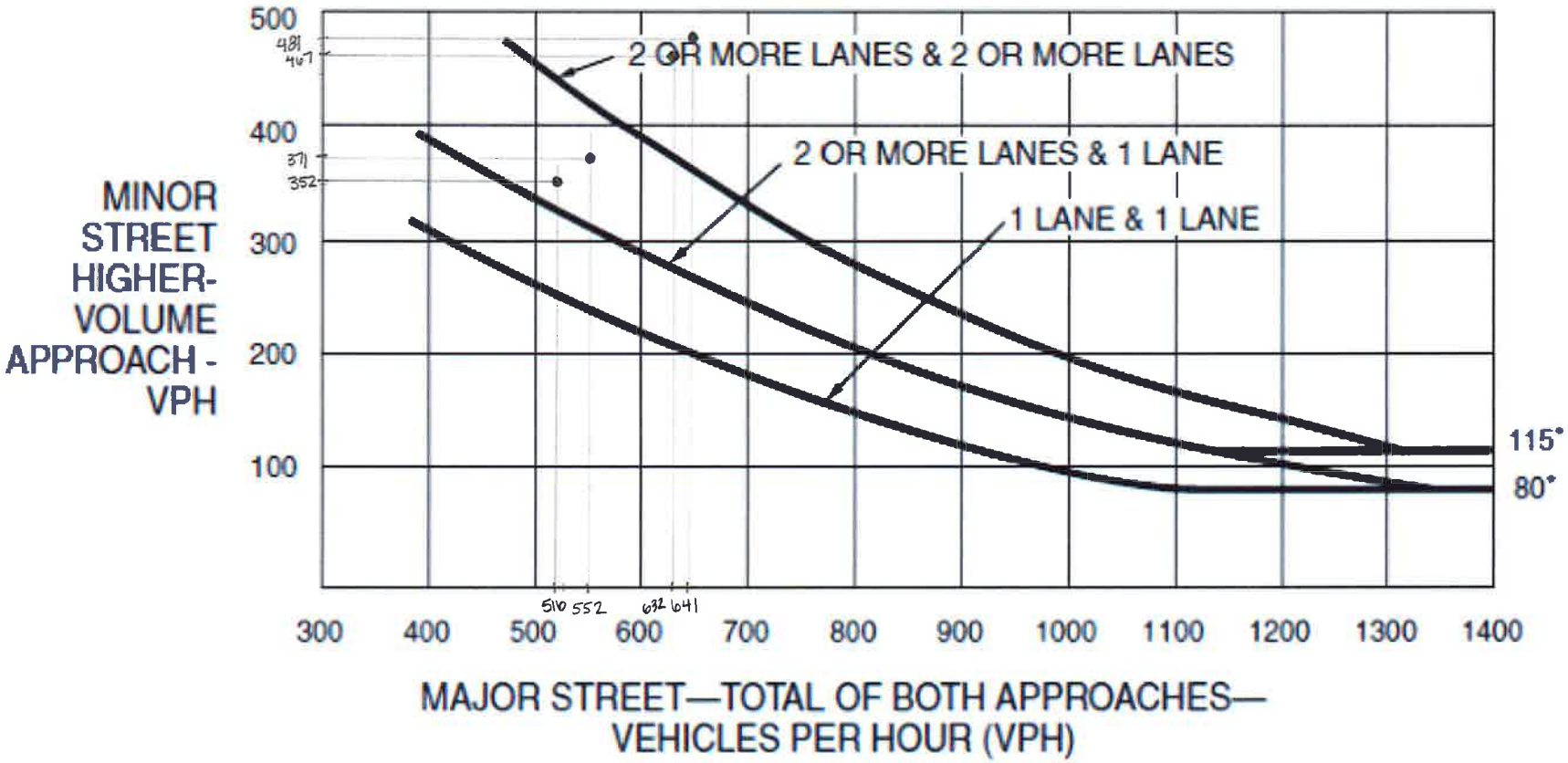
Major route shall have at least one of the following characteristics.

