TRAFFIC IMPACT ANALYSIS FOR
BOWDEN EVENT CENTER
KELLER, TEXAS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This traffic study was conducted to analyze the potential traffic impacts of the proposed Bowden Event Center in Keller, Texas. The proposed site will be located northwest of the intersection of Keller Parkway (FM 1709) and Bloomfield Drive in Keller, Texas. A vicinity map of the study area is shown in **Figure 1** and a concept plan for this site is shown in **Figure 2**. The following elements were included in this study:

Data Collection

- Collected 24-hour directional traffic volumes along Keller Parkway (FM 1709) in the vicinity of the proposed site.
- Collected existing AM and PM peak hour traffic volumes at the intersection of Keller Parkway (FM 1709) and Bloomfield Drive.
- Obtained historical average daily traffic (ADT) volumes on Keller Parkway (FM 1709).
- Obtained the proposed site plan, information related to planned roadway improvements, and other relevant information.

Traffic Analysis

- Assessed the general accessibility of the site.
- Estimated the number of trips that will be generated by the proposed facility.
- Estimated the directional distribution of traffic approaching / departing the facility.
- Assigned the estimated traffic to the street network.
- Performed capacity analyses for the critical roadway sections and intersections within the study area.
- Analyzed the impact of the proposed development on the area roadways.

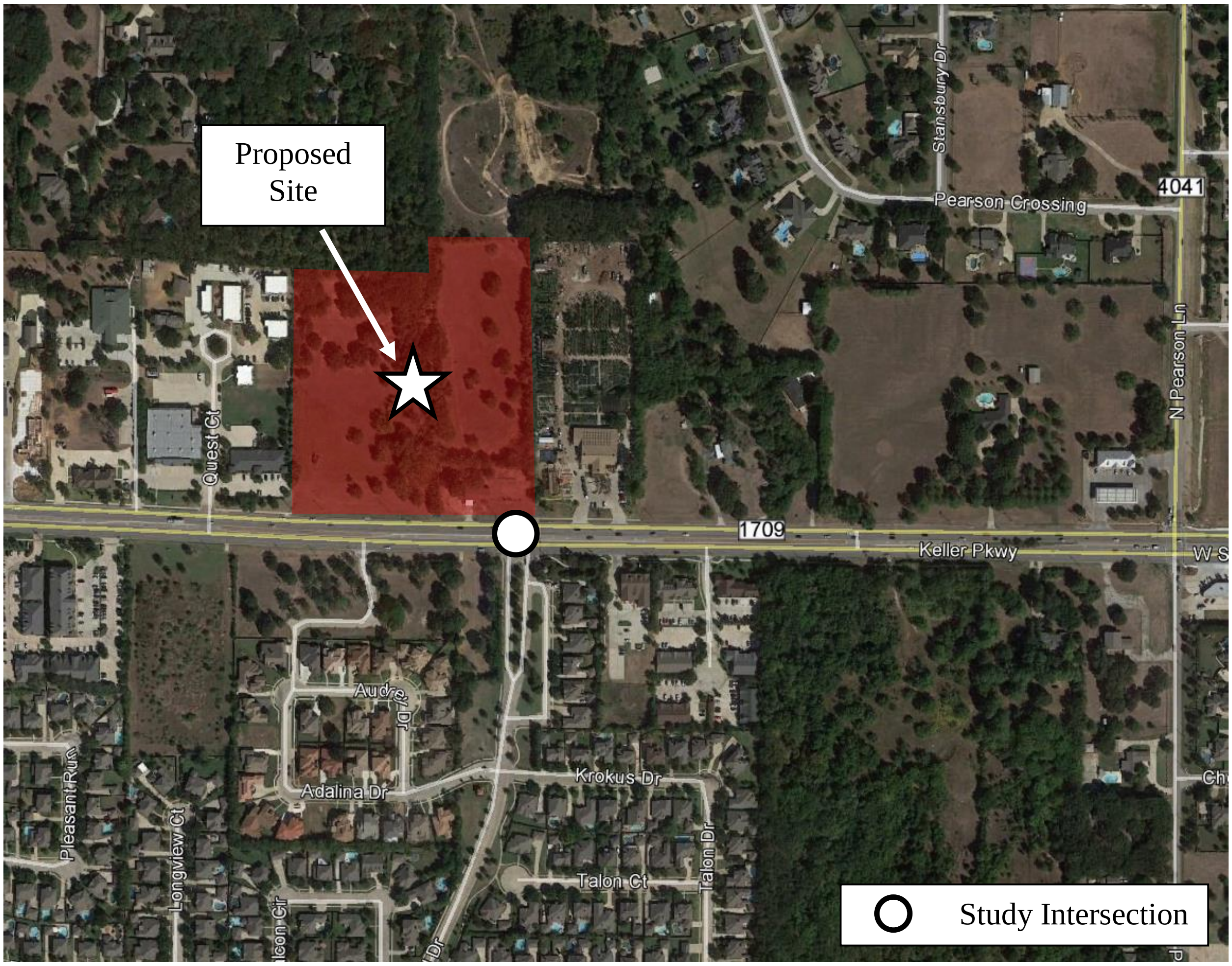
Recommendations

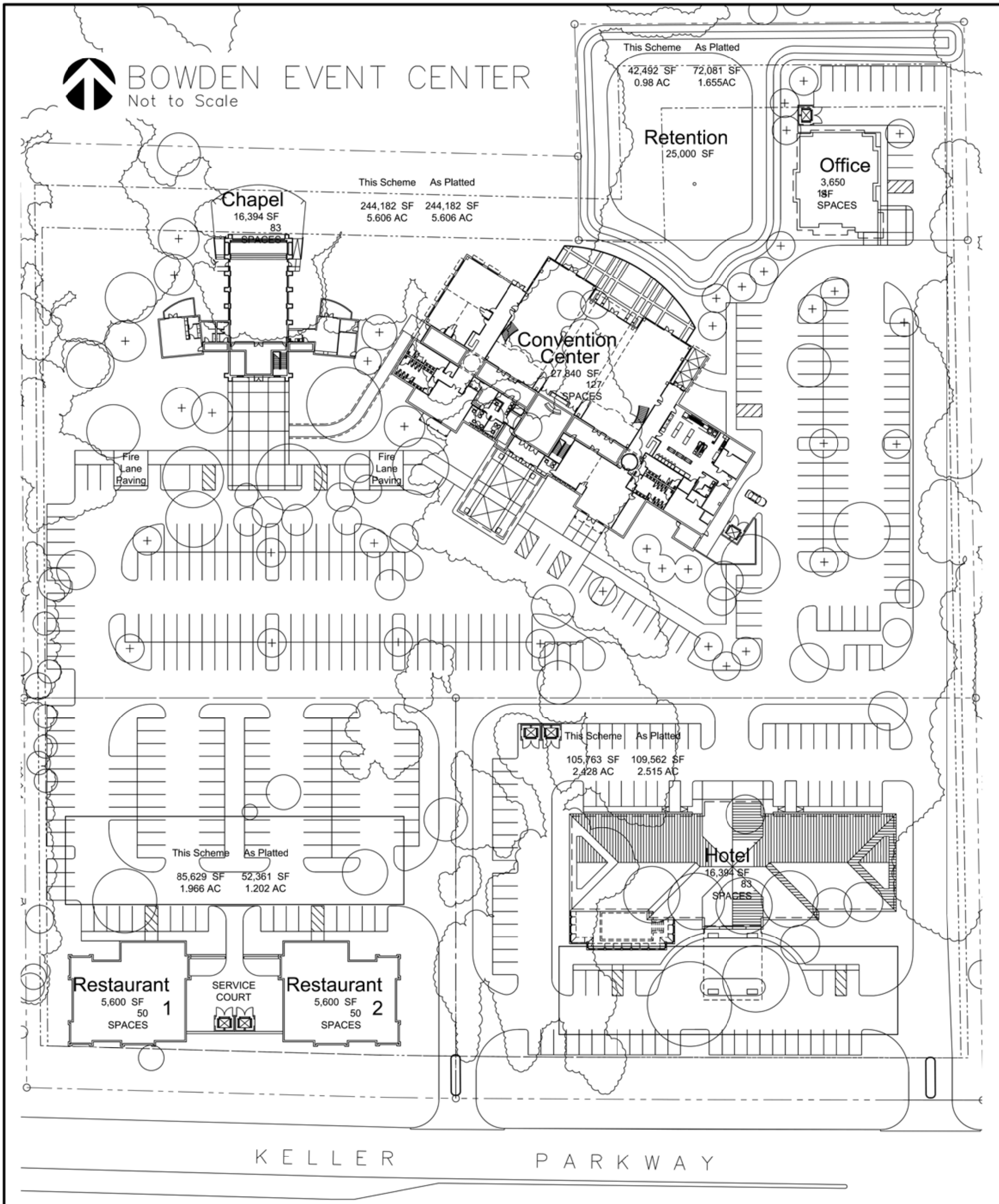
- Determined if any roadway improvements are needed to accommodate projected traffic generated by the proposed facility.

Documentation

- Prepared a report documenting the study procedures and results.

Figure 1: Vicinity Map of the Study Area





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Proposed Site Plan

Figure 2

SITE ACCESSIBILITY

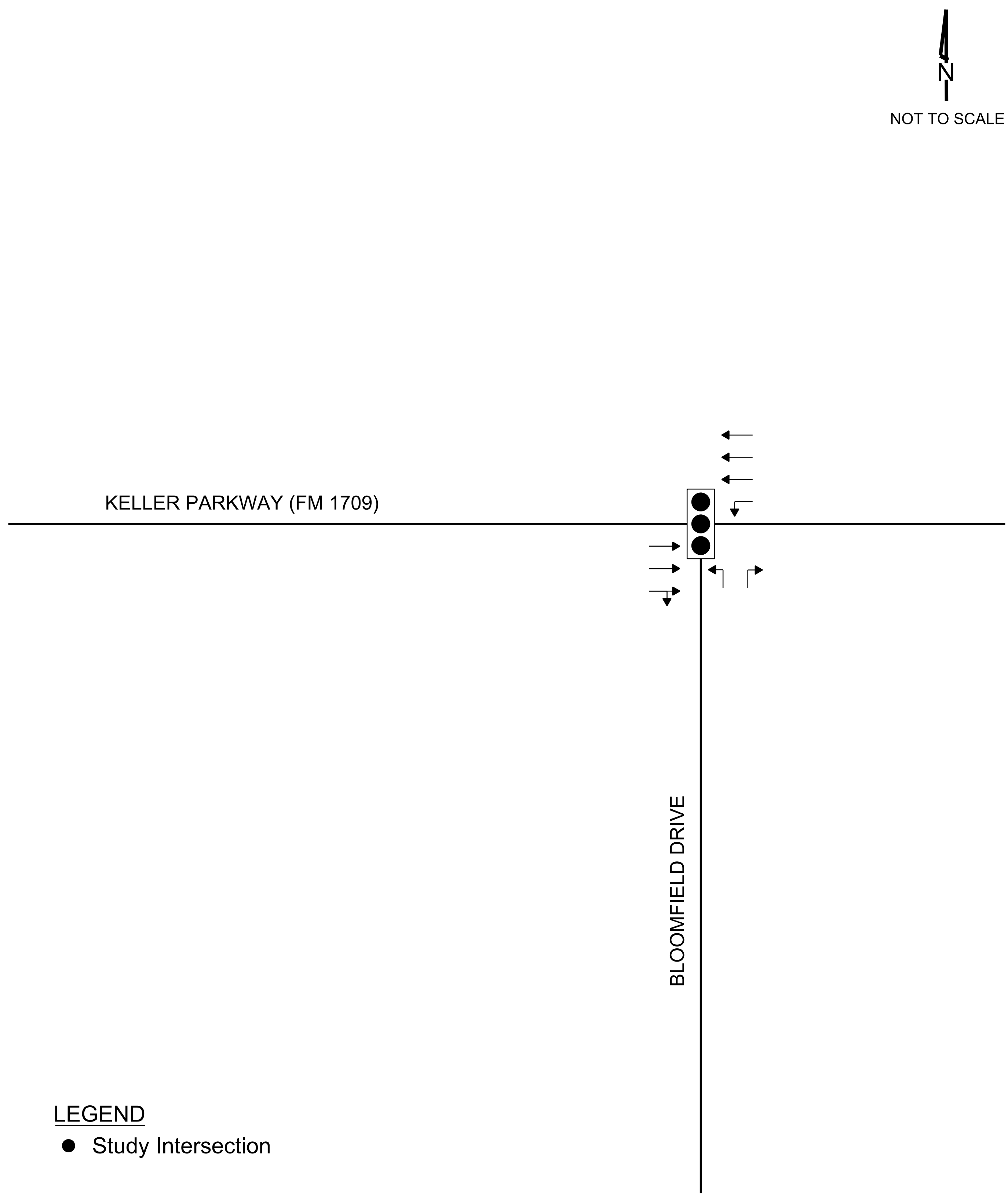
Site accessibility describes the ease with which vehicles can get to and from a development. A site's accessibility is affected by the geographical location of the development with respect to other activity areas, the roadway system, and physical restraints such as rivers or lakes.

