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Senior Residential Development - Traffic Impact Study
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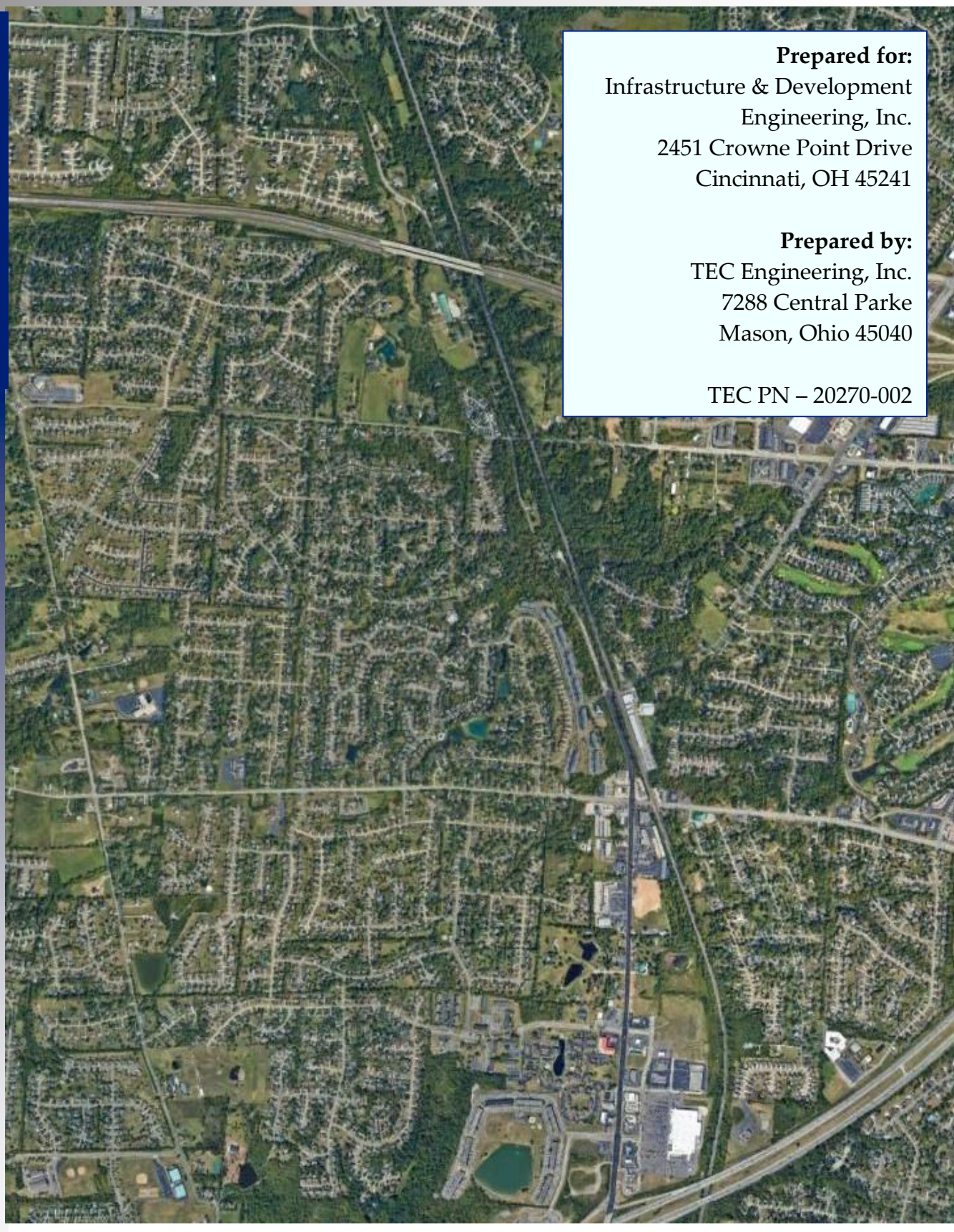

Prepared for:
Infrastructure & Development
Engineering, Inc.
2451 Crowne Point Drive
Cincinnati, OH 45241

Prepared by:
TEC Engineering, Inc.
7288 Central Parke
Mason, Ohio 45040

TEC PN – 20270-002

Traffic Impact Study

Hamilton Mason Road Development
Butler County, Ohio

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January 2021

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Table of Contents

Executive Summary

Purpose and Objectives

TEC Engineering, Inc. was retained by Infrastructure & Development Engineering Inc. to conduct a Traffic Impact Study for a proposed development on the south side of Hamilton Mason Rd., east of Maud Hughes Rd. in West Chester Township in Butler County, Ohio. The objective of this report is to document existing traffic conditions and patterns and evaluate the potential impacts of the proposed development on the surrounding transportation network.

Existing Conditions

Hamilton Mason Rd. is a 2-lane road, with a 45 MPH speed limit, that runs east and west along the northern edge of the proposed development.

Proposed Development

Traffic Analyses

TEC conducted Turning Movement Counts in February of 2020, a 2% growth rate was applied to these volumes to create the 2022 and 2042 volumes . Trips were generated using the *Institute of Transportation Engineers (ITE) Trip Generation Handbook*.