Highway system that serves as the principal network for through traffic, or	Satisfied?	Yes
Highway outside, entering, or traversing city, or	Satisfied?	No
Major route on an official plan.	Satisfied?	Yes

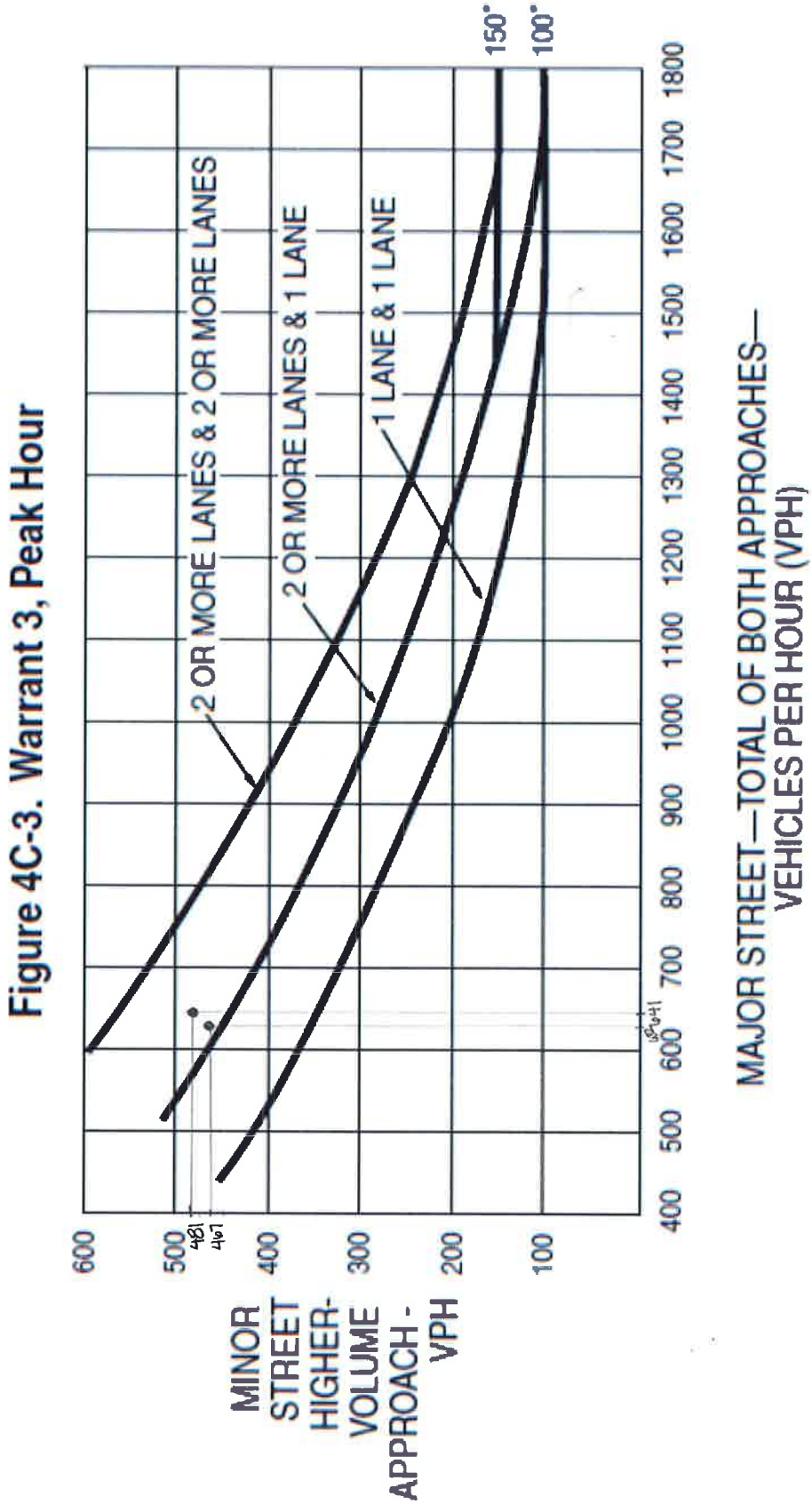
WARRANT 9: INTERSECTION NEAR A GRADE CROSSING **SATISFIED?** N/A

Intersection with major route has a railroad grade crossing within 140', no other signal warrants are met, and consideration has been given to other alternatives. If applicable see additional worksheets.

Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.