The proposed Bowden Event Center will be located northwest of the intersection of Keller Parkway (FM 1709) and Bloomfield Drive in Keller, Texas. The existing lane configurations for these roadways and the critical intersections within the study area are provided in **Figure 3**.

A brief description of area roadways in the vicinity of the development is provided below:

> **Keller Parkway (FM 1709)** – Keller Parkway (FM 1709) borders the proposed facility to the south and is a six-lane divided roadway with a posted speed limit of 45 miles per hour (mph). Keller Parkway (FM 1709) is classified as a 6-Lane Divided Arterial (A6D) in the City of Keller *Comprehensive Thoroughfare Plan* from March 2012. One (1) right-in/right-out access driveway will be provided along Keller Parkway (FM 1709) west of Bloomfield Drive.
>
> **Bloomfield Drive** – Bloomfield Drive is a two-lane undivided roadway approximately 40 feet wide with a posted speed limit of 30 mph. Bloomfield Drive is divided for approximately 320 feet south of Keller Parkway (FM 1709). Bloomfield Drive is considered a local roadway in the City of Keller *Comprehensive Thoroughfare Plan* (March 2012). The existing intersection of Bloomfield Drive with Keller Parkway (FM 1709) is a signalized T-intersection, with only a northbound approach for Bloomfield Drive. As part of the proposed development, Bloomfield Drive will be extended through the intersection to provide access to the Bowden Event Center north of Keller Parkway (FM 1709).

Access to the development site will be provided at the existing intersection of Keller Parkway (FM 1709) and Bloomfield Drive. Access will also be provided by one (1) right-in/right-out driveway along Keller Parkway (FM 1709) west of Bloomfield Drive. The proposed lane configurations for the site are shown in **Figure 4**.



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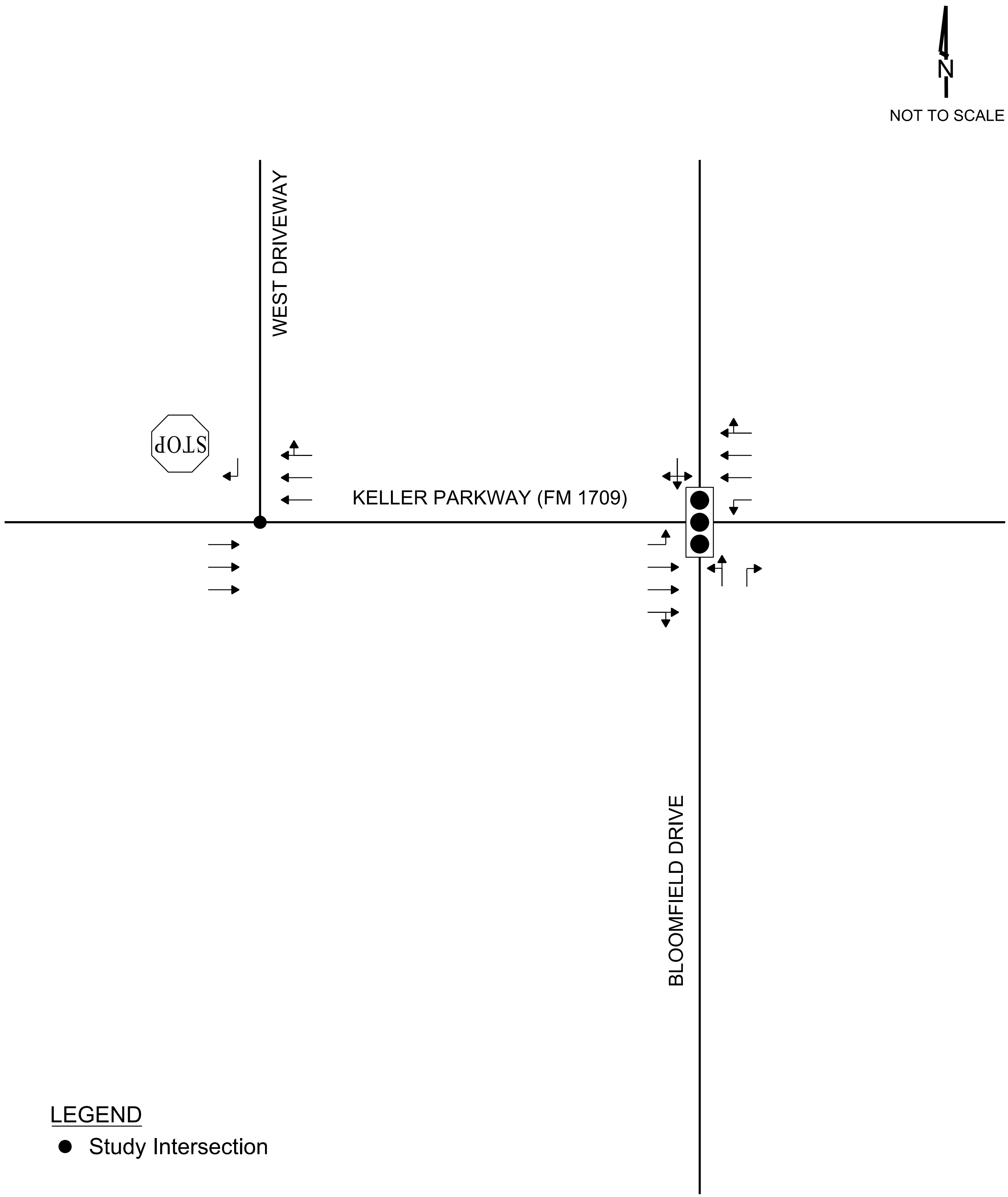
Existing Intersection Lane Configurations

Figure 3



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Proposed Intersection Lane Configurations

Figure 4

PROPOSED DEVELOPMENT

The proposed Bowden Event Center is planned to consist of a 27,840 square foot convention center, with a 16,394 square foot chapel, a 3,650 square foot office, two 5,600 square foot restaurants and a 16,394 square foot (60 rooms) hotel. Based on discussions with the developer, the build-out of the proposed Bowden Event Center will occur in 2015.

The number of trips generated by the Bowden Event Center is a function of the type and quantity of land use for the development. The number of vehicle trips generated by the development was estimated based on the trip generation rates and equations/rates provided in the publication entitled *Trip Generation Manual*, *Ninth Edition*, by the Institute of Transportation Engineers (ITE). Estimates of the number of trips generated by the site were made for the AM and PM peak hour, as well as on a daily basis. The trip generation rates, directional splits, and estimated trip generation for the chapel, restaurant, motel and office portions of this development are shown in **Tables 1A and 1B**. Since 60 room hotel was outside the ITE Trip Generation Land Use "Hotel" modeling space – the Land Use Code 320 (Motel) was used for this analysis.

Table 1A: Trip Generation Rates/Equations

Land Use	ITE Code	Average Weekday	AM Peak Hour	PM Peak Hour
Equations/Rates[1]				
Church	560	T = 9.11*X	T = 0.56*X	T = 0.55*X
Restaurant	932	T = 127.15*X	T = 10.81*X	T = 9.85*X
Motel	320	$Ln(T) = 0.97Ln(X_1) + 2.30$	$Ln(T) = 0.90Ln(X_1) - 0.01$	$T = 0.53*X_1 + 5.95$
General Office Building	710	T = 11.03*X	T = 1.56*X	T = 1.49*X
Directional Splits[2]				
Church	560	50 / 50	62 / 38	48 / 52
Restaurant	932	50 / 50	55 / 45	60 / 40
Hotel/Motel	310/320	50/50	36/64	53/47
General Office Building	710	50 / 50	88 / 12	17 / 83

[1] T = Trips Ends; X = 1,000 ft^2, X_1 = Rooms
[2] XX / YY = % entering vehicles / % exiting vehicles

Table 2B: Trip Generated

Land Use	Variable	Average Weekday			AM Peak Hour			PM Peak Hour		
		Total	Enter	Exit	Total	Enter	Exit	Total	Enter	Exit
Church	16,394 ft^2	150	75	75	9	6	3	9	4	5
Restaurant	11,200 ft^2	1,426	713	713	121	67	54	110	66	44
Hotel/Motel	Rooms	226	113	113	39	14	25	38	220	18
General Office Building	3,650 ft^2	40	20	20	6	5	1	5	1	4

[1] T = Trips Ends; X = 1,000 ft^2, X_1 = Rooms
[2] XX / YY = % entering vehicles / % exiting vehicles

The ITE *Trip Generation Manual, Ninth Edition*, does not include trip generation information for a land type similar to a convention center. Therefore, the number of trips generated by the convention center portion of the Bowden Event Center was estimated with consideration of information such as building size, the proposed number of parking spaces, and anticipated vehicle occupancy.

The site plan (Figure 2) indicates that there are 127 parking spaces designated for the convention center. It was assumed that all parking spaces would be utilized during the Saturday peak hour, resulting in 127 peak hour trips. Based on several other ITE land uses, including shopping center, it was assumed that the weekday peak hours would have approximately 85% of the Saturday peak hour trips. It was also assumed that the peak hour number of trips would be approximately 10% of the total daily number of trips. The directional split was assumed to be 60 / 40 during the AM peak hour, and the reverse during the PM peak hour. The resulting weekday trips for the convention center are shown in **Table 2**.

Table 3: Estimated Trip Generation for Proposed Convention Center

Land Use	Average Weekday			AM Peak Hour			PM Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out
Convention Center	1,080	540	540	108	65	43	108	43	65

Table 3 shows the overall trip generation for the Bowden Event Center, combining the estimated number of trips generated by the chapel, Restaurant, Hotel office, and convention center.

Table 4: Overall Trip Generation for Bowden Event Center

Land Use	Average Weekday			AM Peak Hour			PM Peak Hour		
	Total	In	Out	Total	In	Out	Total	In	Out
Church	150	75	75	9	6	3	9	4	5
General Office Building	40	20	20	6	5	1	5	1	4
Restaurant	1,426	713	713	121	67	54	110	66	44
Motel	226	113	113	39	14	25	38	20	18
Convention Center	1,080	540	540	108	65	43	108	43	65
TOTAL	**2,922**	**1,461**	**1,461**	**283**	**157**	**126**	**270**	**134**	**136**

TRAFFIC VOLUMES, DISTRIBUTION AND ASSIGNMENT

Existing Traffic Volumes

Existing turning movement volumes were collected at the intersection of Keller Parkway (FM 1709) and Bloomfield Drive during the AM (7:00 AM – 9:00 AM) and PM (4:00 PM – 6:00 PM) peak hours on Tuesday, March 10, 2015. Directional 24-hour volumes were also collected on Tuesday, March 10, 2015, along Keller Parkway (FM 1709) west of Bloomfield Drive. **Figure 5** shows the existing peak hour and daily traffic volumes. Raw traffic counts are provided in the Appendix.

Historical Traffic Volumes

Historical traffic volumes were gathered from available TxDOT District count maps and City of Keller annual traffic counts, and compared with the existing traffic count volumes collected. These volumes were used in estimating the annual growth rate necessary to grow the existing background traffic volumes to the Horizon Year (2020). These volumes are presented in **Table 4**.

Table 5: Historical 24-Hour Traffic Volumes

Year	FM 1709 West of Site [1]	FM 1709 East of FM 1938 [1]	FM 1709 East of US 377 [1]	FM 1709 East of Keller Smithfield Road [2]	FM 1709 West of Pearson Lane [2]
2007	38,000	43,000	27,000	37,904	---
2008	38,000	43,000	32,000	---	---
2009	38,000	44,000	35,000	43,567	---
2010	36,000	38,000	32,000	42,845	---
2011	34,000	38,000	31,000	38,680	39,416
2012	38,000	42,000	35,000	39,312	41,171
2013	36,344	41,722	28,079	38,897	38,783
2014	---	---	---	40,752	42,122
Average Annual Growth	-1%	-1%	1%	1%	2%

[1] Source: TxDOT Traffic Count Maps
[2] Source: City of Keller Traffic Count Studies

The traffic volumes in Table 4 indicate that traffic along Keller Parkway (FM 1709) in the vicinity of the study area has varied since 2007, with an average annual growth rate of approximately two percent. **Figure 6** shows the Horizon Year (2020) Background peak hour traffic volumes, which were estimated by increasing the existing traffic volumes at an annual rate of two percent (2%).