Using projected volumes and generated trips, a turn lane warrant was performed for the access points into the site. The following scenarios were analyzed:

- 2022 Build (AM & PM)
- 2042 Build (AM & PM)

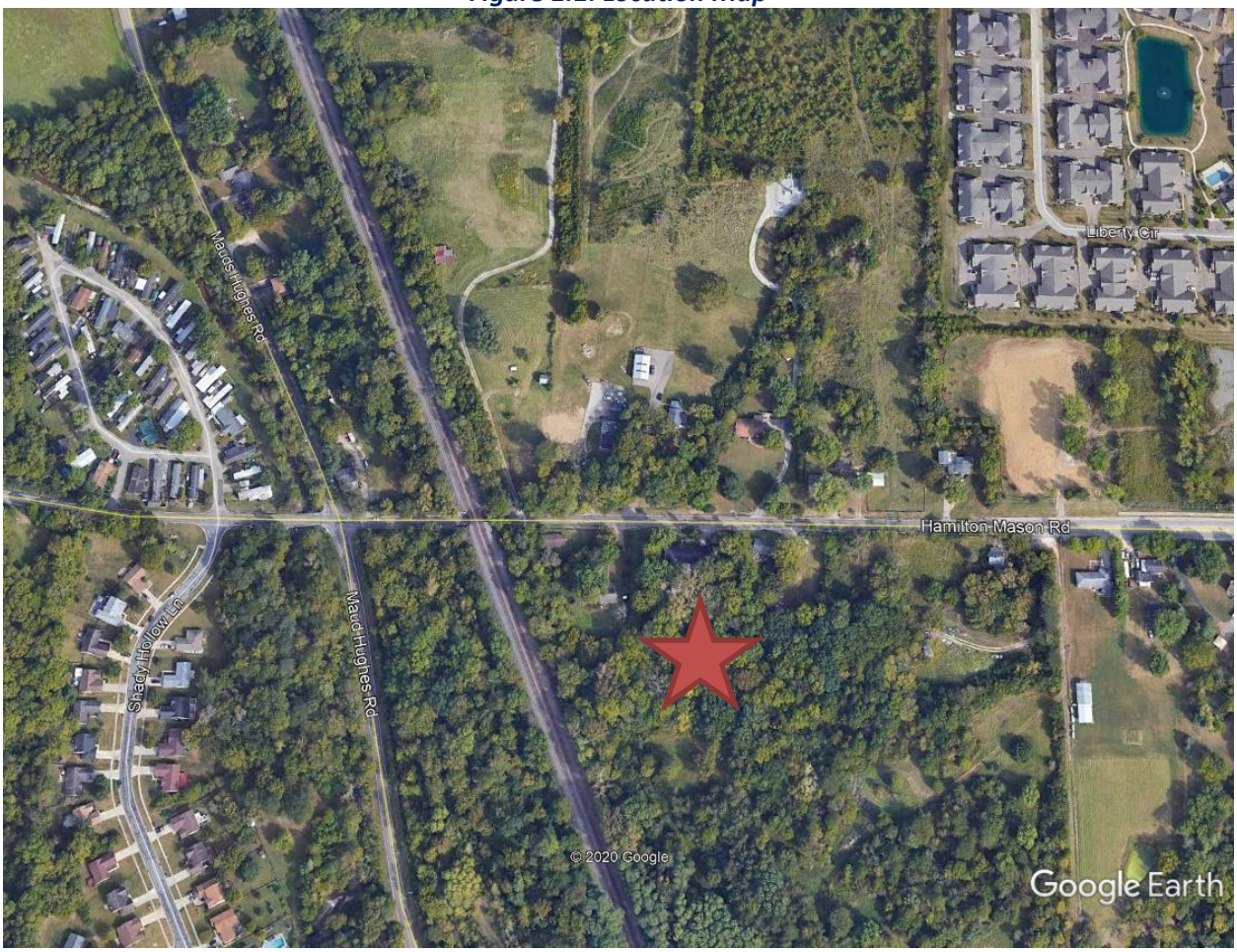
Conclusions and Recommendations

As a result of the study, TEC found that the proposed development did not produce a negative impact on the existing roadway network. There are no improvements required to the existing roadway. Turn lane warrants were not met, and given the small number of trips generated, capacity will not be an issue. The site access should be on the far west end of the site. Care should be taken when designing the profile of the development access to maximize sight distance for drivers exiting the development as well as drivers along Hamilton Mason Road.

1. Introduction

TEC Engineering, Inc. was retained by Infrastructure & Development Engineering Inc. to conduct a Traffic Impact Study for a proposed development on the south side of Hamilton Mason Rd. There is one access point proposed on the south side of Hamilton Mason Rd.

Figure 1.1: Location Map



General Layout

Hamilton Mason Rd. is a 2-lane road that is a Major Collector. Hamilton Mason Rd. has a speed limit of 45 MPH and carries approximately 6,326 vehicles per day. Maud Hughes Rd. is located to the west of the development.

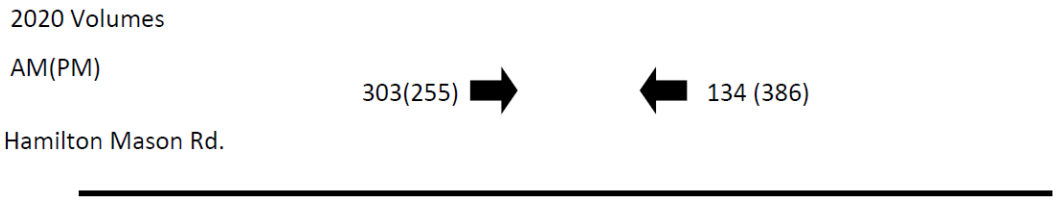
There was one intersection in the study that was analyzed for traffic impact. Using projected background traffic and generated trips, a turn lane warrant was conducted for the two intersections. The intersections are listed below:

- Hamilton Mason Road & Access

2. Background Traffic

TEC conducted Turning Movement Counts at Hamilton Mason Road & Maud Hughes in February of 2020. The peak hours were found to be 7:00-8:00 AM and 5:00-6:00 PM. Due to the recent changes in traffic due to Covid-19, the volumes for this report were calculated based on the turning movements from this adjacent intersection. The 2020 Volume is shown in Figure 2.1.

Figure 2.1: 2020 Traffic Counts



A straight-line growth rate of 2.0% per year was applied to the existing traffic volume data collected to account for traffic volume growth in the area while the site is being developed. The Existing, No Build and Build volumes are shown in *Section 4: Trip Distribution.* Existing volumes can be found in *Appendix B.*

3. Generated Traffic

Trips for Senior Adult Housing were generated based on details provided by the developer in conjunction with the *Institute of Transportation Engineers (ITE) Trip Generation Handbook*. This Handbook is the most widely accepted publication for projecting traffic volumes. Volume projections are based on specifics of the site usage. The trips generated by the proposed development site were projected using the trip generation rates and equations provided in the handbook. The dwellings will be attached units in groups of 2-6 units per building. Land use 252-Senior Adult Housing-Attached was found to best represent the development. The development size of the study locations for the "Attached" land use also better matches the development size of this development. The "Attached" study locations have an average of 148 units, while the LU-251 "Detached" lane use study locations have an average of 582 dwellings, so they are much larger developments overall.

Table 3.1: Trip Generation and Enter/Exit Distributions (Senior Adult Housing-Attached)

Land Use	Units	Quantity	Peak	Generation Rate	Total Trips	Enter %	Exit %	Entering Trips	Exiting Trips
Senior Adult Housing-Attached	Dwellings	120	AM	0.2x-0.18	23	35%	65%	8	15
			PM	0.25x+2.26	33	55%	45%	18	15

4. Trip Distribution

Before newly generated trips could be distributed throughout the network, existing 2020 traffic was projected based on 2.0% growth rate to form the "No Build" base for analysis. The projected 2022 traffic can be seen in *Figure 4.1.* The 2042 volumes are in *Figures 4.2*.

Figure 4.1: 2022 No Build Traffic

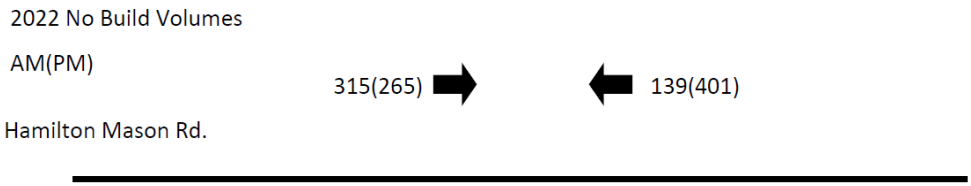
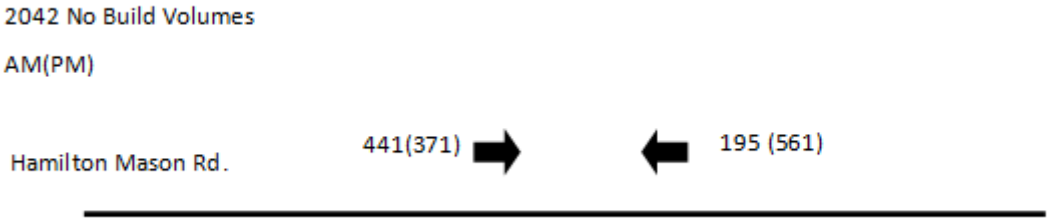


Figure 4.2: 2042 No Build Traffic



Before modeling all "build" traffic volumes, new trips were distributed based on existing traffic patterns. After determining distributions for new traffic. 2022 Build Volumes can be found in *Figures 4.5* and lastly 2032 Build Volumes can be found in *Figures 4.6*.