Trip Distribution

The existing traffic volumes and roadways in the area were used to determine the directions from which traffic would approach and depart the Bowden Event Center. The directional distribution used for site traffic is shown in **Figure 7**.

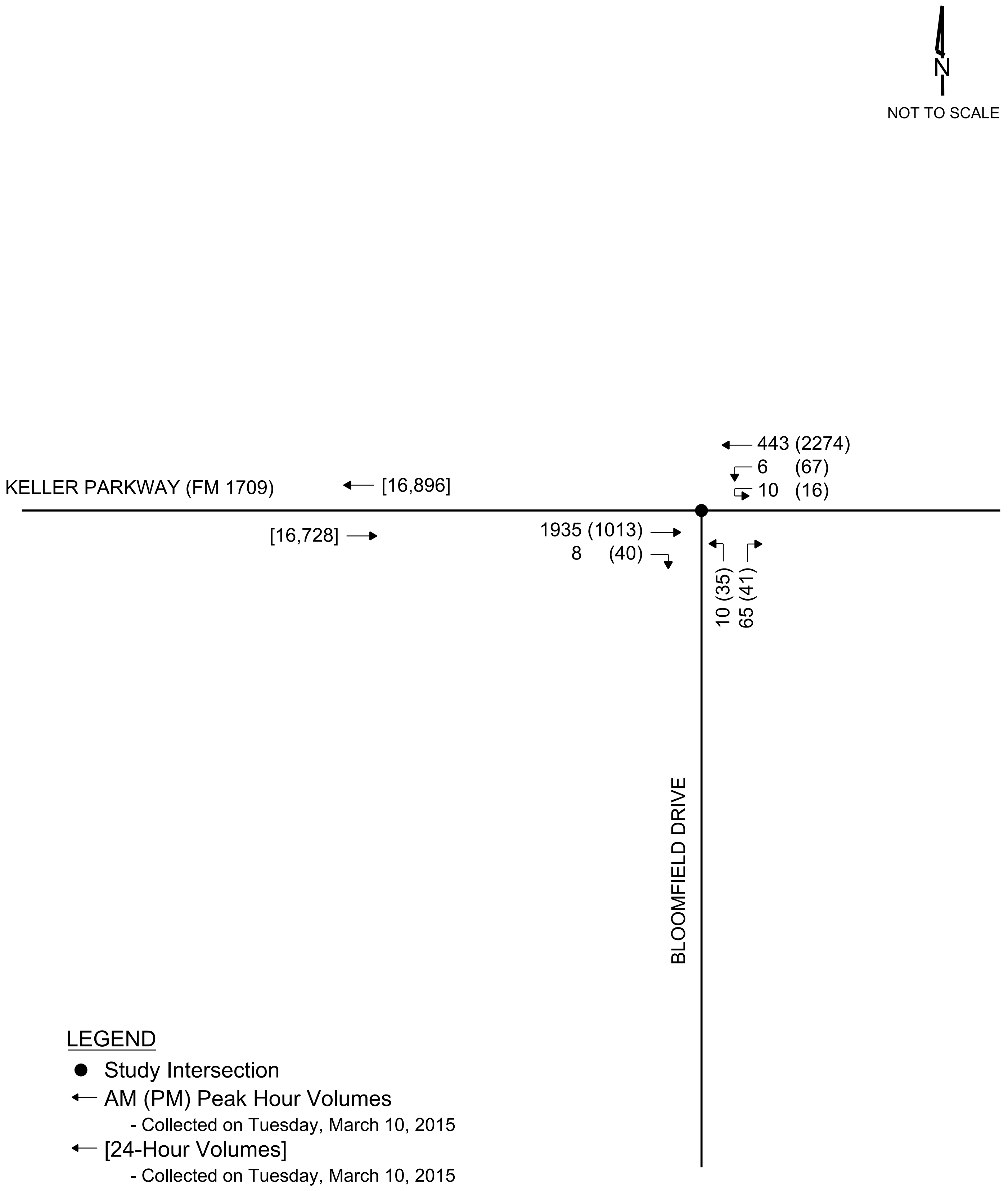
Site Traffic Volumes

Traffic volumes expected to be generated by the proposed Bowden Event Center were assigned to the area roadways and site access points based on the directional distribution identified in Figure 7. The estimated site generated traffic volumes for the AM and PM peak hours are shown in **Figure 8** for the proposed development.

Total Traffic Conditions

Total (background + site) peak hour traffic conditions of the Bowden Event Center for the proposed build-out year were obtained by adding the existing traffic volumes (Figure 5) to the total site generated traffic volumes (Figure 8) to obtain the total traffic volumes during the AM and PM peak hours. The Build-Out (2015) Total traffic volumes are shown in **Figure 9**.

Total (background + site) peak hour traffic conditions of the Bowden Event Center for the Horizon Year were obtained by adding the Horizon Year (2020) Background traffic volumes (Figure 6) to the total site generated traffic volumes (Figure 8) to obtain the total traffic volumes during the AM and PM peak hours. The Horizon Year (2020) Total traffic volumes are shown in **Figure 10**.



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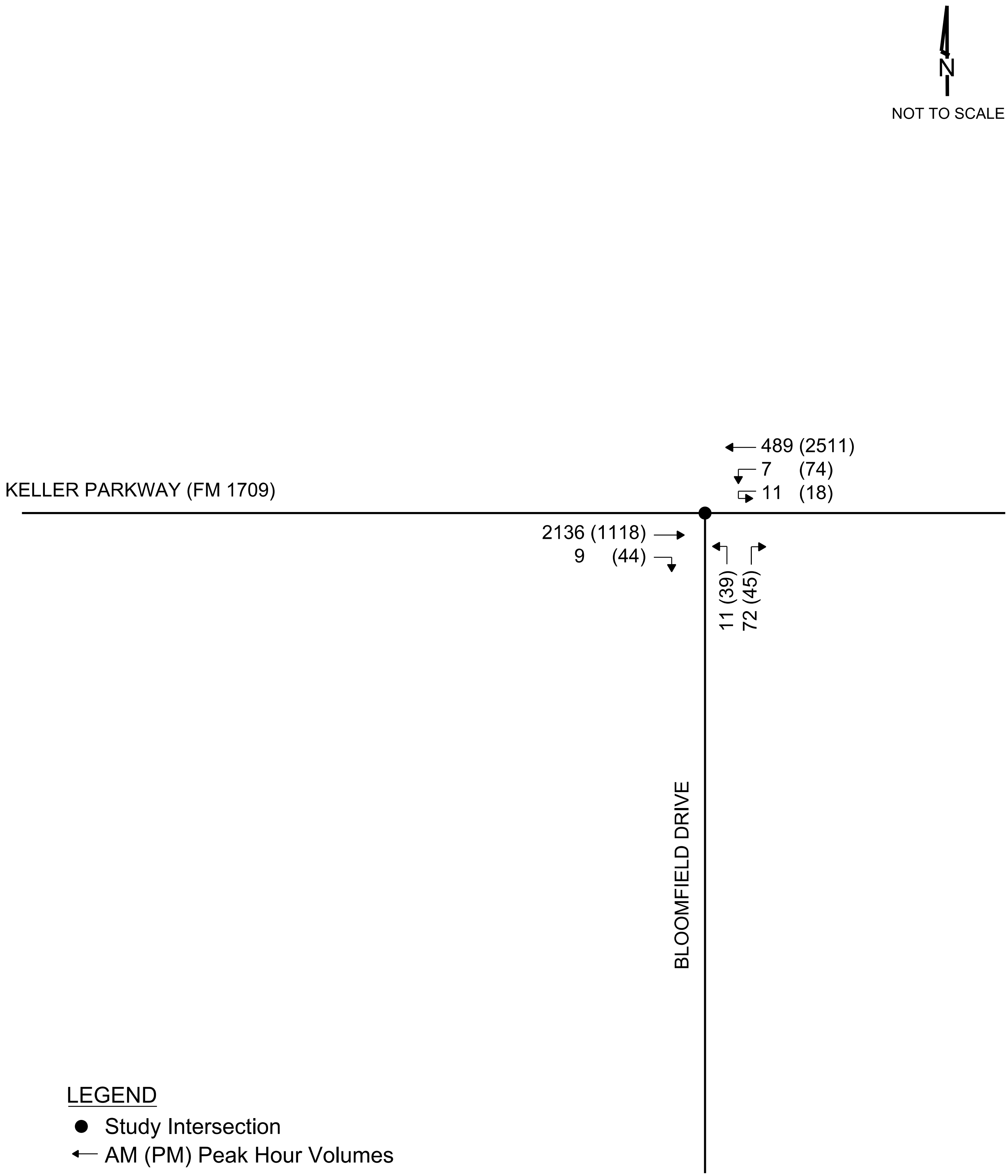
Existing (2015) Peak Hour and Daily Traffic Volumes

Figure 5



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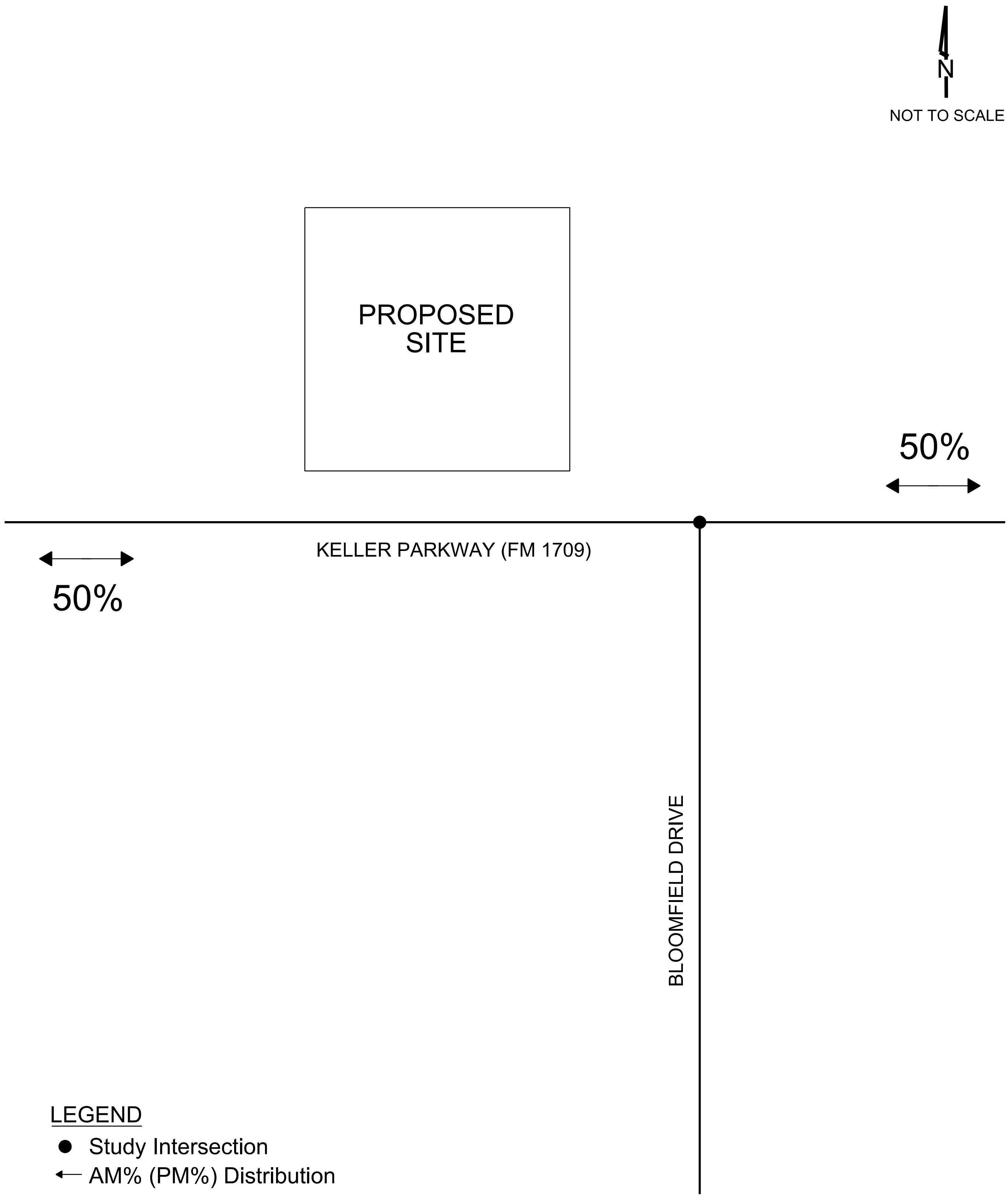
Horizon Year (2020) Background
Peak Hour Traffic Volumes