Figure 4.3: Trip Distribution %

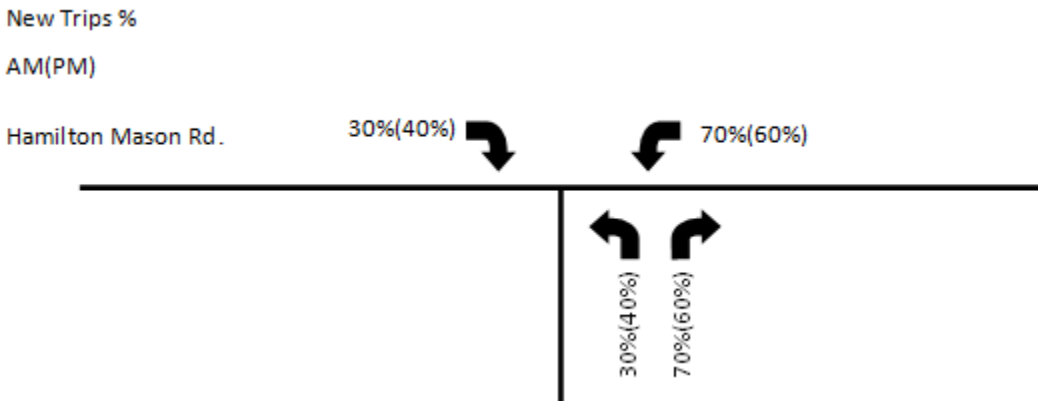


Figure 4.4: New Trips

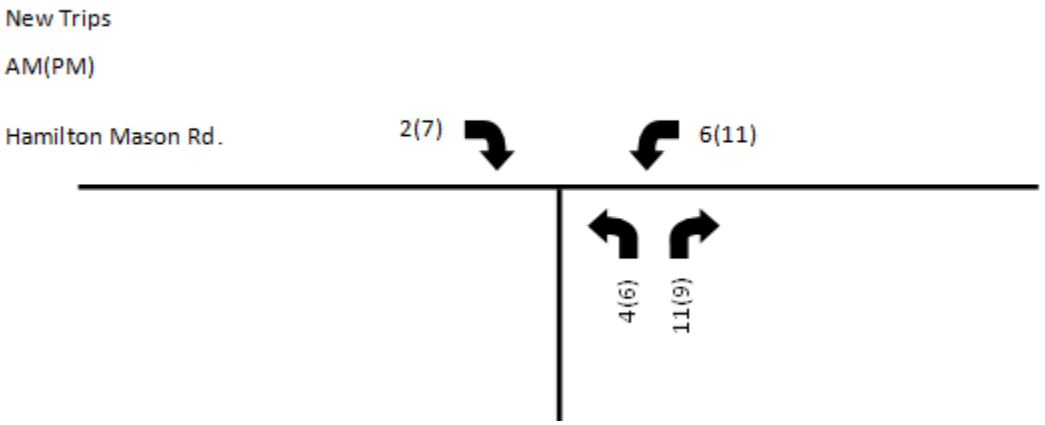


Figure 4.5: 2022 Build Volumes

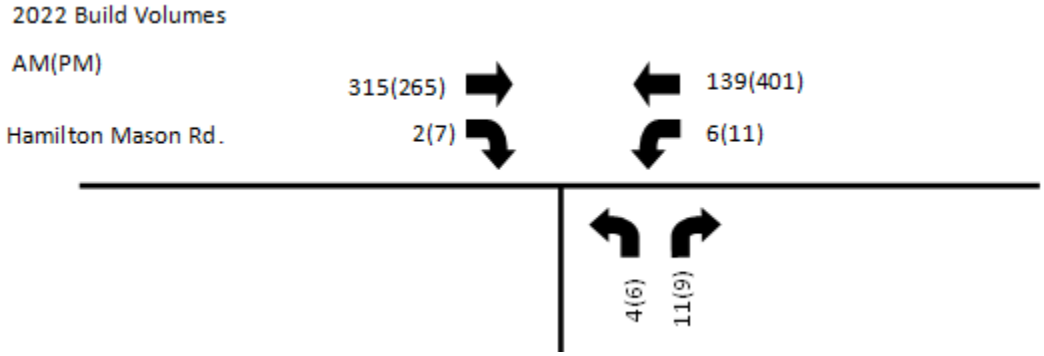
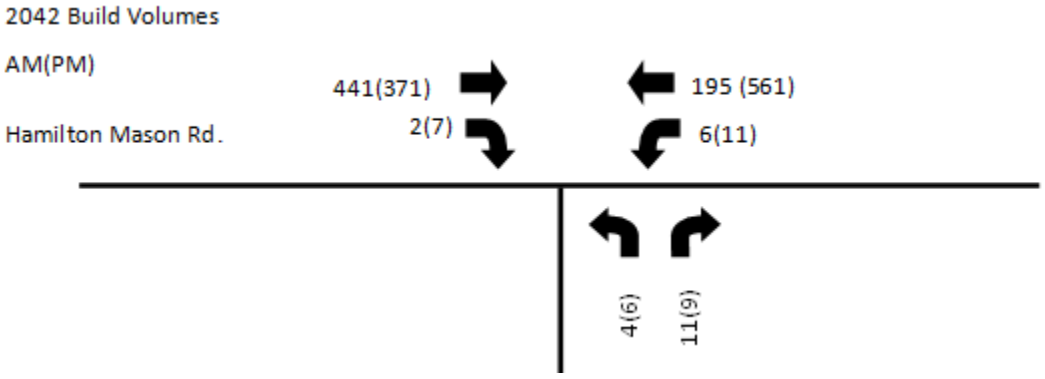


Figure 4.5: 2042 Build Volumes



5. Capacity Analysis

To determine any improvements necessary to accommodate the traffic generated by the proposed development, the following scenarios were compared and analyzed for all scenarios:

- 2022 AM/PM Build
- 2042 AM/PM Build

Capacity Analysis

TEC used the software program *HCS 7* to evaluate each scenario individually. The capacity analysis was performed using the existing conditions for both the "Build" and "No Build" scenarios. The Level of Service (LOS) for the intersection is directly related to the average total delay per vehicle. The total delay is the sum of control delay and queue delay. Control delay is the component of delay caused by the downstream control device and is calculated using the Percentile Delay Method. Queue delay is an analysis of the effects of queues and blocking on short links and short turning bays. LOS is defined in terms of delay and is a measure of driver discomfort and intersection performance with respect to vehicular capacity and quality of service provided to road users. Delay refers to total average stopped delay experienced by motorists at the referenced intersection. The level of service is classified into six different levels, ranging from A to F, and is detailed in *Table 5.1* for unsignalized intersections. Capacity analysis reports from *HCS 7* can be found in *Appendix C.*