Figure 6



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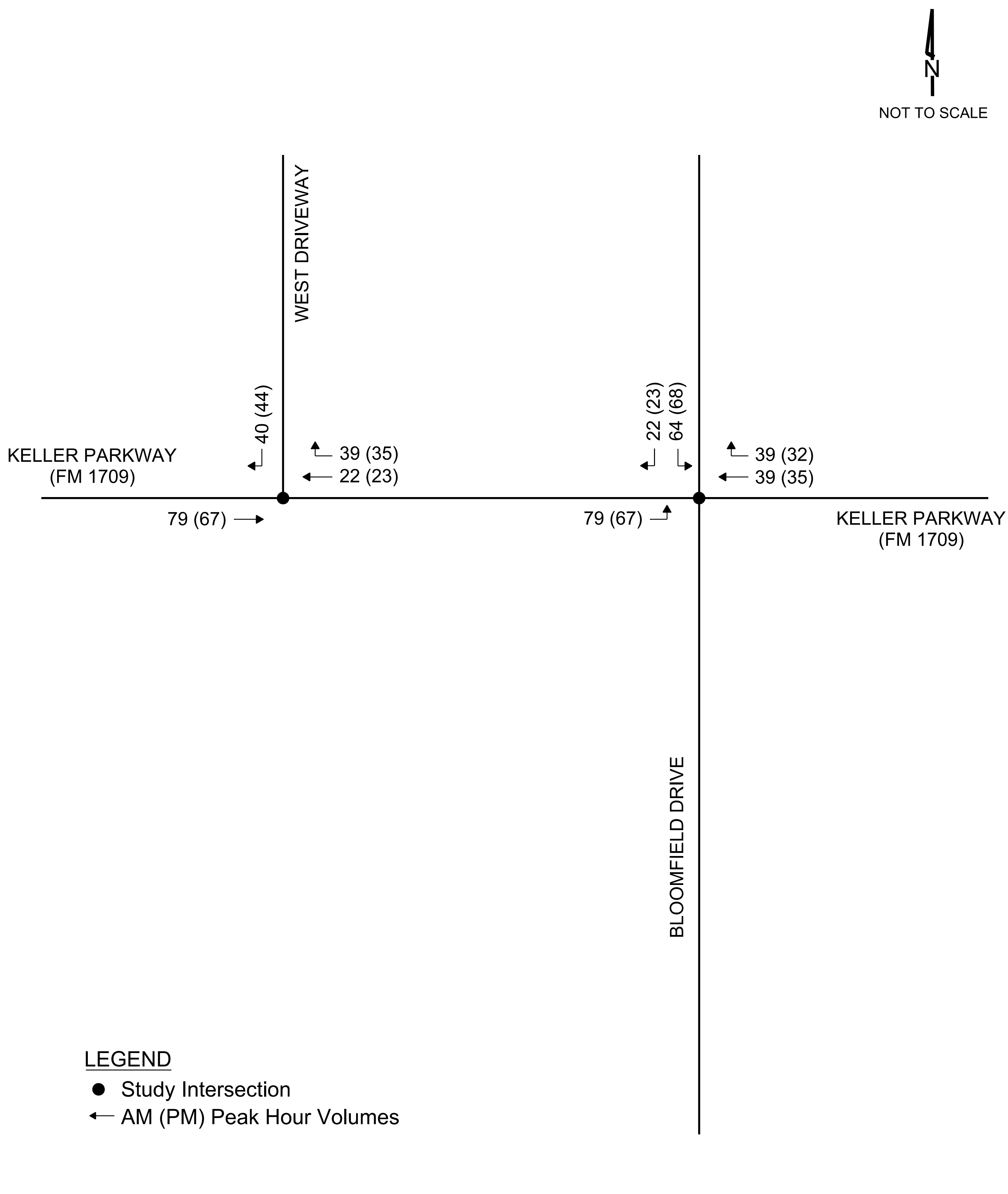
Assumed Directional Distribution

Figure 7



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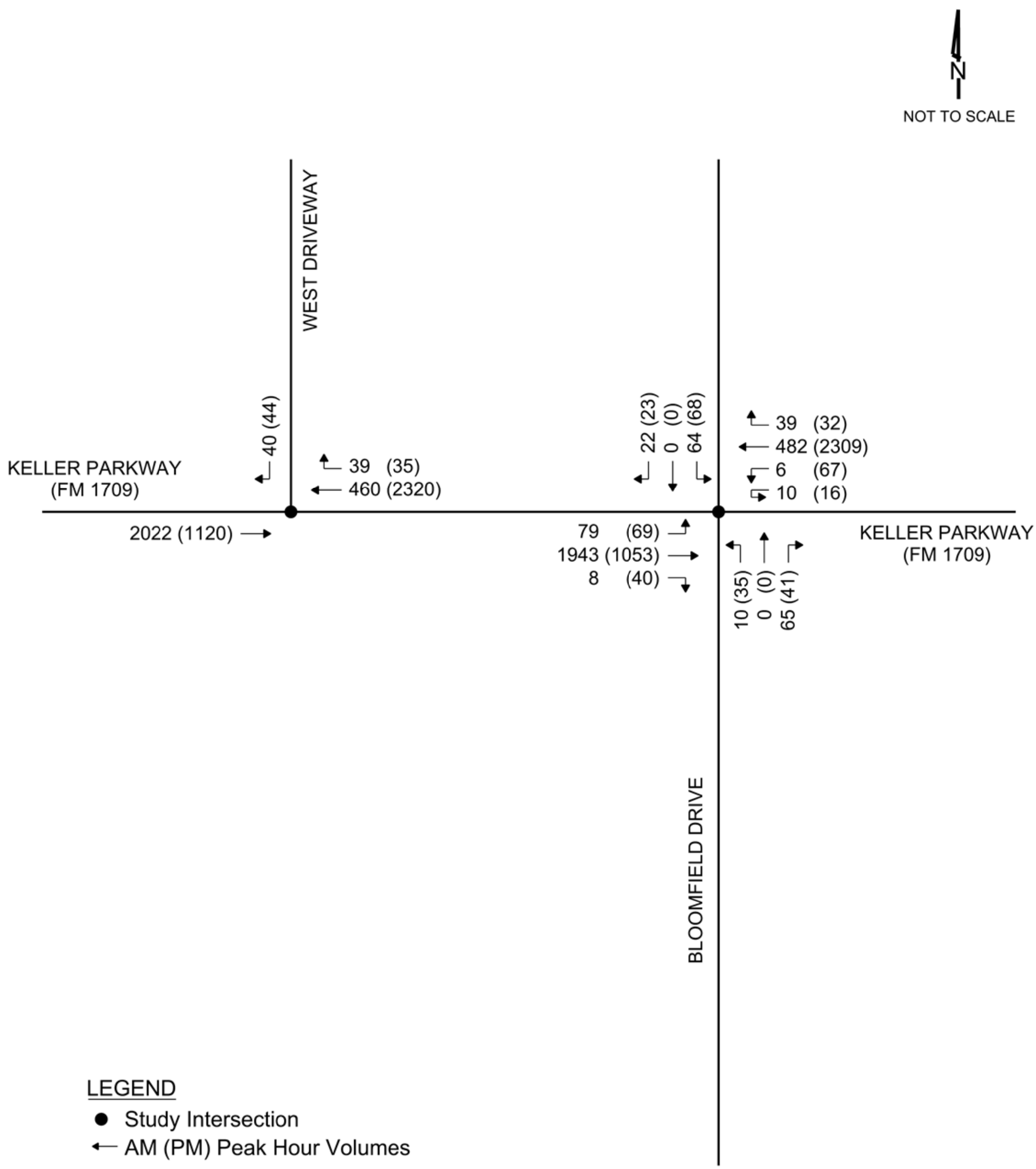
Site Generated Traffic Volumes

Figure 8



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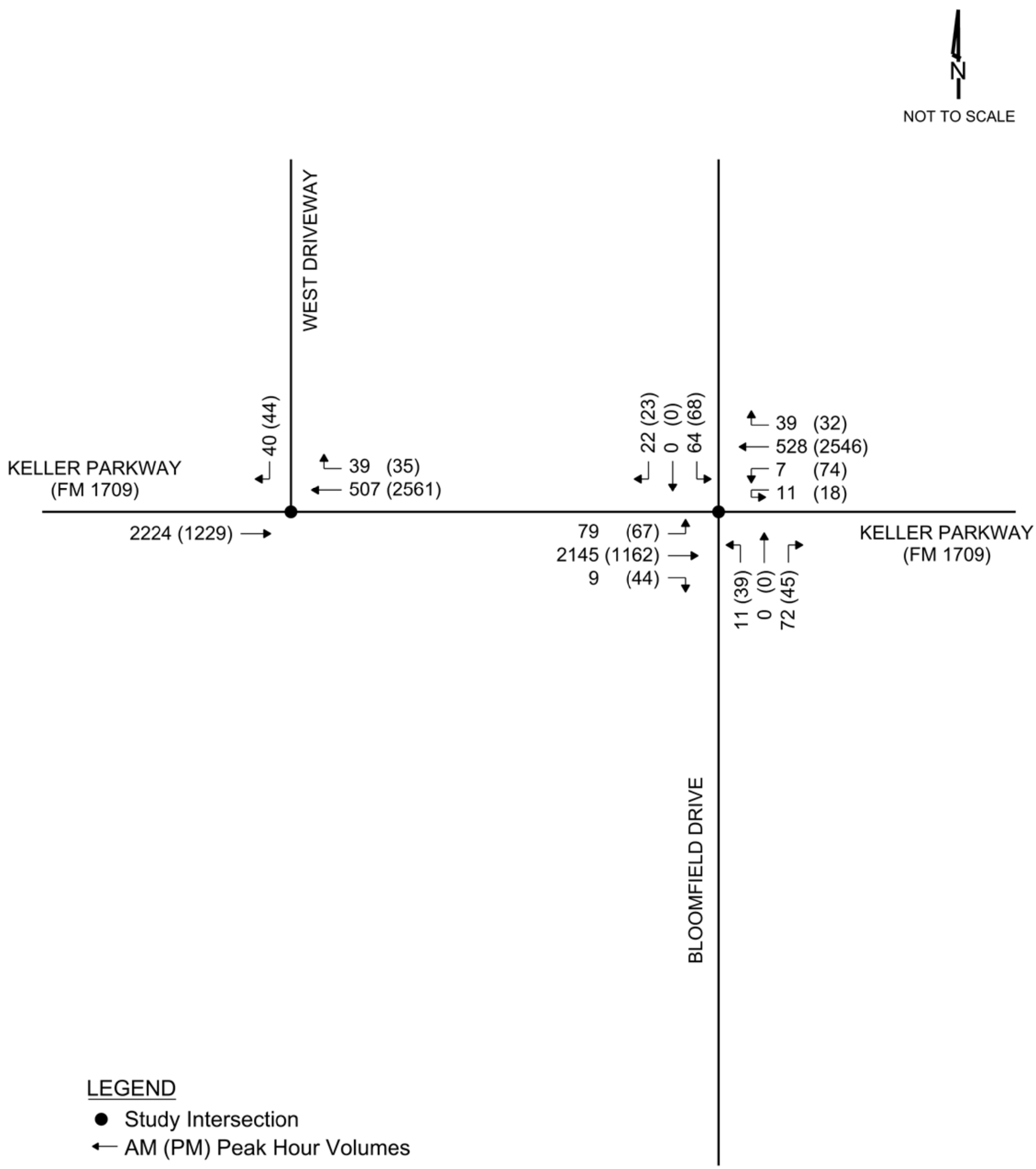
Build-Out (2015) Total Peak Hour Traffic Volumes

Figure 9



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Horizon Year (2020) Total Peak Hour Traffic Volumes

Figure 10

INTERSECTION CAPACITY ANALYSES

The Level of Service (LOS) of an intersection is a qualitative measure of capacity and operating conditions and is directly related to vehicle delay. The LOS criteria for a signalized intersection are shown in **Table 5**. LOS is given a letter designation from A to F, with LOS A representing very short delays (less than 10 seconds of average control delay per vehicle) and LOS F representing very long delays (more than 80 seconds of average control delay per vehicle). LOS D, ranging from 35.1 to 55 seconds of average control delay per vehicle, is typically considered the minimum acceptable condition.

For unsignalized intersections, the levels of service, as shown in **Table 6**, are defined by average control delay in seconds per vehicle. For unsignalized analyses, LOS D is also typically the minimum acceptable condition.

Additional performance measures such as volume to capacity (v/c) ratios and queue lengths also provide an indication of operations. For example, at two-way stop controlled intersections, main street traffic volumes may impose longer average delays for a small number of side-street vehicles, thus creating vehicle delays which correspond to a poor level of service. Motorists and agencies will typically accept longer delays (LOS D to F) if gaps in the traffic stream are anticipated within a reasonable timeframe and the side street traffic volumes do not warrant a traffic signal. As a general guide, gap acceptance thresholds for the longer delay values can be defined when the v/c ratios are under 0.80, which corresponds to 80 percent capacity usage for that movement. Therefore, a traffic movement with a poor level of service and a v/c value below 0.80 could be considered as operating acceptably.