Table 5.1: Unsignalized Intersection Level of Service Classifications

Level of Service	Description	Delay
A	Very low delay	<10 seconds per vehicle
B	Good progression	10-15 seconds per vehicle
C	Limit of acceptable delay	15-25 seconds per vehicle
D	Start of traffic breakdown	25-35 seconds per vehicle
E	High delay	35-50 seconds per vehicle
F	Congested conditions, unacceptable delay	>50 seconds per vehicle

All capacity analysis results can be found in *Tables 5.2.* All intersections were analyzed using "No Build" conditions and "Build" traffic volumes with existing roadway geometries.

Table 5.2: Delay & LOS

Hamilton-Mason Rd. & Access						
Peak	**Scenario**		**Westbound**		**Northbound**	
AM	**2022**	**Build**	0.4	A	10.8	B
	2042	**Build**	0.3	A	12.2	B
PM	**2022**	**Build**	0.3	A	12.0	B
	2042	**Build**	0.3	A	14.5	B

6. Warrants

Turn Lane Warrants

A turn lane warrant was performed to determine the need for a right turn lane or left turn lane on Hamilton Mason Road at the proposed site. The right turn warrant is based on the advancing volumes and the right turning volume. The left turn warrant is based on the advancing volume, the opposing volume, and the percentage of the advancing volume that is turning left. *Table 6.1* displays the results of the turn lane warrant. The warrant graphs are shown in figures 6.1 and 6.2. As a result of the turn lane warrant study, no turn lanes are required.

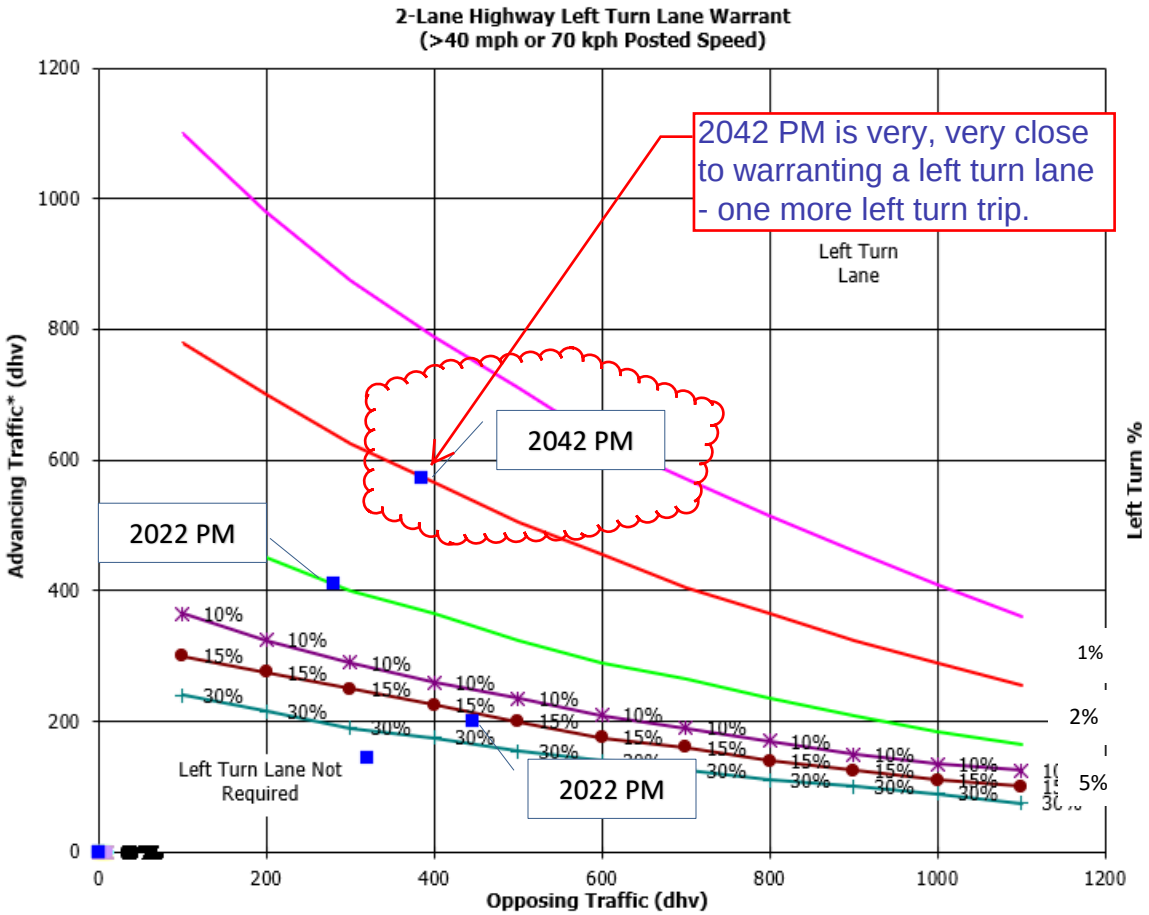
Table 6.1 Turn Lane Warrants

Warrant	Warrants?
WB Left Turn Lane	No
EB Right Turn Lane	No

Figure 6.1 WB Left Turn Lane

FIGURE B: 2-LANE HIGHWAY LEFT TURN LANE WARRANT
(>40 MPH OR 70 KPH POSTED SPEED)

Location	Advancing Traffic					Opposing Traffic			
	Left	Thru	Right	Total	% Left	Left	Thru	Right	Total
2022 AM	6	139	0	145	4.1%	0	315	5	320
2022 PM	11	401	0	412	2.7%	0	265	15	280
2042 AM	6	195	0	201	3.0%	0	441	5	446
2042 PM	11	561	0	572	1.9%	0	371	15	386
	0	0	0	0		0	0	0	0
	0	0	0	0		0	0	0	0
	0	0	0	0		0	0	0	0



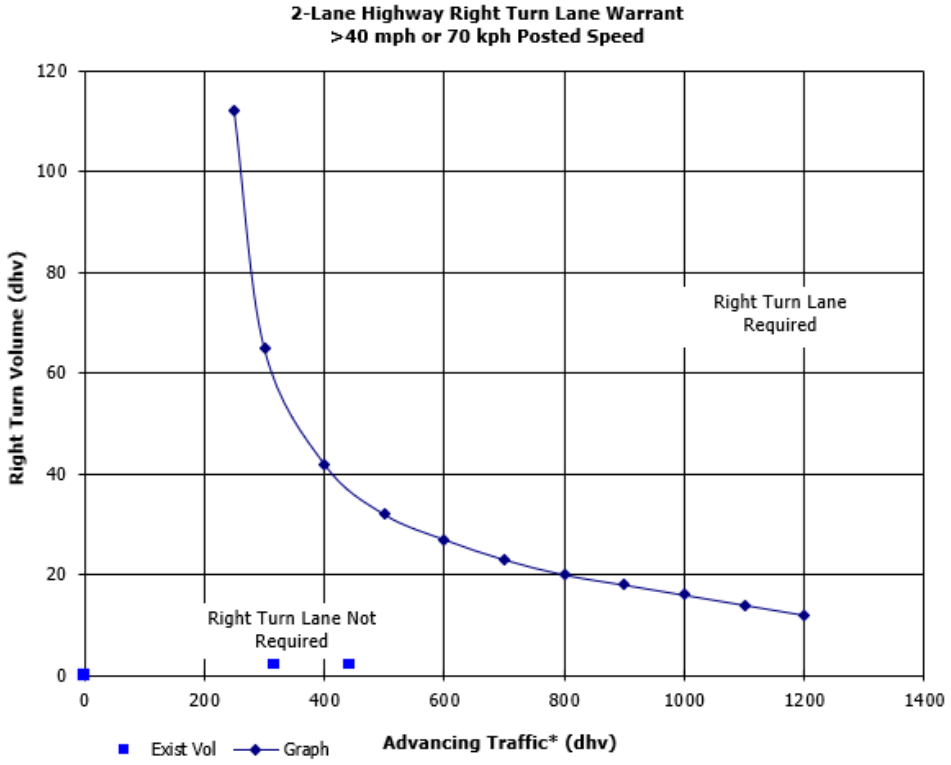
*Includes Left Turns

Is Left Turn Lane Warrant met? No

Figure 6.2 EB Right Turn Lane

2-LANE HIGHWAY RIGHT TURN LANE WARRANT
>40 MPH OR 70 KPH POSTED SPEED

Location	Right Turn Volume	Advancing Traffic			
	Right	Left	Thru	Right	Total
2022 AM	2	0	315	2	317
2022 PM	7	0	265	7	272
2042 AM	2	0	441	2	443
2042 PM	7	0	371	7	378
	0	0	0	0	0
	0	0	0	0	0
	0	0	0	0	0



*Includes Right Turns

Is Right Turn Lane Warrant met? NO

7. Sight Distance Study

A sight distance study was performed at the proposed entrances to the site. TEC evaluated site distance at several points along Hamilton Mason Road. TEC performed a sight distance study to determine the intersection sight distance (ISD) at several points along the property also comparing these values to the stopping sight distance (SSD). Intersection sight was measured from 10-15' from the edge of pavement. This was not possible at some locations due to the brush. Since the brush will be removed with the development, sight lines blocked by brush were not excluded from the study. In these locations, where the brush or fences made this impossible to get the full 15' from the pavement, engineering judgement was used to determine if the sight distance would be the same from the point further back. The original study was done using the intersection sight triangle method with a 4.25' height of object and 3.5' height of eye.

To clarify: The original study was not redone with correct 3.5' height of eye.

As seen in the figure below, points A, B and C were provided by the client. Point D was determined to be the point on the east half of the site with the optimal sight distance. This location does not meet intersection sight distance in either direction.