Capacity analyses were conducted for the study area intersections under the following analysis scenarios:

- Existing (2015) traffic conditions;
- Horizon Year (2020) Background traffic conditions;
- Build-Out (2015) Total traffic conditions; and
- Horizon Year (2020) Total traffic conditions.

The intersection capacity analyses were conducted using HCM methodologies in the *Synchro 9.0* traffic analysis software package. *Synchro 9.0* output sheets are included in the Appendix. For existing and background traffic conditions, the existing intersection lane configurations provided in Figure 3 were used. For total traffic conditions, the proposed intersection lane configurations provided in Figure 4 were used.

Table 6: Level of Service Criteria for Signalized Intersections

Level-of-Service (LOS)	Average Control Delay (seconds/vehicle)	Description
A	≤ 10.0	Very low vehicle delays, free flow, signal progression extremely favorable, most vehicles arrive during given signal phase.
B	10.1 to 20.0	Good signal progression, more vehicles stop and experience higher delays than for LOS A.
C	20.1 to 35.0	Stable flow, fair signal progression, significant number of vehicles stop at signals.
D	35.1 to 55.0	Congestion noticeable, longer delays and unfavorable signal progression, many vehicles stop at signals.
E	55.1 to 80.0	Limit of acceptable delay, unstable flow, poor signal progression, traffic near roadway capacity, frequent cycle failures.
F	> 80.0	Unacceptable delays, extremely unstable flow and congestion, traffic exceeds roadway capacity, stop-and-go conditions.

SOURCE: *Highway Capacity Manual, HCM 2010*, Transportation Research Board, 2010.

Table 7: Level of Service Criteria for Unsignalized Intersections

Level-of-Service (LOS)	Average Control Delay (seconds/vehicle)	Description
A	≤ 10.0	No delays at intersections with continuous flow of traffic. Uncongested operations: high frequency of long gaps available for all left and right turning traffic. No observable queues.
B	10.1 to 15.0	No delays at intersections with continuous flow of traffic. Uncongested operations: high frequency of long gaps available for all left and right turning traffic. No observable queues.
C	15.1 to 25.0	Moderate delays at intersections with satisfactory to good traffic flow. Light congestion; infrequent backups on critical approaches.
D	25.1 to 35.0	Increased probability of delays along every approach. Significant congestion on critical approaches, but intersection functional. No standing long lines formed.
E	35.1 to 50.0	Heavy traffic flow condition. Heavy delays probable. No available gaps for cross-street traffic or main street turning traffic. Limit of stable flow.
F	> 50.0	Unstable traffic flow. Heavy congestion. Traffic moves in forced flow condition. Average delays greater than one minute highly probable. Total breakdown.

SOURCE: *Highway Capacity Manual, HCM 2010*, Transportation Research Board, 2010.

Existing and Background Traffic Conditions

The existing lane configurations shown in Figure 3, the Existing (2015) traffic volumes shown in Figure 5, and the Horizon Year (2020) Background traffic volumes shown in Figure 6 were used for this analysis. **Table 7** presents the analysis results for the study area intersection under Existing (2015) and Horizon Year (2020) Background traffic conditions. The shaded cells indicate approaches or movements which are predicted to fall below acceptable levels of service (LOS D).

Table 8: Capacity Analysis Results – Existing and Background Traffic Conditions

Keller Parkway (FM 1709) and Bloomfield Drive (Signalized)						
Traffic Condition	Peak Hour	Intersection	EB	WB	NB	SB
Existing (2015)	AM	7.6 (A) [1]	6.5 (A)	2.0 (A)	64.2 (E)	---
	PM	5.7 (A)	5.3 (A)	3.4 (A)	62.6 (E)	---
Horizon Year (2020) – Background	AM	8.5 (A)	7.6 (A)	2.1 (A)	63.5 (E)	---
	PM	6.2 (A)	5.7 (A)	4.1 (A)	62.2 (E)	---

[1] Delay in seconds/vehicle (Level of Service)

As shown in Table 7, the intersection of Keller Parkway (FM 1709) and Bloomfield Drive currently operates at an acceptable level of service. During the AM and PM peak hours, the northbound approach operates at a poor level of service (LOS E), likely due to delays associated with long cycle lengths used for coordination along Keller Parkway (FM 1709). The intersection is anticipated to operate at similar levels of service for Horizon Year (2020) Background traffic conditions.

Build-Out (2015) Total Traffic Conditions

To evaluate the study area intersections under Build-Out (2015) Total traffic conditions, the study area intersections were analyzed using the proposed lane configurations (Figure 4) and the projected total traffic volumes in 2015 (Figure 9). **Table 8** presents the capacity analysis results for these conditions. The shaded cells indicate approaches or movements which are predicted to fall below acceptable levels of service (LOS D). The volume to capacity ratio is shown for unsignalized movements operating at LOS E or F.

Table 9: Capacity Analysis Results – Build-Out (2015) Total Traffic Conditions

Keller Parkway (FM 1709) and Bloomfield Drive (Signalized)					
Peak Hour	Intersection	EB	WB	NB	SB
AM	10.4 (A) [1]	8.2 (A)	5.4 (A)	53.5 (D)	56.1 (E)
PM	12.3 (B)	8.1 (A)	11.1 (B)	50.4 (D)	55.9 (E)
Keller Parkway (FM 1709) and West Driveway (TWSC)					
Peak Hour	Intersection[2]	EB	WB	NB	SB
AM	---	0.0 (A)	0.0 (A)	---	11.2 (B)
PM	---	0.0 (A)	0.0 (A)	---	46.1 (E), *0.36*

[1] Delay in seconds/vehicle (Level of Service), *v/c ratio for LOS E or F*
[2] HCM methodology does not provide intersection-wide delay/level of service for TWSC analysis

As shown in Table 8, the intersection of Keller Parkway (FM 1709) and Bloomfield Drive is predicted to operate at acceptable levels of service for Build-Out (2015) Total traffic conditions. Similar to existing conditions, the southbound approach (Bloomfield Drive) operates at LOS E due to coordination along Keller Parkway (FM 1709).

The southbound approach of West Driveway is anticipated to operate at acceptable levels of service during the AM peak hour, but LOS E is predicted for the PM peak hour. However, the volume to capacity ratio is less than 0.80. In addition, the upstream signalized intersection of Keller Parkway (FM 1709) and Bloomfield Drive is expected to create gaps in the traffic flow along westbound Keller Parkway (FM 1709).

Horizon Year (2020) Total Traffic Conditions

To evaluate the study area intersections under Horizon Year (2020) Total traffic conditions, the study area intersections were analyzed using the proposed lane configurations (Figure 4) and the projected total traffic volumes in 2020 (Figure 10). **Table 9** presents the capacity analysis results for these conditions. The shaded cells indicate approaches or movements which are predicted to fall below acceptable levels of service (LOS D). The volume to capacity ratio is shown for unsignalized movements operating at LOS E or F.

Table 10: Capacity Analysis Results – Horizon Year (2020) Total Traffic Conditions

Keller Parkway (FM 1709) and Bloomfield Drive (Signalized)					
Peak Hour	Intersection	EB	WB	NB	SB
AM	11.2 (B) [1]	9.3 (A)	5.2 (A)	53.9 (D)	56.0 (E)
PM	13.6 (B)	9.0 (A)	13.0 (B)	50.3 (D)	55.8 (E)
Keller Parkway (FM 1709) and West Driveway (TWSC)					
Peak Hour	Intersection[2]	EB	WB	NB	SB
AM	---	0.0 (A)	0.0 (A)	---	11.5 (B)
PM	---	0.0 (A)	0.0 (A)	---	61.6 (F), *0.44*

[1] Delay in seconds/vehicle (Level of Service), *v/c ratio for LOS E or F*

[2] HCM methodology does not provide intersection-wide delay/level of service for TWSC analysis

As shown in Table 9, the intersection of Keller Parkway (FM 1709) and Bloomfield Drive is predicted to operate at acceptable levels of service for Horizon Year (2020) Total traffic conditions. Similar to Horizon Year (2020) Background conditions, the northbound approach (Bloomfield Drive) operates at LOS E. The southbound approach is also anticipated to operate at LOS E during the PM peak hour due to delays associated with long cycle lengths used for coordination along Keller Parkway (FM 1709).

The southbound approach of West Driveway is anticipated to continue to operate at acceptable levels of service during the AM peak hour, but at LOS E during the PM peak hour. However, the volume to capacity ratio is less than 0.80. In addition, the upstream signalized intersection of Keller Parkway (FM 1709) and Bloomfield Drive is expected to create gaps in the traffic flow along westbound Keller Parkway (FM 1709).

ACCESS MANAGEMENT ANALYSES

Right-Turn Deceleration Lane Analysis

Auxiliary lanes are utilized to facilitate turning movements at intersections and driveways. As part of this study, the proposed site access driveways for the development were analyzed to determine the need for right turn deceleration lanes. Based on guidelines presented in TxDOT's *Access Management Manual*, right turn deceleration lanes are typically considered under the following conditions:

- Right turn volumes greater than 50 vph (if posted speed limit greater than 45 mph)
- Right turn volumes greater than 60 vph (if posted speed limit less than/equal to 45 mph)

Table 10 summarizes the predicted right turn volumes under Build-Out (2015) Total traffic conditions (Figure 9) for both site access points.

Table 11: Right Turn Deceleration Lane Analysis Results

Intersection	Approach	Speed Limit (mph)	Right Turn Volume (vph) AM (PM)	Threshold Volume (vph)	Exceeds Threshold? AM (PM)
West Driveway at Keller Parkway (FM 1709)	WB	45	39 (35)	60	No (No)
Bloomfield Drive at Keller Parkway (FM 1709)	WB	45	39 (32)	60	No (No)

Based on the projected right turn peak hour traffic volumes and guidelines provided by TxDOT, right turn traffic volumes at the site access driveways are not expected to exceed the threshold value for consideration of a right turn deceleration lane under Total traffic conditions.

The City of Keller requires right-turn deceleration lanes on all approaches at intersections of arterial and collector streets. However, Bloomfield Drive is a local roadway, not an arterial or collector. Right turn lanes are also required at driveways to all commercial developments of five (5) acres or more. The proposed site includes over five acres; therefore, installation of a westbound right turn deceleration lane is recommended at the intersection of Bloomfield Drive and Keller Parkway (FM 1709) when the site is built out.

Based on the TxDOT *Roadway Design Manual*, 30 feet of storage and 345 feet of deceleration length (including 100 feet of taper) should be provided for a right turn deceleration lane along a roadway with a 45 mph speed limit. However, available length is limited by the location of an existing driveway to the east along Keller Parkway (FM 1709) associated with the adjacent site. Additional right turn lane length could be provided if this existing driveway were closed. Cross-access could be provided to the adjacent development to the east to allow it to access the intersection of Bloomfield Drive and Keller Parkway (FM 1709).

Because right turning volumes are below TxDOT criteria for a right turn lane, construction of the right turn lane could be postponed until full development of the major traffic generators on the site which are the restaurants and the convention center.

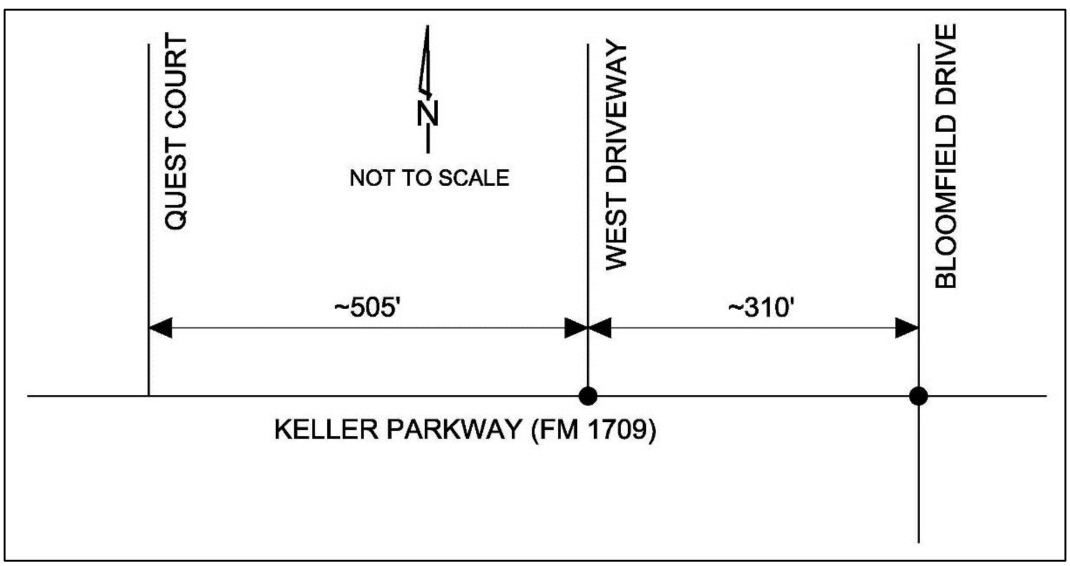
Left-Turn Deceleration Lanes

Per the City of Keller *Unified Development Code, "*left-turn lanes shall be provided on all approaches to existing or proposed intersections when four or six-lane streets cross. Left turn lanes shall also be provided for all divided streets where median openings provide access to streets, alleys or driveways, when required by the City". No left turn access is proposed at West Driveway. An eastbound left turn deceleration lane is already in place at the intersection of Keller Parkway (FM 1709) and Bloomfield Drive, which will serve the proposed north leg of the intersection.

Driveway Spacing

Based on the Texas Department of Transportation (TxDOT) *Access Management Manual*, the required driveway spacing on a state highway with a posted speed limit of 45 mph is 360 feet. The City of Keller requires spacing of 250 feet between an intersection and a non-residential driveway on an arterial street. The proposed driveway spacing for the development is shown in **Figure 11**.

Figure 11: Proposed Driveway Spacing



As shown, spacing between the proposed West Driveway location and the extension of Bloomfield Drive exceeds the spacing requirement for the City of Keller. However, while spacing is less than required by TxDOT, the proposed driveway provides right-in/right-out access only. In addition, the speed limit along Keller Parkway (FM 1709) may drop in the future with continued development along the roadway.

Intersection Sight Distance

As part of this traffic analysis, the available and required intersection sight distances for motorists accessing the adjacent roadways from the proposed site access points were analyzed. The sight distance required at the proposed site driveways was estimated using the procedures developed by the American Association of State Highway and Transportation Officials (AASHTO) and published in the 2011 edition of *A Policy on Geometric Design of Highways and Streets*. At these locations, the motorist should be able to see if and when adequate gaps exist to perform their desired maneuver. **Table 11** presents the required and available sight distance for vehicles exiting West Driveway onto Keller Parkway (FM 1709).

Table 12: Sight Distance Evaluation

Major Roadway	Keller Parkway (FM 1709)
Posted Speed Limit	45 mph
Design Vehicle	Passenger Car[1]
Driveway	West Driveway
Required Intersection Sight Distance to the Left	430’
Required Intersection Sight Distance to the Right	N/A
Available Sight Distance to the Left	>1,000’
Available Sight Distance to the Right	N/A
Sight Distance Available > Required	
To the Left	**YES**
To the Right	N/A

[1] Design vehicle based on classification of major roadway, per City of Keller Unified Development Code

Comparing the field investigation results of the available sight distance to the required sight distance indicates that adequate sight distance is provided along Keller Parkway (FM 1709) for passenger cars exiting at West Driveway.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of the proposed site plan and characteristics of the Bowden Event Center, the following conclusions can be made:

- The proposed Bowden Event Center was estimated to generate approximately 2,576 trips on a daily basis – 270 trips during the AM peak hour and 268 trips during the PM peak hour.

- Under Existing (2015) traffic conditions, the intersection of Keller Parkway (FM 1709) and Bloomfield Drive is anticipated to operate at an acceptable level of service. During the AM and PM peak hours, the northbound approach operates at a poor level of service (LOS E) due to delays associated with long cycle lengths used for coordination along Keller Parkway (FM 1709). The intersection is anticipated to operate at similar levels of service for Horizon Year (2020) Background traffic conditions.

- Under Build-Out (2015) Total traffic conditions and Horizon Year (2020) Total traffic conditions, the intersection of Keller Parkway (FM 1709) and Bloomfield Drive is anticipated to operate at similar levels of service to existing and background conditions. The new southbound approach at the intersection is anticipated to operate at LOS E during the PM peak hour due to delays associated with long cycle lengths used for coordination along Keller Parkway (FM 1709).

- Under Build-Out (2015) Total traffic conditions and Horizon Year (2020) Total traffic conditions, the southbound (stop-controlled) approach at the intersection of Keller Parkway (FM 1709) and West Driveway is anticipated to operate at LOS E, but with a v/c ratio less than 0.80. The upstream signalized intersection of Keller Parkway (FM 1709) and Bloomfield Drive is expected to create gaps in the traffic flow along westbound Keller Parkway (FM 1709).

- Based on the City of Keller *Unified Development Code*, installation of a westbound right turn deceleration lane is recommended at the intersection of Bloomfield Drive and Keller Parkway (FM 1709) when the site is fully developed.
  - Based on the TxDOT *Roadway Design Manual*, 30 feet of storage and 345 feet of deceleration length (including 100 feet of taper) should be provided. However, available length is limited by the location of an existing driveway to the east along Keller Parkway (FM 1709) associated with the adjacent site. Additional right turn lane length could be provided if this existing driveway were closed and cross-access provided to the adjacent development to the east to allow it to access the intersection of Bloomfield Drive and Keller Parkway (FM 1709).

- Spacing between the proposed West Driveway location and the extension of Bloomfield Drive exceeds the spacing requirement for the City of Keller. While spacing is less than required by TxDOT, the proposed driveway provides right-in/right-out access only. In addition, the speed limit along Keller Parkway (FM 1709) may drop in the future with continued development along the roadway.

- Comparing the field investigation results of the available sight distance to the required sight distance indicates that adequate sight distance is provided along Keller Parkway (FM 1709) for passenger cars exiting at West Driveway.

APPENDIX

Movement	EBT	EBR	WBU	WBL	WBT	NBL	NBR
Lane Configurations							
Volume (veh/h)	1935	8	10	6	443	10	65
Number	2	12		1	6	3	18
Initial Q (Qb), veh	0	0		0	0	0	0
Ped-Bike Adj(A_pbT)		1.00		1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00		1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1900		1863	1863	1863	1863
Adj Flow Rate, veh/h	2174	16		8	534	20	76
Adj No. of Lanes	3	0		1	3	1	1
Peak Hour Factor	0.89	0.50		0.75	0.83	0.50	0.86
Percent Heavy Veh, %	2	2		2	2	2	2
Cap, veh/h	4006	29		185	4237	111	99
Arrive On Green	0.77	0.77		0.01	0.83	0.06	0.06
Sat Flow, veh/h	5376	38		1774	5253	1774	1583
Grp Volume(v), veh/h	1415	775		8	534	20	76
Grp Sat Flow(s),veh/h/ln	1695	1856		1774	1695	1774	1583
Q Serve(g_s), s	19.8	19.9		0.1	2.3	1.3	5.7
Cycle Q Clear(g_c), s	19.8	19.9		0.1	2.3	1.3	5.7
Prop In Lane		0.02		1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2608	1428		185	4237	111	99
V/C Ratio(X)	0.54	0.54		0.04	0.13	0.18	0.77
Avail Cap(c_a), veh/h	2608	1428		263	4237	296	264
HCM Platoon Ratio	1.00	1.00		1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00		1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	5.5	5.5		4.6	1.9	53.3	55.4
Incr Delay (d2), s/veh	0.8	1.5		0.1	0.1	0.8	11.5
Initial Q Delay(d3),s/veh	0.0	0.0		0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.3	10.5		0.1	1.1	0.7	2.8
LnGrp Delay(d),s/veh	6.3	7.0		4.7	1.9	54.1	66.9
LnGrp LOS	A	A		A	A	D	E
Approach Vol, veh/h	2190				542	96	
Approach Delay, s/veh	6.5				2.0	64.2	
Approach LOS	A				A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	7.7	98.8				106.5		13.5
Change Period (Y+Rc), s	6.5	6.5				6.5		6.0
Max Green Setting (Gmax), s	6.5	74.5				87.5		20.0
Max Q Clear Time (g_c+I1), s	2.1	21.9				4.3		7.7
Green Ext Time (p_c), s	0.0	34.4				44.4		0.2

Intersection Summary				
HCM 2010 Ctrl Delay			7.6	
HCM 2010 LOS			A	

Notes

User approved ignoring U-Turning movement.

Movement	EBT	EBR	WBU	WBL	WBT	NBL	NBR
Lane Configurations							
Volume (veh/h)	1013	40	16	67	2274	35	41
Number	2	12		1	6	3	18
Initial Q (Qb), veh	0	0		0	0	0	0
Ped-Bike Adj(A_pbT)		1.00		1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00		1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1900		1863	1863	1863	1863
Adj Flow Rate, veh/h	1078	56		80	2394	40	64
Adj No. of Lanes	3	0		1	3	1	1
Peak Hour Factor	0.94	0.71		0.84	0.95	0.88	0.64
Percent Heavy Veh, %	2	2		2	2	2	2
Cap, veh/h	3696	192		463	4270	100	89
Arrive On Green	0.75	0.75		0.04	0.84	0.06	0.06
Sat Flow, veh/h	5118	257		1774	5253	1774	1583
Grp Volume(v), veh/h	738	396		80	2394	40	64
Grp Sat Flow(s),veh/h/ln	1695	1817		1774	1695	1774	1583
Q Serve(g_s), s	8.5	8.5		1.1	17.1	2.6	4.8
Cycle Q Clear(g_c), s	8.5	8.5		1.1	17.1	2.6	4.8
Prop In Lane		0.14		1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2531	1357		463	4270	100	89
V/C Ratio(X)	0.29	0.29		0.17	0.56	0.40	0.72
Avail Cap(c_a), veh/h	2531	1357		579	4270	296	264
HCM Platoon Ratio	1.00	1.00		1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00		1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	4.9	4.9		3.0	2.9	54.7	55.7
Incr Delay (d2), s/veh	0.3	0.5		0.2	0.5	2.6	10.3
Initial Q Delay(d3),s/veh	0.0	0.0		0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.0	4.4		0.6	8.0	1.3	2.3
LnGrp Delay(d),s/veh	5.2	5.5		3.2	3.5	57.3	66.0
LnGrp LOS	A	A		A	A	E	E
Approach Vol, veh/h	1134				2474	104	
Approach Delay, s/veh	5.3				3.4	62.6	
Approach LOS	A				A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	11.2	96.1				107.3		12.7
Change Period (Y+Rc), s	6.5	6.5				6.5		6.0
Max Green Setting (Gmax), s	12.5	68.5				87.5		20.0
Max Q Clear Time (g_c+I1), s	3.1	10.5				19.1		6.8
Green Ext Time (p_c), s	0.1	48.9				56.1		0.2

Intersection Summary			
HCM 2010 Ctrl Delay			5.7
HCM 2010 LOS			A

Notes

User approved ignoring U-Turning movement.

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (veh/h)	79	1943	8	10	6	482	39	10	0	65	64	0
Number	5	2	12		1	6	16	3	8	18	7	4
Initial Q (Qb), veh	0	0	0		0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00		1.00		1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900		1863	1863	1900	1900	1863	1863	1900	1863
Adj Flow Rate, veh/h	86	2183	16		8	581	42	20	0	76	70	0
Adj No. of Lanes	1	3	0		1	3	0	0	1	1	0	1
Peak Hour Factor	0.92	0.89	0.50		0.75	0.83	0.92	0.50	0.92	0.86	0.92	0.92
Percent Heavy Veh, %	2	2	2		2	2	2	2	2	2	2	2
Cap, veh/h	678	3841	28		174	3510	252	195	0	149	136	7
Arrive On Green	0.04	0.74	0.74		0.01	0.72	0.72	0.09	0.00	0.09	0.09	0.00
Sat Flow, veh/h	1774	5208	38		1774	4844	348	1426	0	1583	887	72
Grp Volume(v), veh/h	86	1421	778		8	405	218	20	0	76	94	0
Grp Sat Flow(s),veh/h/ln	1774	1695	1856		1774	1695	1801	1426	0	1583	1287	0
Q Serve(g_s), s	1.4	22.7	22.7		0.1	4.5	4.5	0.0	0.0	5.5	7.2	0.0
Cycle Q Clear(g_c), s	1.4	22.7	22.7		0.1	4.5	4.5	1.5	0.0	5.5	8.8	0.0
Prop In Lane	1.00		0.02		1.00		0.19	1.00		1.00	0.74	
Lane Grp Cap(c), veh/h	678	2501	1369		174	2457	1305	195	0	149	174	0
V/C Ratio(X)	0.13	0.57	0.57		0.05	0.16	0.17	0.10	0.00	0.51	0.54	0.00
Avail Cap(c_a), veh/h	690	2501	1369		253	2457	1305	294	0	264	291	0
HCM Platoon Ratio	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00		1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	3.6	7.1	7.1		6.2	5.2	5.2	49.9	0.0	51.7	53.5	0.0
Incr Delay (d2), s/veh	0.1	0.9	1.7		0.1	0.1	0.3	0.2	0.0	2.7	2.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	10.8	12.1		0.1	2.1	2.3	0.6	0.0	2.5	3.2	0.0
LnGrp Delay(d),s/veh	3.7	8.1	8.8		6.3	5.3	5.4	50.1	0.0	54.4	56.1	0.0
LnGrp LOS	A	A	A		A	A	A	D		D	E	
Approach Vol, veh/h		2285				631			96			94
Approach Delay, s/veh		8.2				5.4			53.5			56.1
Approach LOS		A				A			D			E

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.7	95.0		17.3	9.2	93.5		17.3
Change Period (Y+Rc), s	6.5	6.5		* 6	4.5	6.5		6.0
Max Green Setting (Gmax), s	6.5	74.5		* 22	5.5	77.5		20.0
Max Q Clear Time (g_c+I1), s	2.1	24.7		10.8	3.4	6.5		7.5
Green Ext Time (p_c), s	0.0	34.0		0.6	0.0	42.4		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	10.4
HCM 2010 LOS	B

Notes

User approved ignoring U-Turning movement.