Figure 7.1 Sight Distance Study Points

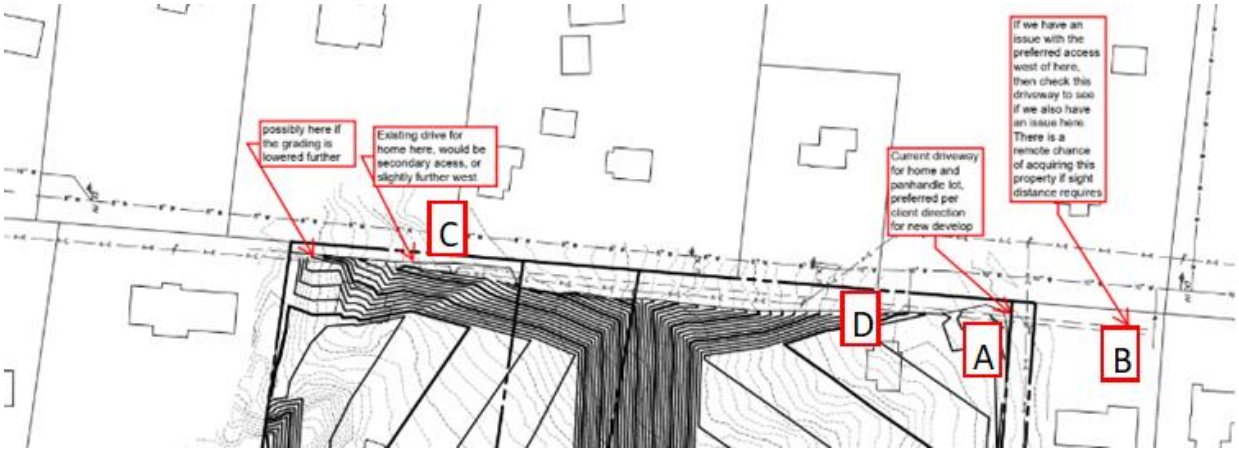


Table 7.1 AASHTO Required Sight Distance

Design Speed	ISD	SSD
35 mph	390'	250'
40 mph	445'	305'
45 mph	500'	360'

Table 7.2 Measured Intersection Sight Distance

Location	Looking Left (to the west)	Looking Right (to the east)	Meets ISD 45mph
A - Preferred Driveway Location	166'	386'	No
B - Preferred Driveway further East	212'	353'	No
C - Secondary Access Point	500'+	430'	No
D - Optimal Sight Distance 99' West of Location A	374'	336'	No

Of the measured points, Point C on the west end of the site has the best sight distance.

TEC also reviewed stopping sight distance at Locations A and B. This is the distance along Hamilton Mason Road where a "car" exiting the access is visible to a driver along Hamilton Mason Road or a vehicle waiting to left into the development form Hamilton Mason Road.

Table 7.3 Measured Stopping Sight Distance

Location	From the West	From the East	Meets SSD 45mph
A - Preferred Driveway Location	298'	290'	No/No
B - Preferred Driveway further East	305'	360'	No/Yes

The table above shows the stopping sight distance to see a 2' object, or the height of a taillight on a typical vehicle, in the road.

Since the original access locations did not meeting the 500' Intersection Sight Distance additional study was needed. IDE determined another possible driveway location shown as shown in Figure 7.2. This study was completed with a 3.5' height of object to meet ODOT L&D requirements.

Figure 7.2 Secondary Sight Distance Study Points

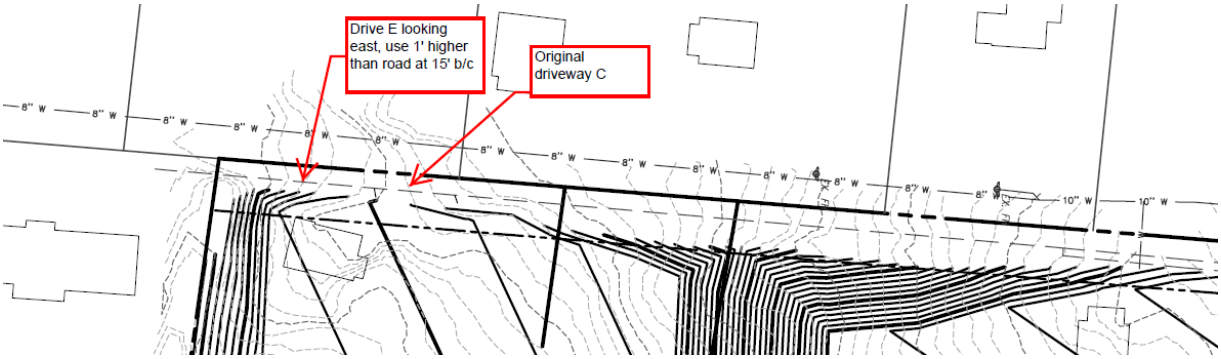


Table 7.4 Measured Intersection Sight Distance

Please provide a distance reference of preferred drive at "far west end". Location	Looking Left (to the west)	Looking Right (to the east)	Meets ISD 45mph
E – far West Driveway Location	573’	532’	YES

Stopping sight distance was also confirmed for the new location. Stopping sight distance was greater than 400’ in both directions.

Based on this study, the new location on the far west end of the site is the preferred location for the access.

8. Conclusions & Recommendations

As a result of the study, TEC found that the proposed development did not produce a negative impact on the existing roadway network. There are no improvements required to the existing roadway. Turn lane warrants were not met, and given the small number of trips generated, capacity will not be an issue. The access should be located on the far west end of the site. Care should be taken when designing profile of the development access to maximize sight distance for drivers exiting the development as well as drivers along Hamilton Mason Road.

The TIS is approved with conditions:
1. Prior to CO, submit a more detailed sight distance study with field survey using actual design of proposed driveway to confirm adequate sight distance is achieved.