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	SBR
Lane Configurations	
Volume (veh/h)	22
Number	14
Initial Q (Qb), veh	0
Ped-Bike Adj(A_pbT)	1.00
Parking Bus, Adj	1.00
Adj Sat Flow, veh/h/ln	1900
Adj Flow Rate, veh/h	24
Adj No. of Lanes	0
Peak Hour Factor	0.92
Percent Heavy Veh, %	2
Cap, veh/h	31
Arrive On Green	0.09
Sat Flow, veh/h	329
Grp Volume(v), veh/h	0
Grp Sat Flow(s),veh/h/ln	0
Q Serve(g_s), s	0.0
Cycle Q Clear(g_c), s	0.0
Prop In Lane	0.26
Lane Grp Cap(c), veh/h	0
V/C Ratio(X)	0.00
Avail Cap(c_a), veh/h	0
HCM Platoon Ratio	1.00
Upstream Filter(I)	0.00
Uniform Delay (d), s/veh	0.0
Incr Delay (d2), s/veh	0.0
Initial Q Delay(d3),s/veh	0.0
%ile BackOfQ(50%),veh/ln	0.0
LnGrp Delay(d),s/veh	0.0
LnGrp LOS	
Approach Vol, veh/h	
Approach Delay, s/veh	
Approach LOS	

Timer

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	2022	460	39	0	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	2198	500	42	0	43

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	542	0	-	0	1400	271
Stage 1	-	-	-	-	521	-
Stage 2	-	-	-	-	879	-
Critical Hdwy	5.34	-	-	-	5.74	7.14
Critical Hdwy Stg 1	-	-	-	-	6.64	-
Critical Hdwy Stg 2	-	-	-	-	6.04	-
Follow-up Hdwy	3.12	-	-	-	3.82	3.92
Pot Cap-1 Maneuver	647	-	-	-	194	620
Stage 1	-	-	-	-	469	-
Stage 2	-	-	-	-	332	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	647	-	-	-	194	620
Mov Cap-2 Maneuver	-	-	-	-	194	-
Stage 1	-	-	-	-	469	-
Stage 2	-	-	-	-	332	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	11.2
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	647	-	-	-	620
HCM Lane V/C Ratio	-	-	-	-	0.07
HCM Control Delay (s)	0	-	-	-	11.2
HCM Lane LOS	A	-	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (veh/h)	67	1053	40	16	67	2309	32	35	0	41	68	0
Number	5	2	12		1	6	16	3	8	18	7	4
Initial Q (Qb), veh	0	0	0		0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00		1.00		1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900		1863	1863	1900	1900	1863	1863	1900	1863
Adj Flow Rate, veh/h	73	1120	56		80	2431	35	40	0	64	74	0
Adj No. of Lanes	1	3	0		1	3	0	0	1	1	0	1
Peak Hour Factor	0.92	0.94	0.71		0.84	0.95	0.92	0.88	0.92	0.64	0.92	0.92
Percent Heavy Veh, %	2	2	2		2	2	2	2	2	2	2	2
Cap, veh/h	189	3442	172		416	3674	53	214	0	173	139	8
Arrive On Green	0.04	0.69	0.69		0.04	0.71	0.71	0.11	0.00	0.11	0.11	0.00
Sat Flow, veh/h	1774	4961	248		1774	5166	74	1410	0	1583	791	69
Grp Volume(v), veh/h	73	765	411		80	1594	872	40	0	64	99	0
Grp Sat Flow(s),veh/h/ln	1774	1695	1819		1774	1695	1850	1410	0	1583	1151	0
Q Serve(g_s), s	1.4	10.7	10.7		1.5	30.7	30.9	0.0	0.0	4.5	7.5	0.0
Cycle Q Clear(g_c), s	1.4	10.7	10.7		1.5	30.7	30.9	3.1	0.0	4.5	10.6	0.0
Prop In Lane	1.00		0.14		1.00		0.04	1.00		1.00	0.75	
Lane Grp Cap(c), veh/h	189	2352	1262		416	2411	1315	214	0	173	178	0
V/C Ratio(X)	0.39	0.33	0.33		0.19	0.66	0.66	0.19	0.00	0.37	0.56	0.00
Avail Cap(c_a), veh/h	203	2352	1262		488	2411	1315	270	0	237	252	0
HCM Platoon Ratio	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00		1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.0	7.3	7.3		5.1	9.4	9.5	49.0	0.0	49.6	53.2	0.0
Incr Delay (d2), s/veh	1.3	0.4	0.7		0.2	1.4	2.6	0.4	0.0	1.3	2.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	5.1	5.6		0.7	14.6	16.5	1.2	0.0	2.0	3.4	0.0
LnGrp Delay(d),s/veh	13.3	7.6	8.0		5.3	10.9	12.1	49.4	0.0	50.9	55.9	0.0
LnGrp LOS	B	A	A		A	B	B	D		D	E	
Approach Vol, veh/h		1249				2546			104			99
Approach Delay, s/veh		8.1				11.1			50.4			55.9
Approach LOS		A				B			D			E

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	11.2	89.8		19.1	9.1	91.8		19.1
Change Period (Y+Rc), s	6.5	6.5		* 6	4.5	6.5		6.0
Max Green Setting (Gmax), s	9.5	73.5		* 20	5.5	79.5		18.0
Max Q Clear Time (g_c+I1), s	3.5	12.7		12.6	3.4	32.9		6.5
Green Ext Time (p_c), s	0.1	51.0		0.5	0.0	40.6		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	12.3
HCM 2010 LOS	B

Notes

User approved ignoring U-Turning movement.

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	SBR
Lane Configurations	
Volume (veh/h)	23
Number	14
Initial Q (Qb), veh	0
Ped-Bike Adj(A_pbT)	1.00
Parking Bus, Adj	1.00
Adj Sat Flow, veh/h/ln	1900
Adj Flow Rate, veh/h	25
Adj No. of Lanes	0
Peak Hour Factor	0.92
Percent Heavy Veh, %	2
Cap, veh/h	32
Arrive On Green	0.11
Sat Flow, veh/h	291
Grp Volume(v), veh/h	0
Grp Sat Flow(s),veh/h/ln	0
Q Serve(g_s), s	0.0
Cycle Q Clear(g_c), s	0.0
Prop In Lane	0.25
Lane Grp Cap(c), veh/h	0
V/C Ratio(X)	0.00
Avail Cap(c_a), veh/h	0
HCM Platoon Ratio	1.00
Upstream Filter(I)	0.00
Uniform Delay (d), s/veh	0.0
Incr Delay (d2), s/veh	0.0
Initial Q Delay(d3),s/veh	0.0
%ile BackOfQ(50%),veh/ln	0.0
LnGrp Delay(d),s/veh	0.0
LnGrp LOS	
Approach Vol, veh/h	
Approach Delay, s/veh	
Approach LOS	
Timer	

Intersection	
Int Delay, s/veh	0.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	1120	2320	35	0	44
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	1217	2522	38	0	48

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	2560	0	-	0	3028	1280
Stage 1	-	-	-	-	2541	-
Stage 2	-	-	-	-	487	-
Critical Hdwy	5.34	-	-	-	5.74	7.14
Critical Hdwy Stg 1	-	-	-	-	6.64	-
Critical Hdwy Stg 2	-	-	-	-	6.04	-
Follow-up Hdwy	3.12	-	-	-	3.82	3.92
Pot Cap-1 Maneuver	64	-	-	-	25	134
Stage 1	-	-	-	-	25	-
Stage 2	-	-	-	-	533	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	64	-	-	-	25	134
Mov Cap-2 Maneuver	-	-	-	-	25	-
Stage 1	-	-	-	-	25	-
Stage 2	-	-	-	-	533	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	46.1
HCM LOS			E

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	64	-	-	-	134
HCM Lane V/C Ratio	-	-	-	-	0.357
HCM Control Delay (s)	0	-	-	-	46.1
HCM Lane LOS	A	-	-	-	E
HCM 95th %tile Q(veh)	0	-	-	-	1.5

Movement	EBT	EBR	WBU	WBL	WBT	NBL	NBR
Lane Configurations							
Volume (veh/h)	2136	9	11	7	489	11	72
Number	2	12		1	6	3	18
Initial Q (Qb), veh	0	0		0	0	0	0
Ped-Bike Adj(A_pbT)		1.00		1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00		1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1900		1863	1863	1863	1863
Adj Flow Rate, veh/h	2400	18		9	589	22	84
Adj No. of Lanes	3	0		1	3	1	1
Peak Hour Factor	0.89	0.50		0.75	0.83	0.50	0.86
Percent Heavy Veh, %	2	2		2	2	2	2
Cap, veh/h	3970	30		158	4208	121	108
Arrive On Green	0.76	0.76		0.01	0.83	0.07	0.07
Sat Flow, veh/h	5375	39		1774	5253	1774	1583
Grp Volume(v), veh/h	1562	856		9	589	22	84
Grp Sat Flow(s),veh/h/ln	1695	1856		1774	1695	1774	1583
Q Serve(g_s), s	24.3	24.4		0.1	2.7	1.4	6.3
Cycle Q Clear(g_c), s	24.3	24.4		0.1	2.7	1.4	6.3
Prop In Lane		0.02		1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2585	1415		158	4208	121	108
V/C Ratio(X)	0.60	0.61		0.06	0.14	0.18	0.78
Avail Cap(c_a), veh/h	2585	1415		235	4208	296	264
HCM Platoon Ratio	1.00	1.00		1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00		1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	6.3	6.3		5.8	2.0	52.7	55.0
Incr Delay (d2), s/veh	1.1	1.9		0.1	0.1	0.7	11.2
Initial Q Delay(d3),s/veh	0.0	0.0		0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.7	13.1		0.1	1.3	0.7	3.1
LnGrp Delay(d),s/veh	7.3	8.2		5.9	2.1	53.4	66.2
LnGrp LOS	A	A		A	A	D	E
Approach Vol, veh/h	2418				598	106	
Approach Delay, s/veh	7.6				2.1	63.5	
Approach LOS	A				A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	7.8	98.0				105.8		14.2
Change Period (Y+Rc), s	6.5	6.5				6.5		6.0
Max Green Setting (Gmax), s	6.5	74.5				87.5		20.0
Max Q Clear Time (g_c+I1), s	2.1	26.4				4.7		8.3
Green Ext Time (p_c), s	0.0	36.5				53.1		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	8.5
HCM 2010 LOS	A

Notes

User approved ignoring U-Turning movement.