Matthew J. Loeffler

Digitally signed by Matthew J. Loeffler
DN: cn=Matthew J. Loeffler, o=BCEO, ou, email=loefflerm@bceo.org, c=US
Date: 2021.02.09 15:32:45 -05'00'

Appendix

HCS7 Two-Way Stop-Control Report

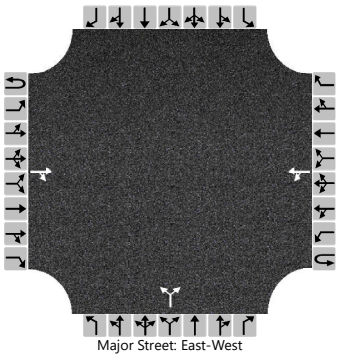
General Information

Analyst	
Agency/Co.	
Date Performed	11/17/2020
Analysis Year	2022
Time Analyzed	AM BUILD 2022
Intersection Orientation	East-West
Project Description	

Site Information

Intersection	Hamilton Mason Rd & Acces
Jurisdiction	
East/West Street	Hamilton Mason Rd.
North/South Street	Access
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume (veh/h)			315	2		6	139			4		11				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized																
Median Type | Storage						Undivided										

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						7					16					
Capacity, c (veh/h)						1209					639					
v/c Ratio						0.01					0.03					
95% Queue Length, Q_{95} (veh)						0.0					0.1					
Control Delay (s/veh)						8.0					10.8					
Level of Service (LOS)						A					B					
Approach Delay (s/veh)						0.4				10.8						
Approach LOS										B						

HCS7 Two-Way Stop-Control Report

General Information

Analyst	
Agency/Co.	
Date Performed	11/17/2020
Analysis Year	2022
Time Analyzed	PM BUILD 2022
Intersection Orientation	East-West
Project Description	

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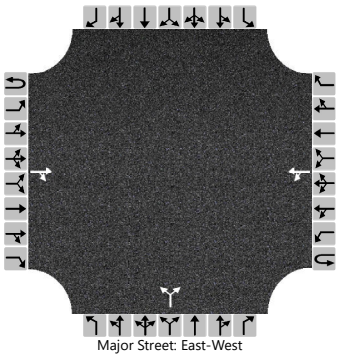

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume (veh/h)			265	7		11	401			6		9				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized																
Median Type | Storage						Undivided										

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
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Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						12					16					
Capacity, c (veh/h)						1260					532					
v/c Ratio						0.01					0.03					
95% Queue Length, Q_{95} (veh)						0.0					0.1					
Control Delay (s/veh)						7.9					12.0					
Level of Service (LOS)						A					B					
Approach Delay (s/veh)						0.3				12.0						
Approach LOS										B						

HCS7 Two-Way Stop-Control Report

General Information

Analyst	
Agency/Co.	
Date Performed	11/17/2020
Analysis Year	2042
Time Analyzed	AM BUILD 2042
Intersection Orientation	East-West
Project Description	

Site Information

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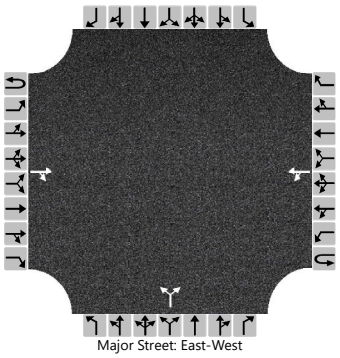
Jurisdiction	
East/West Street	Hamilton Mason Rd.
North/South Street	Access
Peak Hour Factor	0.92
Analysis Time Period (hrs)	0.25

Lanes



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Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume (veh/h)			441	2		6	195			4		11				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized																
Median Type | Storage	Undivided															

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Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						7					16					
Capacity, c (veh/h)						1076					519					
v/c Ratio						0.01					0.03					
95% Queue Length, Q_{95} (veh)						0.0					0.1					
Control Delay (s/veh)						8.4					12.2					
Level of Service (LOS)						A					B					
Approach Delay (s/veh)					0.3				12.2							
Approach LOS					B											

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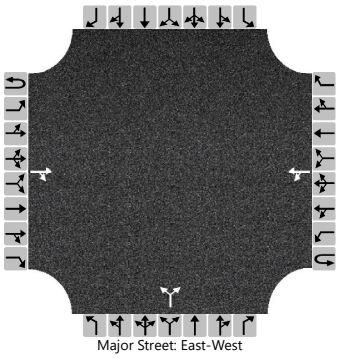

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Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	0	1	0	0	0	1	0		0	1	0		0	0	0
Configuration				TR		LT					LR					
Volume (veh/h)			371	7		11	561			6		9				
Percent Heavy Vehicles (%)						3				3		3				
Proportion Time Blocked																
Percent Grade (%)										0						
Right Turn Channelized																
Median Type | Storage						Undivided										

Critical and Follow-up Headways

Base Critical Headway (sec)						4.1				7.1		6.2				
Critical Headway (sec)						4.13				6.43		6.23				
Base Follow-Up Headway (sec)						2.2				3.5		3.3				
Follow-Up Headway (sec)						2.23				3.53		3.33				

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						12					16					
Capacity, c (veh/h)						1143					394					
v/c Ratio						0.01					0.04					
95% Queue Length, Q_{95} (veh)						0.0					0.1					
Control Delay (s/veh)						8.2					14.5					
Level of Service (LOS)						A					B					
Approach Delay (s/veh)						0.3				14.5						
Approach LOS										B						