Movement	EBT	EBR	WBU	WBL	WBT	NBL	NBR
Lane Configurations							
Volume (veh/h)	1118	44	18	74	2511	39	45
Number	2	12		1	6	3	18
Initial Q (Qb), veh	0	0		0	0	0	0
Ped-Bike Adj(A_pbT)		1.00		1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00		1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1900		1863	1863	1863	1863
Adj Flow Rate, veh/h	1189	62		88	2643	44	70
Adj No. of Lanes	3	0		1	3	1	1
Peak Hour Factor	0.94	0.71		0.84	0.95	0.88	0.64
Percent Heavy Veh, %	2	2		2	2	2	2
Cap, veh/h	3671	191		422	4248	107	96
Arrive On Green	0.74	0.74		0.04	0.84	0.06	0.06
Sat Flow, veh/h	5117	258		1774	5253	1774	1583
Grp Volume(v), veh/h	814	437		88	2643	44	70
Grp Sat Flow(s),veh/h/ln	1695	1817		1774	1695	1774	1583
Q Serve(g_s), s	9.8	9.8		1.3	21.4	2.9	5.2
Cycle Q Clear(g_c), s	9.8	9.8		1.3	21.4	2.9	5.2
Prop In Lane		0.14		1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2514	1348		422	4248	107	96
V/C Ratio(X)	0.32	0.32		0.21	0.62	0.41	0.73
Avail Cap(c_a), veh/h	2514	1348		537	4248	296	264
HCM Platoon Ratio	1.00	1.00		1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00		1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	5.3	5.3		3.3	3.4	54.3	55.4
Incr Delay (d2), s/veh	0.3	0.6		0.2	0.7	2.5	10.1
Initial Q Delay(d3),s/veh	0.0	0.0		0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.6	5.1		0.6	10.1	1.5	2.6
LnGrp Delay(d),s/veh	5.6	5.9		3.5	4.1	56.8	65.5
LnGrp LOS	A	A		A	A	E	E
Approach Vol, veh/h	1251				2731	114	
Approach Delay, s/veh	5.7				4.1	62.2	
Approach LOS	A				A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	11.2	95.5				106.7		13.3
Change Period (Y+Rc), s	6.5	6.5				6.5		6.0
Max Green Setting (Gmax), s	12.5	68.5				87.5		20.0
Max Q Clear Time (g_c+I1), s	3.3	11.8				23.4		7.2
Green Ext Time (p_c), s	0.1	51.4				57.5		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	6.2
HCM 2010 LOS	A

Notes

User approved ignoring U-Turning movement.

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (veh/h)	38	2136	9	11	7	528	34	11	0	72	64	0
Number	5	2	12		1	6	16	3	8	18	7	4
Initial Q (Qb), veh	0	0	0		0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00		1.00		1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900		1863	1863	1900	1900	1863	1863	1900	1863
Adj Flow Rate, veh/h	41	2400	18		9	636	37	22	0	84	70	0
Adj No. of Lanes	1	3	0		1	3	0	0	1	1	0	1
Peak Hour Factor	0.92	0.89	0.50		0.75	0.83	0.92	0.50	0.92	0.86	0.92	0.92
Percent Heavy Veh, %	2	2	2		2	2	2	2	2	2	2	2
Cap, veh/h	642	3827	29		151	3598	208	196	0	152	136	7
Arrive On Green	0.03	0.74	0.74		0.01	0.73	0.73	0.10	0.00	0.10	0.10	0.00
Sat Flow, veh/h	1774	5207	39		1774	4918	285	1424	0	1583	870	76
Grp Volume(v), veh/h	41	1562	856		9	437	236	22	0	84	94	0
Grp Sat Flow(s),veh/h/ln	1774	1695	1856		1774	1695	1813	1424	0	1583	1270	0
Q Serve(g_s), s	0.7	27.2	27.2		0.2	4.8	4.8	0.0	0.0	6.1	7.2	0.0
Cycle Q Clear(g_c), s	0.7	27.2	27.2		0.2	4.8	4.8	1.7	0.0	6.1	8.9	0.0
Prop In Lane	1.00		0.02		1.00		0.16	1.00		1.00	0.74	
Lane Grp Cap(c), veh/h	642	2492	1364		151	2480	1326	196	0	152	174	0
V/C Ratio(X)	0.06	0.63	0.63		0.06	0.18	0.18	0.11	0.00	0.55	0.54	0.00
Avail Cap(c_a), veh/h	668	2492	1364		228	2480	1326	294	0	264	288	0
HCM Platoon Ratio	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00		1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	3.6	7.8	7.8		7.2	5.0	5.0	49.8	0.0	51.8	53.4	0.0
Incr Delay (d2), s/veh	0.0	1.2	2.2		0.2	0.2	0.3	0.2	0.0	3.1	2.6	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	13.0	14.6		0.1	2.2	2.5	0.7	0.0	2.8	3.2	0.0
LnGrp Delay(d),s/veh	3.6	9.0	10.0		7.4	5.1	5.3	50.1	0.0	54.9	56.0	0.0
LnGrp LOS	A	A	B		A	A	A	D		D	E	
Approach Vol, veh/h		2459				682			106			94
Approach Delay, s/veh		9.3				5.2			53.9			56.0
Approach LOS		A				A			D			E

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	7.8	94.7		17.5	8.2	94.3		17.5
Change Period (Y+Rc), s	6.5	6.5		* 6	4.5	6.5		6.0
Max Green Setting (Gmax), s	6.5	74.5		* 22	5.5	77.5		20.0
Max Q Clear Time (g_c+I1), s	2.2	29.2		10.9	2.7	6.8		8.1
Green Ext Time (p_c), s	0.0	35.3		0.6	0.0	48.9		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	11.2
HCM 2010 LOS	B

Notes
User approved ignoring U-Turning movement.
* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	SBR
Lane Configurations	
Volume (veh/h)	22
Number	14
Initial Q (Qb), veh	0
Ped-Bike Adj(A_pbT)	1.00
Parking Bus, Adj	1.00
Adj Sat Flow, veh/h/ln	1900
Adj Flow Rate, veh/h	24
Adj No. of Lanes	0
Peak Hour Factor	0.92
Percent Heavy Veh, %	2
Cap, veh/h	31
Arrive On Green	0.10
Sat Flow, veh/h	324
Grp Volume(v), veh/h	0
Grp Sat Flow(s),veh/h/ln	0
Q Serve(g_s), s	0.0
Cycle Q Clear(g_c), s	0.0
Prop In Lane	0.26
Lane Grp Cap(c), veh/h	0
V/C Ratio(X)	0.00
Avail Cap(c_a), veh/h	0
HCM Platoon Ratio	1.00
Upstream Filter(I)	0.00
Uniform Delay (d), s/veh	0.0
Incr Delay (d2), s/veh	0.0
Initial Q Delay(d3),s/veh	0.0
%ile BackOfQ(50%),veh/ln	0.0
LnGrp Delay(d),s/veh	0.0
LnGrp LOS	
Approach Vol, veh/h	
Approach Delay, s/veh	
Approach LOS	

Timer	

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	2224	507	39	0	40
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	2417	551	42	0	43

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	593	0	-	0	1539	297
Stage 1	-	-	-	-	572	-
Stage 2	-	-	-	-	967	-
Critical Hdwy	5.34	-	-	-	5.74	7.14
Critical Hdwy Stg 1	-	-	-	-	6.64	-
Critical Hdwy Stg 2	-	-	-	-	6.04	-
Follow-up Hdwy	3.12	-	-	-	3.82	3.92
Pot Cap-1 Maneuver	612	-	-	-	164	596
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	298	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	612	-	-	-	164	596
Mov Cap-2 Maneuver	-	-	-	-	164	-
Stage 1	-	-	-	-	438	-
Stage 2	-	-	-	-	298	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	11.5
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	612	-	-	-	596
HCM Lane V/C Ratio	-	-	-	-	0.073
HCM Control Delay (s)	0	-	-	-	11.5
HCM Lane LOS	A	-	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.2

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Volume (veh/h)	67	1162	44	18	74	2546	32	39	0	45	68	0
Number	5	2	12		1	6	16	3	8	18	7	4
Initial Q (Qb), veh	0	0	0		0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00		1.00		1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900		1863	1863	1900	1900	1863	1863	1900	1863
Adj Flow Rate, veh/h	73	1236	62		88	2680	35	44	0	70	74	0
Adj No. of Lanes	1	3	0		1	3	0	0	1	1	0	1
Peak Hour Factor	0.92	0.94	0.71		0.84	0.95	0.92	0.88	0.92	0.64	0.92	0.92
Percent Heavy Veh, %	2	2	2		2	2	2	2	2	2	2	2
Cap, veh/h	169	3423	172		378	3664	48	218	0	178	139	8
Arrive On Green	0.04	0.69	0.69		0.04	0.71	0.71	0.11	0.00	0.11	0.11	0.00
Sat Flow, veh/h	1774	4960	249		1774	5174	67	1408	0	1583	770	67
Grp Volume(v), veh/h	73	845	453		88	1753	962	44	0	70	99	0
Grp Sat Flow(s),veh/h/ln	1774	1695	1819		1774	1695	1851	1408	0	1583	1120	0
Q Serve(g_s), s	1.4	12.3	12.3		1.7	37.5	37.9	0.0	0.0	4.9	7.5	0.0
Cycle Q Clear(g_c), s	1.4	12.3	12.3		1.7	37.5	37.9	3.4	0.0	4.9	11.0	0.0
Prop In Lane	1.00		0.14		1.00		0.04	1.00		1.00	0.75	
Lane Grp Cap(c), veh/h	169	2339	1255		378	2401	1311	218	0	178	178	0
V/C Ratio(X)	0.43	0.36	0.36		0.23	0.73	0.73	0.20	0.00	0.39	0.56	0.00
Avail Cap(c_a), veh/h	183	2339	1255		449	2401	1311	270	0	237	248	0
HCM Platoon Ratio	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00		1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	19.9	7.7	7.7		5.4	10.6	10.6	48.8	0.0	49.5	53.1	0.0
Incr Delay (d2), s/veh	1.7	0.4	0.8		0.3	2.0	3.7	0.5	0.0	1.4	2.7	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	5.9	6.5		0.8	18.0	20.3	1.4	0.0	2.2	3.4	0.0
LnGrp Delay(d),s/veh	21.6	8.1	8.5		5.7	12.6	14.3	49.3	0.0	50.9	55.8	0.0
LnGrp LOS	C	A	A		A	B	B	D		D	E	
Approach Vol, veh/h		1371				2803			114			99
Approach Delay, s/veh		9.0				13.0			50.3			55.8
Approach LOS		A				B			D			E

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	11.2	89.3		19.5	9.1	91.5		19.5
Change Period (Y+Rc), s	6.5	6.5		* 6	4.5	6.5		6.0
Max Green Setting (Gmax), s	9.5	73.5		* 20	5.5	79.5		18.0
Max Q Clear Time (g_c+I1), s	3.7	14.3		13.0	3.4	39.9		6.9
Green Ext Time (p_c), s	0.1	53.5		0.5	0.0	37.0		0.7

Intersection Summary		
HCM 2010 Ctrl Delay		13.6
HCM 2010 LOS		B

Notes

User approved ignoring U-Turning movement.

* HCM 2010 computational engine requires equal clearance times for the phases crossing the barrier.

Movement	SBR
Lane Configurations	
Volume (veh/h)	23
Number	14
Initial Q (Qb), veh	0
Ped-Bike Adj(A_pbT)	1.00
Parking Bus, Adj	1.00
Adj Sat Flow, veh/h/ln	1900
Adj Flow Rate, veh/h	25
Adj No. of Lanes	0
Peak Hour Factor	0.92
Percent Heavy Veh, %	2
Cap, veh/h	32
Arrive On Green	0.11
Sat Flow, veh/h	283
Grp Volume(v), veh/h	0
Grp Sat Flow(s),veh/h/ln	0
Q Serve(g_s), s	0.0
Cycle Q Clear(g_c), s	0.0
Prop In Lane	0.25
Lane Grp Cap(c), veh/h	0
V/C Ratio(X)	0.00
Avail Cap(c_a), veh/h	0
HCM Platoon Ratio	1.00
Upstream Filter(I)	0.00
Uniform Delay (d), s/veh	0.0
Incr Delay (d2), s/veh	0.0
Initial Q Delay(d3),s/veh	0.0
%ile BackOfQ(50%),veh/ln	0.0
LnGrp Delay(d),s/veh	0.0
LnGrp LOS	
Approach Vol, veh/h	
Approach Delay, s/veh	
Approach LOS	
Timer	

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	0	1218	2561	35	0	44
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	-	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	1324	2784	38	0	48

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	2822	0	-	0	3333	1411
Stage 1	-	-	-	-	2803	-
Stage 2	-	-	-	-	530	-
Critical Hdwy	5.34	-	-	-	5.74	7.14
Critical Hdwy Stg 1	-	-	-	-	6.64	-
Critical Hdwy Stg 2	-	-	-	-	6.04	-
Follow-up Hdwy	3.12	-	-	-	3.82	3.92
Pot Cap-1 Maneuver	47	-	-	-	17	109
Stage 1	-	-	-	-	17	-
Stage 2	-	-	-	-	506	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	47	-	-	-	17	109
Mov Cap-2 Maneuver	-	-	-	-	17	-
Stage 1	-	-	-	-	17	-
Stage 2	-	-	-	-	506	-

Approach	EB	WB	SB
HCM Control Delay, s	0	0	61.6
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	47	-	-	-	109
HCM Lane V/C Ratio	-	-	-	-	0.439
HCM Control Delay (s)	0	-	-	-	61.6
HCM Lane LOS	A	-	-	-	F
HCM 95th %tile Q(veh)	0	-	-	-	1.9